Original Research Article

EXPLORING THE CORRELATION BETWEEN FACIAL INDEX,ORBITAL WIDTH AND INTERCANTHAL DISTANCE IN ADULT IGBOSOF A NIGERIAN POPULATION

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Abstract

Background

Facial anthropometry provides useful information on different facial features as well as population-specific variations that are crucial in forensic science and facial surgeries.The major aim of this research was to determine normal facial and orbital parameters in adult Igbos living in Enugu, Nigeria and to investigate the correlation between these variables.

Materials and methods: This was an anthropometric study of adult Igbos of Igbo ancestry residing in Enugu metropolis, a town in South-eastern Nigeria.The morphological facial height, the maximum facial width,orbital width and intercanthaldistanceof each subject were measured. All data were collated and analyzed.

Results: Subjects studied were 312. They had a mean age of 37.05. The mean morphological facial height was116.26mm for males and 109.66mm for females. The mean maximum facial width for males was 121.31mm, and for females 119.25. The mean facial index for males was

96.06, and 92.17 for females (p <0.01)The mean right eye width of the men was 38.01mm and that of the women was 37.22 mm (p <0.05). The mean intercanthal distance of males was 34.94mm, and3.22mm for females.There was significant correlation (p <0.01) between maximum facial width and the widths of both eyes and the intercanthal distance respectively. Morphological facial height had a similar correlation. However, there was no significant correlation between the facial index and the eye widths and none with intercanthal distance.

Conclusion: There is strong correlation between orbital parameters and facial parameters except for facial index which had no significant correlation. The findings of this study have potential applications in forensic science, in the planning and assessment of facial reconstruction, aesthetic surgeries and orthodontics, as they provide valuable information about the facial structure of the Igbo population.

Keywords: Facial index, facial dimensions, eye width, intercanthal distance, Igbo, Nigeria, anthropometry

1 INTRODUCTION

Facial anthropometry provides useful information about key relationship between different facial features as well as population-specific variations that are crucial in forensic science, as well as in facial surgeriesdone by maxillofacial and plastic surgeons. The study of facial index, facial proportions and symmetry has been utilized in understanding facial structure,which helps in predicting and evaluating clinical outcome of diverse facial reconstructions.Facial measurements are used in diagnosing congenital facial abnormalities, planning corrective procedures for these anomalies,[1] and customizing medical devices like facial prosthetics. The assessment of these dimensions also quite useful in forensic studiesand investigations that identify human remains.

Facial dimensions, including facial index, eye width and intercanthal distancewere reported to differ significantly among diverse ethnic groups, as well various races,[1-5]due to genetic,

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environmental, climatic and nutritional factors.[4,6,7]Facial index is the basis for classification of the face into hypereuryprosopic face (with index<79.9), the broad or euryprosopic (index: 80.0 - 84.9), the round or mesoprosopictype (85.0 -89.9), the long or leptoprosopic face (90-94.9) and the very long or hyperleptoprosopicface (>95).[8,9]

The Igbos are one the predominant ethnic groups in Nigeria with unique anthropometric characteristics that have been studied. However, there is limited research focused on the correlation between facial dimensions and orbital dimensions especially among Igbos. Understanding these correlations in the Igbo population could provide critical data that would have relevant medical and forensic applications like designing of facial gear establishing aesthetic standards in clinical practice[10,11].The aim of the study was to explore the correlation between facial dimensions (facial index) and orbital measurements (orbital width and intercanthal distance) in adult Igbos living in Enugu, Nigeria.The study will add to the existing body of knowledgeby providing population-specific anthropometric dataand also enhance the understanding of ethnic differences in facial morphology**.**

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2 MATERIALS AND METHODS

2.1 Design and Sample Size

The was a cross-sectional study of Igbo men and women living in Enugu metropolis. Enugu is the most popular town in Eastern Nigeria. According to a national census, the population of Enugu metropolis was seven hundred and twenty-two thousand, six hundred and sixty-four people (722,664). The calculated sample size was 200 using Bourley's formula.[12]Using cluster sampling method, 312 subjects aged between 20 and 69 years were recruited from tertiary institutions, a ministry at the Enugu State Government secretariat,and a gathering of

retirees.Ethical approval was obtained for the original proposal, “Craniofacial Dimensions in the Igbos of Enugu” from theHealth and Research Ethics Committee of the University of Nigeria Teaching Hospital. Enuguwith certificate number NHREC/05/01/2008B-FWA00002458-1RB00002323.

2.2 Study Criteria

Inclusion Criteria:

Subjects with facial anatomy and body stature that were consistent with the norm were recruited.

Exclusion Criteria:

1. Individuals with a history of congenital facial anomalies, such as hypertelorism or facial asymmetry, or facial trauma were excluded.

2. Individuals from other ethnic groups or any Igbo with a parent or grandparent who was not Igbo were excluded.

2.3 Data Collection Method

The facial parameters of each subject were measured while standing erect or sitting in a comfortable chair with the head in anatomical position. The morphological facial heightisstraight distance between the nasal root (nasion) and the mid-point of lowest part of the mandible (Gnathion). The maximum facial width isthe distance between the most lateral part of zygomatic prominences. These points were palpated on either sides and the distance between them measuredt. The facial index was calculated as the morphological facial height divided by the maximum facial width multiplied by 100.[10]

The eye width is the distance between the endocanthus and exocanthus. The endocanthus is the inner corner of the eye where the upper and lower eyelids meet, while the exocanthus is the outer corner of the eye where the eyelids meet laterally. The left and right eye widths were

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measuredfor each subject. The intercanthal distanceis located centrally between both eyes. It is the distance between the two endocanthi of eyes.

2.4 Statistical Analysis

The data were analyzed using statistical package for social sciences (SPSS) version 25. They were subjected to statistical analyses for means, and standard deviation and depicted in tables and figures as applicable. The mean values for both genders were compared using student t-test and a probability (p values of less than 0.05 were considered statistically significant. Using SPSS Pearson's correlation coefficient (r) were determined used to check for any relationship between the facial variables and the eye width on one hand and with the intercanthal distance on the other hand.

3 RESULTS

3.1 Demographics

Out of the 312 subjects evaluated and measured, 126 were males and 186 females. They had a mean age of 37.05 (±15.83). The age range of the subjects was 20 to 69 years.

3.2 Morphological Facial Heights:

The mean morphological facial height was 116.26mm for males and 109.66mm for females and there was significant difference between the values for both sexes ($p < 0.01$) – Table 1.

Table 1: The mean values of all the parameters by sex

	Males				Females				
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	p value

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Facial Height (mm)	126	116.26	6.69	0.60	186	109.66	5.46	0.400	.000
Facial Width (mm)	126	121.31	6.55	0.58	186	119.25	6.52	0.478	.007
Facial Index	126	96.06	6.90	0.61	186	92.17	6.00	0.44	.000
WIdth of Rt Eye (mm)	126	38.01	5.20	0.46	186	37.22	2.00	0.15	.107
Width of Lt Eye (mm)	126	36.69	2.57	0.23	186	36.37	1.88	0.14	.207
Intercanthal Distance (mm)	126	34.94	2.70	0.24	186	33.22	3.03	0.22	.000

******p < 0.01

*****p < 0.05

Table 2 shows that apart from the 50-59yrs group, morphological facial height was found to be higher in the males of all the groups, and the differences were statistically significant.

Table 2: Morphological facial heights and maximum facial widths of adult males and females

	Morphological facial height					**Maximum facial width**				
	Males		**Females**			**Males**		**Females**		
Age(yrs)	**Means**	**SD**	**Means**	**SD**	**p value**	**Means**	**SD**	**Means**	**SD**	**p value**

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20-29	115.6	6.5	109.4	5.2	0.00**	121.6	6.0	119.0	6.8	0.04*
30-39	116.7	8.6	109.7	3.7	0.00**	120.6	8.2	119.5	5.7	0.61
40-49	117.8	6.9	108.1	6.9	0.00**	123.0	4.0	119.4	8.6	0.08
50-59	114.5	5.8	113.2	4.5	0.42	120.0	7.5	121.0	3.8	0.60
60-69	117.5	6.2	108.7	7.7	0.00**	120.9	7.6	117.6	5.8	0.17

******Significant at $p < 0.01$

*****Significant at $p < 0.05$

3.3 Maximum Facial Widths

The mean maximum facial width for males was 121.31mm; it was higher than that of females which was 119.25 for females and the difference between them was statistically significant ($p < 0.01$)(Table 1).In all the age groups, the males had wider maximum facial width than the females but the differences were not statistically significant except in the 20-29 years group (Table 2).

Facial Index: The mean facial index for males was 96.06, and it was higher than that of females which was 92.17, and difference between them is statistically significant ($p <0.01$) (Table 1). The mean facial index for the whole sample population was 93.7. In all the age groups the males had higher facial indices. In the second, third, fourth and sixth decades of life, the differences between both sexes were statistically significant ($P < 0.05$), but the difference in the 50-59ys age group was not statistically significant(Table 3).

Table 3: The facial indices of adult males and females

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	MALES			FEMALES			
Age (yrs)	**No.**	**Mean**	**SD**	**No.**	**Mean**	**SD**	**p value**
20-29	42	95.2	5.3	100	92.2	6.1	0.01*
30-39	15	97.2	9.4	30	91.9	4.5	0.02*
40-49	24	95.9	5.8	22	90.8	7.2	0.01*
50-59	23	95.8	8.7	20	93.7	5.8	0.35
60-69	22	97.5	6.9	14	92.6	6.6	0.04*

******Significant at $p < 0.01$

*****Significant at $p < 0.05$

Figure 1 shows that hyperleptoprosopic face (20.50%) was the commonest among males, and this was followed by leptoprosopic (11.50%) and mesoprosopic (7.70%)faces.The pattern was different for females where the same number of women had leptoprosopic and mesoprosopic faces (18,60%) and the number of women with hyperleptoprosopic (17.90%) was slightly lower than these two.

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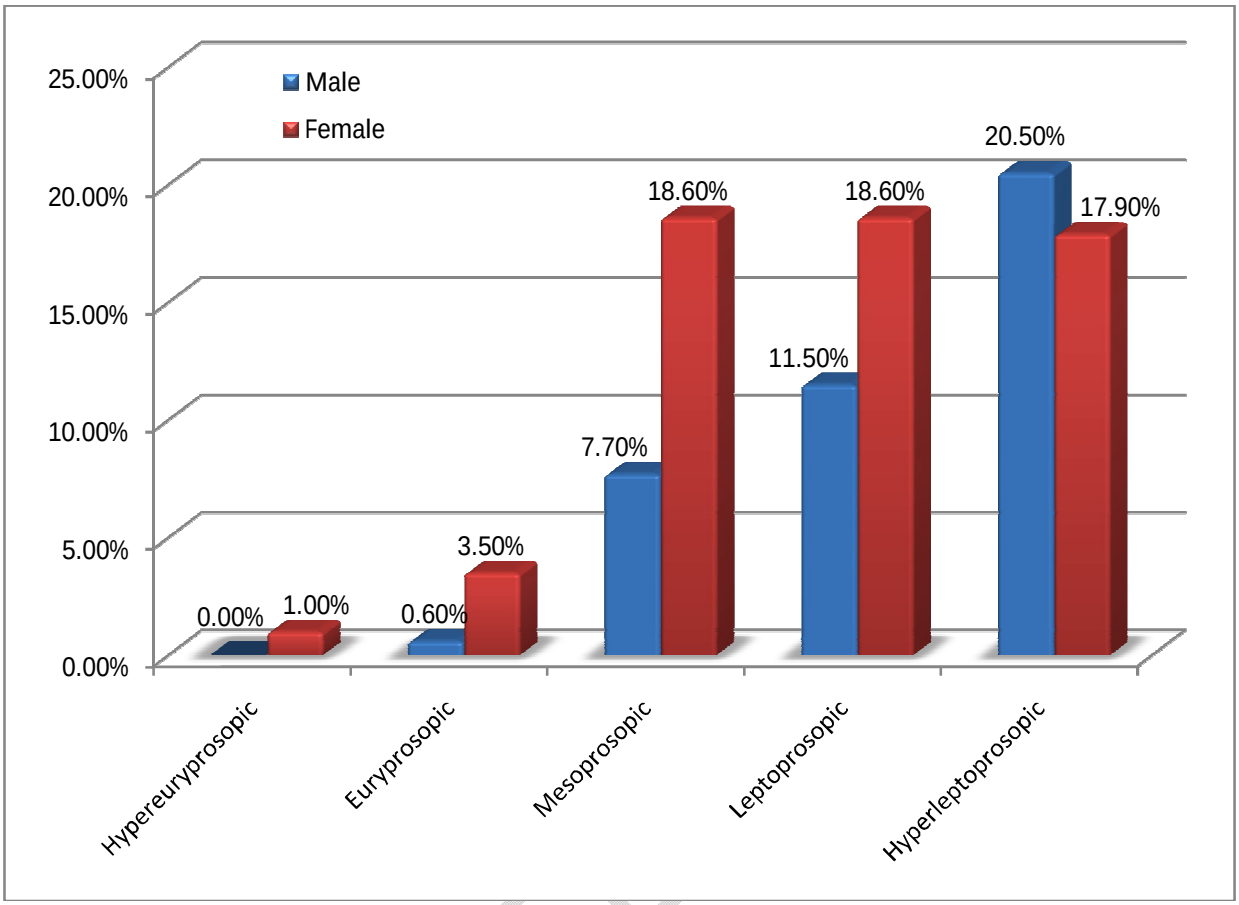

Figure 1: The distribution of facial types among adult Igbos by sex

Majority of the subjects (38.4%) had very long faces (hyperleptoprosopic), next in number was the leptoprosopic face (30.10%), followed by mesoprosopic face (26.3%). The number of people with euryprosopic and hypereuryprosopic faces were quite few, 4.1% and 1.0% respectively. **Widths of bothEyes:** The mean width of the right eye was 38.01mm in males and 37.22 mm in females but the difference between them was not statistically significant at $p < 0.05$(Table 1). The width of the left eye was 36.69mm in males and 33.22 mm in females but there was no statistically significant difference between them with $p < 0.05$(Table 1). There were no statistically significant differences in both eyes and in all the age groups except for the right eye in the 20-29yrs age group(Table 4).

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Table 4: The widths of the eyes in the adult males and females

	RIGHT EYE					LEFT EYE				
	Males		Females			Males		Females		
Age (yrs)	Means	SD	Means	SD	p value	Means	SD	Means	SD	p value
20-29	38.1	2.3	37.3	1.9	0.04*	36.9	2.7	36.3	1.7	0.15
30-39	38.2	2.2	38.2	1.4	1.00	37.8	1.7	37.5	1.5	0.51
40-49	40.1	10.7	37.3	2.1	0.22	37.4	2.4	36.1	2.2	0.06
50-59	37.4	2.0	36.4	2.0	0.10	36.5	1.9	36.2	1.6	0.53
60-69	36.0	3.3	35.5	2.7	0.65	35.0	2.9	35.2	2.6	0.89

******Significant at $p < 0.01$

*****Significant at $p < 0.05$

Intercanthal Distance: The intercanthal distance of males 34.94mm, and was significantly higher than that of females which was 33.22mm ($p<0.01$) (Table 1).Males had wider intercanthal distance than females and the differences were statistically significant in all the age groups(Table 5).

Table 5: Intercanthal distances of the adult males and females

	MALES			FEMALES			
Age(yrs)	No.	Mean	SD	No.	Mean	SD	p value

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20-29	42	35.1	2.5	100	33.9	3.1	0.03*
30-39	15	34.9	1.8	30	32.5	2.5	0.00**
40-49	24	33.5	3.1	22	31.5	3.6	0.04*
50-59	23	35.3	2.1	20	33.1	1.9	0.00**
60-69	22	35.8	3.2	14	32.4	2.1	0.00**

******Significant at $p < 0.01$

*****Significant at $p < 0.05$

Correlations: There was significant correlation ($p < 0.01$) between maximum facial width and the widths of both eyes and the intercanthal distance respectively (Table 6). There was also significant correlation between morphological facial height and width of the left eye and intercanthal distance respectively. However, facial index had no significant correlation with the eye widths and none with intercanthal distance (Table 6).

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Table 6: Correlations of facial variables and orbital variables

	Width of Rt Eye (mm)		**Width of Lt Eye (mm)**		**Intercanthal Distance (mm)**	
	Pearson Correlation	**Sig. (2-tailed)**	**Pearson Correlation**	**Sig. (2-tailed)**	**Pearson Correlation**	**Sig. (2-tailed)**
Morp. Facial Height (mm)	0.070	0.219	0.199**	0.000	0.277**	0.000
Max Facial Width (mm)	0.201**	0.000	0.362**	0.000	0.295**	0.000

Facial Index	-0.102	0.072	-0.117*	0.038	0.017	0.765

****Significant at p < 0.01**

***Significant at p < 0.05**

4 Discussions

The aesthetic appearance of the face is dependent on the unique relationship between various structures and parts of the face.Some of the important features contributing to the unique appearance of the face are the shape of the face, the orbital dimensions and thepositioning of the eyes, which is defined by the intercanthal distance. The intercanthal distance has been postulated to be approximately the same length as width of either eye with a ratio of 1:1:1.[14]This knowledge about normal values of intercanthal distance is applied in the correction of hypertelorism and telecanthus, as well as reduction of naso-ethmoidal fractures.[14]The shape of the face is defined by facial index calculated from the morphological facial height and the maximum facial width.[8,9].Based on the present study, the mean facial index for adult Igbos in Enugu Metropolis was 93.7 (leptoprosopic face). Facial index exhibited sexual dimorphism, with males having a higher mean facial index of 96.1±6.90, meant forhyperleptoprosopic face, while that of the females was 92.2±6.00 (leptoprosopic face).The values were lower than the values from the study of Okoh et al,[15]where males and females had mean facial indices of 103.13±9.35 and 96.10±13.65 respectively, both being values for hyperleptoprosopic face – very long face. Okoh et al[15]used photogrammetric method different from the direct method used in the present study.Leptoprosopic face was also reported to be the dominant among the Idomas and Igede ethnic groups of Benue state who reside close to Igbos of Enugu, the population of the present study.[5]

The percentages of females that had mesoprosopic (18.6%) and leptoprosopic (18.6%) faces were equal, and they were close to the percentage of females with hyperleptoprosopic (17.9%) face. The pattern was different for males, who were predominantly hyperletoroscopic (20.5%),

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followed by leptoprosopic face (11.5%) and mesoprosopic (7.7%). The pattern of distribution of facial type reported by Okoh et al. [15]differed from that of the present study. The predominant facial type for both sexes was hyperleptoprosopic, with quite a few having any other type of face. Furthermore, in the present study, it was noted that facial index did not increase with age, which was the finding in the study ofEwunonuet al.[16]

On the other hand, the Igbo men had a mean eye width of 38.0mm for the right side, and 36.7mm for the left, while for the women the mean eye width for the right and left were 37,2mm and 36.4mm respectively. Eze et al.[17] reported lesser valuesand the dimension they reported for menwas 32.8mm and for the women, 32.6mm. Igbos and non-Igbos in Enugu were measured in their study unlike the present study where non-Igbos were excluded. This and a few other differences in the methodologies of the two studies are the reasons for the difference in values observed. The values for the left and right eyes were not determined separately in the study by Eze and his colleagues[17] unlike in the present study. The left eye had lower values in the present study, compared to the right eye, and the pattern was the same in both genders. The widths of the eyes in females were also less than those of the males. According to the report of Oladipo et al.,[18]Ijaw men had a mean eye width of 38.1mm and the women 36.0mm. These values are closer to those of the present study compared those reported by Eze et al[17] The mean intercanthal distance of Igbo men in the present study was 34.9mm and this was higher than the mean for Igbo women which was 33.2mm.The findings were similar to that ofIroanya et al,19]who reported 36.27 ± 0.49 for males and 34.25 ±0.83mm for females amongIgbos in a University in Lagos, a state in Nigeria.However, the present study had values that were less than those reported for people in Ebonyi State of Eastern Nigeria by Egwu et al[20]The males had 43.90mm and the females had 41.77mm. The study at Ebonyi was not limited to the Igbos alone unlike the present study, and this difference in the nature of the sample populationshould be responsible for the disparity in values.The intercanthal distance of

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Ikwere of South-South Nigeria had values that were closer to those of the present study since the men had intercanthal distance of 33.9mm and the women 33.8mm.[21]The intercanthal distance of Africans was reported to be 39.8 ± 2.9 for males and 37.1 ± 2.9 for females.[14]In the present study, the men had significantly wider intercanthal distances than the women in all the age groups ($P < 0.05$).Fewehinmi et al [22]reported the same sexual dimorphism exhibited by intercanthal distance.

One of the facial relationships that has been well studied is the “golden proportion”.[23]There is need to look at the relationship between other facial features like that between the facial parameters and eye widths or with the intercanthal distance. Maximum facial width and morphological facial height both have significant correlation with eye width and intercanthal distance. However, there is facial index did not have similar correlation. This suggests that what the eye widths and intercanthal distance is strongly related to facial dimensions but is not related to the shape of the face. There is need for further studies to explore this significant facial feature.

5. CONCLUSION

Majority of Igbo men in Enugu have either a very long face or just a long one, only a few have round faces, while short faces are uncommon among them. About two thirds of Igbo women have either a long face or a very long one, but about a third of them have round faces. Facial dimensions, facial index and intercanthal distance exhibited sexual dimorphism, but eye width did not. The width of each eye is slightly longer than the intercanthal distance. There is strong correlation between orbital parameters and facial parameters except for facial index which had no significant correlation. The findings of this study have potential applications in forensic science, in the planning and assessment of facial reconstruction, aesthetic surgeries and orthodontics, as they provide valuable information about the facial structure of the Igbo population.

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CONFLICT OF INTEREST

All the authors declare that there is no conflict of interest

CONSENT

Informed consent was obtained from all individual participants included in the study.

ETHICAL APPROVAL

Ethical approval was obtained for the original proposal, “Craniofacial Dimensions in the Igbos of Enugu” from the University of Nigeria Teaching Hospital Health and Research Ethics Committee

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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