

**CORRELATION BETWEEN FACIAL INDEX, ORBITAL  
WIDTH AND INTERCANTHAL DISTANCE IN ADULT  
IGBOS OF A NIGERIAN POPULATION**

**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 aim of this study was to establish 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 a descriptive cross-sectional study of 312 adult Igbos in Enugu, Nigeria. Cluster sampling was used. The facial, orbital and intercanthal dimensions were measured with digital Vernier's calipers. All data were collated and analyzed.

**Results:** Subjects studied were 312. They had a mean age of 37.05. The mean morphological facial height was 116.26mm 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 width of the right eye was 38.01mm in males and 37.22 mm in females ( $p < 0.05$ ). The intercanthal distance of males was 34.94mm, and 32.22mm 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, facial index had no significant correlation with the eye widths and none with intercanthal distance.

**Conclusion:** There is strong correlation between orbital parameters and facial parameters except for facial index and no significant correlation. These relationships are essential in understanding the facial structure and aid in facial reconstruction and forensic identification.

**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 surgeries done 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 studies and investigations that identify human remains.

Facial dimensions, including facial index, eye width and intercanthal distance have been reported to vary significantly among different ethnic groups, as well racial groups,[1-5] due to genetic, environmental, climatic and nutritional factors.[4,6,7] Facial index has been used in classifying the human face into hypereuryprosopic face (very broad face, range: <79.9), euryprosopic (broad face, range: 80-84.9), mesoprosopic (round face, range: 85-89.9), leptoprosopic (long face, range: 90-94.9) and hyperleptoprosopic faces (very long face, range: >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. The aim of this study is to investigate 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 knowledge by providing population-specific anthropometric data and also enhance the understanding of ethnic differences in facial morphology.

## **2 MATERIALS AND METHODS**

### **2.1 Study design and Sample Size**

The Study was a descriptive cross-sectional study of adult Igbos. It was conducted in Enugu, the capital of Enugu state, in Southeastern Nigeria. According to a national census, the population of Enugu was 722,664. The calculated sample size was 200 using Bourley's formula. Cluster sampling method was used in recruiting 312 subjects aged between 20 and 69 years from tertiary institutions, staff and visitors to the ministry of lands in Enugu state, as well as a group of retirees. 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.

## **2.2 Study Criteria**

Only subjects with normal body stature and facial anatomy were recruited. Exclusion criteria included those with a history of any facial trauma or congenital facial anomaly, like hypertelorism, facial asymmetry. Those of other ethnic groups or any Igbo with a parent or grandparent that was not Igbo were also excluded.

## **2.3 Data Collection Method**

Each subject was made to stand erect or sit in a comfortable chair with the head in anatomical position and the facial parameters were obtained. The morphological facial height was measured as the straight distance between the nasion (nasal root) and the gnathion (the lowest mid-point of the mandible) The maximum facial width/breadth was measured as the widest distance between the zygomatic prominences. The most lateral points of the zygomatic arches were palpated on either sides and the end of the calipers placed on these points to take the measurement. The facial index was calculated as the morphological facial height divided by the maximum facial width multiplied by 100.[10]

The width of the eye was measured as the distance between the exocanthus and endocanthus of each eye. The endocanthus is the inner corner of the eye fissure where the eyelids meet, while the exocanthus is the outer corner of the eye fissure where the eyelids meet. The distance was measured for the right and left eyes. The intercanthal distance was measured as the distance between the two endocanths of both eyes.

## **2.4 Data Analysis**

The data collected were entered and analyzed using statistical package for social sciences (SPSS) version 25. The data 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 and p values of less than 0.05 were considered statistically significant.

Pearson's correlation coefficient (r) was 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 ( $\pm 15.83$ ) and the age range was 20 to 69 years. Age distribution had 142 individuals in the 20 – 29 years group, 45 in 30 – 39 years group, 46 in 40 – 49 years group, 43 in 50 – 59 years group, and 36 persons in the 60 – 69 years group.

#### 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				p value
	N	Mean	Std. Deviation	Std. Error	N	Mean	Std. Deviation	Std. Error	
<b>Morp. Facial Height (mm)</b>	126	116.2	6.69	0.60	186	109.66	5.46	0.400	.000
<b>Max Facial Width (mm)</b>	126	121.3	6.55	0.58	186	119.25	6.52	0.478	.007
<b>Facial Index</b>	126	96.06	6.90	0.61	186	92.17	6.00	0.44	.000
<b>Width of Rt</b>	126	38.01	5.20	0.46	186	37.22	2.00	0.15	.107

<b>Eye (mm)</b>										
<b>Width of Lt</b>	126	36.69	2.57	0.23	186	36.37	1.88	0.14	.207	
<b>Eye (mm)</b>										
<b>Intercanthal Distance (mm)</b>	126	34.94	2.70	0.24	186	33.22	3.03	0.22	.000	

\*\*Significant at  $p < 0.01$

\*Significant at  $p < 0.05$

Table 2 shows that morphological facial height was significantly higher in the males of all the groups except for the 50-59 years.

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

Age(yrs)	Morphological facial height					Maximum facial width				
	Males		Females		p value	Males		Females		p value
	Means	SD	Means	SD		Means	SD	Means	SD	
<b>20-29</b>	115.6	6.5	109.4	5.2	0.00**	121.6	6.0	119.0	6.8	0.04*
<b>30-39</b>	116.7	8.6	109.7	3.7	0.00**	120.6	8.2	119.5	5.7	0.61
<b>40-49</b>	117.8	6.9	108.1	6.9	0.00**	123.0	4.0	119.4	8.6	0.08
<b>50-59</b>	114.5	5.8	113.2	4.5	0.42	120.0	7.5	121.0	3.8	0.60
<b>60-69</b>	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 significantly higher than that of females which was 119.25 for females ( $p < 0.01$ ) – table 1. The males had wider maximum facial width than the females in all the groups but the only significant difference was seen in 20-29 years group (table 2).

**Facial Index:** The mean facial index for males was 96.06, and it was significantly higher than that of females that was 92.17 ( $p < 0.01$ ) – table 1. The mean facial index for adults, males and females put together, was 93.7. Males had higher facial indices in all the age groups. The differences between both sexes were statistically significant for the 20-29 yrs, 30-39 yrs, 40-49 yrs and 60-69 years ( $P < 0.05$ ), but not so for the 50-59 yrs group ( $P < 0.05$ ) – table 3.

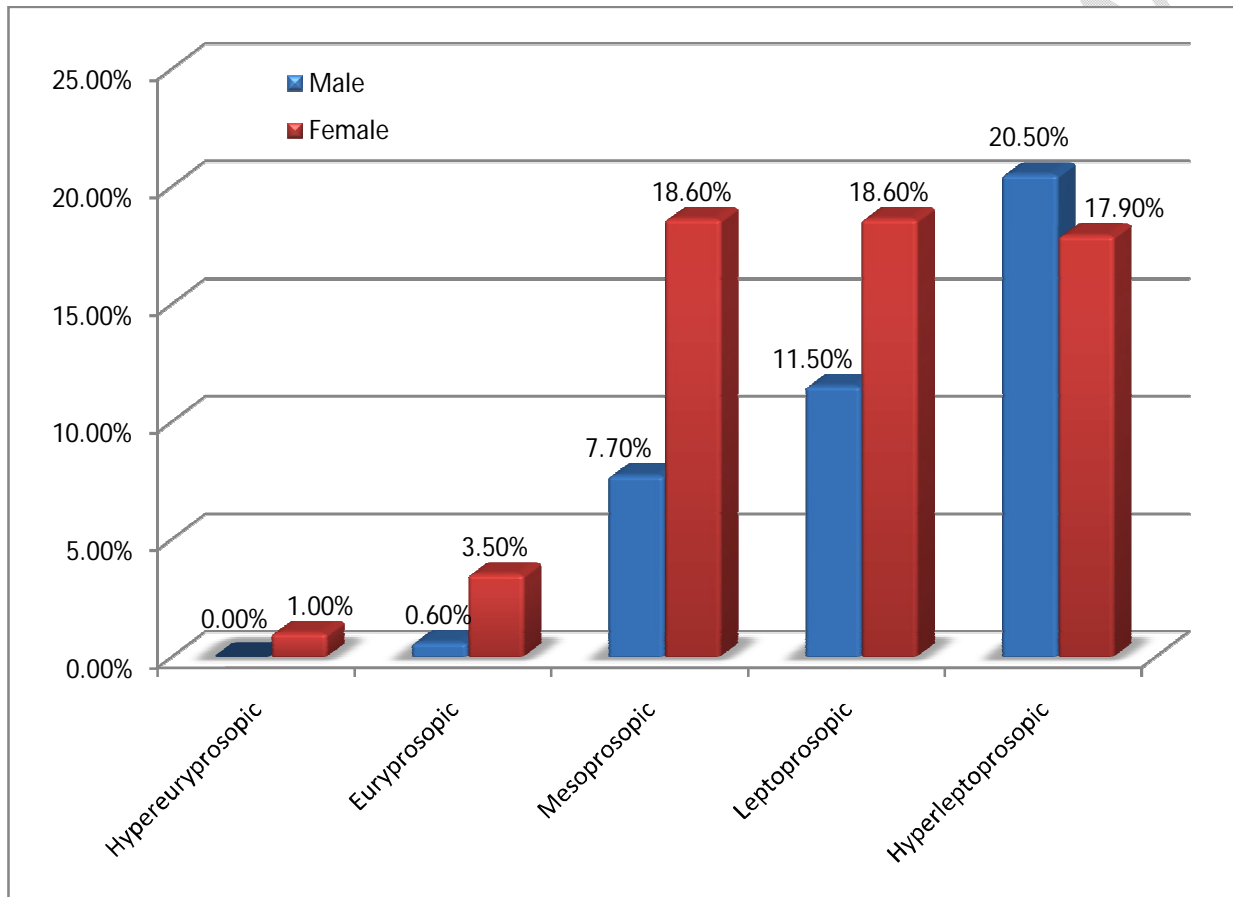
**Table 3: The facial indices of adult males and females**

Age (yrs)	MALES			FEMALES			p value
	No.	Mean	SD	No.	Mean	SD	
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 in males, hyperleptoprosopic face was the commonest followed respectively by leptoprosopic and mesoprosopic faces but this was different in the females were the same number of people had leptoprosopic and mesoprosopic faces.



**Figure 1: The distribution of types of faces in adults by sex.**

Looking at the whole sample population, 71.6% had long faces (27.4% of these had leptoprosopic faces while 44.2% had hyperleptoprosopic faces). On the other hand, 22.6% had round faces (mesoprosopic) while 5.8% had short faces (4.7% were euryprosopic and 1.1% hypereuryprosopic).

**Widths of the Right and Left Eyes:** 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 ( $p < 0.05$ ) – 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 ( $p < 0.05$ ) – table 1. The widths of the eyes were essentially longer in the in the males but this was statistically significant for the right eye in the second decade of age (table 4).

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

Age (yrs)	RIGHT EYE					LEFT EYE				
	Males		Females		p value	Males		Females		p value
	Means	SD	Means	SD		Means	SD	Means	SD	
<b>20-29</b>	38.1	2.3	37.3	1.9	0.04*	36.9	2.7	36.3	1.7	0.15
<b>30-39</b>	38.2	2.2	38.2	1.4	1.00	37.8	1.7	37.5	1.5	0.51
<b>40-49</b>	40.1	10.7	37.3	2.1	0.22	37.4	2.4	36.1	2.2	0.06
<b>50-59</b>	37.4	2.0	36.4	2.0	0.10	36.5	1.9	36.2	1.6	0.53
<b>60-69</b>	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. The intercanthal distances of the males were significantly wider than those of the females in all the age groups (table 5).



<b>Morp. Facial</b>	.070	.219	.199**	.000	.277**	.000
<b>Height (mm)</b>						
<b>Max Facial Width (mm)</b>	.201**	.000	.362**	.000	.295**	.000
<b>Facial Index</b>	-.102	.072	-.117*	.038	.017	.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 of the face, different parts or divisions 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 the positioning 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.[11] 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.[11] The shape of the face is defined by its facial index. The mean facial index for adults in the present study was 93.7 which is for leptoprosopic face. Facial index exhibited sexual dimorphism, with males having a higher mean facial index of  $96.1 \pm 6.90$ , meant for hyperleptoprosopic face, while that of the females was  $92.2 \pm 6.00$  (leptoprosopic face). The values were lower than those in the report of Okoh et al,[12] where males and females had mean facial indices of  $103.13 \pm 9.35$  and  $96.10 \pm 13.65$  respectively, both being values for hyperleptoprosopic face – very long face. Okoh et al[12] 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 Iggede 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 hyperleptoprosopic (20.5%), followed by leptoprosopic face (11.5%) and mesoprosopic (7.7%). The pattern of distribution of facial type reported by Okoh et al[12] 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, the facial index in this present study did not increase with age and this is similar to the report of Ewunonu et al.[13]

On the other hand, the mean eye widths for males in this study were 38.0mm and 36.7mm for the right and left eyes and for females, it was 37.2mm and 36.4mm for the right and left eyes respectively. These values are higher than those reported by Eze et al. (2013) who showed that adult males had 32.8mm and the females 32.6mm but they measured the eyes of the Igbos and non-Igbos in Enugu unlike the present study where the eyes of Igbos only were measured and there were other differences in the methodologies. These are the possible reasons for the differences observed in the two studies. The values for the left and right eyes were not determined separately in the study by Eze and his colleagues[14] unlike in the present study. In the present study, the left eye had lower values compared to the right eye in both genders. The widths of the eyes in females were also less than those of the males. Oladipo et al.[15] reported a mean eye width of 38.1mm for adult Ijaw males and 36.0mm for adult Ijaw females, and these appear to be closer to the values in this present study than those of Eze et al.[14]

The mean intercanthal distance of males in this present study was 34.9mm and it was higher than in females which was 33.2mm. The findings were similar to the findings of Iroanya et al.[16] who reported  $36.27 \pm 0.49$  for males and  $34.25 \pm$

0.83mm for females among Igbos in a University in Lagos, a state in Nigeria. However, the present study had values that were less than those reported for the people in Ebonyi State by Egwu et al., [17] where males had 43.90mm and the females had 41.77mm. The study at Ebonyi State was not limited to the Igbos alone, and this heterogeneity of the sample population could be the reason for the disparity in values. The intercanthal distance of another ethnic group, Ikwere of South-South Nigeria had values closer to the present study since their males had intercanthal distance of 33.9mm and the females had 33.8mm. [18] The intercanthal distance of Africans was reported to be  $39.8 \pm 2.9$  for males and  $37.1 \pm 2.9$  for females. [11] In the present study, the males had significantly wider intercanthal distances than the females in all the age groups ( $P < 0.05$ ). Fewehinmi et al [19] reported the same sexual dimorphism exhibited by intercanthal distance.

One of the facial relationships that has been well studied is the “golden proportion”. [20] 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, the 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.

## **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

## **REFERENCES**

1. Sarna K, Sonigra KJ, Ngeow WC. A Cross-Sectional Study to Determine and Compare the Craniofacial Anthropometric Norms in a Selected Kenyan and Chinese Population. *Plastic Surgery*. 2023 Feb;31(1):84-90.
2. Soumboundou S, Ndiaye ML, Farhat O, Lecor PA. Three-dimensional anthropometric study of the facial morphology of black African Senegalese: 3D photogrammetric approach. *Journal of Oral Biology and Craniofacial Research*. 2023 Sep 1;13(5):522-6.
3. Vasanthakumar P, Kumar P, Rao M. Anthropometric analysis of palpebral fissure dimensions and its position in South Indian ethnic adults. *Oman medical journal*. 2013 Jan;28(1):26.
4. Ranga MS, Mallika MV. Cephalic Index and Facial Index of Adults in Rural South Kerala, India. *International Journal of Scientific Study*. 2020;8(9):41-5.
5. Obaje SG, Ibegbu AO. Dominance of the leptoprosopic face and mesorrhine nose types: Does stature and facial types matter in Northern Nigerian adults? *Journal of Craniofacial Surgery*. 2021 Jun 1;32(4):1452-4.
6. Appiah NK, Appiah AK, Tetteh J, Diby TK, Abaidoo CS. Anthropometric study of facial and nasal indices of the Akan ethnic population of Ghana. *Sri Lanka Journal of Forensic Medicine, Science & Law*. 2023 Jun 30;14(1).
7. Eliakim-Ikechukwu C, Onugh E, Bassey T, Mesembe OE. Cephalofacial indices of the Ibo and Yoruba ethnic groups in Southern Nigeria. *Journal of Biology, Agriculture and Healthcare*. 2012;2(11):144-8.
8. Ebrahimi B, Ghaffari N, Alizamir T, Jaberi KR, Nazmara Z. Gender determination using Nasofacial anthropometry in the Iranian population. *Iraq Medical Journal*. 2022 Jun 26;6(2).
9. Sarkodie FK, Abaidoo CS, Tetteh J, Adjei-Antwi C, Okwan DK. Facial indices and morphology: A study among Bono and Ewe adult population in the Bono region, Ghana. *Scientific African*. 2022 Mar 1;15:e01092.
10. Maalman RS, Abaidoo CS, Darko ND, Tetteh J. Facial types and morphology: A study among Sisaala and Dagaaba adult population in the Upper West Region, Ghana. *Scientific African*. 2019 May 1;3:e00071.

11. Bouhadana G, Gornitsky J, Saleh E, Trabelsi NO, Borsuk DE. Expanding the Classic Facial Canons: Quantifying Intercanthal Distance in a Diverse Patient Population. *Plastic and Reconstructive Surgery–Global Open*. 2022 Apr 1;10(4):e4268.
12. Okoh PD, Fawehinmi HB, Ebieto CE, Asiwe N. Photogrammetric Based Analysis of Facial and Nasal Indices: A Cross-sectional Study among the Igbo Ethnic Group of Nigeria. *Asian Journal of Advanced Research and Reports*. 2024;18 (9):55-62.
13. Ewunonu EO, Anibeze CI. Anthropometric study of the Facial Morphology in a South-Eastern. *Hum Bio Rev*. 2013;2(4), 314- 323
14. Eze BI, Uche JN, Shiweobi JO, Mba CN. Oculopalpebral dimensions of adult Nigerians: report from the Enugu normative ocular anthropometry study. *Medical Principles and Practice*. 2012 Dec 1;22(1):75-9.
15. Oladipo GS, Okoh PD, Hart JS. Anthropometric study of ocular dimensions in adult Ijaws of Nigeria. *Res J Med Med Sci*. 2010;5:121-4.
16. Iroanya OO, Oyeyemi MT, Egwuatu TF. Sexual dimorphism and anthropometric comparison of craniofacial features of Igbo and Yoruba Undergraduate Students of University of Lagos, Nigeria. *Brazilian Journal of Forensic Sciences, Medical Law and Bioethics*. 2019 Sep 21;9(1):68-91.
17. Egwu OA, Ewunonu EO, Etuedo AN, Ovuoba KN, Njoku CO, Ugwu AC. Normal values of inner and outer intercanthal distances in a student population in southeast Nigeria. *International Journal of Biological and Chemical Sciences*. 2008 Oct 29;2(3):355-8.
18. Oladipo Gabriel S, YorkumLeyira K, Okoh Peter D. Measurements of head circumference, intercanthal distances, canthal index and circumference interorbital index of Ikwerre school children in Nigeria. *Journal of Natural Sciences Research*. 2013;3(4).
19. Fewehinmi HB, Okoh PD, Oghenemavwe LE, Amadi MA, Ebieto CE, Bobbo KA, Asiwe N. Facial Analysis of the Igbo Ethnic Group of Nigeria for the Evaluation of Sexual Dimorphism. *Asian Journal of Medicine and Health*. 2023 Dec 20;21(12):67-75.
20. Kaya KS, Türk B, Cankaya M, Seyhun N, Coşkun BU. Assessment of facial analysis measurements by golden proportion. *Braz J Otorhinolaryngol*. 2019 Jul-Aug;85(4):494-501.