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# A regression analysis to determine personal stature from craniofacial parameters of idoma tribe in Nigeria

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## Abstract

**BACKGROUND:** Stature reconstruction from skeletal remains forms part of forensic investigations in anthropology for the purpose of individual identifications. Despite a growing number of forensic cases in Idomaland, a very little work has been done to document stature estimation among modern Idoma people.

**AIM:** This study aimed to determine stature from anthropometric parameters and generate a regression model among Idoma tribe in Nigeria.

**MATERIALS AND METHODS:** A total of 300 healthy individuals of Idoma tribe were randomly selected. Out of which, 155 males and 145 females aged 15–18 years from Methodist High Schools in Otukpo participated in the study. Measurements were taken with the help of standard instruments. Stature and six parameters (head length, head width, bizygomatic distance, nasal length, nasal width, and facial height) were determined to the nearest centimeters.

**RESULTS:** The nasal width was higher in males than females. In addition, the nasal length was higher in males than females while bizygomatic distance was close in values among both sexes with a significance level of $P < 0.05$. Pearson's correlation coefficient and linear regression equations were derived for male and females separately for all individuals in the study group. Stature was higher in males than females in perfect distribution (174.38 and 156.35, respectively). The facial height was higher in males than females (11.57 and 11.00, respectively). Although it was not significant ($P < 0.05$), the parameter expressed a higher value. The simple Pearson's correlation ($r$) was high in bizygomatic distance and low in nasal width ($r = 0.28$ and 0.05, respectively) of males, while nasal width was low ($r = 0.12$) and head width was high ($r = 0.38$) in females. There was a statistically significant level in head length for both males and females ($P < 0.001$).

**CONCLUSION:** Facial height, nasal length, and bizygomatic distance had statistically significant weak positive correlation with stature for both Idoma males and females. Human stature cannot be predicted from cephalofacial variables.

**Keywords:**

Craniofacial parameter, Idoma tribe, Otukpo, regression analysis

## Introduction

Anthropometry is the study of human body measurements. Recently, medical education and anthropometric studies have contributed in the identification of body parts in crime scenes and understanding physical variations in humans (Krishan 2007; Patil *et al.*, 2005; Sarangi *et al.*, 1981; Vojdani *et al.*, 2009; and Golalipour *et al.*, 2005). In addition, forensic experts have used the regression analysis of stature from craniofacial parameters in tribes to examine cases of unknown, discomposedly mutilated, and fragmented human parts. From adulthood to childhood, there is a direct increase in stature with age of the individuals (Saxena *et al.*, 1981; Golalipour *et al.*, 2005; Introna *et al.*, 1993; and Ozaslan *et al.*, 2003). Furthermore, stature decreases



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with age in diseased conditions. It is worst around cartilages. This sis because there is abasence of elasticity of intervertebral substance (Vojdani *et al*., 2009; Saxena *et al*., 1981; Chiba and Terazawa, 1998; Ghosh and Sawant, 2017; and Krishan and Kumar, 2007). Stature is best studied with regression equations (Manjunnath, 2002; Golalipour *et al*., 2003; Hwang *et al*., 1995; Kouchi, 1986; and Chovalopoulou *et al*., 2016). The formulae to represent individual's craniofacial variables in each population groups were calculated (Chiba and Terazawa, 1998; Jibonkumar and Lilinchandra, 2006; and Ricklan and Tobias, 1986). There is a strong relationship between age, sex, and tribe with craniometry (Agnihotri *et al*., 2009; Hwang *et al*., 1995; Ivanovsky, 1923; Jorgensen *et al*., 1974; and Kondo *et al*., 1999). From cranial and facial indexes, determination of racial differences was done (Hwang *et al*., 1995; Hossain *et al*., 2004; Hossain *et al*., 2005; and Huizinga *et al*., 1965). Data to determine stature from cranial and facial regions using regression model among Idoma tribe are scanty. Hence, this study intended to evaluate the correlation between stature and cephalic indices, gender differences between stature and craniofacial parameters, generate regression equation to predict stature of individuals, and to make comparison with other international findings. It is important to know that this study will assist in knowledge for forensic investigations among idoma tribe.

## Materials and Methods

### Study location

Idoma, an ethno-linguistic group, is primarily situated in the lower western areas of Benue State (middle-belt region) in Nigeria. The tribe with a population of over 98,000 and nine local government areas occupy a large hectare of land which is on longitude and latitude of 6 × 27′ 38″ E and 4 × 37′ 48″ N. In addition, the region is richly blessed with abundant mineral resources with kaolinite and gemstone at Otukpo Island. Agriculture is the mainstay of the economy which produces yam, rice, beans, sorghum, and maize.

### Sample size

This research was conducted on 300 individuals of Methodist High School in Otukpo local government area in Benue State, Nigeria. Normal healthy children and adults of aged 15–18 years living in Idomaland for at least three generations were recruited in the study by simple random sampling technique.

### Anthropometric methodology

The individuals were good representatives of the tribe. Furthermore, they were apparently healthy and without any facial or head deformities. The age of the participants ranged from 15 to 18 years. The height of the participants was measured using anthropometric rod from the vertex of the head to the floor, which was observed with precautionary measure that upper part of the rod was straight and vertical. In addition, the measurements of participants were done at Frankfurt plane where the highest point on upper and lower margins of external auditory canal and lower part of orbit was identified, with the individual maintained in anatomical position. The measurement of height was in nearest centimeter (cm) by international standard (WHO) millimeter. The six craniofacial parameters were as follows:

A. Head length – This was measured using a sliding caliper from the glabella in the anterior to the posterior side of occipital protuberance
B. Head width – It is the maximum biparietal diameter and measured with spreading caliper between the most lateral points of parietal bones
C. Bizygomatic distance – This was measured with the use of a sliding caliper between the two most lateral sides of zygomatic bones as illustrated in Figure 1
D. Nasal length: It was measured from the nasal root to the tip (subnasale) using sliding caliper as shown in Figure 2
E. Nasal width: It was measured in between the two lateral sides of nose using the sliding caliper
F. Facial height: It was measured from the root of the nose to the lowest point on the tip of mandible using sliding caliper. The research was done during 2014–2015 and in accordance with the International Standard practices (Krishan, 2007).

### Ethical approval

The form (ABU/SPG120/1456) for the original research proposal "A Regression Analysis of Stature from Cephalofacial Parameters of Adolescence and Adults in Benue State, Nigeria," was approved by the Research and Ethic Committee, Ahmadu Bello University Teaching Hospital, Shika. In addition, data were obtained under informed consent.

**Figure 1:** A participant (Enayi Bridget, SS III) of Otobi School (JC) Otukpo in Idoma tribe, Benue State, Nigeria

### Statistical analysis

Excel 2007 and SPSS Version 18 (Version 18.0. Chicago: SPSS Inc. USA) were used for the statistical analysis. Normality test for gender was done. Descriptive analysis (means and standard deviations), correlation coefficient® and simple linear regression model were presented respectively. Also, nonparametric test was calculated. Values were statistically significant at $P < 0.05$.

## Results

Of the 300 participants aged 15–18 years in Idomaland, 155 males and 145 females participated in the study. Results show normality test on stature with six anthropometric parameters as follows: head length, head width, bizygomatic distance, nasal length, nasal width, and facial height. Although not statistically significant, except females, the result expressed perfect distribution in the normality test [Table 1]. Following the application of parametric test (mean test) in Table 2, there were almost the same values of craniofacial variables except in stature which were higher in males (174.38 ± 7.60) than females (156.35 ± 6.18). Furthermore, the test of normality by gender on stature and craniofacial parameters followed perfect distributions in Table 3. Except facial height and bizygomatic distance, there were statistically significant levels ($P < 0.05$) in head length, nasal length, and head width among males. In addition, except nasal width, it was significant in head length, bizygomatic distance, and facial height among females. Again, stature in both males and females showed no statistically significant level. The strength and direction summarized in Table 4 showed that all the six craniofacial parameters for both males and females have no significant correlation with stature ($P < 0.05$) except head length. Male and female stature models ($r = 0.393$ and 0.323, respectively) from six craniofacial parameters in the study determine a regression with gender. However, only three of these parameters (nasal length, nasal width, and facial length) regressed positively with stature.

**Figure 2:** Nasal length of a participant (Grace Okpole, SS II) in senior secondary school, Methodist High School in Otukpo local government area of Benue State

**Table 1: Test of normality on stature and gender**

| Test of normality | Statistic | df | *P* |
|---|---|---|---|
| Male | 0.96 | 75 | 0.26 |
| Female | 0.95 | 75 | 0.014 |

**Table 2: Descriptive statistics for stature and craniofacial parameters by gender (*n*=155 and *n*=145 each for both males and females)**

| Parameters | Mean of male | Mean of female | SD of male | SD of female |
|---|---|---|---|---|
| Stature | 174.38 | 156.35 | 7.60 | 6.18 |
| Head length | 18.67 | 18.12 | 0.78 | 0.89 |
| Head width | 14.29 | 14.28 | 0.95 | 1.02 |
| Bizygomatic distance | 14.20 | 14.20 | 0.95 | 1.01 |
| Nasal length | 5.28 | 5.28 | 0.33 | 0.33 |
| Nasal width | 3.27 | 2.96 | 0.50 | 0.38 |
| Facial height | 11.57 | 11.00 | 0.72 | 0.57 |

SD=Standard deviation

Female:
$R = A + B + C = 0.323$

Male:
$R = A + B + C = 0.393$

A, B, and C represented the craniofacial parameters (nasal length, nasal width, and facial length) while R represented regression model. Although the regression model was higher in males than females in the study, it was not statistically significant.

## Discussion

Anthropometry is one of the subdivisional areas of biological anthropology where measurements of human body parts have been successfully used in medical education. The importance of forensic science to crime scenes for identifications of dismembered or mutilated bodies has been yielding good results from understanding regional anatomy of craniofacial parameters.

Establishing stature from craniofacial variables has been of high interest to human anatomists. Other medical commentators have worked tirelessly in estimating height and cephalofacial parameters. One of the challenges is having generalized regression formulae to represent entire body's parts with heights in the world of science. This is not possible because of the variation of body parts in race, sex, and age. Hence, it is important that every tribe, regions, and nations should have theirs and documented.

**Table 3: Test of normality on stature and craniofacial measurements by gender**

| Parameters | Gender | | Statistic | | df | | *P* | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Stature | Male | Female | 0.95 | 0.95 | 75 | 75 | 0.222 | 0.413 |
| Head length | Male | Female | 0.97 | 0.95 | 75 | 75 | 0.002 | 0.145 |
| Head width | Male | Female | 0.94 | 0.93 | 75 | 75 | 0.033 | 0.090 |
| Bizygomatic distance | Male | Female | 0.98 | 0.97 | 75 | 75 | 0.432 | 0.178 |
| Nasal length | Male | Female | 0.96 | 0.94 | 75 | 75 | 0.004 | 0.063 |
| Nasal width | Male | Female | 0.94 | 0.96 | 75 | 75 | 0.001 | 0.001 |
| Facial height | Male | Female | 0.97 | 0.95 | 75 | 75 | 0.234 | 0.344 |

**Table 4: Correlation coefficients between stature and six craniofacial parameters for males and females (*n*=155 and *n*=145) each**

| Parameters | Correlation coefficient (*r*) | | *P* (two tailed) | |
|---|---|---|---|---|
| | Females | Males | Females | Males |
| Head length | 0.16 | 0.33 | 0.18 | 0.001* |
| Head width | 0.19 | 0.12 | 0.10 | 0.90 |
| Bizygomatic distance | 0.28 | 0.18 | 0.02 | 0.13 |
| Nasal length | 0.15 | 0.19 | 0.19 | 0.10 |
| Nasal width | 0.05 | 0.38 | 0.65 | 0.001* |
| Facial length | 0.16 | 0.33 | 0.16 | 0.001* |

One of the surest ways for individual identity is the height. It is being noted of a relationship between personal height of adults and body measurement from upper and lower extremities in human. This study looks at the previous works in estimating height from head and face parameters. It established a regression model which only represented the study population of the Idoma tribe in Nigeria. To nutrition, genetics, and anthropology, the six cephalofacial parameters in this study are important tools for clinical records.

Normality test established perfect distribution and mean test as summarized in Tables 1 and 2. The result showed the differences between the sexes in the upper face, lower face, and head length. The highest shape classification rate was obtained from the upper face region. The study recorded the female height smaller than males and some of the craniofacial parameters were higher in males than females respectively. It was found that cephalofacial parameters are significant for sexual dimorphism in the upper face region. This agreed with results in the shape differences between the sexes in the upper face and the orbits, and the highest shape classification rate was obtained from the upper face region (Ghosh and Sawant, 2017; Krishan and Kumar, 2007; Ozaslan *et al*., 2003; and Ozaslan *et al*., 2006).

Height was higher in males than females (174.38 and 156.35, respectively). Krishan (Ozaslan *et al*., 2003; Ozaslan *et al*., 2006; Nagesh and Pradeep Kumar, 2006; and Kumar and Patnaik, 2013) conducted a study on 996 adult male Gujjars of North India in the age group of 8–30 years. Five cephalofacial measurements were taken and the results indicated that cephalofacial measurements are strongly and positively correlated ($P < 0.001$) with stature. The measurements of the cephalic region had stronger correlation with stature than those of facial region. Stature was higher in males than females in perfect distribution (174.38 and 156.35, respectively). The facial height was higher in males than females (11.57 and 11.00, respectively). Although it was not significant ($P < 0.05$), the parameter expressed a higher value. The simple Pearson's correlation® was high in bizygomatic distance and low in nasal width ($r = 0.28$ and 0.05, respectively) of males while nasal width was low ($r = 0.12$) and head width was high ($r = 0.38$) in females. There was a statistically significant level in head length for both males and females ($P < 0.001$). Furthermore, a research supporting this study was conducted on 252 Koli male adolescents from North India (Ozaslan *et al*., 2006; Nagesh and Pradeep Kumar, 2006; Kumar and Patnaik, 2013; and Shah *et al*., 2015). Here, stature and 6 cephalofacial measurements were taken and the findings showed that all the cephalofacial measurements were significantly correlated with stature ($P < 0.001$, $P < 0.01$), but cephalic measurements had stronger correlation with stature than the facial measurements (Krishan and Kumar, 2007; Ozaslan *et al*., 2003; Ozaslan *et al*., 2006; and Agnihotri *et al*., 2011). It was also supported by the regression analysis, which shows that the cephalic measurements gave better prediction of stature (Ozaslan *et al*., 2006; Nagesh and Pradeep Kumar, 2006; Kumar and Patnaik, 2013; and Shah *et al*., 2015).

The anthropometric measurement having the highest correlation coefficient with stature among males is morphological facial length and among female is maximum head length. Maximum head breadth showed insignificant correlation with stature in both sexes. Hence, the use of cephalofacial parameters to predict adults' personal height will not be realistic. A research conducted implicated the cephalic length to have positively correlated with stature.

## Conclusion

The anatomy of facial height, nasal length, and bizygomatic distance has statistically significant weak positive correlation with stature for both Idoma males and females. Personal height cannot be predicted from cephalofacial variables.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

There are no conflicts of interest.

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