

Photogrammetric Analysis of Soft Tissue Profile of the Face of Igbo in Port Harcourt

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Abstract: The understanding of soft tissues of the face in relation to the underlying dentoskeletal tissues is an essential guide in aesthetic treatment plan. The present study quantify the average parameters that define the soft tissue norms for young Igbo adults by means of linear and angular measurements. Standardized photographic records of 200 (100 males and 100 females) subjects taken in the Natural Head Position (NHP) were analyzed. Igbo male subjects had a mean percent ratio of 41.85 ± 0.03 for middle face and 58.15 ± 0.03 ratio for lower face, a nasofrontal angle of $130.18 \pm 8.84^\circ$, a nasofacial angle of $39.92 \pm 4.720^\circ$, a nasomental angle of $112.99 \pm 8.91^\circ$ and a mentocervical angle of $91.11 \pm 2.25^\circ$. In Igbo female subjects the mean values for middle face, lower face, nasofrontal angle, nasofacial angle, nasomental angle and mentocervical angle were $43.03 \pm 0.03^\circ$, $56.97 \pm 0.03^\circ$, $134.29 \pm 9.18^\circ$, $38.06 \pm 5.22^\circ$, $117.25 \pm 8.240^\circ$ and $90.37 \pm 1.280^\circ$, respectively. Statistical analysis (using the z score) showed significant gender differences for all parameters ($p < 0.05$). The data presented in this study could be potentially useful in orthodontics and facial plastic surgery.

Key words: Igbo, lower face, middle face, nasomental, nasofacial, nasofrontal

INTRODUCTION

The face is the anterior aspect of the head from the forehead to the chin and from one ear to the other. It provides identity for individual human. Soft tissue of the face together with the underlying dentoskeletal tissues defines the facial traits of a person. Facial traits are major features in physical feature which is well correlated to social appearance, psychological well being and self esteem of an individual (Hershon and Giddon, 1980). Therefore, defects (malformations, scarring, or other alterations from pathology or trauma) have marked consequences beyond physical effects. One of primary goals of all medical specialty concerned with the treatment of the face is to attain and preserve optimal attractiveness. Most treatment plan based on only dentoskeletal analysis of the face has sometime led to aesthetic problems. As soft tissues covering the bones and teeth can vary so greatly that dentoskeletal pattern may be an inadequate to guide in formulating treatment plan (Arnett and Bergman, 1993; Bergman, 1999; Park *et al.*, 2004). Thus, the understanding of soft tissues and their normal ranges is essential in restoring or enhancing facial traits.

It is well established that a single facial aesthetic is not appropriate for application to diverse race and ethnic populations (Proffit, 1999), as facial traits are largely

influenced by factors such as races, ethnicity, age, sex, culture, etc (Mandall *et al.*, 2000; Sahin Saglam and Gazileri, 2001). In addition, features of different races and ethnic groups are not randomly distributed, but appear in geographical clusters (Krishan and Kumar, 2007). Therefore, the need to study the soft tissues of the face in different ethnic groups to establish anthropometric data for populations with different ethnic backgrounds is imperative.

Various methods such as anthropometry (Frakas, 1981) and photogrammetry (Fernandez-Riveiro *et al.*, 2003; Jain *et al.*, 2004) have been used to study soft tissues norm in different populations. Soft tissue profile standards using photogrammetry have been reported for North American population (Powell and Humphreys, 1984), Spanish (Fernandez-Riveiro *et al.*, 2003), Indians (Jain *et al.*, 2004), Brazilllian Caucasians (Reis *et al.*, 2006), Croatians (Anic-Milosevic *et al.*, 2008) and Turkish (Kale-Varlk, 2008; Senem *et al.*, 2009).

In literature, several studies have been carried out to determine facial traits of African tribes (Didia and Dapper, 2005; Garba *et al.*, 2008; Fawehinmi and Eroje, 2009; Olotu *et al.*, 2009). Most of these studies focused on facial dimensions rather than soft tissue analysis. Vertical and angular facial parameters of soft tissue profile have reported for the Urhobos Oghenemavwe *et al.*, 2010).

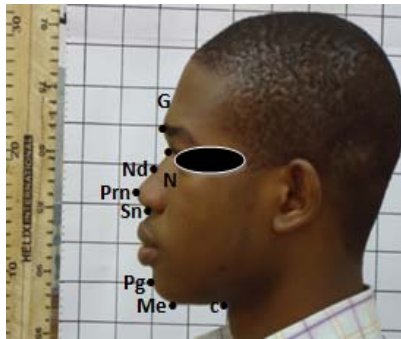


Fig. 1: Sft tissue landmarks used in this investigation: glabella (G), nasion (N), nasal dorsum (Nd), pronasale (Prn), subnasale, pogonion (Pg), menton (Me) cervical point-(c)

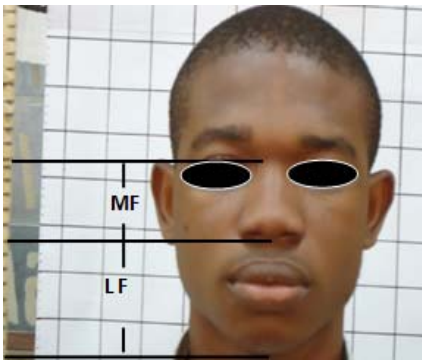


Fig. 2: Vertical measurements: middle face height (ML), lower face height (LF)

Against these background this study was carried determine normal range of soft tissues profile of the face in young adult Igbos in Port Harcourt of South- South Nigeria. These will provide a data base that will be useful in orthodontics and facial plastic surgeries.

METHODOLOGY

This research was conducted in Friendship Center across Port Harcourt city the capital of Rivers State situated in the South-South Nigeria between April to November, 2009. Two hundred volunteers of Igbo extraction consisting of one hundred males and one hundred females participated in this study, which was approved by the Ethics Committee of the College of Health Sciences University of Port Harcourt. Subjects included in this study were required to be 18 through 35 years of age to minimize the effect of aging on facial dimensions. Other inclusion criteria consisted of parents and 4 grandparents of Igbo extraction, no previous plastic reconstructive surgery of the face, no major trauma of the face, body mass index of not greater than 27, and no history of craniofacial syndrome.

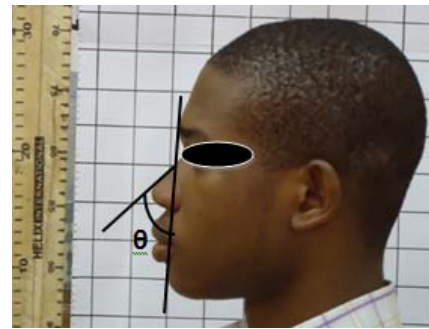


Fig. 3: Naofrontal angle

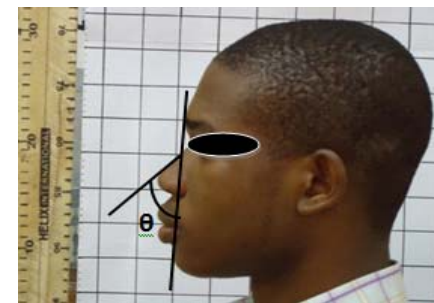


Fig. 4: Nasofacial angle

After obtaining informed consent, demographic data were obtained; including age, weight, height, tribe of volunteer and that of their parents and grandparents. Standard photograph of the lateral and front view of the face were obtained in the Natural Head Position (NHP). The photographic set up consist of a tripod (Seagull A300) supporting a digital camera (Samsung S850, 7.8 megapixel, x4 zoom). The adjustment of the tripod height allows the optical axis of the lens to be maintained in a horizontal position. This was adapted to the subject height during recording. Each subject was asked to relax with both hands hanging beside the trunk. The subjects were position on a line marked on the floor 100 cm from the camera and placed beside the subject was a meter rule that allows measurement at life size. 120 cm in front of the subject on the opposite was a mirror. The subject have to look into their eyes in the mirror with their lips relax so that both the front and side view can be 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. Using the meter rule on the side as a guide all photographic records were scaled to life size and eight landmarks (Fig. 1) were used to obtain the following parameters (Fig. 2-6).

- **Middle face proportion:** This is the distance between the nasion and subnasale expressed in percent ratio by dividing it with the distance from nasion to menton and multiplying by 100 (i.e., $N-Sn/N-Me \times 100$)

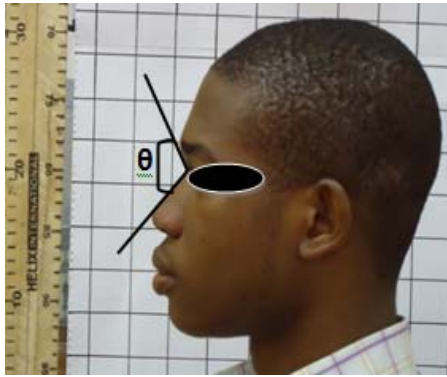


Fig. 5: Nasomental angle

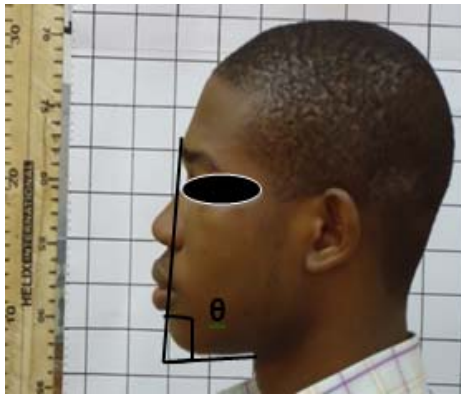


Fig. 6: Mentocervical angle

- **Lower Face proportion:** This is the distance between the subnasale and menton expressed in percent ratio by dividing it with the distance from nasion to menton and multiplying by 100 (i.e., $\text{Sn-Me/N-Me} \times 100$)
- **Nasofrontal angle (G-N-Prn):** It is formed by drawing a line tangent to the glabella through the nasion that will intersect a line drawn tangent to nasal dorsum
- **Nasofacial angle:** It is formed by drawing a vertical line tangent to the forehead at the glabella (G) and tangent to the chin at pogonion (Pg) so that a line drawn along the nasal dorsum (Nd) intersects it
- **Nasomental angle (N-Prn-Pg):** It is formed by a line drawn from the nasion through the nasal dorsum intersecting a line drawn from the soft tissue chin pogonion at the pronasale
- **Mentocervical angle (G-Pg/C-Me):** A vertical line tangent to the forehead passing through the glabella and pogonion intersecting a second line tangent to the menton

All photographic records were analyzed by the same investigator to ensure uniformity. Data were presented as the mean plus standard deviation (SD). Statistical analysis

Table 1: Values for vertical measurements of facial proportions

Parameter	Sex	Min.	Max.	Mean
Middle face	Male	34.78	48.55	41.85±0.03
proportion	Female	33.33	49.28	43.03±0.03
Lower face	Male	51.85	65.22	58.15± 0.03
proportion	Female	50.72	66.67	56.97±0.03

was performed using the Z score. A value for *P* less than 0.05 was considered significant.

RESULTS AND DISCUSSION

The mean measured values for males and females are shown in Table 1 and 2. All parameters were statistically significant ($p < 0.05$) sexual dimorphism. The nasofrontal and nasomental angles were wider in the females. The greatest variability was found for the nasofrontal angle, which had the highest standard deviation and error of mean. Table 3 is comparative data on vertical and angular measurements in different populations.

The purpose of this study was to evaluate average variables that define the profile of the soft tissue of the face of Igbo subjects using standardized photogrammetric methods taken in the Natural Head Position (NPH). NPH has gained an increasing interest as a basic reference in orthodontics, facial plastic surgery and craniofacial anthropometry (Fernandez-Riveiro *et al.*, 2003). Houston (1991) stated, "Clearly it is desirable that norms for different population groups are obtained from radiographs taken in NHP". There are several facial analysis methods and landmarks (Epker, 1992; Arnett and Bergman, 1993; Auger and Turley, 1999; Fernandez-Riveiro *et al.*, 2003). These methods with the exception of those based on photography are expensive and require complex procedures that are difficult to evaluate mathematically (Ferrario *et al.*, 1998). Photography has been used as an excellent and convenient anthropometry tool for facial analysis and to compare pre and post operative outcome in facial plastic surgery (Larrabee, 1967; Andrews and Schoenrock, 1998; Pasinato *et al.*, 2008). Most plastic surgeons concerned with facial aesthetic work primarily from photographs or "real patients" and not radiograph (Park *et al.*, 2004). Photographic based study of soft tissues eliminates the exposure of subjects to x-ray. Malkoc *et al.* (2005a, b) also enumerated other advantages offered by photogrammetry. Firstly, with photogrammetric analysis, angular measurements are not affected by photographic enlargement as in cephalometric analysis. Secondly, every profile fiducial point can be moved freely on a computer monitor using cephalometric software program to determine the most appropriate profile point. Thirdly, angular photographic profile analysis does not require equipment and complex procedures and it offer digitized results that are easily evaluated. Furthermore, the collected data can be arranged in unified charts.

Table 2: Descriptive statistical data and comparison of males and females angular measurements

Parameter	Sex	n	Min.	Max.	Mean	SE	SD	p
Nasofrontl angle	Male	100	105	149	130.18	0.88	8.84	p<0.05
	Female	100	110	152	134.29	0.91	9.18	
Nasofacial angle	Male	100	29	52	39.92	0.47	4.72	p<0.05
	Female	100	28	49	38.06	0.52	5.22	
Nasomental angle	Male	100	92	132	112.92	0.89	8.91	p<0.05
	Female	100	91	135	117.25	0.82	8.24	
Mentocervical angle	Male	100	88	105	91.11	0.22	2.25	p<0.05
	Female	100	87	94	90.37	0.13	1.28	

n: sample size; Standard error of mean; SD: Standard deviation

Table 3: Comparative data on vertical and angular measurement in differe

Author/Date	Population	MF (%)	LF (%)	NFR (^o)	NFA (^o)	NM (^o)	MC (^o)
Present study	Igbos	41.85±0.03(M)	58.15±0.03 (M)	130±8.84(M)	39.92±4.72(M)	112.99±8.91(M)	91.92±2.25(M)
		43.03±0.03	56.97±0.03	134.29±9.18	38.06±5.22	117.25±8.24	90.37±1.28
Oghenemaywe <i>et al.</i> (2010)	Urhobos	42.27±3.17(M)	57.73±57(M)	121.75±9.07(M)	40.77±6.29(M)	121.95±7.93(M)	93.33±3.27(M)
		43.51±3.67	56.49±3.69(F)	127.85±8.50(F)	35.60±7.46(F)	126.55±6.93(F)	90.88±3.58(F)
Fernandez-Riveiro <i>et al.</i> (2003)				138.57(M)			
Anic-Milosevic <i>et al.</i> (2008)	Croatsians			141.98(F)			
				139.11(F)			
Jain <i>et al.</i> (2004)	Himachalis	44.63	55.37	134	33.26	128	99.88
Epker (1992)	Caucasians			130			
Powell and Humphreys (1984)	North American	47	53	122.5	35	126	87.5
Frakas (1981)	Caucasians		53-56				

In the present study, the lower face proportion was bigger than the middle face and these well correlate with studies of Powell and Humphreys (1984) on North American Caucasians and Jain *et al.* (2004) on Himachalis of Indian. North American Caucasians have average values of 43 and 557% while the Himachalis of Indian have average values of 44.63 and 55.57% for middle and lower face proportions respectively. One study showed a lower face of 53% for very attractive females and 54% for attractive females. (Frakas and Kolar, 1987) The lower face proportion obtained in this study and that of Powell and Humphreys (1984) contradict the assertion by Frakas (1981) that the normal range for lower face is 53 to 56%. The middle and lower face are extremely important in surgical orthodontic diagnosis and treatment planning. The important consideration is the proportionate measurement as opposed to absolute measurement (Bergman, 1999). Decrease in the lower face is found in vertical maxillary deficiency and deep bite mandibular retrusion.

The ultimate compensators of facial contour are soft tissues. Extensive evaluation of angular relationship are essential in soft tissues profiling as not all facial traits directly follow the underlying dentoskeletal profile (Subtenly, 1959). The nasofrontal, nasofacial and nasomental angles were formulated by Powell and Humphreys (1984) to show the relationship between the nose and the face. Currently these parameters dominate facial plastic surgery literature. The nasofrontal angle showed significant sexual dimorphism (p<0.05) in our study with mean values of 130.18±8.84° for males and 134.29±9.18° for females. These values are lower than

those of most Caucasians studied. Anic-Milosevic *et al.* (2008) reported a mean value of 136.38±6.70° for males and 139.11±6.35° for females of Croatian origin. It was 138±57° for males and 141±9.8° for females of Galician origin (Fernandez-Riveiro *et al.*, 2003). The reason for the low value in this study may be attributed to prominent glabella. Sexual dimorphism observed in this study agrees with the findings of Anic-Milosevic *et al.* (2008) and Fernandez-Riveiro (2003). It however contradicts that of Epker (1992).

The relationship of the nose with the facial plane is a facial parameter of aesthetic importance. An average of 35° and 33.26° has been reported for North American Caucasians and Himachalis population respectively. This is low when compared to the samples in this study. Higher nasofacial angle in this study suggest that the projection of the nose in the Igbos is more than those of the Himachalis and North American population.

Pasinato *et al.* (2008) stated that the expected range for nasomental angle is 120° to 132°. This is variance with our study. Studies by Powell and Humphreys (1984) and Jain *et al.* (2004) established an average value of 126° and 128°, respectively.

The mean of the mentocervical angle for the Igbos is higher than that of North America population and lesser than that of the Himachalis. Less prominent glabella results in higher mentocervical and nasofrontal angles. Bergman (1999) noted that this is critical in anteroposterior facial dysplasia and that an obtuse should warn against procedures that reduce the prominence of the chin in surgical cases.

CONCLUSION

In conclusion, racial and ethnic differences in the facial structure is a well accepted fact. The correct concept for aesthetics for a Brazilian Negroid facial trait is different for that for a Nigerian Negroid. Hence, it is imperative that effort should be made to establish general norms for different races and ethnic groups with consideration for certain individual characteristic features. This study has shown as in most other population that the vertical and angular variables that tissue profile are sexually dimorphic amongst the Igbos of Nigeria.

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