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Comparison of Facial Parameters Based on Levels of Masculinity and Femininity of Adult Hausa Male Taxi and Tricycle Drivers in Kano, Nigeria

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ABSTRACT

Several studies have demonstrated that the face that contains a combination of highly feminine and masculine characteristics may obtain a score that recommends average masculinity in the other racial division, but whether this is true for the African population is not yet known. Therefore, the aim of the present study is to determine frequency distribution of masculinity and femininity levels of each facial parameter and to find out the best facial parameter that discriminate facial masculinity and femininity of the study population. Four hundred and two (402) subjects were selected from two associations in Kano State, Nigeria [Tsaya da Kafarka Taxi Drivers Association and Tricycle Operators Association Kano (TOAKAN)], using random sampling methods. The age range of the participants was between 18-50 years. Photographic methods were used to capture the face to measure the facial distance. Facial masculinity and femininity were derived from facial distances (captured image face). The present study established the base line data of frequency distribution of masculinity and femininity levels of facial parameters of the study population of Hausa ethnic origin. It was observed that facial parameter that best differentiated the level of masculinity and femininity was nose width per interpupillary distance (al1_al2: ipd: %).

Keywords: facial masculinity, facial femininity, frequency distribution

INTRODUCTION

Faces of human encompass a number of signs, for instance identity, emotional expression, age, gender, ethnicity, attractiveness, personality traits and others[1]. The face form, the most flexible part of the human body, is affected by age, sex, race and ethnicity[1]. Surgical modification of craniofacial anatomic structures depends on knowledge of the craniofacial norms of the patient's ethnic groups[2]. The study of specific facial constructions of patients is requisite for surgeons when planning maxillofacial and reconstructive surgery[3]. Number of facial features have been affected by testosterone. High level of testosterone-to-oestrogen (T/E) ratio in juvenile males is expected to facilitate the lateral growth of the cheekbones, the forward growth of the bones of the eyebrow ridges, mandibles, chin, and the lengthening of the lower face result to a more robust face shape, on the other hand the influence of oestrogen (E) results to a more gracile facial shape with high eyebrows, less robust jaws and fuller lips[4]. Brow ridges and lower jaw is motivated by androgens[5] and fullness of lip parallels E-dependent fat deposits elsewhere on the female body[6]. Masculinity is anticipated to be related to males' exposure to testosterone (T) during puberty period. Contact to T during development produces numerous changes in the male body, such as the rise of secondary sexual characteristics and greater development in musculoskeletal system. Males' nervous system is also involved[7]. Acquaintance with T induces both their physical appearance[8] and human male behaviour[9]. Facial width-to-height ratio, is one of sexual dimorphism of the face that was independent of body size, from a morphometric analysis of skulls. Males and females were established to have different growth trajectories that diverge at puberty for bi-zygomatic width and not for upper facial height, resulting in a width-to-height facial dimorphism (a larger ratio in men than in women) that is independent of sex difference and increased body size[10].

Certain measure of facial masculinity based on a single trait is the eye-mouth-eye (EME) angle. Some researcher discuss that EME is a sexually dimorphic trait, significantly smaller in males[11], even though this sexual dimorphism has also been questioned[12]. Facial characteristics can indicate the different effects of hormone exposure during the pre-natal period and of real chromosomal gender, and can be used to understand characteristic differences and classify a person as "masculine" or "feminine" and the consequences of perceptions and choice of partner[13]. Feminine features are connected with greater oestrogen in females. Similarly, in women, femininity

may also be linked to fertility through an association with oestrogen[14]. A face with a combination of extremely masculine and feminine characteristics may obtain a mark that suggests average masculinity. This was based on the fact that men and women differ in localized face shape at several regions, nevertheless particularly at the lower jaw[15, 16]. A study proposed a combination of highly masculine and feminine traits are found attractive[17]. The aim of present research is to determine frequency distribution of masculinity and femininity levels of each facial parameter and to determine the best facial parameter that discriminate facial masculinity and femininity of the study population.

MATERIALS AND METHODS

Study area

The study was conducted among one of the largest ethnicity in the West African population, the Hausa ethnicity in Kano State, Nigeria, which is the most populated state in Nigeria, with a population of 9,383,682 million people. The city area of the State covers 137 km^2 and comprises six local government areas (LGAs), Kano Municipal, Fagge, Dala, Gwale, Tarauni and Nassarawa with population of 2,163,225 at the 2006 Nigerian census. The main people of the city are Hausa people[18].

Study design

The study employed a prospective cross sectional approach.

Sample size determination

Sample size was determined using the formula developed by Cochran[19] as shown below;

$$n = \frac{Z^2pq}{d^2}$$

where:

n = desired sample size

Z = confidence level (How confident the actual mean falls within your confidence interval) 1.96 at 95%

p = How much variance expected in the responses 50%

q = 1 – p,

d = degree of precision/ margin of error which is 5%.

$$\mathbf{n} = \frac{Z^2pq}{d^2} = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384$$

The minimum sample size needed for the study was 384

Study Subjects

The population was made up of commercial drivers within the urban area of the State. Four hundred and two (402) subjects were selected from the two association in Kano state [Tsaya da Kafarka Taxi Drivers Association and Tricycle Operators Association Kano (TOAKAN)], using random sampling methods. The participants' age range was between 18-50 years. Participants who reported injuries to the face (including face anomalies, deformities, scars, or inflammation), or non - Hausa ethnic groups and non-commercial drivers were excluded from the study. Before the commencement of the research, ethical approval was provided by the Ethical Committee of the College of Health Science Bayero University Kano at Aminu Kano Teaching Hospital, Kano. Informed consents were obtained from the participants.

Facial photographing

The photographic set up consists of a tripod supporting a digital camera. To obtain the photographs (frontal), individuals were asked to sit and look directly at the camera in front of them[20] keeping an upright and normal posture, with both arms free along the body. This position corresponds to the Broca's Natural Head Position[21, 22, 23, 24]. Each participant was asked to relax with both hands hanging beside the trunk. The participants were positioned on a line marked on the floor. The participants were photographed at 1.00 m and in front of a standard white background with a Nikon D40 digital camera, while posing in a neutral facial expression[23, 24]. The subjects had to look into the lens of the camera with their lips relaxed so that the front view profile was taken in the natural head position before every recording. The operator ensured that the subjects' forehead, neck and ear were clearly visible and their lip in repose. Before capturing the face, the operator ensured that the participant's forehead, neck, and ears were clearly visible during the process[25]. After the images were captured, they were downloaded to a computer for processing and analyses.

Facial Analyses

The facial images captured were imported into a software, bio-analyser. Each image contained explicit

identification code. The arrangement of images were in a serial number of the frontal image. The facial image was showed in the picture space. The facial landmarks were placed in the corresponding points. The present facial distances were measured automatically in a fraction of a minute by the bio-analyser.

Facial Measures of Masculinity and Femininity

The facial measures of masculinity and femininity used in the present study:

1. Facial width to upper face height ratio (fWHR): This was measured as a ratio of the distance between left and right zygions (bizygomatic width) and upper facial height (a distance between nasion and prosthion) (Figure 1) [26, 28].

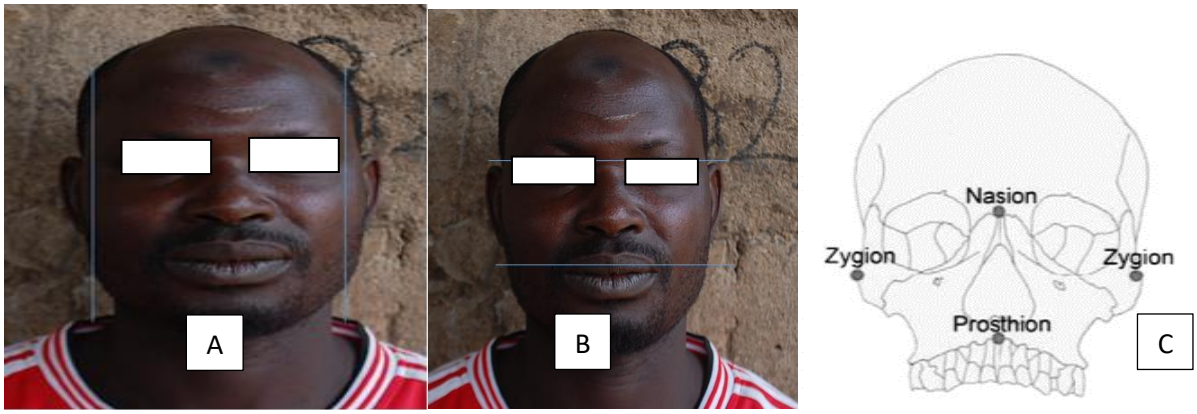

Figure 1: Upper Facial Height and Width with their Associated Landmarks[26]

Key: A= Facial Width B= Special Face Height C= Facial Width Height Ratio

2. Eye-Mouth-Eye (EME) Angle: This was measured with the apex in the middle of the mouth and the arms crossing the centres of pupils (Figure 2). The right part of the EME angle was measured between the line that started in the middle of the mouth and ended in the middle of the right pupil and a facial midline defined by two anthropological points, stomion (middle of the mouth) and nasion. Similar with the line that ended in the middle of the left pupil, the left part of the EME angle was also measured. The total EME angle was measured as angle formed by the two arms at the vertex[11, 28].

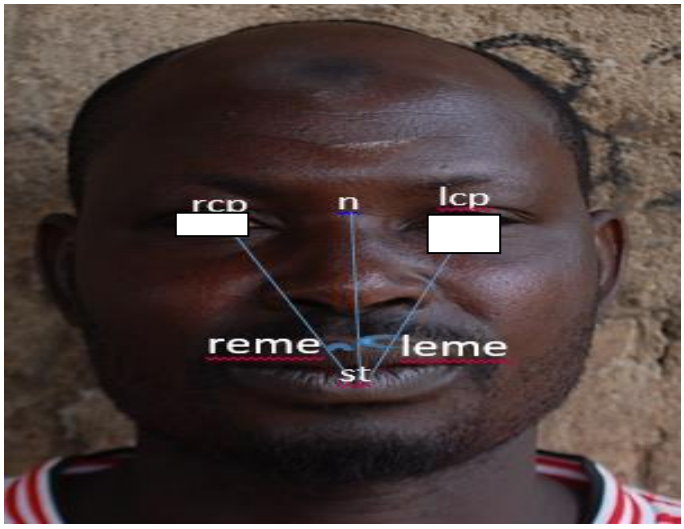

Figure 2: Eye–Mouth–Eye Angle Divided for Left and Right Part[11].

Key: rcp: right centre of the pupil, lcp: left centre of the pupil, reme: right eye- mouth eye angle

leme: left eye- mouth-eye angle, st: stomium, n: nasion

3. Upper Lip Height (ULh), Lower Lip Height (LLh) and Nose Width (Nw): These measurements were expressed as percentage of interpupillary distance (which is a distance measured from the centre of the right pupil to the centre of the left pupil.). The upper lip height was determined as the vertical distance between the stomion and the labiale superius, and lower lip height as the vertical distance between the stomion and the labiale inferius. Nose width was measured as the horizontal distance between the left and right alares (Figure 3) as reported in previous studies[27, 28].

Figure 3: Upper Lip Height (ULh), Lower Lip Height (LLh) and Nose Width (Nw)[27]..

Key:

al: alare, st: stomion, ls: labiale superior, li: labial inferior

4. Index I: This was determined as the sum of special face length/face height and cheek-bone prominence (Figure 4). The special face length (SFH) was measured as a distance from the pupils (corresponding to nasion) to the tip of the chin (gnathion) as a proportion of the total face length (FH). Cheek-bone prominence was calculated as a ratio of the width of the face at cheek- bone (bizygomatic width) (UFW) divided by the width of the face at the level of the mouth (bigonion) (LFW) [28, 29].

$$\textbf{Index I} = (\textbf{SFH}/\textbf{FH}) + (\textbf{UFW}/\textbf{LFW}) \quad [28, 29]$$

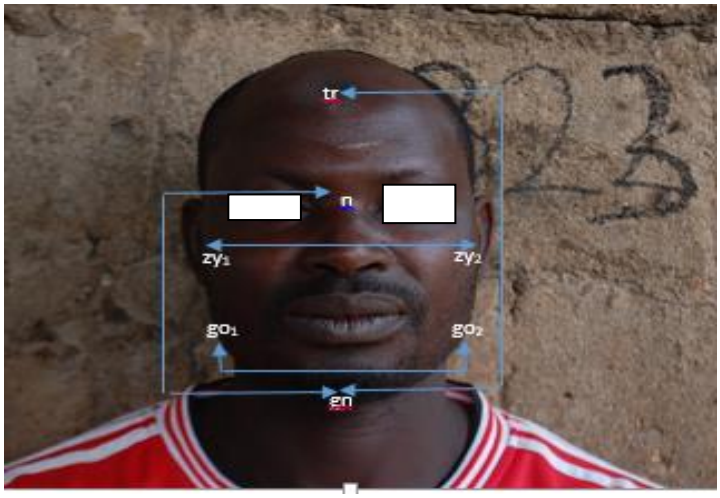

Figure 4: Special Face Length/Face Height and Cheek-Bone Prominence[28, 29].

Key: SFH: Special face height, FH: Face height, UFW: Upper face width, LFW: Lower face width

n: Nasion, gn: Gnathion, zy: Zygion, go: Gonion, tr: Trachion

5. Index II: This was determined as sum of eye length, special face height/face height and cheekbone prominence, face width/special face height and mean eyebrow length (Figure 5), all of them divided by interpupillary distance. The eye length (EL) was measured by distance between the right and left exocanthion minus the distance between the right and left endocanthion divided by two (eye length = $D_1 - D_2/2$). 2. Special face height (SFH)/ face height (FH) was measured as the distance of the face from the pupils to the tip of the chin over distance of the face from the hairline to the tip of the chin D_8/ D_7. The cheek bone prominence (UFW/LFW) was measured as the distance between the left and right zygion (bizygomatic width) over the width of the face at the level of the mouth, D_3/ D_6. Face width (UFW)/special face height (SFH) was measured as the distance between the left and right zygion (bizygomatic width) over height which was measured as the distance of the face from the pupils to the tip of the chin. Mean eye brown height (MEBL) was measured as the sum right eye brow length (distance from the right outer eye brow border to the right inner eye- brow border D_9) and left eye brow length (distance from the left inner eye brow border to the left outer eye- brow border D_{10}) divided by two (2) [28, 30].

$$\textbf{Index II} = \frac{\left(\frac{\textbf{SFH}}{\textbf{FH}}\right)+\left(\frac{\textbf{UFW}}{\textbf{LFW}}\right)+\textbf{EL}+\left(\frac{\textbf{UFW}}{\textbf{SFH}}\right)+\textbf{MEBL}}{\textbf{IPD}}$$

(28, 30)

Key

D_1 = Distance between right and left exocanthion

D_2 = Distance between right and left endocanthion

D_3 = Upper face width (UFW)

D_4 = Nose width

D_5 = Mouth width,

D_6 = Lower face width (LFW)

D_7 = Face height (FH)

D_8 = Special face height (SFH)

D_9 = Right eye brow length

D_{10} = Left eye brow length

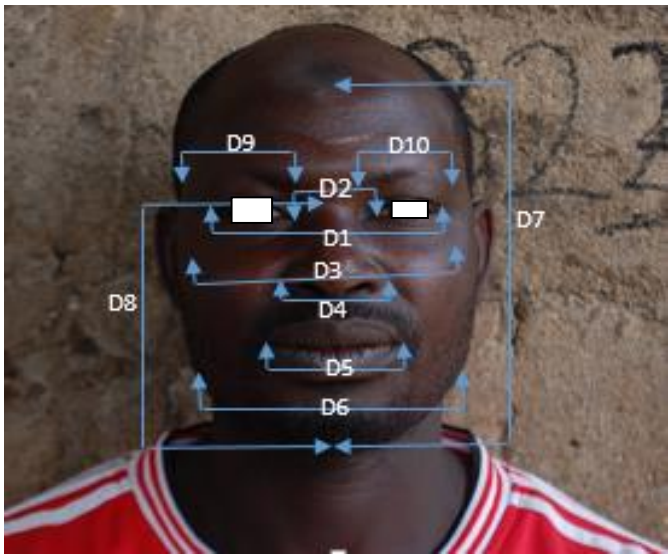

Figure 5: Lower Face Length, Cheek-bone Prominence, Eye Length, and Lower Face Height/Face Height, Face Width/Lower Face Height and Mean Eyebrow Length with their Associated Landmarks[28, 30].

6. Index III: This was determined as sum of facial width to upper face height ratio (fWHR), upper lip height (ULh), lower lip height (LLh) and nose width (Nw), special face length/face height (SFH/FH) and cheek-bone prominence (UFW/LFW), Eye length (EL), face width (UFW)/special face height (SFH) and mean eyebrow length (MEBL), all of them divided by inter- pupillary distance (IPD) [28].

$$\textbf{Index III} = \frac{\text{fWHR}+\text{ULh}+\text{LLh}+\text{NW}+\left(\frac{\text{SFH}}{\text{FH}}\right)+\left(\frac{\text{UFW}}{\text{LFW}}\right)+\text{EL}+\left(\frac{\text{UFW}}{\text{SFH}}\right)+\text{MEBL}}{\text{IPD}}$$ [28]

Facial masculinity-femininity scores:

The facial measures of masculinity-femininity were converted into standardized values (z scores). The data-driven z scores were used to classify individuals into masculine or feminine. The mean z score was used as classification boundary[31]. Individuals below the mean z score were classified as feminine and equal or above mean z score were classified as masculine (feminine <mean score ≥ masculine). Hence, a face with a mixture of highly masculine and feminine characteristics may receive a score that suggests average masculinity. This was based on the fact that men and women differ in localized face shape at several regions, though particularly at the lower jaw [16, 30].

1. Facial width to upper face height ratio (fWHR):

Masculine males have higher fWHR than females [10, 26, 29, 32].

2. Eye-mouth-eye (EME) angle:

Smaller EME is an indicator of masculinity[11, 12, 29].

3. Upper lip height (ULh), lower lip height (LLh) and nose width (Nw):

Some authors employed three measures that were significantly different between sexes: upper lip height (ULh, lowerin men), lower lip height (LLh, lower in men) and nose width (Nw, larger in men). All their measures were expressed as a percentage of interpupillary distance, masculine faces had lower upper lip height, lower lip height and larger nose width[27, 29].

4. Index I (special face length/face height and cheek-bone prominence):

In masculine face there is larger special face length /face height and smaller cheek-bone prominence. This index (I) yields higher scores when these features are more masculine[29, 30].

5. Index II (Eye length, special face height/face height and cheekbone prominence, face width/special face height and mean eyebrow length, all of them divided by interpupillary distance). This index yields higher scores when these features are more masculine (smaller eyes, smaller eyebrow distance, smaller cheekbone prominence, smaller face width and larger lower face)[12], [29,30.]

Index III (sum of all the facial masculinity-femininity measures):

In this index high scores indicted masculine face and low scores predicting facial femininity[31].

Statistical analyses

The data were expressed as frequency, and percentages. Independent-sample t-test was used to determine the differences in facial variables based on levels of masculinity and femininity. The analyses were carried out using SPSS version 20. $P < 0.05$ was considered as level significance.

RESULTS

Table 1: Indicates the percentages of individuals classified as masculine (54%) or feminine (46%) based on fWHRZ-scores. Masculine individuals were more (53.5%) than the feminine based on Zy1_zy2n_gnipd Using index I Z-scores, masculine individuals had higher frequency (50.7%), whereas, feminine were same as masculine individuals with regard to index II (50%).

Table 1: Frequency distribution of Masculinity and Femininity levels of Facial parameters of the study population

Parameters(MM)	Levels	Frequency (%)	Parameters(MM)	Levels	Frequency (%)
fWHR	Feminine	185 (46.0)	ebo_ebi	Feminine	192 (47.8)
	Masculine	217 (54.0)		Masculine	210 (52.2)
Right EME	Feminine	190(47.3)	al1_al2:ipd%	Feminine	195 (48.5)
	Masculine	212 (52.7)		Masculine	207 (51.5)
Right EME	Feminine	200(49.8)	zy1_zy2/n_gn:ipd	Feminine	187(46.5)
	Masculine	202 (50.2)		Masculine	215 (53.5)
Total EME	Feminine	194(48.3)	n_gn/tr_gn:ipd	Feminine	182 (45.3)
	Masculine	208 (51.7)		Masculine	220(54.7)
ls_st	Feminine	199(49.5)	zy1_zy2/go1_go2:ipd	Feminine	199(49.5)

	Masculine	203 (50.5)		Masculine	203 (50.5)
st_li	Feminine	198(49.3)	ls_st:ipd%	Feminine	198 (49.3)
	Masculine	204 (50.7)		Masculine	204(50.7)
al1_al2	Feminine	194 (48.3)	st_li:ipd%	Feminine	198 (49.3)
	Masculine	208 (51.7)		Masculine	204(50.7)
n_gn	Feminine	192 (47.8)	ebo_ebi:ipd	Feminine	192 (47.8)
	Masculine	210 (52.2)		Masculine	210 (52.2)
zy1_zy2/go1_go2	Feminine	200(49.8)	El:ipd	Feminine	195 (48.5)
	Masculine	202 (50.2)		Masculine	207(51.5)
El	Feminine	194(48.3)	Index I	Feminine	198 (49.3)
	Masculine	208 (51.7)		Masculine	204 (50.7)
n_gn/tr_gn	Feminine	191 (47.5)	Index II	Feminine	201 (50.0)
	Masculine	211 (52.5)		Masculine	201 (50.0)
zy1_zy2/n_gn	Feminine	185(46.0)	Index III	Feminine	197 (49.0)
	Masculine	217 (54.0)		Masculine	205 (51.0)

Table 2 shows comparison of facial parameters based on levels of masculinity and femininity of the study population. It was observed that there were significant (P <0.001) differences between masculinity and femininity levels in all the facial dimensions. It was also observed that nose width per interpupillary distance (al1_al2: ipd %) was ranked as the best parameter that differentiate between masculinity and femininity (t= -27.64). This was followed by upper lip height (ls_st:ipd %:t = 27.47) and the least was special face height/ face height (n_gn/tr_gn: t = -12.00).

Table 3 shows comparison of masculinity-femininity based on facial eye-mouth-eye angles of the study population. It was observed that there were significant (P <0.001) differences between masculinity and femininity levels in eye-mouth-eye angles. Left eye mouth eye angle was ranked better parameter than the right to differentiate between masculinity and femininity (t= -26.81). Total eye mouth eye angle was the least (t = -25.62) angle to differentiate between masculinity and femininity levels.

Table 2: Comparison of the levels of Masculinity-Femininity in Facial parameters of the study population

Parameters (mm)	Levels	Mean ± SD	t-value	P Value	Rank
fWHR.	Feminine	1.58±0.10	-21.46	<0.001	14th
	Masculine	1.87±0.16			
ls_st	Feminine	12.80±1.38	26.62	<0.001	7th
	Masculine	9.19±1.33			
st_li	Feminine	13.47±1.50	26.39	<0.001	9th
	Masculine	9.54±1.48			
al1_al2	Feminine	43.62±2.78	-26.73	<0.001	6th
	Masculine	51.65±3.24			
n_gn	Feminine	102.69±6.28	-24.80	<0.001	11th
	Masculine	120.85±8.33			
zy1_zy2: go1_go2	Feminine	1.01±0.04	24.07	<0.001	13th
	Masculine	0.91±0.04			
EL	Feminine	33.14±2.59	25.32	<0.001	10th
	Masculine	27.41±1.92			
n_gn:tr_gn	Feminine	0.57±0.34	-12.00	<0.001	21st
	Masculine	0.61±0.38			
zy1_zy2: n_gn	Feminine	1.06±0.47	24.30	<0.001	12th
	Masculine	0.95±0.04			

ebo_ebi	Feminine	39.07±2.47	-27.02	<0.001	5th
	Masculine	46.48±3.01			
al1_al2: ipd: %	Feminine	64.33±3.08	-27.64	<0.001	1st
	Masculine	72.95±3.17			
zy1_zy2/n_gn:ipd	Feminine	0.02±0.00	17.99	<0.001	18th
	Masculine	0.01±0.00			
n_gn/tr_gn:ipd	Feminine	0.01±0.00	-19.37	<0.001	16th
	Masculine	0.01±0.00			
zy1_zy2/go1_go: ipd	Feminine	0.02±0.00	16.18	<0.001	19th
	Masculine	0.01±0.00			
ls_st:ipd:%	Feminine	18.37±1.85	27.47	<0.001	2nd
	Masculine	13.26±1.87			
st_li:ipd:%	Feminine	19.08±1.74	27.24	<0.001	3rd
	Masculine	13.91±2.06			
ebo_ebiinp	Feminine	0.58±0.04	-19.11	<0.001	17th
	Masculine	0.65±0.04			
El:inp	Feminine	0.46±0.04	14.39	<0.001	20th
	Masculine	0.40±0.03			
Index I	Feminine	1.49±0.6	-19.42	<0.001	15th
	Masculine	1.60±0.53			
Index II	Feminine	1.03±0.4	-27.07	<0.001	4th
	Masculine	1.14±0.4			
Index III	Feminine	99.12±7.20	-26.54	<0.001	8th
	Masculine	117.23±6.08			

Table 3: Comparison of the levels of Masculinity-Femininity in Facial eye-mouth-eye angle of the study population

Parameters	Level of masculinity	Mean ± SD	t-value	P Value	Rank
Right EME	Feminine	27.64±1.57	-25.81	<0.001	2nd
	Masculine	23.87±1.36			
Left EME	Feminine	28.09±1.45	-26.81	<0.001	1st
	Masculine	24.55±1.18			
Total EME	Feminine	55.04±2.51	-25.62	<0.001	3rd
	Masculine	49.13±2.11			

DISCUSSION

The masculinity level is expressed by different indices; hence, a mixed proportion of masculinity and femininity is supposed to be expressed within an individual. This suggest that even for a masculine face there will be an element of feminine characteristic and vice visa. This suggestion was in line with the previous studies which stated that a face with a combination of greatly masculine and feminine characteristics may obtain a mark that suggests average masculinity[33]. This was based on the fact that men and women vary in restricted face shape at several regions, especially at the lower jaw[16, 30]. Many researches have typically computed facial masculinization by measuring sexually dimorphic traits, such as jaw width, cheeks width, lower face height, the width and height of eyes [28,30, 33, 34]. All these traits, however, depend strongly on face size. Because males tend to have larger heads and faces than women, the absolute size of their facial metric features are also larger.

The best facial indices that may discriminate between masculinity and femininity face in male was nose width per inter pupillary distance in the present study and the lowest was special face height/ face height. Therefore, these indices would be of preference as prominent index for facial masculinity characterization in the study population. It can also be

inferred that the influence of sex hormone will be greater in associated parameters than the others. This is supported by research conducted by Mazur and Booth where early exposure to higher levels of Testosterone was likely to produce more male-like characteristics (masculinization) and fewer female characteristics (defeminization) [35], whereas less exposure to Testosterone caused the reverse. While interpreting this magnitude of masculinity using theses indices, the confounding effect of facial size as reported in the previous literature[30, 33, 34, 36] will be eliminated since the study was conducted only in male population. Similarly, eye-mouth-eye angles was also found to be an additional discriminator of masculinity and femininity. Smaller EME was reported to be a good indicator of masculinity[11, 12, 29]. This support the fact that eye-mouth-eye angle is a well-known facial parameter that demonstrates potential of masculinity index within a homogenous population[11].

The significant differences between masculinity and femininity levels in all the facial dimensions found in the present study was due to the fact that the facial characteristics can indicate factors such as effects of hormone exposure during the pre-natal period and real chromosomal gender. These factors can be used to understand characteristic differences and classify a person as "masculine" or "feminine"[13]. It was observed by previous work that Men with ''feminine'' values of fWHR, EME, ULh, Nw and ProcDist were not perceived as less masculine by others. While LLh does not show sexual dimorphism in their sample, it shows a positive correlation with perceived masculinity in another study[29].

CONCLUSION

The present study established the base line data of Frequency distribution of masculinity and femininity levels of facial parameters of the study population of Hausa ethnic origin. It was observed that facial parameter that best differentiated the level of masculinity and femininity was nose width per interpupillary distance (al1_al2: ipd: %).

REFERENCES

1. Zebrowitz, L. A. Finally, faces find favor. *Social Cognition*, 2006; 24 (5): 657–701.
2. Choe, K. S., Sclafani, A. P., Litner, J. A., Yu, G. P., & Romo, T. The Korean American woman's face anthropometric measurements and quantitative analysis of facial aesthetics. *Archives of Facial Plastic Surgery*, 2004; 6: 244–252.
3. Gündüz Arslan, S., Genç, C., Odabaş, B., & Devecioğlu Kama, J. Comparison of facial proportions and anthropometric norms among Turkish young adults with different face types. *Aesthetic Plastic Surgery*, 2008; 108, 233–242. https://doi.org/10.1007/s00266-007-9049-y
4. Enlow & Hans, D. Essential of facial growth. Saunders Company; Philadelphia, 1996; p281-293.
5. Tanner J. M. (ed.). Physical growth from conception to maturity. In: foetus into man. Open Books London, 1978; chapter 5, 60-77.
6. Farkas, L. G. Anthropometry or the head and face in Medicine. Elsevier; New York, 1981; ISBN-13-978-0444005571
7. Sisk, C. L., & Zehr, J. L. Pubertal hormones organize the adolescent brain and behavior. *In Frontiers in Neuroendocrinology*, 2005; 26, 163–174. https://doi.org/10.1016/j.yfrne.2005.10.003
8. Zitzmann, M., & Nieschlag, E. Testosterone levels in healthy men and the relation to behavioural and physical characteristics: Facts and constructs., *In European Journal of Endocrinology*, 2001; 144, 183–197. https://doi.org/10.1530/eje.0.1440183
9. Schulz, K. M., Molenda-Figueira, H. A., & Sisk, C. L. Back to the future: The organizational-activational hypothesis adapted to puberty and adolescence. *Hormones and Behavior*, 2009; 55, 597–604. https://doi.org/10.1016/j.yhbeh.2009.03.010
10. Weston, E. M., Friday, A. E., & Liò, P. Biometric evidence that sexual selection has shaped the hominin face. *PLoS ONE*, 2007; 2:1–8. https://doi.org/10.1371/journal.pone.0000710
11. Danel, D., & Pawlowski, B. Eye-mouth-eye angle as a good indicator of face masculinization, asymmetry, and attractiveness (Homo sapiens). *Journal of Comparative Psychology*, 2007; 121, 221–225. https://doi.org/10.1037/0735-7036.121.2.221
12. Van, S., & Sprengers, E. Hand Grip Strength in Relation to Morphological Measures of Masculinity, Fluctuating Asymmetry and Sexual Behaviour in Males and Females. *In Sex Hormones*, 2012; 293–306. https://doi.org/10.5772/25880
13. Fink, B., Grammer, K., Mitteroecker, P., Gunz, P., Schaefer, K., Bookstein, F. L., & Manning, J. T. Second to fourth digit ratio and face shape. *Proceedings of the Royal Society B: Biological Sciences*, 2005; 272, 1995-2001. https://doi.org/10.1098/rspb.2005.3179
14. Law Smith, M. J., Perrett, D. I., Jones, B. C., Cornwell, R. E., Moore, F. R., Feinberg, D. R., Boothroyd, L. G., Durrani, S. J., Stirrat, M. R., Whiten, S., Pitman, R. M., & Hillier, S. G. Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society B: Biological Sciences*, 2006; 273, 135–140. https://doi.org/10.1098/rspb.2005.3296

15. Penton-Voak, I. S., Jones, B. C., Little, A. C., Baker, S., Tiddeman, B., Burt, D. M., & Perrett, D. I. Symmetry, sexual dimorphism in facial proportions and male facial attractiveness. *Proceedings of the Royal Society B: Biological Sciences*, 2001; 268(1476), 1617–1623. https://doi.org/10.1098/rspb.2001.1703
16. Hennessy, R. J., McLearie, S., Kinsella, A., & Waddington, J. L. Facial surface analysis by 3D laser scanning and geometric morphometrics in relation to sexual dimorphism in cerebral-craniofacial morphogenesis and cognitive function. *In Journal of Anatomy*, 2005; 207, 285- 93.https://doi.org/10.1111/j.1469-7580.2005.00444.x
17. Cunningham, M. R., Barbee, A. P. & Pike, C. L. What do women want? Facial metric assessment of multiple motives in the perception of male facial physical attractiveness. *Journal of Personality and Social Psychology*, 1990; 59:61-72.
18. Barau, A. S. The Great Attractions of Kano. Research and Documentation publications. Research and Documentation Directorate. Government House Kano, 2007; ISBN 978-8109-33-0.
19. Cochran, W. G. Sampling Techniques (3rd) New York: John Wiley & Sons, 1977.
20. Moorrees C, F, A. Natural head position-a revival. *American Journal of Orthodontics and Dentofacial Orthopedics*, 1994; 105(5): 512-513. https://doi.org/10.1016/S0889-5406 (94)70014-1
21. Clement J. G. & Marks M. K. Computer-Graphic Facial Reconstruction Amsterdam and Boston, Elsevier Academic Press, 2005, pp. 1-390, ISBN 012473051
22. Ferrario V, F, Sforza C, Miani A, & Tartaglia G. Craniofacial morphometry by photographic evaluations. *American Journal of Orthodontics and Dentofacial Orthopedics*, 1993; 103(4): 327-37. https://doi.org/10.1016/0889-5406 (93)70013-E
23. Meiyappan N., Tamizharasi S., Sen-thilkumar K. P. & Janardhanan K. Natural Head Position: An overview. *Dental Science-Review Articles*, 2015 7(6): 424:427.
24. Ibrahim, I., Nuhu, S., Yuhana, A., Isyaku, U, M. Facial Morphometric Study of adult Hausa Male Taxi and tricycle Drivers in Kano, Nigeria. *Kampala International University Journal of Science, Engineering and Technology*, 2023; 2(2):182-197.
25. Reddy M, Ahuja N, Raghav P, Kundu V, & Mishra V. A. Computer-assisted Angular Photogrammetric Analysis of the Soft Tissue Facial Profile of North Indian Adults. *The Journal of Indian Orthodontic Society*, 2011; 45(3): 119-123. https://doi.org/10.5005/jp-journals-10021-1021
26. Carré, J. M., & McCormick, C. M. In your face: Facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. *Proceedings of the Royal Society B: Biological Sciences*, 2008; 275(1651):2651–2656. https://doi.org/10.1098/rspb.2008.0873
27. Burriss, R. P., Little, A. C., & Nelson, E. C. 2D:4D and sexually dimorphic facial characteristics. *Archives of Sexual Behavior*, 2007; 36(3), 377–384. https://doi.org/10.1007/s10508-006-9136-1
28. Ibrahim I, Yahaya AI, Umar MI, Buba MA, Obeagu EI. Relationship between Facial Musculinity and Digit Ratio (2D:4D) Among Hausa Taxi and Tricycle Drivers in Kano Metropolis, Nigeria. *Asian Journal of Dental and Health Sciences*, 2023; 3(3):19-29.
29. Sanchez-Pages, S., Rodriguez-Ruiz, C., & Turiegano, E. (2014). Facial masculinity: How the choice of measurement method enables to detect its influence on behaviour. *PLoS ONE*, 2014; 9(11). https://doi.org/10.1371/journal.pone.0112157
30. Penton-Voak, I. S., Jones, B. C., Little, A. C., Baker, S., Tiddeman, B., Burt, D. M., & Perrett, D. I. Symmetry, sexual dimorphism in facial proportions and male facial attractiveness. *Proceedings of the Royal Society B: Biological Sciences*, 2001; 268(1476): 1617–1623. https://doi.org/10.1098/rspb.2001.1703
31. Gangestad, S. W., Thornhill, R., & Garver-apgar, C. E. Men's facial masculinity predicts changes in their female partners' sexual interests across the ovulatory cycle, whereas men's intelligence does not. Evolution and Human Behavior, 2010; 31(6), 412–424. https://doi.org/10.1016/j.evolhumbehav.2010.06.001
32. Stirrat, M., & Perrett, D. I. Valid facial cues to cooperation and trust: Male facial width and trustworthiness. *Psychological Science*, 2010; 21, 349–354. https://doi.org/10.1177/0956797610362647
33. Gangestad, S. W., & Thornhill, R. Facial masculinity and fluctuating asymmetry. *Evolution and Human Behavior, 2003*; 24, 231–241. https://doi.org/10.1016/S1090-5138 (03)00017-5
34. Scheib, J. E., Gangestad, S. W., & Thornhill, R. Facial attractiveness, symmetry and cues of good genes. *Proceedings of the Royal Society B: Biological Sciences*, 1999; 266(1431), 1913–1917. https://doi.org/10.1098/rspb.1999.0866
35. Mazur, A., & Booth, A. Testosterone and dominance in men. *In Behavioral and Brain Sciences*, 1998; 21, 353-363. https://doi.org/10.1017/S0140525X98001228
36. Koehler, N., Simmons, L. W., Rhodes, G., & Peters, M. The relationship between sexual

dimorphism in human faces and fluctuating asymmetry. *Proceedings of the Royal Society B: Biological Sciences*, 2004; 271, S233–S236. https://doi.org/10.1098/rsbl.2003.0146