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Facial Index Among Adolescents and Young Adults of Yoruba Ethnic Groups in Nigeria

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ABSTRACT

Facial differences in facial dimension exist in different populations, forming an important source of ethnical and/or racial identification. This study established the baseline measurements of facial anthropometric parameters and facial index of 2,109 unrelated male and female individuals from the Yoruba ethnic population, aged 15–29 years, using a photographic procedure. To annotate the landmarks, digimizer software was used, and 2 linear distances were measured, and a facial index was calculated. Our results on facial index (FI) showed that the commonest type of facial shape among Yoruba males (98.0%) and females (97.9%) was hyperleptoproscopic, and the same is observed across age groups. Also, correlation statistics revealed a weak and significant positive correlation between facial index and biometric parameters such as weight, age, and height, but a weak and significant negative correlation with the BMI. The study concluded that the majority of adolescents and young adults of Yoruba ethnic groups in Nigeria have hyperleptoproscopic (very long) faces, with males having longer faces than females. Clinicians, plastic surgeons, maxillofacial surgeons, and geneticists can use the information from this study to diagnose and treat craniofacial abnormalities.

Keywords: facial morphometric, hyperleptoproscopic, Yoruba

1. INTRODUCTION

Facial dimensions are of utmost importance in evaluation of facial morphology, identification of individuals based on age and sex (1), classification of individuals according to race and ethnic groups (2), forensic investigations (3), diagnosis and treatments of facial abnormalities or dysmorphic faces (4,5) and reconstruction of facial prosthesis (6). Thus, the study of the face cannot be over-emphasized as it is important to anatomists, anthropologists, plastic surgeons, genetists, and maxillofacial surgeons (7,8). The need for identification of remains of individuals arises due to increased rate of violence, criminal offences, mass disasters due to war, fire outbreaks, flood, road traffic accidents, dispute over land boundaries, human trafficking, terrorist attack and communal crisis. Identification of highly decomposed, mutilated, skeletal remains or criminal suspects is a humanitarian need and imperative for closure towards peace building (9).

According to studies conducted among African adolescents and adults, different ethnic groups have different facial traits. Okwesili et al. (1) found that hyperleptoproscopic faces predominated among

adolescent male and female Igbos; Omotoso et al. (10) discovered that mesoproscopic faces predominated among Ibo adults; Eliakim-ikechukwu et al. (11) found hypereuriproscopic faces among Yoruba and Igbo adults and hyperleptoproscopic faces among adult Hausa. According to Maalman et al.(2), hyperleptoproscopic faces still predominated among Ghanaians of the Daagaba and Sisala ethnic groups. The differences in the mean values of FI are due to ethnic variation.

The facial index studied in other populations of the world still shows that ethnicity and race play a major factor in the type of face an individual carries. Shetti et al.(12) found meoproscopic faces among Indian and Malasian populations; Jahanshahi et al.(13) found mesoproscopic faces among Iranian males while they found euriproscopic among Iranian females. This shows that ethnicity, race, and sexual differences determine a person's face.

It is worthy of note that age has a strong influence on the facial types an individual carries. Thus, in order to minimize the effect of age influence on facial morphology, a range of 18-29 years was chosen for this study. Bishara et al. (14) observed that significant changes in facial morphology occur more later in life, after the mid-twenties. Nevertheless, previous studies (15) have shown that children have a smaller facial index when compared to adults of the same race and sex, and that the face type may be different for different age groups.

It must also be borne in mind that facial index bears a direct relationship with morphological facial height and indirect relationship with maximum facial width. Age was found to have a positive connection with morphological face height (16). It's one of the facial features that grows the fastest. It's dimorphic in gender, with males having greater values than females (17,18). In contrast to Li et al. (16), who found a negative association between age and maximum face width among males and females of Hans' ethnic group in China (19) found a positive link between maximum facial width and age. Cho et al. (20) found that BMI, height, and fat distribution vary greatly depending on gender, age, and genetic factors. Hence, covariate factors (weight, height, and body mass index (BMI)) that could cause false positive results should also be taken into consideration. Nigeria is a cosmopolitan country with multiple socially identifiable populations (Yoruba, Hausa, and Igbo), leading to more variations and complexities in the identification of forensic evidence. Thus, the ease of studying craniofacial morphology with a novel digital method that is less intrusive to the patients, more cost-effective, provides a permanent record of the face that can be accessed at a later time, and provides consistency in measurements (21) is critical in Nigeria.

2. MATERIALS AND METHODS

2.1. Study population

The study was carried out among University of Ilorin students who are indigenes of Yoruba sub-ethnic States of Nigeria, including Lagos, Ogun, Osun, Oyo, Ekiti, Ondo, Kwara, and Kogi. Two thousand one hundred and nine (2,109) healthy volunteers with no obvious facial abnormalities were selected using self-administered questionnaires. Participants were divided into 3 age groups according to WHO classification; Group 1: 15 - 19 years, Group 2: 20 -24 years and Group3: 25-29 years.

2.1.1 Sample size determination

The sample size was determined using Fischer's formula for population (>10,000) as follows:

$N=Z^2Pq/d^2$ where:

N= desired sample size; Z=1.96 (at 95% C.I)

P= proportion of the target population to have characteristics being measured from previous study. According to a study done by (3) in South- East Nigeria, it has a prevalence of 18%.

d= error margin (error limit 0.05) and q=1-p

Thus, Z= 226.81 approx. 227 (minimum sample size calculated)

2.1.2. Subjects and selection method

Participants who met the inclusion criteria were randomly selected from different areas in Yoruba speaking States - Lagos, Ogun, Osun, Oyo, Ekiti, Ondo, Kwara and Kogi (24) of Nigeria, resident in Ilorin using stratified random sampling technique. The period of data collection was from July 2019 to December 2019.

2.1.3. Exclusion and Inclusion criteria:

Participants with obvious abnormality of the face such as like cleft lips and palate; congenital conditions known to affect the head or face, obvious asymmetry of the face; family history of craniofacial syndromes/ facial anomalies; and participants who have had severe facial injury in the past and of first degree relatives were excluded from the study. Apparently healthy individuals within the age of 15-29 years were recruited. They were of Yoruba descent (history traced down to second generation). A total of 2,109 unrelated male and female students aged 15-29 years from the University of Ilorin sub-ethnic groups of Yoruba were recruited for the study. Participants within this age bracket were chosen because criminal tendency tends to be rampant in adolescence or early adulthood (3) and to minimize the effect of age-related influences on face morphology.

2.2. Procedure methodology

Consent was gotten from each of the participants after being explained what the study is all about and what society stands to gain following the World Medical Declaration of Helinskii Ethical Principles for Medical Research Involving Human Subjects (25).

2.2.1. Pre-photography

Participants were given numbers, instructed on how the pictures were to be taken, asked to remove their accessories on the face, pulled their hair backwards/ or used hair net for those that had long hairs. Partipants's age, sex, height, states of origin were collected alongside using self-administered questionnaires.

2.2.2. Photograghy

The photographs were taken with a digital camera (Amkov 3.0 Super Amoled 24 mega pixel, x4 zoom) following standard protocol (26) and a tripod stand to hold the camera and adjust for participants height (21). Photographs were taken from frontal view. The facial photograghs were taken at a fixed time of the day usually between 9a.m- 5p.m in order to avoid diurnal variations that may occur. Participants were asked to stand relaxed behind a marked line (65 cm away from the camera) on the floor facing the mirror of the camera with their forehead, neck and ear clearly visible; eyes opened (eye level at the Frankfurt position), lips gently closed; faces relaxed (neutral facial expression); heads held out straight in anatomical position and; participants with long hair were asked to pull their hair backward or use hair nets; accessories such as ear rings, nose rings, glasses were asked to be removed.

2.2.3. Image Processing

Facial landmarks (Figure 1) were annotated by a Digimizer software (version 5.3.5, MedCalc, Belgium). Two linear craniofacial distances were digitally located and measured on each facial photograph image. For the 2 craniofacial distances that were measured, facial index was calculated following the method adopted by Barash et al. (27).

Additional phenotypic traits (weight, height, Body mass index (BMI), sex, age, ancestry) were collected and analyzed. The phenotypic data collection was done by a trained examiner for each of the parameter.

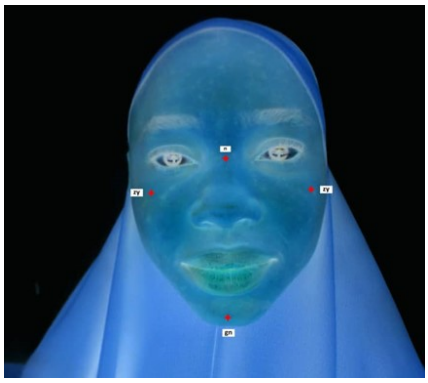

Figure 1: Landmarks of Anthropometric Measurement. The craniofacial distances that were measured are: Morphological facial height- nasion (n) –gnathion (gn); Bizygomatic distance- zygium (zy) - zygium (zy)(27).

2.2.4. Height and weight determination

Height: each participant was asked to stand erect against the wall and height was measured using standiometer (2-metre Stature meter)

Weight: weight of each participant was taken using weighing scale (Toughened Glass Electronic Digital Scale- LWG-2018A)

Body Mass Index (BMI) was calculated using weight (kg)/height $(m)^2$

Facial index calculation from the linear measurements distances was as follows:

Facial index (FI) is calculated as follow (27):

$$FI = \frac{facial\ height\ (n-gn)}{Bizygomatic\ width\ (zy-zy)} \times 100$$

Facial Index (FI) is one of the indices that are used to classify human faces into races and different ethnic backgrounds.

According to Martin and Saller's (1957), FI can be classified as follows: Leptoprosopic (long face): FI 88-92.9%; Mesoprosopic (round face): FI 84-87.9%; Euriprosopic (broad face): FI 79-83.9%; Hypereuriprosopic (very broad face): FI 78.9%.

Table 1: Comparison of Morphological facial index (FI) in male and Female Yoruba and other Nigerians previously studied

Population	Male (Mean±SD) FI (%)	Facial types (Dominant)	Female (Mean±SD) FI (%)	Facial types (Dominant)	Authors
Igbo (Enugu) (adolescent)	100.2±13.6	Hyperleptoprosopic	93.4±4.7	Hyperleptoprosopic	(1)
Igbo (adult)	87.98±2.55	Mesoproscopic	85.88±2.48	Mesoproscopic	(10)
Ibo	75.49±0.50	hypereuriprosopic	73.76±0.54	hypereuriprosopic	(11)
Yoruba	77.60±2.82	hypereuriprosopic	73.72±1.05	Hypereuriprosopic	(11)
Hausa	97.53±8.56	leptoprosopic	----------	Hyperleptoproscopic	(11)

Table 2: A comparison of facial index in male & Female of different populations of the world

Population	Male (Mean±SD) FI (%)	Facial types (Dominant)	Female (Mean±SD) FI (%)	Facial types (Dominant)	Authors
Ghana (Sisaala)	104.25	Hyperleptoprosopic	102.11	Hyperleptoprosopic	(2)
Ghana (Dagaaba)	99.70	Hyperleptoprosopic	98.29	Hyperleptoprosopic	(2)
Japanese	-	-	82.66 ± 7.67	Mesoprosopic	(22)
India	87.19±5.2	Mesoprosopic		Mesoprosopic	(12)
Malaysia	85.72±5.4	Mesoprosopic	87.71±5.1	Mesoprosopic	(12)
Iran (Fars)	88.22 ± 5.21	Mesoprosopic (Banister's classification)	84.48 ± 5.85	Euriprosopic (Banister's classification)	(13)
Iran (Turkman)	87.25 ± 5.18	Mesoprosopic	81.48% ± 5.28	Euriprosopic	(13)
Ghana (Sisaala)	104.25	Hyperleptoprosopic	102.11±0.00	Hyperleptoprosopic	(2)
Malaysia	85.72±5.4	Mesoprosopic	87.71±5.10	Mesoprosopic	(12)
Iran (Turkman)	87.25 ± 5.18	Mesoprosopic	81.48 ± 5.28	Euriprosopic	(13)
India (Sikkim)	-	-	103.1±12.65	Hyperleptoprosopic	(23)

Table 3: Demographic Distributions of the study participants.

Classification	Participants biodata	Frequencies	Percentages (%)
Gender	Male	865	41.0
	Female	1244	59.0
Age (years)	15-19 years	1179	55.9
	20-24 years	858	40.7
	25-30 years	72	3.4
States of Origin	Ekiti	109	5.2
	Kogi	150	7.1
	Kwara	872	41.3
	Lagos	37	1.8
	Ogun	169	8.0
	Ondo	98	4.7
	Osun	342	16.2
	Oyo	332	15.7

Table 4: Crosstab Gender (M/F) Facial Index Categorization

		Mean (±SD)	Hypereury-proscopic	Eurypro-scopic	Meso-proscopic	Lepto-proscopic	Hyperlepto-proscopic	Total
Facial index	Male	116.81± 13.21	0_a	0_a	2_a	15_a	**848_a**	865
			0.0%	0.0%	0.2%	1.7%	**98.0%**	100.0%
	Female	113.65± 14.55	1_a	1_a	4_a	20_a	**1217_a**	1243
			0.1%	0.1%	0.3%	1.6%	**97.9%**	100.0%
Total		114.95±14.10	1	1	6	35	**2065**	2108
			0.0%	0.0%	0.3%	1.7%	**98.0%**	100.0%

Each subscript letter denotes a subset of Facial Index (FI) categories whose column proportions do not differ significantly from each other at p≤0 .05.FI= n-gn/zy-zy *100

2.3. Data processing and Analysis

The measured landmarks were imported into a Microsoft excel 2016 version and statistical analysis was done using IBM Statistical Package for Social Sciences version (SPSS) 23.0. The results were presented in tables, frequencies distribution, ranges and standard deviation. The ranges, mean values and standard deviation of craniofacial variables and facial index calculated are listed in the tables below:

3. RESULTS

The results showed that the male to female ratio was 1:1.4, with adolescents having the highest frequency, and each representative state of the Yoruba-speaking language was adequately represented (Table 3). The mean age of all the participants was 19.5 years while the mean height and weight were 1.60 m and 58.43 kg respectively (Table 6).

3.1. Facial index classification

The mean values for facial index (FI) were 116.81±13.21 (for males) and 113.65±14.55 (for females) (Table 4).The mean values for morphological facial index (FI) across age groups were: 114.30±14.86 (15-19 yrs), 115.71±13.10 (20-24 yrs) and 116.51±12.22 (25-29 yrs) with a total mean of FI 114.95±14.10 (Table 5). As shown in Tables 4 and 5, the Yoruba males and females had hyperleptoproscopic (very long) faces**.** Correlating facial index and biometric parameters revealedthat FI had a weak and significant positive correlation with weight, age, and height but a weak and significant

Table 5: Crosstab Age Categorization of Facial Index.The dominant face type was hyperleptoproscopic (very long face).

	AgeCat (years)	Mean (±SD) per age grp	Hypereury-proscopic	Eurypro-scopic	Meso-proscopic	Lepto-proscopic	Hyperlepto-proscopic	Total
Facial index (FI)	15 - 19	114.30±14.86	1_a	1_a	3_a	16_a	1158_a	1179
			0.1%	0.1%	0.3%	1.4%	98.2%	100.0%
	20 - 24	115.71±13.10	0_a	0_a	3_a	18_a	836_a	857
			0.0%	0.0%	0.4%	2.1%	97.5%	100.0%
	25 - 30	116.51±12.22	0_a	0_a	0_a	1_a	71_a	72
			0.0%	0.0%	0.0%	1.4%	98.6%	100.0%
Total	N	114.95±14.10	1	1	6	35	2065	2108
	%		0.0%	0.0%	0.3%	1.7%	98.0%	100.0%

Table 6: Correlations between facial index and biometric parameters.

Biological data	Mean (±SD)		Facial index
Age (years)	19.50±2.23	Pearson correlation (r)	0.057*
		p-value	0.009
Height (m)	1.59±0.097	Pearson correlation (r)	0.234**
		p-value	0.000
Weight (kg)	58.43 ±10.78	Pearson correlation (r)	0.000
		p-value	0.089**
BMI		Pearson correlation (r)	-0.067*
		p-value	0.002

r= Pearson Correlation; *. Correlation is significant at the 0.05 level; m=meters; kg=kilogram; S.D= standard deviation

negative correlation with BMI (Table 6)

4. DISCUSSION

In this present study, out of a total of 2109 participants that took part in the study, the demographic distribution showed that females (1244) outnumbered males (865) with a ratio of 1.4:1. This was because females turned out better for the study than males, and it is also not impossible that more females were admitted than males in the session in which recruitment was done.

In addition, when the participants were grouped into age categories according to WHO, adolescents (15–19 years) accounted for the majority (1179), followed by young adults (20–24 years) with 858, and 72 adults (25–29 years) with an average age of 19.5 years across all age groups. The choice of these age groups is in accordance with Barash, (27), who discovered that younger age has little or no impact on face morphology, and Bishara *et al.* (14), who observed that significant changes in facial morphology occur more later in life, after the mid-twenties. Furthermore, earlier research (28) has revealed that criminal behaviors rise in adolescence or early adulthood, which coincides with the most common age groups present in postsecondary institutions. Also, at about that age, facial laxity is lessened and the main growth at the basocranium is completed.

In this study, covariate factors (weight, height and body mass index (BMI)) that could cause false positive results were also taken into consideration. The average BMI calculated in this study was 23.02,

which showed that most of the participants were of normal weight, and thus BMI may not have had a significant effect on the parameters studied. Thus, the result of this current study showed that MFI had a weak and significant positive correlation with weight, age and height but a weak and significant negative correlation with BMI. The current results differs from that of Adhikari *et al.* (29), who discovered that most of the facial features studied have a moderate to significant relation with BMI, age, sex, and ancestry. The fact that the results of this study differ from those of prior studies could indicate that BMI, height, and fat distribution vary greatly depending on gender, age and genetic factors (20).

Our results on facial index (FI) showed that the commonest type of face among Yoruba males (98.0%) and females (97.9%) washyperleptoproscopic (very long). Few participants had other face types. The pattern of facial types among our participants is similar to what was observed by Okwesili *et al*. (1), which showed that the predominant type of face among adolescent Igbo males and females was hyperleptoproscopic, followed by leptoproscopic and mesoproscopic, with a lower percentage having either euryproscopic or hypereuryproscopic types of faces, and by Eliakim-ikechukwu *et al*. (11), who also found out that the dominant type of face among hausa males was hyperleptoproscopic. The reason for the similarity in results could be due to the fact that both Yorubas (as seen in the present study) and Hausas and Igbos (as seen in the previous study) are of African descent, and the differences in the mean values of FI are due to ethnic variation (Table 1).

Also, when the mean of the FI of the present study for both males (116.81±13.21) and female (113.64±14.55) was compared, it showed that males had a higher mean facial index than females. This was similar with Igbo population in a study carried out by Okwesili *et al*., (1), who found FI for males to be 100.2±13.6 and FI for females to be 93.4±4.7. The differences in the results showed that there was sexual dimorphism as well as ethnic influences affecting facial morphology. On the other hand, the results of this study contradict the findings of Omotoso *et al.* (10) and Eliakim-ikechukwu *et al.* (11), who found that the dominant types of face among Igbo adolescents and adults were mesoproscopic (10) and hypereuriproscopic 11) (Table 1). These further buttresses the fact that there are sexual and ethnic differences affecting facial morphology and differences may also be due to differences in the methods of measurements, as spreading and sliding calipers were used by the two authors as opposed to the photography that was used in the current study.

Our values for FI were 113.6414.55 (females) and 116.8113.21 (males), indicating that hyperleptoprosopic faces predominated among Yoruba males and females. When our results were compared to other populations around the world, such as the studies of Maalman *et al*., (2) (Ghanian population); Chettri *et al*., (23) (Indian population), found hyperleptoproscopic type of face; while Shetti et al.(12) (Indians and Malaysian populations); Jahanshahi *et al*., 2008 (Iranian population) found the mesoproscopic type of face has been the dominant type among males. In a study of another tribe in Iran, Jahanshahi et al. (13) found that the dominant face type among females was euriproscopic. The differences in the results showed that there is racial differences across populations (Table 2).

The results of this study that showed that FI had a weak and significant positive correlation with weight, age, height and BMI was not in line with the study of Okwesili *et al*. (1), who observed that facial index had no significant correlation with age, height, and weight. Previous studies (15) also demonstrated that FI in children differs from that in adults of the same race and gender, though children were not considered in this study. Barash *et al*. (27) also said that with substantial weight loss or weight gain that could affect soft facial tissue, BMI as a covariate has to date been ignored in association studies of normal craniofacial morphology, but the current study has demonstrated a kind of relationship and, thus, BMI should be considered in association studies.

The findings of this study's FI can be applied to forensic medicine, plastic surgery, genetics to diagnose craniofacial dysmorphology (22), and person identification, particularly in ethnic and racial differences. When the findings of this study were compared to those of previous studies, it was discovered that there are racial and ethnic differences, as well as sexual dimorphism, in the facial index analyzed.

5. CONCLUSION

The study concluded that the majority of adolescents and young adults of Yoruba ethnic groups in Nigeria have hyperleptoproscopic (very long) faces, with males having longer faces than females. A small percentage of the population had leptoproscopic and mesoproscopic faces, with none of the participants having euryproscopic or hypereuryproscopic types of faces. Our results showed that FI had a weak and significant positive correlation with weight, age, and height but a weak and significant negative correlation with BMI. The facial parameters exhibited sexual dimorphism all throughout. Clinicians, plastic surgeons, maxillofacial surgeons, and geneticists can use the information from this study to diagnose and treat craniofacial disorders.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

Ethical Statement

Ethical approval was obtained from the University of Ilorin Ethical Committee through the Faculty of Basic Medical Sciences Ethical Review Committee (UERC/ASN/2019/1694). Informed consent forms were signed by the volunteers after been informed about the study.

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