Journal of Anatomical Sciences

Email:anatomicaljournal@gmail.com

J Anat Sci 10 (2)

Facial Anthropometry Among Hausa Ethnic Group in Tarauni Local Government Area of Kano State, Nigeria

[1]Umar MI, [2]Musa Bayi, [2]Adamu LH.
[1]Human Anatomy Department, Federal University Dutse, Jigawa state
[2]Anatomy Department, Bayero University, Kano

Corresponding Author: Umar MI
E-mail: mikaumar.muk@gmail.com; +2348034520566

ABSTRACT
The morphology of the human face varies with individuals and even more with races and ethnic group. The study was aimed at to ascertain the variations of facial anthropometry among Hausa ethnic group at Tarauni local government, Kano state using the facial linear dimensions. The objectives of the study are to determine the sexual dimorphism in facial linear distances and also to find out the correlation between facial linear dimensions and ages in males and females among the study population. A total of 400 subjects comprising 250 males and 150females age range 18–30 years participated. A 2D Photographs method was used to carry out the study. Independent sample t-test was used to test for the variations in the variables between the opposite sexes. The results showed that there were significant differences $P < 0.05$ between males and females in all the facial linear distances with the exception of right orbital length and left orbital length while for the correlation of the facial dimensions and ages in males and females, No significant correlation was observed with the exception of mouth width and nasal length where significant correlation $P<0.05$ exist in only females and found to be negative and it implies that the distances decreases with age advancement. In conclusion, the sex of an individual of Hausa ethnic group of Tarauni local government can be determined using facial linear dimensions.

Keywords: Facial anthropometry, age, sexual dimorphism, Hausa population

INTRODUCTION
The morphology of the human face varies with individuals and even more with races and ethnic group. The identification of aesthetic facial qualities began with ancient civilizations such as Egyptians and Greeks, who captured their ideals of facial beauty in art form.[1] Population studies contain a quantitative record of the average facial characteristics that exist for different ethnic groups.[2,3] This type of information makes possible analysis of the differences in facial proportions amongst the ethnic groups. It was hypothesized that certain facial features have more inter-ethnic variability than others.[2] It is well known that a single facial esthetics is not appropriate for application to diverse ethnic groups.[4,5]

Facial traits are largely influenced by factors such as age, sex, ethnicity, culture and environment among others.[6] Therefore, the precise prediction of biological sex, age and ancestry is a necessity for the recognition of unknown human remains in forensic investigations.[7] Understanding the variation of facial features of different ethnic populations is critical in preserving the ethnic identity of individuals while pursuing the ideal facial characteristics.

Several researches[8,9] were carried out on facial profiles of different ethnic groups but there lack of data on facial anthropometry of Hausa ethnic group especially using 2D facial image analyses. Most of the studies on Hausa population[10] were either among the Hausa population of Nigeria or Kano state with no attempt on Hausa population in a specific local government in the Kano metropolis such as Tarauni local government using the 2D method of anthropometry. The morphology of the human face varies with individuals and even more with races and ethnic group. So this brought the need to find out the variation upon facial parameters particularly among Hausa population at Tarauni local government. Also to provide a reference data for individual identification for people living in Tarauni local government. In Nigeria particularly among Hausa ethnic group there is lack of sufficient data for which the forensic identification of individual from this tribe can be made. Hence, facial proportion receives less attention among Hausa ethnic group. Even among other population, the anthropological approach to establishing the relationship is often neglected. The objectives of the study were (i) to determine the sexual dimorphism in facial linear distances and (ii) to find out the correlation between facial linear dimensions and ages in males and females, among Hausa population at Tarauni local government.

MATERIALS AND METHODS

Study Area: Language has been used over time as one of the markers of ethnic differentiation. This ethnic group is located on a large scale in the Sahelian areas of the Northern Nigeria and the southeastern Niger and spread across other African countries. The study was conducted in Tarauni local government which is one of the local governments of the Kano state, Nigeria.

Subjects: The subjects for the study were indigene of Tarauni local government of Kano state comprising of 400 (males 250 and 150 females).

Using $n = \frac{Z^2Pq}{d^2}$ [11]

Where, n= minimum sample size
Z= standard normal deviation (±1.96) 95%
P= prevalence of target study 50% (0.5)
q= 1-P (1-0.5=0.5)
d= standard error = 0.05

by substitution, $n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384.16$

This was rounded up to 400

The following subjects are included in the research:-

- Subjects must be within Tarauni local government
- Hausa/ fulani tribe
- They are within the age range of 18-30 years
- Physically fit person with no deformity

The following subjects are excluded in the research:-

- None Hausa/ fulani ethnic groups
- Subjects from other geographical region other than Tarauni local government
- Subjects below the age of 18 years or above 30 years of age (this were excluded to control the confounding effect of aging on the facial measurements).
- Subjects with deformity, inflammation , or any kind of pathological changes

Before the commencement of the research (measurement), the explanations of the procedure as well as the intended use of the research were properly addressed to the subjects and their consent for the participation was obtained.

Vernier Caliper Measurement: Measurements of facial parameters were first taken using the vernier caliper (Neiko 01407A, China) for the purpose of determining a factor. The factor is obtained by dividing the actual size measurement with actual pixel measurement which was used in the face Art software in maintaining the real size measurement from the photography.

Facial Photographing: Photography of the subjects was taken using Olympus digital camera which was set to a desirable settings and mounted on the tripod stand (WT3750, China).The mounted camera was then standardized to a distance of 100cm between it and the subject by considering the centre of gravity of the Tripod stand and the chair on which the subjects sat using measuring tape. Also the camera was adjusted according to the height of the subject. To obtain the photographs (frontal) the individuals were asked to sit and looked directly at the camera in front of them, keeping upright and normal posture with both arms free along the body and removed anything that may interfere with the photography.[12,13,14] Identification of the subject number was written on masking tape using permanent marker which was placed close to the subject's head. The photography was then preceded and each point in time the identification number of the individuals was placed.[10]

Figure 1: Facial photographing

Image Processing: The images were transferred to an android phone (P5W Gionee) for the purpose of resizing them. The resized images were then uploaded to a personal computer (HP Windows 8) and stored for processing and analyses. The measurement of the facial distances was carried out using the face-Art software which was installed and the results of the measurements were produced in Excel form.

Anatomical Facial Landmarks: Fifteen facial land marks were used as per the previous study. [3,15,16]
Table 1: Facial landmarks and their anatomical description.

S/N	Landmarks	Abbr.	Anatomical description
1	Alar	Al	Most lateral point of the nasal wings
2	Endocanthion	en	Inner corner of the eye fissure at the meeting point of eyelids
3	Exocanthion	ex	Outer corner of the eye fissure at the meeting point of eyelids
4	Glabella	g	Most prominent point in the median sagittal plane
5	Gnathion	gn	Lowest point on the lower border of the chin, in the midline
6	Gonion	go	Midpoint of the mandibular angle
7	Labiale superious	Ls	Midpoint of the upper vermilion line
8	Labiale inferious	Li	Midpoint of the lower vermilion line
9	Nasion	N	The middle point of the nasofrontal suture
10	Zygoma	zy	Most lateral point on the zygomatic arch
11	Trachion	Tr	The midpoint of the hair line at the top of forehead
12	Subnasale	sn	Junction between the lower border of the nasal septum with cutaneous portion of the upper lip, in the midline
13	Stomion	sto	Midpoint of the mouth orifices
14	Palpebrale superious	ps	Upper eyelid center
15	Palpebrale inferious	pi	Lower eyelid center

Facial Linear Distances Measured
The facial linear distances were obtained as the distance measured between one anatomical land mark to another. The Table 2 illustrates the facial linear distances.

Table 2: Linear dimensions with their corresponding landmarks

S/N	Facial Linear distance	Landmarks
1	Special facial height	en-gn
2	Forehead height II	tr-n
3	Nose length	n-sn
4	Lower face height	sn-gn
5	Forehead height I	tr-g
6	Special upper face height I	g-sn
7	Inter ocular distance	en-en
8	Nasal width	al-al
9	Philtrum length	sn-ls
10	Upper facial width	zy-zy
11	Lower facial width	go-go
12	Mouth height	ls-li
13	Mouth width	ch-ch
14	Orbital width	ex-en
15	Orbital length	ps-pi
16	Right orbital width	ex1_en1
17	Left orbital width	ex2_en2

Statistical Analysis: The data were expressed in mean and ±SD (descriptive analysis).The facial linear distances of the sexes were compared using independent sample *t*-test. The tests for the correlation of facial linear dimensions and ages in both sexes were analyzed using the Pearson's correlation. The statistical analysis of the study was performed using SPSS statistic version 20.0 and values of $P < 0.05$ were considered as the level significant.

RESULTS

Table 3 shows descriptive statistics of the facial linear distances. The minimum and maximum ages are 18 and 30years respectively. The mean of special facial height was 104 ± 8.64, fore head height II was 70.41 ± 7.58, nose length was 43.03 ± 4.49, lower face height was 65.04 ± 6.92, forehead height I was 51.29 ± 6.42, special upper face I was 85.52 ± 8.46, inter ocular distance was 30.37 ± 3.79, nasal width was 43.71 ± 4.00, upper facial width was 119.85 ± 10.83, the lower facial width was 10.22 ± 2.18, mouth height was 108.33 ± 10.35, the philtrum length was 28.01 ± 3.41, mouth width was 50.13 ± 4.52, right orbital length was 16.90 ± 2.29, left orbital length was 16.72 ± 2.23.

Table 3: Descriptive statistics of the facial linear dimensions and ages of the study population

	Landmarks	Minimum	Maximum	Mean ± SD
Age	-	18	30	23.15 ± 2.56
Special facial height	en-gn	79.52	123.31	104.9 ± 8.64
Forehead height II	tr-n	50.59	89.57	70.41 ± 7.58
Nasal length	n-sn	28.1	56.64	43.03 ± 4.49
Lower face height	sn-gn	44.77	81.97	65.04 ± 6.92
Forehead height I	tr-g	33.03	66.69	51.29 ± 6.42
Special upper face height	g-sn	65.61	106.54	85.52 ± 8.46
Inter ocular distance	en-en	22.77	45.54	30.79 ± 3.79
Nasal width	al-al	33.4	56.62	43.71 ± 4.00
Upper facial width	zy-zy	95.39	150.68	119.85 ±10.83
Philtrum length	sn-ls	4.03	17.56	10.22 ± 2.18
Lower facial width	go-go	84.67	139.21	108.33 ±10.35
Mouth height	ls-li	17.47	38.47	28.01 ± 3.41
Mouth width	ch-ch	38.43	63.07	50.13 ± 4.52
Right orbital length	ps1_pi1	11.21	23.63	16.9 ± 2.29
Left orbital length	ps2_pi2	12.03	23.62	16.72 ± 2.23
Right orbital width	ex1_en1	23.15	41.35	31.98 ± 3.08
Left orbital width	ex2_en2	21.28	33	47.46 ± 3.50

Table 4 shows variation in horizontal and vertical facial linear distances between the sexes. There was significant difference between males and females horizontal linear distances (P<0.001). In all the horizontal linear dimensions males tend to have higher mean values with the exception of right orbital width (ex1-en1) and left orbital width (ex2-en2) where their mean values tend to be higher in females. A significant difference between sexes in special facial height (en-gn), forehead height II (tr-n), nasal length (n-sn), lower face height (sn-gn), forehead height I (tr-g), special upper face height I (g-sn), philtrum length (sn-ls), mouth height (ls-li) were observed. However, no significance (P > 0.05) variations exist between males and females in right orbital length (ps1-pi1) and left orbital length (ps2-pi2). In all the vertical linear dimensions males tend to have higher mean values than females.

Table 4: variation in horizontal facial linear distances between males and females

	Landmarks	Male	Female		
Variables (mm)	Sex	Mean ± SD	Mean ± SD	t	P value
Special facial height	en-gn	107.69 ±7.29	98.63 ± 8.30	7.734	<0.001
Forehead height II	tr-n	71.42 ± 7.02	68.06 ± 8.36	2.928	0.004
Nasal length	n-sn	43.80 ± 4.22	41.24 ± 4.62	3.826	0.002
Lower face height	sn-gn	66.90 ± 5.98	60.68 ± 7.08	6.381	<0.001
Forehead height I	tr-g	52.02 ± 6.20	49.57 ± 6.67	2.514	<0.001
Sspecial upper face height I	g-sn	87.54 ± 7.62	80.78 ± 8.53	5.554	<0.001
Philtrum length	sn-ls	10.65 ± 2.05	9.24 ± 2.20	4.356	<0.001
Mouth height	ls-li	28.82 ± 3.13	26.11 ± 3.33	5.500	<0.001
Right orbital length	ps1_pi1	16.95 ± 2.28	16.81 ± 2.33	0.368	0.713
Left orbital length	ps2_pi2	16.89 ± 2.14	16.33 ± 2.41	1.652	0.103
Inter ocular distance	en-en	31.54 ± 3.89	29.03 ± 2.93	4.486	<0.001
Nasal width	al-al	44.63 ± 3.68	41.55 ± 3.92	5.31	<0.001
Upper facial width	zy-zy	122.81 ± 9.80	112.73 ± 9.89	6.659	<0.001
Lower facial width	go-go	110.94 ± 9.41	101.50 ± 9.47	6.501	<0.001
Mouth width	ch-ch	51.00 ± 4.31	48.10 ± 4.38	4.345	<0.001
Right orbital width	ex1_en1	30.49 ± 2.73	32.80 ± 3.53	-3.677	<0.001
Left orbital width	ex2_en2	31.60 ± 2.59	84.76 ± 4.84	-1.494	<0.001

Table 5 shows a correlation of vertical facial linear distances in males and females with age. No significant correlation was observed with the exception of nasal length (n-sn) where significant correlation (P<0.05) exist in females. However, the correlation tends to be negative. No significant correlation was observed horizontal distances with the exception of mouth width (ch-ch) where significant correlation (P<0.05) exist in females. However, the correlation tends to be negative.

Table 5: Pearson's correlation between the facial vertical and horizontal linear distances and ages

		Age (Male)	Age (Female)
Variables	Landmarks	r	R
Special facial height	en-gn	0.086	-0.043
Forehead height II	tr-n	0.108	-0.167
Nose length	n-sn	-0.097	-0.276*
Lower face height	sn-gn	0.071	0.081
Forehead height I	tr-g	0.029	-0.081
Special upper face height I	g-sn	0.013	-0.112
Philtrum length	sn-ls	0.102	0.17
Mouth height	ls-li	-0.037	-0.026
Orbital length	ps1_pi1	-0.049	0.029
Orbital length	ps2_pi2	0.092	-0.009
Inter ocular distance	en-en	0.03	-0.103
Nasal width	al-al	0.057	0.046
Upper facial width	zy-zy	0.121	-0.052
Lower facial width	go-go	0.165	-0.006
Mouth width	ch-ch	-0.028	-0.288*
Right orbital width	ex1_en1	0.005	-0.034
Left orbital width	ex2_en2	-0.007	0.005

* $P < 0.05$, r= correlation coefficient

DISCUSSION

It has been noted that in the field of facial anthropometry, Farkas and coauthors had compiled the single most comprehensive survey of ethnic groups from multiple regions around the world.[8] However, despite this all-inclusive approach, the global range of variation for each facial measurement was not well documented.[2] The appearance of the face, the most variable part of the human body, is influenced by age, sex, race, ethnicity, culture and environment among others.[6] However, the purpose of conducting the present study is to ascertain the variations of facial anthropometry among Hausa ethnic group at Tarauni local government, Kano state.

There were significant differences between males and females in all the facial linear distances with the exception of right orbital length and left orbital length. In line with the present findings, it was reported that certain facial features show no sexual dimorphism while others the differences were in favor of females or males.[17] In this study the right and left orbital width were significantly higher in females while for the other horizontal linear dimensions like the nasal width, mouth width, upper facial width, lower facial width and inter ocular distance were significantly higher in males than females. The vertical facial linear distances were significantly higher in males than in females. The facial linear dimension that sexual dimorphism does not exist are the right and left orbital lengths and this can be suggested that certain facial regions have less proportionate developmental processes with other body parts, as such they are less influenced by intrinsic factors of the body.[10]

In another context similar to our present study, males tend to have significantly higher mean value in most of the facial variables.[18,19] This may indicate that females were, in general, having smaller faces than males.[18]

This also to supports the idea that males have an averagely larger body size and proportion compared to females which is also manifesting in certain regions of the face. In the establishment of sex dimorphism, a significant difference has been reported in most of the measurements of facial linear dimensions except the upper face width and forehead height.[20] A review of the literature on facial features of five principal population groups (European, African, East Asian, South Asian, Native American) have shown that among the facial features that presented with the largest differences between the different groups was the forehead height.[2, 21]

It was reported that according to Zhuang *et al.*[22] with every increase in body height, there is a significant increase in some facial dimensions such as face width, nasal root breadth, and nose breadth as well as a

significant decrease in other variables such as bigonial breadth. This study has analyzed the facial metrics with respect to age of the study population. Some of the facial features show an increase in the metric value while some decreases with age.

Also with regards to different populations, among the Turkish adults, the mean value of the some facial parameters such as nasal height in males was similar to Chinese. [23] and American Caucasians mean values. [3] For a female, the mean nose length was the same as in Malaysian Indian.[24] But it is longer than the nose length of American Caucasian female. [3] The nasal width of the present study was less than that of other studies but very close to that of American Caucasians. In another comparison, it was reported that African-Americans had significantly different face length and lip length from Caucasians, Hispanics, and the other ethnic groups. Moreover, face width of African-Americans, Hispanics, and others was all significantly different from the Caucasian race group. All of which are different from the Hausa population of the present study. Another contrast research was observed in Inter-ethnic variability among the facial variables from a review comprising 27 different ethics populations of five principal racial groups (European, African, East Asian, South Asian, Native American) showed that the lowest level of variation was in the upper face widths, outer canthal distance along with the lower face width. The forehead height was observed to have the greatest degree of variation.

It is well known that face is one of the first lines of identity of the different populations due to the significantly marked differences between them. But from, the ongoing discussion it can be deduced that the variation usually affects the horizontal distances more than the vertical which is contrast to the study conducted in Kano. [10] This may also correlate with differences in the horizontal body proportion compared to the vertical ones. It is also a fact that environmental factors such as ultra-violet radiation stimulate the synthesis of vitamin D, a precursor in the process of bone formation. As such individuals leaving in areas with higher exposure to ultra-violet rays (such as areas near the equator) will tend to be longer (vertical body proportion) and probably higher vertical facial proportion. Of course, other factors such as nutrition, adaption to the environment, genetic makeup can't be excluded as factors responsible for inter-ethnic variation and sexual dimorphism among the different populations.[10]

The sexual dimorphism shows that the upper and lower facial widths can be use in the prediction of sex among the study population. Other variables that will add to the prediction were special upper face height I, special face height, nasal width, nose length, inter ocular distance, forehead height I, forehead height II, mouth width and orbital width. With regards to correlation of the facial dimensions with age in males and females, No significant correlation was observed with the exception of mouth width and nose length where significant negative correlation exist only in females which implies that the distances decreases as age advances. However, because the age affects the naso-oral region it may be due to softness of the associated organs.

CONCLUSION

Sexual dimorphism was observed in all the facial linear distances with the exception of right orbital length and left orbital length. No significant correlation was observed with the exception of mouth width and nasal length where significant negative correlation exists in only females. The facial anthropometry may hold potential in sex discrimination among individual of Hausa ethnic group in Tarauni local government of Kano state Nigeria. Hence, the used of facial linear distance in sex determination may recommended among Hausa population of the Tarauni local government. Similar study is needed to explore the facial of the facial dimensions in sex determination in children and elderly.

Conflict of interest: None declare
Funding: None

REFERENCES

1. Peck, H. and Peck, S. A. Concept of facial esthetics. *Angle Orthodontontics* 1970; 40(4):284–318.
2. Fang, F., Clapham, P.J. and Chung, K.C. A Systematic review of interethnic variability in facial dimensions. *Plastic Reconstruction Surgery*, 2011; 127(2):874–81.
3. Farkas, L.G. Anthropometry of the head and face. *2nd press*. New York, *Raven pres.* 1994; 2(233):102-106.
4. Moyers, R. Handbook of Orthodontics. *III Mosby*, *Chicago*, 1988; pp. 67
5. Wuerpel, E. On facial balance and harmony. *Angle orthod*. 1936; 7, 81–89.
6. Mandall, N.A., McCord, J.F., Blinkhor, A.S., Worthington, H.V. and O'Brien, K.D. Perceived asthetics impact of malo-occusion and oral selfperceptions in 14-15yrs old Asian and Caucasian children in Greater Manchester. *Europeans Journals of Orthodontics.* 2000; 21(40):175–183.
7. Kranioti, E.F., Garcia-Donas, J.G. and Langstaff, H. Sex estimation of the Greek mandible with the aid of discriminant function analysis and posteriorprobabilities. *Romans Journal of Legal Medicin.* 2014; 22(43):101–104.
8. Farkas, L.G, Katic, M.J. and Forrest, C.R. International anthropometric study of facial morphology in various ethnic groups/races. *Journal of Craniofacial Surgery*, 2005; 3(16):615–646.
9. Ferrario ,V.F., Sforza, C., Schmitz, J.H., Ciusa, V.,

and Colombo, A. Normal growth and development of the lipsa 3-dimensional study from 6 years to adulthood using a geometric model. *Journal of Anatomy.* 2000; *2* (*19*6):415–23.
10. Adamu, L.H., Ojo, S.A., Danborno,B., Adebisi, S.S. and Taura, M.G. Sex determination using facial linear dimensions and angles among Hausa population of Kano state, Nigeria. *Egyptian Journal of Forensic Sciences.* 2016; *6, 459–467*
11. Lwanga S.K. and Lemeshow, S. Sample size determination in health studies; *a* practical manual, World Health Organization, Geneva, 1991; 10.
12. Ferrario VF, Sforza C, Mianim A, Tartaglia G. Craniofacial morphometry by photografic evaluations. Am J Orthod Dentofacial Orthop 1993;103:327–37.
13. Moorrees CF. Natural head position - a revival. Am J Orthod Dentofacial Orthop 1994;105: 512–513.
14. Morosini AC, Peron APLM, Correia KR, Moresca R. Study of face pleasantness using facial analysis in standardized frontal photographs. Dental Press J Orthod 2012;17(5):24–34.
15. Porter JP, Olson KL. Anthropometric facial analysis of the African American woman. Arch Fac Plast Surg 2001;3:191–7.
16. Gibelli D, Mapelli A, Obertova` Z, Poppa P, Gabriel P, Ratnayake M, et al. Age changes of facial measurements in European young adult malesImplications for the identification of the living. HOMO – J Comp Hum Biol 2012; 63:451–8.
17. Karaca, O., Gu¨ lcen, B., Kus,_ M.A., Elmalı, F., and Kus,_ I. Morphometric facial analysis of Turkish adults. *Balikesir Saglik Bil Derg* . 2012; 2(1):20-40.
18. Zhuang, Z., Guan, J., Hsaio, H. and Bradtmiller, B. Evaluating the representativeness of the LANL respirator fit test panels for the current U.S. civilian workers. *International Socual and Respiratory Protectives.* 2004; 6 (21):83-93.
19. Sforza, C., Grandi, G., Catti, F., Tommasi, D.G., Ugolini, A. and Ferrario, V.F. Age- and sex-related changes in the soft tissues of the orbital region. *Forensic Sciences International.* 2009; 185, 115e1–115e8.
20. Porter, J.P. "The average African American male face: an anthropometric analysis," *Archives of Facial Plastic Surgery*. 2004; 6(2):78–81.
21. Van, de, Graaff, K.M. Human Anatomy, 6th ed. *McGraw-Hill*, New York.Vij, K. (2005). Textbook of Forensic Medicine and Toxicology – Principles and Practice, 3rd ed. *Elsevier, Missouri,* 2001; pp. 50–104.
22. Zhuang, Z., Landsitte, D., Benson, S., Roberge, R. and Shaffer, R. Facial anthropometric differences among gender, ethnicity, and age groups. *Annals of Occupational Hygiene*. 2010; 6(54): 391–402.
23. Aung, S.C., Foo, C.L. and Lee ,S.T. Three dimensional laser scan assessment of the oriental nose with a new classification of oriental nasal types. *British Journal of Plastic Surgery*. 2000; 3(53): 109–116.

Ngeow, W.C. and Aljunid, S.T. Craniofacial anthropometric norms of Malaysian Indians. *Indian Journal of Dental Researches.* 2009; 3(20):313–319.