

**Special Edition**

"Anthropological Indices: A Holistic Approach to Forensic and Medical Investigation"

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E-mail: [ekeziejervas@gmail.com](mailto:ekeziejervas@gmail.com)**Special Edition 2****Article Ref. #: 1000ANTPOJSE2101****Article History****Received:** July 17<sup>th</sup>, 2017**Accepted:** August 10<sup>th</sup>, 2017**Published:** August 11<sup>th</sup>, 2017**Citation**

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# Angular Craniofacial Photometric Analysis of the Facial Profile of Igalas in Nigeria

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**ABSTRACT**

The morphology of the human face varies with individuals and even more with populations and ethnic groups.

**Objectives:** This study aims to determine the mean values of some craniofacial angles of Igala males and females from standardized facial profile photographs and to compare them with each other and with norms of different ethnic groups proposed by other researchers.

**Materials and Methods:** Standardized photographs of 1116 Igala subjects, comprising 558 males and 558 females were used in this study. The following angles were measured: nasofrontal, nasomental, nasofacial, nasolabial and angle of facial convexity.

**Results:** Four of the facial angles have been studied which showed sexual dimorphism except the nasolabial angle. Four craniofacial angles have significant sexual differences among which the males had a higher value only in the nasofacial angle. Nasofacial angle (NFa) had the highest index of sexual dimorphism. The mean value of nasolabial angle (Cm-Sn-Ls) as well as facial convexity angle (G-Sn-Pg) found in the Igala is less than that reported in other populations.

**Conclusion:** The result of this study will be useful in orthodontics, anatomical modeling, forensic identification purposes, and in plastic surgery to compare the pre- and post-operative results.

**KEY WORDS:** Angular; Photometric; Facial; Profile; Igalas.

**ABBREVIATION:** G: Glabella; N: Nasion; Pm: Pronasale; Cm: Columella; Sn: Subnasale; Ls: Labial superior; Pg: Pogonion; NF: Nasofrontal angle; NM: Nasomental angle; NFa: Nasofacial angle; NL: Nasolabial Angle; AFC: Angle of Facial Convexity.

**INTRODUCTION**

Craniofacial traits are major features in physical appearance, which is related to social acceptance, psychological well-being and self-esteem of an individual. Facial beauty analysis can be characterized as a combination of symmetry, proportions and harmonious relationship among the structures.<sup>1</sup> Various methods have been used to evaluate facial characteristics such as: Craniofacial anthropometry, Photogrammetry,<sup>2-9</sup> Cephalometric radiography,<sup>10</sup> Stereophotogrammetry,<sup>11</sup> Computer tomography and Laser scanning.<sup>12</sup> Fernandez-Riveiro and colleagues standardized the photographic technique and record taking in natural head position (NHP) and gave average values for white adults,<sup>2</sup> whereas Arnett and Bergman (1993) also took records in NHP and described the facial profile using the angle of facial convexity.<sup>13</sup>

According to Oghenemavwe and colleagues, facial angle assesses the forehead-to-jaw relationship and has long been employed to make judgments of inferiority and superiority of certain human populations.<sup>14</sup> The facial angle was one of the main initiators of racial craniology, which emerged during the nineteenth century to justify racism. Populations vary genetically and geographically in their craniofacial features. Therefore, a single standard of anthropometric variables is not appropriate to apply to diverse racial and ethnic groups.<sup>15</sup>

Soft tissue profile standards using photogrammetry have been reported for North American populations,<sup>16</sup> Spanish,<sup>2</sup> Himachalis of India,<sup>17</sup> Brazillian Caucasians,<sup>18</sup> Croatians<sup>4</sup> and Turkish.<sup>19</sup> Photometric analysis of the soft tissue profile of adult Urhobos<sup>20</sup> and Igbos in Nigeria<sup>21</sup> has been reported. Anibor et al., reported the photometric analysis of the facial angle of the Urhobos in Nigeria.<sup>22</sup> Photometric facial analysis of the Igbo Nigerian adult male has also been reported by Ukoha et al.<sup>9</sup> Facial angle of the Itsekiris in Nigeria using a computer-assisted photometric analysis has been reported by Anibor and Okobiah<sup>22</sup> but no report exists for the Igalas ethnic group of Nigeria.

Therefore this research was undertaken to determine the mean values of some craniofacial angles of Igala males and females from standardized facial profile photographs and to compare them with each other and with norms of different ethnic groups proposed by other researchers.

## MATERIALS AND METHODS

### Study Participants

This research was carried out on Igalas aged between 18 and 45 years in Kogi State, Nigeria. The sample populations used for this research included 1116 Igalas, comprising 558 males and 558 females. The participants were without any history of acquired or genetic craniofacial anomalies. Subjects were considered to be "Igala" if their two grandparents were of Igala origin. Individuals who had facial defects or injuries were not part of the research. The ethical approval for this study was obtained from the Ethical Committee, Faculty of Basic Medical Sciences, College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus. Written consent was used during this research.

### Photographic Set-up

The photographic set-up consists of a tripod supporting a digital camera. Adjustment of the tripod height allowed the optical axis of the lens to be maintained in a horizontal position during the recording. Each subject was asked to relax with both hands hanging beside the trunk. The subject was positioned on a line marked on the floor. A mirror was placed 120 cm in front of the subject on the opposite side. The subjects looked into their eyes in the mirror with their lips relaxed so that the side view profile was taken in the natural head position (NHP) before every recording.

### Photograph Taking

All right profile photographs were taken with a digital camera (Nikon Coolpix P7700, Tokyo, Japan). The camera was positioned approximately 1.0-1.5 meter distance from the subject, and raised to the ear level of the participant to provide good quality of image and to prevent distortion of the face.<sup>23</sup> All photographs were taken with the participant standing in a relaxed position with their heads held in the natural head position.<sup>2</sup>

### Photo Analysis

The following cutaneous points were used on the photographs to determine the values of the various angles measured: Glabella (G), Nasion (N), Pronasale (Prn), Columella (Cm), Subnasale (Sn), Labial Superior (Ls), Pogonion (Pg). These points were used to trace and measure the following facial parameters: nasofrontal angle (NF), nasomental angle (NM), nasofacial angle (NFa), nasolabial angle (NL), and angle of facial convexity (AFC). Quantitative analysis of the photographs was done using a computer program (Photoshop CS4, CA, USA). The 'ruler tool' on the tools bar of this software was used as a protractor in measuring the angles.

### Statistical Analysis

The statistical analysis for this research was done using two computer based softwares – Statistical Package for Social Sciences (SPSS version 20) and Microsoft Office Excel (2007). The ranges and mean±standard deviations (SDs) were calculated for each angle, and unpaired Student's *t*-test was calculated to find out the differences in facial angles between Igala males and females. Index of sexual dimorphism was also calculated.<sup>24</sup> Linear regression analysis was also carried out to generate a model for the estimation of facial angle from the variables.

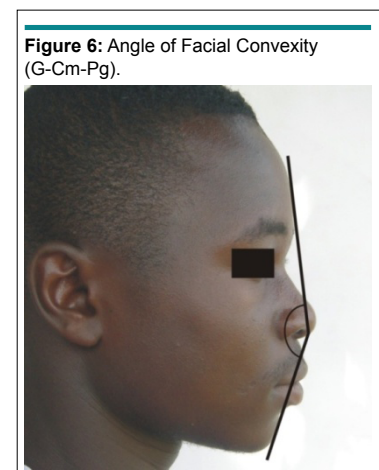
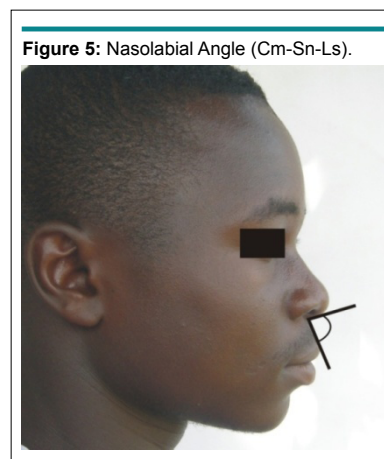
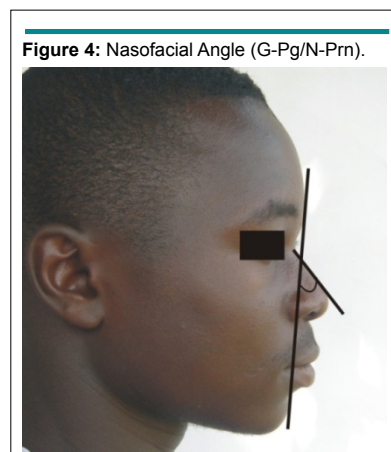
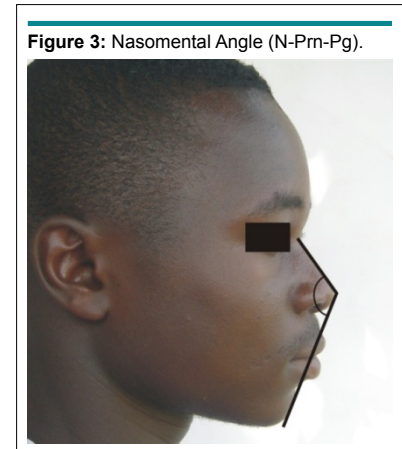
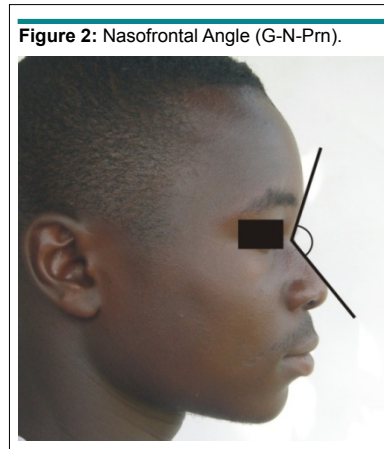
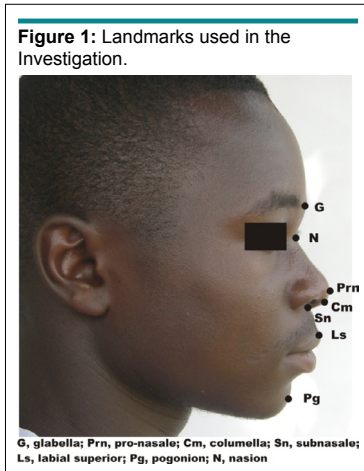
## RESULT

Table 1 shows the group statistics of the craniofacial angles of Igala males and females. The mean, standard deviation and standard error of mean of the craniofacial angles of Igala males and females are shown in this table. The results of unpaired student's *t*-test comparing male and female angular measurements (*p*-value) and calculated index of sexual dimorphism are also shown in this table.

Statistical significant sexual differences were found in four craniofacial angles: nasofrontal angle (males=127.73°±7.82°; females=130.93°±7.34°; *p*<0.05), nasomental angle (males=125.99°±4.83°; females=127.41°±5.61°; *p*<0.05), nasofacial angle (males=40.18°±4.42°; females=38.65°±4.89°; *p*<0.05), and angle of facial convexity (males=152.99°±5.59°; females=155.23°±4.94°; *p*<0.05). There was no significant sex difference found in the nasolabial angle (males=79.48°±11.86°; females=79.29°±11.40°; *p*>0.05). Of the four craniofacial angles that have significant sex differences, the females had higher values in three (nasofrontal, nasomental, and angle of facial convexity), while the males had a higher value in the nasofacial angle.

According to the index of sexual dimorphism, the highest level of sexual differences among the craniofacial angle of the Igala people was seen in the nasofacial angle (NFa), and then the nasofrontal angle (NF). Negative indexes were seen for angles where the females have the higher values.

Index of sexual dimorphism=[(Male mean-Female mean)/Male mean]×100



**Table 1:** Group Statistics of Craniofacial Angles of Igala Females (F) and Males (M).

	Sex	Mean±SD (°)	Std. Error Mean	p value	Index of Sexual Dimorphism
NF	F	130.93±7.34	0.310	0.000	-2.51
	M	127.73±7.82	0.331		
NM	F	127.41±5.61	0.237	0.000	-1.13
	M	125.99±4.83	0.204		
NFa	F	38.65±4.89	0.207	0.000	3.81
	M	40.18±4.42	0.187		
NL	F	79.29±11.40	0.482	0.792	0.23
	M	79.48±11.86	0.502		
AFC	F	155.23±4.94	0.209	0.000	-1.46
	M	152.99±5.59	0.237		

NF: Nasofrontal angle; NM: Nasomental angle; NFa: Nasofacial angle; NL: Nasolabial angle, AFC: Angle of facial convexity.

The equations shown in Table 2 can be used to estimate the value of NF angle of a male Igala from NM, NFa, NL or AFC.

The equations shown in Table 3 can be used to estimate the value of NF angle of a female Igala from NM, NFa, NL or AFC.

The Table 4 presents, in summary, the comparative data of the craniofacial angular measurements in different populations of the world as reported by different authors.

**DISCUSSION**

The Powell analysis which is made up of the nasofrontal, na-

**Table 2:** Regression equations for estimating NF from NM, NFa, NL or AFC in Igala Males.

	Craniofacial Angle	Regression Equation
NF	NM	65.11+0.497 NM
	NFa	162.79-0.873 NFa
	NL	119.27+0.106 NL
	AFC	155.62-0.182 AFC

Dependent variable: NF: Nasofrontal angle; NM: Nasomental angle; NFa: Nasofacial angle; NL: Nasolabial angle; AFC: Angle of facial convexity.

**Table 3:** Regression Equations for Estimating NF from NM, NFa, NL or AFC in Igala Females in Kogi State Nigeria.

	Craniofacial Angle	Regression Equation
NF	NM	74.50+0.443 NM
	NFa	165.76-0.901 NFa
	NL	137-0.077 NL
	AFC	160.97-0.193 AFC

Dependent variable: NF: Nasofrontal angle; NM: Nasomental angle; NFa: Nasofacial angle; NL: Nasolabial angle; AFC: Angle of facial convexity.

solabial, nasomental, nasofacial and mentocervical angles provides an insight into an ideal facial profile.<sup>16</sup> Photogrammetric analysis had advantages in facial profile analysis especially on angular measurements, as they are not affected by photographic enlargement, non-invasive and commonly used method to investigate pre- and post-operative changes and provides a permanent record of patients.<sup>11</sup> Compared with other methods, photogrammetric analysis does not require expensive or complex equipment and offers digital results that are easily evaluated using computer software. In contrast to cephalometric analysis, angu-

lar measurements are not affected by photographic reduction.<sup>5</sup> Furthermore, there is no radiation exposure, so it is ethically more acceptable to develop populations norms through population-based studies.

The higher values (Table 1) for the females as observed in this study could be explained by the fact that in general the facial contours of female subjects were more rounded than those of males, especially in the area of the nose, lips, and chin.<sup>4</sup>

**Table 4:** Shows a Comparative Data on Angular Measurements in Different Populations.

Author/Date	Populations	NF(°)	NM(°)	NFA(°)	NL(°)	AFC(°)
Present study 2016	Igalas	127.73±7.82 (M)	125.99±4.83 (M)	40.18 ±4.42(M)	79.48 ±11.86 (M)	152.99±5.59 (M)
		130.93±7.34 (F)	127.41±5.61 (F)	38.65 ±4.89 (F)	79.29 ±11.40 (F)	155.23±4.94 (F)
Osunwoke and Onyeriodo <sup>25</sup>	Khanas	133.63±8.59 (M)	128.99±5.52 (M)	33.54±4.10 (M)	86.21±16.61 (M)	
		137.36±6.37 (F)	130.97±5.68 (F)	32.09±3.61 (F)	91.73±14.85 (F)	
Mussamat et al <sup>26</sup>	Bangladeshi Garo	129.56±7.96 (M)	129.75±7.32 (M)	40.27±4.54 (M)	91.28±12.98 (M)	158.65±12.17 (M)
		137.96±4.79 (F)	132.79±5.10 (F)	38.67±4.05 (F)	91.92±8.90 (F)	169.26±4.43 (F)
Ukoha et al <sup>9</sup>	Igbos	134 (M)	126 (M)	39 (M)		
Reddy et al <sup>7</sup>	North Indians	136.71±3.64 (M)	127.71±1.97 (M)	34.38±1.77(M)	102.32±4.69 (M)	168.54±3.23 (M)
		144.33±1.75 (F)	127.11±1.81 (F)	33.69±1.37 (F)	101.50±4.39 (F)	166.64±4.09 (F)
Oghenemawwe et al <sup>20</sup>	Urhobos	121.75±9.07 (M)	121.95±7.93 (M)	40.77±6.29 (M)		
		127.85±8.50 (F)	126.55±6.93 (F)	35.60±7.46 (F)		
Fernandez-Riveiro et al <sup>2</sup>	Spanish	138.57±6.81 (M)			105.20±13.28 (M)	168.2±4.96 (M)
		141.98±6.06 (F)			107.57±8.5 (F)	167.0±5.36 (F)
Anicy-Milosevicy et al <sup>4</sup>	Croatsians/ Caucasians	136.38±6.71 (M)	130.47±3.73 (M)	29.53±2.51 (M)	105.42±9.52 (M)	168.78±4.97 (M)
		139.11±6.35 (F)	130.19±3.47 (F)	30.36±2.38 (F)	109.39±7.84 (F)	169.05±4.69 (F)
Wamalwa et al <sup>8</sup>	Kenyans	132.44±6.91 (M)				
		137.97±5.21 (F)				
Malkoc et al <sup>5</sup>	Turkish	146.03±8.19 (M)			101.09±10.19 (M)	170.60±6.15 (M)
		148.61±6.66 (F)			102.94±10.43 (F)	168.78±5.44 (F)
Anibor and Okumagba <sup>6</sup>	"Negroids"	132.0±7.50 (M)				
		137.70±7.60 (F)				

NF: Nasofrontal angle; NM: Nasomental angle; NFA: Nasofacial angle; NL: Nasolabial angle; AFC: Angle of facial convexity.

The nasofrontal angle (G-N-Prn) showed significant sex differences in the adult Igala populations ( $127.73 \pm 7.82$  in males;  $130.93 \pm 7.34$  in females), and the angle was wider in females. This is in agreement with the findings by Osunwoke and Onyeriodo in Khana people ( $133.63 \pm 8.59$  in males and  $137.36 \pm 6.37$  in females),<sup>25</sup> Mussammat et al in adult Bangladeshi Garo ( $129.56 \pm 7.96$  in males and  $137.96 \pm 4.79$  in females),<sup>26</sup> Reddy et al in the North Indian populations ( $136.71 \pm 3.64$  in males and  $144.33 \pm 1.75$  in females),<sup>7</sup> Oghenemavwe et al in Urhobos ( $121.75 \pm 9.07$  in males and  $127.85 \pm 8.50$  in females),<sup>21</sup> Fernandez-Riveiro et al for Spanish ( $138.57 \pm 6.81$  in males and  $141.98 \pm 6.06$  in females),<sup>2</sup> Anic-Milosevic et al for Croatian ( $136.38 \pm 6.71$  in males and  $139.11 \pm 6.35$  in females)<sup>4</sup> and Wamalwa et al for Kenyans ( $132.44 \pm 6.91$  in males and  $137.97 \pm 5.21$  in females).<sup>8</sup> Ukoha and colleagues reported for Igbo Nigerian ( $134^\circ$  in males). However, Malkoc and colleagues found no sex differences in this angle for Turkish ( $146.03 \pm 8.19$  in males and  $148.61 \pm 6.66$  in females).<sup>5</sup> Anibor and Okumagba found higher mean male value than the female in "Negroid" populations ( $132.0 \pm 7.50$  in males and  $137.70 \pm 7.6$  in females).<sup>6</sup> The lower mean value of nasofrontal angle in males may be attributed to prominent glabella.

The average value of nasomental angle (N-Prn-Pg) found in the Igala ( $125.99 \pm 4.83$  in males and  $127.41 \pm 5.61$  in females) is similar to that of Khana people ( $128.99 \pm 5.52$  in males and  $130.97 \pm 5.68$  in females), adult Bangladeshi Garo population ( $129.75 \pm 7.32$  in males and  $132.79 \pm 5.10$  in females), Igbo Nigerian ( $126^\circ$  in males), North Indian populations ( $127.71 \pm 1.97$  in males and  $127.11 \pm 1.81$  in females), Urhobo people ( $121.95 \pm 7.93$  in males and  $126.55 \pm 6.93$  in females), and Croatian/Caucasian populations ( $130.47 \pm 3.73$  in males and  $130.19 \pm 3.47$  in females).<sup>4,7,9,20,25,26</sup> Wider nasomental angle suggests a more prominent chin. Significant sexual dimorphism was also observed ( $p < 0.05$ ).

The mean value of nasofacial angle (G-Pg/N-Prn) found in the adult Igala populations ( $40.18 \pm 4.42$  in males and  $38.65 \pm 4.89$  in females) is more comparable with the values given by Mussammat and colleagues ( $40.27 \pm 4.54$  in males and  $38.67 \pm 4.05$  in females),<sup>26</sup> Ukoha et al ( $39^\circ$  in males),<sup>9</sup> Osunwoke and Onyeriodo ( $33.54 \pm 4.10$  in males and  $32.09 \pm 3.61$  in females),<sup>25</sup> Reddy and colleagues<sup>7</sup> ( $34.38 \pm 1.77$  in males and  $33.69 \pm 1.37$  in females), and Oghenemavwe et al ( $40.77 \pm 6.29$  in males and  $35.60 \pm 7.46$  in females)<sup>14</sup> but larger than that reported by Anicy-Milosevic et al ( $29.53 \pm 2.51$  in males and  $30.36 \pm 2.38$  in females).<sup>4</sup> Significant sexual dimorphism was observed. Higher nasofacial angle as seen in males suggests that higher projection of the nose was seen in males.<sup>8,17</sup>

The nasolabial angle (Cm-Sn-Ls), evaluating the relationship of the nasal base and upper lip, is one of the measurements with greater clinical relevance during orthodontic diagnosis and treatment planning because its magnitude depends on the antero-posterior position and inclination of the upper ante-

rior teeth, and it can be altered by orthodontics or orthognathic surgery.<sup>8</sup> The mean value of nasolabial angle (Cm-Sn-Ls) found in the Igala ( $79.48 \pm 11.86$  in males and  $79.29 \pm 11.40$  in females) is less than that in Khana people ( $86.21 \pm 16.61$  in males and  $91.73 \pm 14.85$  in females), Bangladeshi Garo populations ( $91.28 \pm 12.98$  in males and  $91.92 \pm 8.90$  in females), North Indian populations ( $102.32 \pm 4.69$  in males and  $101.50 \pm 4.39$  in females), Turkish populations ( $101.09 \pm 10.19$  in males and  $102.94 \pm 10.43$  in females), White European populations ( $105.2 \pm 13.28$  in males and  $107.57 \pm 8.5$  in females) and Croatian/Caucasian populations ( $105.42 \pm 9.52$  in males and  $109.39 \pm 7.84$  in females).<sup>2,4,5,7,25,26</sup> Significant sexual dimorphism was not observed between the males and females.

The average value of facial convexity angle (G-Sn-Pg) found in the Igala ( $152.99 \pm 5.59$  in the males and  $155.23 \pm 4.94$  in the females) is less than that reported for the Bangladeshi Garo ( $158.65 \pm 12.17$  in males and  $169.26 \pm 4.43$  in females), North Indian populations ( $168.54 \pm 3.23$  in males and  $166.64 \pm 4.09$  in females) and the White European populations ( $168.2 \pm 4.96$  in males and  $167.0 \pm 5.36$  in females) while slightly less than the values in Turkish populations ( $170.60 \pm 6.15$  in males and  $168.78 \pm 5.44$  in females) and Croatian/Caucasian populations ( $168.78 \pm 4.97$  in males and  $169.05 \pm 4.69$  in females).<sup>2,4,5,7,26</sup> Significant sexual dimorphism was observed between the males and females.

## CONCLUSION

It was assumed that a study on the facial angle measurements on Igala populations of Kogi state, Nigeria would contribute to the establishment of standardized normal values for the populations. The mean values of the various craniofacial angles in male and female Igala subjects have been determined and compared. Sexual dimorphism ( $p < 0.05$ ) was observed in all the craniofacial angles of Igala males and females, except nasolabial angle. From the present study it can be appreciated that craniofacial angles portray ethnic and phenotypic differences. The result of this study will be particularly useful in plastic surgery to compare the pre- and post-operative results, orthodontics, anatomical modeling and for identification purposes.

## RECOMMENDATION

The results of this study would help in understanding how the Igala populations stands anthropometrically among the various populations of the world indicating the variations it shows from different other populations. Therefore, more research is needed for testing the accuracy of photogrammetric method in Nigeria. In conclusion, a database on craniofacial angles for Igala people has been established. An effort should be made to establish the same angles for different populations and ethnic groups.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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