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Asian Journal of Dental and Health Sciences
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Open Access Research Article

Relationship between Facial Musculinity and Digit Ratio (2D:4D) Among Hausa Taxi and Tricycle Drivers in Kano Metropolis, Niger

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Article Info:

Article History:

Received 19 June 2023
Reviewed 27 July 2023
Accepted 21 August 2023
Published 15 September 2023

Cite this article as:

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, Niger, Asian Journal of Dental and Health Sciences. 2023; 3(3):19-29

DOI: http://dx.doi.org/10.22270/ajdhs.v3i3.49

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Abstract

Studies have recognized an association between 2D: 4D ratios and testosterone-dependent traits. The aim of the present study is to determine the relationship of 2D: 4D and facial masculinity. 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 age range of the participants between 18-50 years. The lengths of the 2nd and 4th digits were determined by a direct method of measurement. Photographic approaches were used to capture the face, facial masculinity was derived from facial distances (captured image face). We use several approaches of measuring facial masculinity to study the association with digit ratio. The data were expressed as mean ± SD, Pearson correlation was used to quantify the relationships between the 2D: 4D and facial masculinity. None of the facial masculine- measures correlated with both right and left 2D:4D ratios.

Keywords: Facial masculinity, 2D:4D (Digit ratio), Photographic methods, Correlation

INTRODUCTION

Studies have established an association between 2D: 4D ratios and testosterone-dependent characters. This investigation found such a relationship in the right but not the left hand [1]. The fourth digit is the ring finger of the human hand and it is located between the little finger and middle finger while the index finger is the first finger, and it is second digit of the human hand. The index finger is situated between the middle and the thumb finger and usually the most skilled and sensitive finger of the hand but show that males have relatively shorter index finger than the ring finger [2]. The relative of the 2nd and 4th digits lengths (2D:4D) is a sexually dimorphic trait in which males have an affinity to have shorter 2nd digits relative to 4th digits than in females [3]. This showed that digit ratio (2D:4D) is standby marker of prenatal testosterone [3]. Distinct digit ratio (2D:4D) values remain comparatively stable across development [4]. A study indicated the indirect signal that E (estrogen) stimulates the growth of the second finger whereas T (testosterone) excites prenatal growth of the fourth finger. A low 2D: 4D ratio might act as a marker for a uterine environment high in T and low in E, and such a ratio is more commonly seen in males. Similarly, a high 2D: 4D ratio may aid as a marker for a uterine environment low in T and high in E, more commonly found in females [1]. The study between the digit ratios in two-year-old children and the levels of prenatal testosterone and estrogen in the amniotic fluid for the period of their prenatal development the outcome shows that low 2D:4D correlates with high concentrations of prenatal testosterone in comparative to estrogen [5]. Initial exposure to higher levels of T is expected to produce more male-like characteristics (masculinization) and less female characteristics (defeminisation) [6], whereas less exposure to T is expected to produce more female characteristics (defeminisation) and fewer male-like characteristics (masculinization).

Facial distances are influenced highly by factors such as sex, age, genetic factors and environmental [7,8]. Testosterone (T) distressed several facial features, and in Adolescent males, a high testosterone-to-oestrogen (T/E) ratio is thought to simplify the lateral growth of the chin, mandibles, cheekbones, the lengthening of the lower face and the frontward growth of the bones of the eyebrow ridges leading to a more robust face shape [9]. In the pubertal female, the upshot of oestrogen (E) leads to a more gracile facial shape with, less robust jaws, filled lips and great eyebrows [9]. Masculinity is related to males' testosterone (T) exposure during puberty [10]. T exposure during development produces several variations in the male body, such as the increase of secondary sexual characteristics and greater musculoskeletal development [10]. Nevertheless, T exposure stimuli both human male behaviour [11] and their physical appearance [12].

Females and Males have different growth trajectories that diverge at puberty for bi-zygomatic width and not for upper facial height, leading to a width-to-height facial dimorphism (larger ratio in men than in women) that is independent of sex difference and enlarged body size [13]. Facial masculinity founded on a single trait is the eye-mouth-eye (EME) angle. Researchers' deliberation that EME is a sexually dimorphic trait, significantly lesser in males [14], even though this sexual dimorphism is vague [15]. This measure only shows a slight correlation with inter-pupillary distance and upper face height even though both features define this angle. Certain studies have shown that women and men differ in restricted face shape at several regions, though particularly at the lower jaw [16,17]. Some of these variances are apparent from an early age. Male nose width, as model, is significantly greater from about age eight [18]. Other methods of measuring masculinity integrate several measures of sexually dimorphic features in an index. Index 1 simply by adds up standardised measures of cheek-bone prominence (Upper facial width/lower facial width) and lower face length [19]. Some index usually employed adds five facial measures that show dimorphic differences between sexes (eye length, lower face height/face height, cheekbone prominence, face width/lower face height and mean eyebrow height, all of them divided by interpupillary distance) [20]. This index yields higher values when these features are more masculine (smaller eyes, smaller eyebrow distance, smaller cheekbone prominence, smaller face width and larger lower face).

They engaged three measures that were significantly different between sexes: nose width (Nw, larger in men), upper lip height (ULh, lower in men) and lower lip height (LLh, lower in men). All their measures were summarised as an inter-pupillary distance percentage. Facial indices of masculinity were not associated with 2D:4D [21]. The 2D:4D and shape of the face differs depending on hormonal presence earlier to the onset of puberty, which gives the characteristics of masculinity [22]. Research found no significant association between 2D:4D and perceptual and structural facial masculinity. These studies calculated different indices of structural masculinity, using principal components analysis of the relative locations of facial landmarks. Though this technique may produce indices that accurately reflect structural masculinity such indices will, by nature, be averages of masculinity. A face with a combination of highly masculine and feminine characteristics may receive a score that suggests average masculinity. Therefore, it remains possible that 2D:4D is associated with localized differences in face shape, i.e., differences that occur at specific regions of the face (such as the nose or jaw). Growth spurts at puberty further increase sex differences, particularly at the mandible [23]. The aim of the present study is to determine the relationship of 2D: 4D and facial masculinity. However, In the present research, we look the relationship between a different set of measures of masculinity employed by different scholars and digit ratio to determine how different facial masculinity correlate with digit ratio And find out the hypothesis of association between facial masculinity with 2D:4D ratio, which support to the effects of prenatal androgens (as indicated by 2D:4D) on facial masculinity and femininity similarly, in the previous research there was inconsistency with regards to the relationship of 2D:4D with facial anthropometrics as reported.

MATERIALS AND METHODS

Study Location

The present study was conducted in Kano state of Nigeria. The rainfall in this part of the country is less than 100cm, with long dry season that begins from October and end at April. The rainy season is shorter which is just for five months and the temperature is between 24- 27ºC and can be as high as 38ºC. Kano is the most populous state in Nigeria, with a population of 9,383,682 million people. The urban area of the state covers 137 km2 and comprises of six local government areas (LGAs), Tarauni ,Kano Municipal, , Fagge, Dala, Gwale, and Nassarawa with a population of 2,163,225 at the 2006 Nigerian census [24, 25].

Study Population

Four hundred and two (402) subjects were selected from the male taxi and tricycle drivers within the urban area of the State. Seemingly healthy male taxi and tricycle drivers whose face and fingers were free from any inflammation, pathological changes, or deformity within the age range of 18-50 years who was Hausa up to the level of 2 grandparents.

Ethical Approval and Informed Consent

Before the commencement of the research, ethical approval was sought from the Ethical Committee of the Bayero University Kano College of Health Science at Aminu Kano Teaching Hospital, Kano. Informed consents were sought from the participants.

Methodology

Measurement of the Digit Lengths and Determination of 2d: 4d

The lengths of the 2nd and 4th digits were determined using a direct method of measurement. Following Manning and Tailor (Manning & Taylor, 2001), the participants were asked to remove rings and the lengths of the 2nd and 4th digits were measured directly (using vernier calipers accurate to 0.01 mm) on the ventral surfaces of both right and left hands from the basal crease of the digit to its tip. Every digit was measured twice, and the average was taken. When there was a crowd of creases at the base of the digit, the most proximal crease was considered. Digit lengths measured (in mm) were computed for determination of the 2D: 4D by dividing the 2nd digit length by the 4th digit length (Plates I).

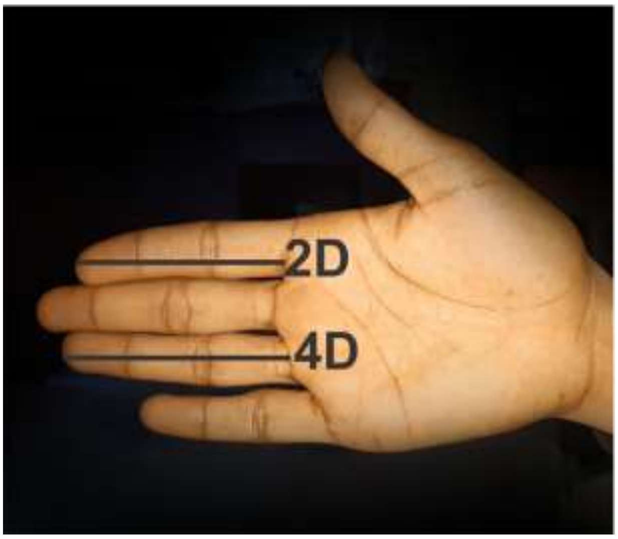

Plate I: Photograph Showing the Landmarks for Measurement of 2D and 4D Digits

Photographs

The photographic set up comprises of a tripod, supporting a digital camera. The tripod was used for modification of height of the camera that allows the optical axis of the lens to be maintained in a horizontal position during the recording. In order to obtain the photographs (frontal), individuals were asked to sit and look directly at the camera in front of them [26] keeping an upright and normal posture, with both arms free along the body. This position corresponds to the Broca's Natural Head Position [27, 28]. Each participant was asked to ease with both hands hanging beside the trunk. The participants were positioned on a line marked on the floor. The participants were photographed with a Nikon D40 digital camera at 1.00 m and in front of a standard white background, while posing in a neutral facial expression. 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 operative ensured that the subjects' neck, ear and forehead, were clearly visible and their lip in restfulness. The tripod helped to avoid undesirable movements of operator and camera while taking photographs [29]. Before taking the face, the operator ensured that glasses (if worn) had been removed and the participant's neck, ears, and forehead, were clearly visible during the process [30]. After the images were captured, they were downloaded to a private computer and stored in jpeg format for processing and analyses.

Processing and Analyses

The captured facial images were imported into a software, bio-analyser (a software developed using Microsoft visual basic version 6). The database was customized with land marks [30] that was used in the study. The software was used to compute all the linear dimension and angles.

Facial Landmarks Identification

Standard anatomical landmarks and reference points were recognised according to prior works [31-34] and were recognized using Bioanalyzer (a software developed using Microsoft visual basic version 6) for frontal facial analysis.

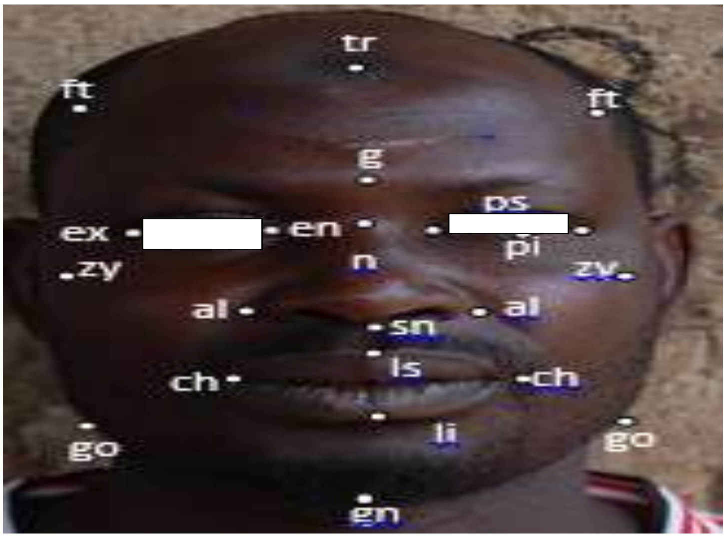

Plate II: Landmarks Used for Facial Measurements [33].

Key: al; alar, ch; cheilion en; endocanthion, ex; exocanthion, gn; gnathion, go; gonion, ls; labiale superious, li; labiale inferious, n; nasion, pi; palpebrale inferious, ps; palpebrale superious, sn; subnasale, st; stomium, tr; trichion, zy; zygon, ft: frontotemporale.

Facial Measures of Masculinity

The facial measures of masculinity used in the present study include the following:

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) (Plate III) [35].

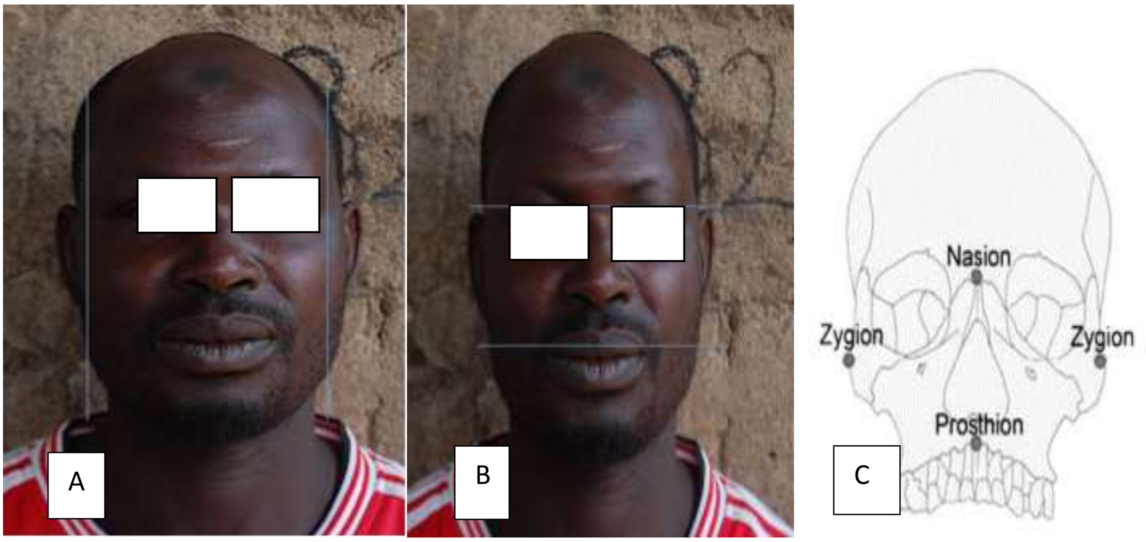

Plate III: Upper Facial Height and Width with their Associated Landmarks [35].

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

2. 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 (Plate IV) as reported in the previous study.

Plate IV: Upper Lip Height (ULh), Lower Lip Height (LLh) and Nose Width (Nw).

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

3. Index I: This was determined as the sum of special face length/face height and cheek-bone prominence (Plates V). 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) [36].

$$\textbf{Index I} = (\textbf{SFH}/\textbf{FH}) + (\textbf{UFW}/\textbf{LFW})$$

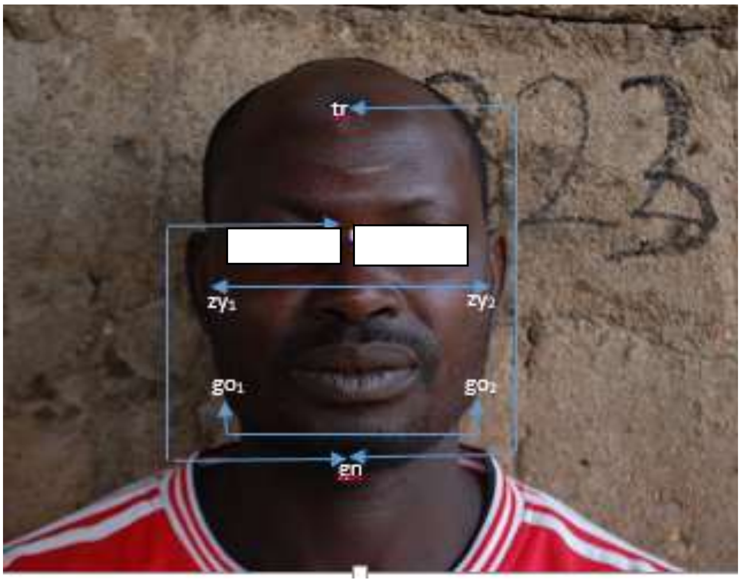

Plate V: Special Face Length/Face Height and Cheek-Bone Prominence [36]

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

4. 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 (Plate VI), 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) [17]..

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

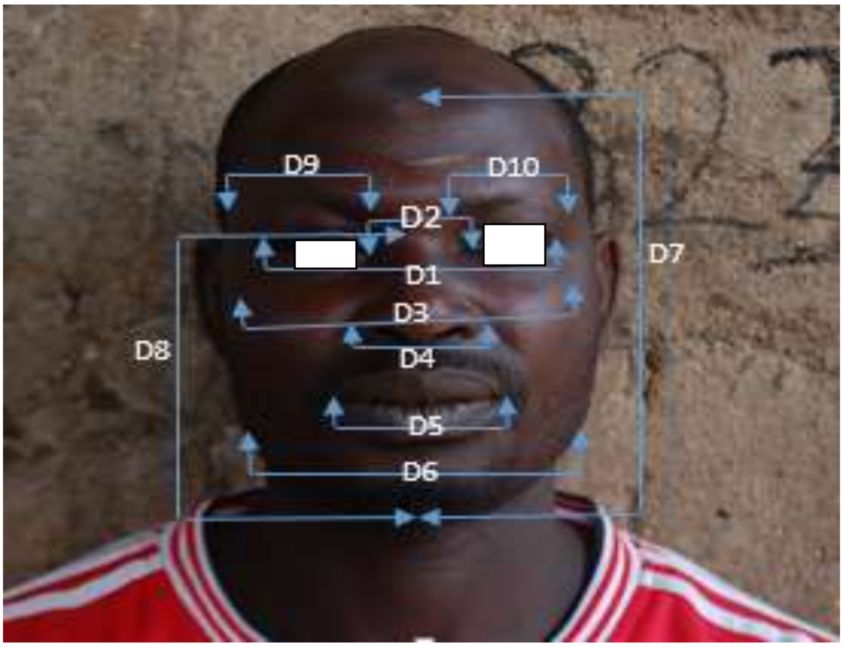

Plate VI. Lower Face Length, Cheek-bone Prominence, Eye Length, and Lower Face Height/Face Height, Face Width/Lower Face Height and Mean Eyebrow Length with their Associated Landmarks [17].

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

5. 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).

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

MEASUREMENT ERROR

Direct Measurements of Facial Features

For measurement error analyses, a direct facial anthropometry was adopted [34]. This involved asking a participant to sit with his head in natural head position. A digital vernier caliper was then used to measure the facial linear dimension of face directly (Plate: VI). This helped in the determination of the factor to be used for real size measurements of the photographs. The factor was 0.50 which was obtained by dividing actual size measurement with actual pixel of the image measurement.

Precision of Measurements

To calculate precision, the technical error of measurement was determined, a set of two measurements were taken with each method. These measurements were matched using technical error of measurement (TEM). This allowed assessment of random error. The TEM (also called the ''method error statistic'') is a standard-deviation−like estimate of error magnitude expressed in the original units of measurement. It can be used to generate both Intra and inter-observer precision estimates. When there are two measurements involved, the formula for TEM [37] is as follows:

Absolute TEM = $\sqrt{\sum di^2/2n}$

Where $\sum d2$ = summation of deviations (the difference between the 1st and 2nd measurements) raised to the second power,

n = a number of volunteers measured,

i= the number of deviations

The absolute TEM was expressed as percentages as follows.

Relative TEM = Absolute TEM/ VAV × 100

Where VAV = Variable average value, is the arithmetic mean of the mean between both measurements obtained (1st and 2nd measurements) of each volunteer for the same variable.

This procedure was performed for each of the n participants and the n averages obtained and was summed up and divided by n (total of a number of participants) [38]. The percentage scores were divided into five precision categories: scores less than 1% was deemed ‘‘excellent,’’ scores ranging from 1% to 3.9% were deemed ‘‘very good,’’ scores ranging from 4% to 6.9% were deemed ‘‘good,’’ scores ranging from 7% to 9.9% were deemed ‘‘moderate,’’ and scores exceeding 10% were deemed ‘‘poor [39].

Strength of Measurements (r)

The r was computed to demonstrate the strength of the relationship (similarities) between two measurements. Intra-class correlation (ICC) was used for this purpose. The values for the reliability coefficient ranged from 0 to 1, where ICC< 0 indicated ‘‘no reliability’’ and 0.6 to <0.8 indicated substantial reliability, and 1 indicated almost perfect reliability [40]. The interval between two measurements was at least one week. 30 randomly selected records were used for this evaluation. Those dimensions with many differences between the first and the second measurements were discarded.

Statistical Analyses

The data were expressed as mean ± SD, frequency, and percentages. Pearson correlation was used to quantify the relationships between the facial masculinity and digit ratio. The analyses were carried out using SPSS version 20. P < 0.05 was considered as level significance

RESULTS

Table 1 Shows assessment of technical error of measurements (TEM) in linear facial dimensions. It was observed that special face height showed the least TEM (1.65%) whereas philtrum length showed higher value (9.66%). The rest of the facial measurements were also within the acceptable level of TEM no variables was greater than 10%. Therefore, all measurements were retained.

Table 1: Assessment of Measurement Error in Linear Facial Dimension

Variables	N	VAV	TEM	RTEM%
zy1_zy2	30	105.16	1.98	1.88
n_pr	30	64.94	1.84	2.83
tr_gn	30	186.74	4.20	2.25
al1_al2	30	46.10	3.21	6.97
n_gn	30	108.40	1.79	1.65
go1_go2	30	111.82	2.00	1.79
ex1_en1	30	27.52	1.29	4.70
ex2_en2	30	28.23	1.46	5.17
en1_en2	30	38.82	2.03	5.22
ls_st	30	11.28	0.71	6.33
st_li	30	11.59	0.99	8.53
ebo_ebi	30	43.05	1.04	2.42
ex1_ex2	30	95.02	2.14	2.25
sn_gn	30	63.28	5.16	8.15
g_sn	30	61.67	1.40	2.27
sn_ls	30	14.67	1.42	9.66
n_sn	30	45.77	2.74	5.98
st_gn	30	37.95	1.16	3.05
ls_li	30	21.79	1.33	6.10
ps1_pi1	30	10.81	0.65	5.99

Table 2 shows another method of the assessment of error in the facial dimensions. The higher single measured intra class correlation (ICC) was found in Philtrum length (sn-ls) and the lowest values found in nose width (al_al). The rest of the measurements were greater than 0.89.

Table 2: Intra-Class Correlation (ICC) Measurements of Facial Dimensions

S/N	VARIABLE	MEASUREMANT	N	ICC
1	zy1_zy2	Single measures	30	0.944
		Average measures		0.971
2	n_pr	Single measures	30	0.950
		Average measures		0.975
3	tr_gn	Single measures	30	0.931
		Average measures		0.964
4	al1_al2	Single measures	30	0.714
		Average measures		0.833
5	n_gn	Single measures	30	0.970
		Average measures		0.985
6	go1_go2	Single measures	30	0.953
		Average measures		0.976
7	ex1_en1	Single measures	30	0.850
		Average measures		0.919
8	ex2_en2	Single measures	30	0.794
		Average measures		0.885
9	en1_en2	Single measures	30	0.744
		Average measures		0.854
10	ls_st	Single measures	30	0.810
		Average measures		0.895
11	st_li	Single measures	30	0.759
		Average measures		0.863
12	ebo_ebi	Single measures	30	0.812
		Average measures		0.896
13	ex1_ex2	Single measures	30	0.938
		Average measures		0.968
14	rcp_lcp	Single measures	30	0.921
		Average measures		0.959
15	sn_gn	Single measures	30	0.946
		Average measures		0.972
16	g_sn	Single measures	30	0.958
		Average measures		0.979
17	sn_ls	Single measures	30	0.823
		Average measures		0.903
18	n_sn	Single measures	30	0.767
		Average measures		0.868
19	st_gn	Single measures	30	0.940
		Average measures		0.969
20	ls_li	Single measures	30	0.878
		Average measures		0.935
21	ps1_pi1	Single measures	30	0.711
		Average measures		0.831

Table 3 shows the descriptive statistics of the derived facial measures of masculinity of the study population. It was observed that averaged facial width to height ratio was 1.71±0.19. Upper lip height (ULh) was 15.86±3.16mm, lower lip height (LLh) was 16.53±3.21 and nose width (Nw) was 68.51±5.33. All the three measures were rendered as percentage of interpupillary distance. Upper lip height (ULh) was lower than lower lip height (LLh). Averaged Cheek-bone prominence was 0.96±0.06. For the Index I, II and III were measured as 1.55±0.07, 1.09±0.07 and 108.36 ±11.35, respectively.

Table 3: Descriptive Statistics of the Derived Facial Measures of Masculinity of the Study Population

Parameters	Minimum	Maximum	Mean ± SD
fWHR.	1.00	2.74	1.71±0.19
al1_al2:ipd %	53.75	84.02	68.51±5.33
zy1_zy2 /n_gn (fWSHR)	0.70	1.30	1.00±0.07
zy1_zy2 /n_gn:ipd	0.00	0.02	0.01±0.00
n_gn/tr_gn (sFHFHR)	0.50	1.00	0.59±0.04
n_gn/tr_gn:ipd	0.00	0.01	0.01±0.00
zy1_zy2/go1_go2 (cbp)	0.75	1.24	0.96±0.06
zy1_zy2/go1_go2: ipd	0.00	0.02	0.01±0.00
ls_sti :pd%	8.20	26.39	15.86±3.16
st_li:ipd%	6.53	25.47	16.53±3.21
ebo_ebi	32.51	58.68	42.60±4.61
ebo_ebi:inp	0.49	1.00	0.62±0.05
El	21.69	43.29	30.18±3.65
el:inp	0.00	0.56	0.43±0.04
rcp_lcp	53.38	90.17	69.46±6.59
Index I	1.32	2.00	1.55±0.07
Index II	0.88	1.27	1.09±0.07
Index III	74.63	143.21	108.36 ±11.35

Table 4 shows descriptive statistics of digit lengths, digit ratio of the study population. The mean value for 2DRight was 72.18±4.86mm, lower than the 4DRight, which was 74.09±5.08mm, similar to the left digit. The mean value of 2DR: 4DR was 0.98±0.04 which was the higher than 2DL: 4DL with mean value of 0.96±0.05.

Table 4: Descriptive Statistics of Digit Lengths, Digit ratio

Parameters (mm)	Minimum	Maximum	Mean ± SD
2DR	55.65	87.21	72.18±4.86
4DR	54.47	88.00	74.09±5.08
2D:4DR	0.83	1.13	0.98±0.04
2DL	52.86	87.45	72.15±4.83
4DL	57.14	90.42	75.10±5.33
2D:4DL	0.84	1.11	0.96±0.05

Table 5 shows correlation between different derived facial parameters (measures of masculinity), digit length and ratios. It was observed that facial width to height ratio (FWHR) showed significant negative correlation with 2DR, 4DR, 2DL and 4DL. Nose width/ special face height (cZzy1_zy2/n_gn:ipd) showed significant negative correlation with 2DR, 4DR and 2DL and 4DL. Cheek-bone prominence interpupillary distance (zy1_zy2:go1_go: ipd) showed significant negative correlation with 2DR, 4DR and 4DL. It was noted that eyebrow length (ebi_ebi) showed significant positive correlation with 2DR, 4DR, 2DL and 4DL. Finally, Eye length (El) showed significant positive correlation with 2DR, 4DR, 2DL and 4DL, while Index III was positively correlated with 2DL only.

Table 5: Pearson's Correlation between Derived Facial Parameters (Measures of Masculinity) with Digit Length and Ratios

PARAMETERS (mm)	2DR	4DR	2D:4DR	2DL	4DL	2D:4DL
fWHR.	-0.161**	-0.148**	-0.014	-0.137**	-0.120*	-0.022
al1_al2:ipd%	0.092	0.07	0.025	0.07	0.052	0.019
zy1_zy2 /n_gn	-0.124*	-0.110*	-0.022	-0.123*	-0.052	-0.095
zy1_zy2 /n_gn:ipd	-0.175**	-0.160**	-0.024	-0.174**	-0.115*	-0.077
n_gn/tr_gn	0.09	0.069	0.027	0.085	0.03	0.075
n_gn/tr_gn:inp	-0.064	-0.059	-0.01	-0.063	-0.061	-0.004
zy1_zy2:go1_go2	-0.067	-0.095	0.043	-0.084	-0.075	-0.008
zy1_zy2:go1_go2: ipd	-0.143**	-0.151**	0.012	-0.152**	-0.127*	-0.029
ls_st:ipd%	-0.022	0.017	-0.054	0.032	0.025	0.016
st_li:ipd%	0.048	0.043	0.014	0.081	0.057	0.039
ebo_ebi	0.150**	0.155**	-0.01	0.136**	0.143**	-0.016
ebo_ebi:ipd	-0.015	-0.025	0.013	-0.049	-0.041	0.003
El	0.112*	0.106*	0.007	0.141**	0.115*	0.025
El:ipd	-0.02	-0.01	-0.017	0.01	0.017	-0.021
Right EME	-0.042	-0.056	0.021	-0.02	-0.032	0.016
Left EME	-0.036	-0.018	-0.028	-0.037	0.007	-0.064
Total EME	-0.048	-0.047	-0.003	-0.035	-0.016	-0.027
Index I	-0.007	-0.042	0.051	-0.024	-0.047	0.035
Index II	-0.036	-0.037	-0.002	-0.044	-0.03	-0.016
Index III	0.082	0.082	-0.001	0.100*	0.081	0.026

*P< 0.05, **P <0.01

DISCUSSION

From this study, the measurements were found to be reproducible with a negligible error for the intra observer errors estimated. This was based on the acceptable level of TEM reported in the previous study [39]. The ICC of the measurements have fallen within the prescribed limits as in Oliveira *et al.*[41]. This has made the results more robust and reliable. The minimal error of measurement observed in the present study will be have less influence in the interpretation of the results in the context of the global data. Similarly, this may provide more opportunities to compare results using different methodologies. Since, the facial morphometric quantified using photogrammetric methods has proved to be similar to what was obtained using direct anthropometry with the acceptable methods level of error.

The main objective of this research was to examine different approaches of measuring facial masculinity in order to standardise the method employed to compute this feature. To achieve this aim, we have engaged several methods of measuring facial masculinity. We studied how these different measures are related to digit ratio. However, as facial masculinity has been previously linked to different variables based on sex hormone activities right from intra-uterine life, we expected at least some of the masculinity measurements to correlate with digit ratio. Our main concern is to explain which of the different measurement methods are more suitable to analyse the association between masculinity and digit ratio. In the present study no significant correlation was observed between the 2D:4D with indices of masculinity. The absence of the correlation may also be attributed to influences of several confounding factors such latitude and techniques of finger length measurement on 2D:4D as suggested in the literature [42].

Contrary to the present study, it was reported that weak but significant negative correlations exist between 2D: 4D ratios and both masculinity and dominance, supporting their argument that high prenatal testosterone levels serve to 'organize' male facial features to subsequently reflect dominance and masculine characteristics at puberty [43]. But this is based on the opposite sex rated facial masculinity, facial dominance, and facial attractiveness. It is therefore imperative to explain the possible reasons of the discrepancy between present finding and literature [43] due to the fact that a face with a mixture of highly masculine and feminine characteristics may receive a score that suggests average masculinity. Therefore, it remains possible that 2D:4D is correlated with localized differences in face shape, meaning differences that occur at specific regions of the face (such as the nose or jaw). Studies have shown that men and women differ in localized face shape at several regions, particularly at the lower jaw [44]. Hence, the subjects rated in the above study v may be have more of feminine facial characteristics.

CONCLUSION

The main objective of this research was to examine different approaches of measuring facial masculinity but none of the facial masculine- measures correlated with both right and left 2D:4D ratios. We therefore recommend further study should be carried out on different population and also among different ethnic group and larger sample sizes should also be used in order to explore more on the relationship between facial anthropometry with digit ratio.

ACKNOWLEDGMENTS

I must acknowledge the approval to conduct the study from these two noble associations in Kano state, Tsaya da Kafarka Taxi Drivers Association Kabuga and Tricycle Operators Association Kano (TOAKAN). I would like to express my sincere and special appreciation to my mentor Dr A. I. Yahaya for his guidance, advice, support.

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