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# Sex and Stature Estimation from Odontometric Parameters of Kalabari Ethnic Group in Rivers State, Nigeria

Loveday Ese Oghenemavwe, Micheal Omonkheoa Oyakhire, Ugochukwu Emmanuel Onwugbufor

**ABSTRACT**

**The resistance of the teeth to human and taphonomic factors has made it a choice for the identification of persons. The aim of this study is to estimate sex and stature from odontometric parameters of Kalabari ethnic group of Rivers State in Nigeria. The cross-sectional descriptive study involved 100 volunteers between the ages of 15 to 30 years (50 males and 50 females) whose parents and four grandparents were from Kalabri ethnic group. The parameters measured were the crown height (CH), maximum mesiodistal width (MD), buccolingual dimension (BL) of the right maxillary and mandibular incisors, canines, and premolars. The heights (HT) of the volunteers were also measured. Discriminant function analysis was used to design a predictive model for sex and Multivariate Regression Analysis was used to design a predictive model for stature. The results showed that the mean values of all teeth variables were larger in males than in females except buccolingual dimensions of second maxillary incisor (BL2) and crown height of first maxillary premolar (CH4). Discriminant Function Analysis of all measured parameters showed the score that predicts male is 1.067 while -1.067 for female. Stepwise Discriminant Function Analysis showed maxillary canine to be the best predictor of sex followed by mandibular incisor. Predictive model for sex identification was derived. Multivariate regression analysis was used to derive equation for stature estimation. This study showed that the combination of the teeth could be used for sex and stature estimation.**

**Keywords:** Kalabari, odontometry, sex estimation, stature estimation.

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**L. E. Oghenemavwe***
Anatomy Department, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria.
e-mail: (loveday.oghenemavwe@uniport.edu.ng)

**M. O. Oyakhire**
Anatomy Department, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria.
(e-mail: ovbiadolor@gmail.com)

**U. E. Onwugbufor**
Anatomy Department, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Rivers State, Nigeria.
(e-mail: onwugbuforugochukwu@yahoo.com)

***Corresponding Author***

## I. Introduction

The Kabalari people are Izon speaking group mainly located in Rivers State of Nigeria. They are well known for their commercial prowess because of the early contact with Europeans whom they established flourishing trade in the fifteenth century for the exchange of slaves and western goods [1]. Currently, the Kalabari lands are a major hub for oil exploration and exploitation activities in Nigeria and the wealth from oil has also come with its challenges which are environmental degradation, militancy and human right violations. These activities have resulted in increase in crimes such as kidnapping, cultism, and gang tussle for control of oil wells and oil bunkering. The effect of these crimes is that people get missing or are burnt beyond recognition during illegal oil refining [2]-[4]. Identification of some of the victims is difficult due to lack of proper documentation and tools for identification process.

The human teeth are not only useful in mastication and defence but also identification of persons [5]-[7]. They are useful tool for sex and stature estimation for archaeological, anthropological and medico-legal situations [6]-[11]. Sex and stature are important in building the biological profile of unidentified skeletal remains recovered in forensic contexts, making the search for missing persons possible, with the potential of recovering pre-mortem records for comparison and establishing identity [10], [11].

There are some advantages of using the teeth to estimate sex and stature. First, the teeth has the ability to withstand post mortem assaults caused by human and taphonomic factors that alters the morphology of remains [12]-[15]. Thus, teeth are still intact for forensic analysis when other tissues such as bones have decayed. The second is that it is difficult to lose all the teeth in forensic context because of the number of teeth found in humans. This is not so with bones, as they could be lost over a long period of time when subjected to harsh taphonomic conditions.

Estimation models for sex and stature are more effective if they are specific to a population because they take into account the variations that exist within the population [6], [16]-[21]. There are simple and multivariate regression formulae established for the estimation of stature from teeth among Indians [22]-[24], Nigerians [7], [8] and South East Asian [25]. Estimation of sex using metric or mathematical methods uses discriminant function [26]. This produces range of values that could predict sex from measured anthropometric parameters. There is paucity of information on sex and stature estimation from teeth of Kabalari people of Nigeria. The purpose of the study is therefore to formulate multivariate regression formula for stature estimation and predictive discriminant model for sex estimation among the kalabaris.

## II. Material and Method

This cross-sectional descriptive study involved 100 volunteers between the ages of 15 to 30 years. They were randomly selected from Kalabari towns of Kula, Degema, Bile, Obuama, Abonnema, Buguma, Bakama and Tombia. The study involved measurements of tooth dimensions and height of the volunteers. Only young adults with complete set of fully erupted healthy teeth, intact and free of pathology and wear participated in the study. We ensured that the subjects had no dental history of crown restorations, supernumerary teeth which reflects altered dental anatomy. The volunteers were briefed regarding the nature of the procedure and given a questionnaire to ascertain demographic data such as tribe and age. Only those who signed informed consent and showed unforced cooperation participated in the study. For the purpose of the study, an individual is considered a Kalabari if the parents and four grandparents are from Kalabari. Mobile dental clinics were created in the centres used for the study.

### *A. Measurements*

Each subject was made to sit on a chair. With the aid of a light source, the lips were retracted using sterile wooden tongue depressor. The mesiodistal width (MD) was measured as the maximum distance between the mesial surface and distal surface of the teeth. It is usually the point where the crown of the teeth makes contact with adjacent teeth. This distance was measured directly on the subjects using a pair of sterile manual divider held parallel to the occlusal plane (Fig. 1).

The dimension of the divider was read on a digital vernier caliper to the nearest 0.01mm. The mesiodistal width of the following right maxillary teeth were measured; these include the first incisor (MD1), second incisor (MD2), canine (MD3), first premolar (MD4) and second premolar (MD5). This was also done for the right mandibular teeth and parameters measured were the first incisor (MD6), second incisor (MD7), canine (MD8), first premolar (MD9) and second premolar (MD10).

The buccolingual diameter (BL) was measured as the distance between the buccal and lingual surfaces of the teeth taken at the thickest point (see Fig. 2). The dimension of the divider was read on the digital vernier caliper to the nearest 0.01mm. The buccolingual diameters of the following right maxillary teeth were measured. These include, the first incisor (BL1), second incisor (BL2), canine (BL3), first premolar (BL4) and second premolar (BL5) and the parameters measured for the right mandibular teeth were the first incisor (BL6), second incisor (BL7), canine (BL8), first premolar (BL9) and second premolar (BL10).

The crown height (CH) was measured as the vertical distance between the tip of the occlusal surface and marginal gingival (line of the gum) (see Fig. 3). The measurement was taken using sterile pair of dividers over the buccal surface and the dimensions of the pair of divider were read on a digital vernier caliper to the nearest 0.01mm. The crown height of the following right maxillary teeth were measured, these include, the first incisor (CH1), second incisor (CH2), canine (CH3), first premolar (CH4) and second premolar (CH5). This was done also for the right mandibular teeth and the parameters measured were the first incisor (CH6), second incisor (CH7), canine (CH8), first premolar (CH9) and second premolar (CH10).

The Stature (HT) of each subject was measured as the vertical distance from the vertex to the floor with the volunteer standing barefooted using anthropometric meter rule. An L-shaped stadiometer, with one arm sliding against the vertical plane, was brought down on to the volunteer's head and the height read off the scaled vertical plane.


Fig. 1. Mesiodistal width of the teeth.

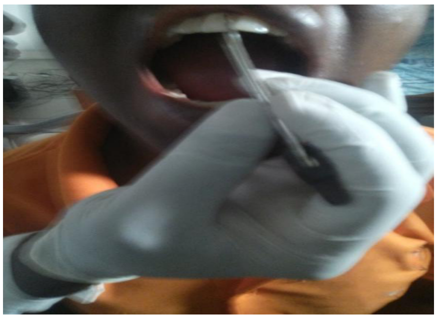
Fig. 2. Buccolingual diameter of the teeth.


Fig. 3. Crown height of the teeth.

All these measurements were taken by a single examiner to eliminate inter-observer error and were taken two times. The averages of the two values were recorded to minimize the intra-observer error.

The Ethics Review Committee of the College of Health Sciences approved the research.

### *B. Statistical Analysis*

SPSS software version 20.0 was utilized for the data analysis. The data collected were tabulated and the mean,

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standard deviation, standard error, variance, minimum and maximum value were calculated for the tooth size and stature. Multivariate Stepwise discriminant function analysis was used to generate a predictive model for sex estimation. Regression analysis was used to derive predictive model for stature estimation from measured parameters with respect to sex.

## III. Results

### A. Descriptive Statistics

The results of the study are presented in tables and bar charts. Table I shows result of the mean value, standard error, range, standard deviation, variance, minimum value and maximum value of all the measured parameters irrespective of sex. CH1, BL4, MD1 and BL5 have the greatest mean value ranging from 9.34 mm, 9.32 mm, 9.01mm and 8.97 mm respectively while MD6, BL7, BL2 and BL6 were shown to have the least mean value ranging from 6.06 mm, 5.89 mm, 5.70 mm and 5.55 mm respectively.

Results in Table II show the mean value, standard error, range, standard deviation, variance, minimum and maximum values of all the measured parameters for female volunteers. BL4, CH1, MD1 and BL5 have the greatest mean value ranging from 9.22 mm, 9.01mm, 8.72 mm and 8.72 mm respectively while MD6, BL2, BL7 and BL6 were shown to have the least mean value ranging from 5.86 mm, 5.83 mm, 5.82 mm and 5.27mm respectively. The mean values of the odontometric parameters for female are shown in Fig. 4.

Table III showed the result of the mean value, standard error, range, standard deviation, variance, minimum value, and maximum value of all the measured parameters for male volunteers. CH1, BL4, MD1 and BL5 have the greatest mean values of 9.67mm, 9.43 mm, 9.31 mm, and 9.22 mm respectively while MD6, BL7, BL6 and BL2 were shown to have the least mean values of 6.26 mm, 5.97 mm, 5.83 mm, and 5.57 mm respectively. Fig. 5 is the bar chart which showed the mean value of the odontometric parameters for male.

Results in Table IV showed Wilks' Lambda test to determine if the measured parameters could be used to generate a Discriminant Function Analysis (DFA) model needed for estimation of sex. The result showed the parameters are fit for DFA model for Kalabari ethnic group. Table V showed the results of standardize canonical discriminant function analysis which was used to derive the equation for Discriminant function score. The values calculated is the co-efficient of each measured variable for both sexes which is the constant for calculating the Discriminant function score (DF score).

TABLE I: DESCRIPTIVE STATISTICS OF MEASURED PARAMETERS IRRESPECTIVE OF SEX

| Parameters | N | Range | Minimum value | Maximum value | Mean | | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| HT (m) | 100 | 0.33 | 1.52 | 1.85 | 1.66 | 0.01 | 0.06 | 0.00 |
| Age (years | 100 | 5.00 | 15.00 | 20.00 | 16.61 | 0.13 | 1.25 | 1.57 |
| BL1 (mm) | 100 | 5.03 | 4.77 | 9.80 | 6.67 | 0.08 | 0.84 | 0.71 |
| MD1 (mm) | 100 | 3.63 | 7.17 | 10.80 | 9.01 | 0.09 | 0.89 | 0.79 |
| CH1 (mm) | 100 | 5.33 | 6.32 | 11.65 | 9.34 | 0.10 | 0.95 | 0.90 |
| BL2 (mm) | 100 | 5.99 | 3.30 | 9.29 | 5.70 | 0.09 | 0.95 | 0.90 |
| MD2 (mm) | 100 | 3.23 | 5.57 | 8.80 | 7.20 | 0.07 | 0.72 | 0.51 |
| CH2 (mm) | 100 | 4.46 | 5.50 | 9.96 | 8.00 | 0.09 | 0.93 | 0.86 |
| BL3 (mm) | 100 | 4.02 | 5.38 | 9.40 | 7.85 | 0.08 | 0.83 | 0.69 |
| MD3 (mm) | 100 | 4.65 | 5.28 | 9.93 | 8.12 | 0.07 | 0.74 | 0.55 |
| CH3 (mm) | 100 | 5.65 | 5.49 | 11.14 | 8.74 | 0.11 | 1.09 | 1.19 |
| BL4 (mm) | 100 | 4.47 | 7.32 | 11.79 | 9.32 | 0.08 | 0.81 | 0.65 |
| MD4 (mm) | 100 | 2.94 | 6.22 | 9.16 | 7.71 | 0.05 | 0.55 | 0.30 |
| CH4 (mm) | 100 | 3.03 | 5.87 | 8.90 | 7.40 | 0.08 | 0.79 | 0.62 |
| BL5 (mm) | 100 | 3.94 | 6.87 | 10.81 | 8.97 | 0.10 | 1.01 | 1.02 |
| MD5 (mm) | 100 | 4.86 | 4.92 | 9.78 | 6.89 | 0.09 | 0.92 | 0.85 |
| CH5 (mm) | 100 | 4.79 | 4.30 | 9.09 | 6.24 | 0.09 | 0.90 | 0.81 |
| BL6(mm) | 100 | 5.15 | 3.70 | 8.85 | 5.55 | 0.09 | 0.88 | 0.77 |
| MD6 (mm) | 100 | 4.92 | 3.39 | 8.31 | 6.06 | 0.07 | 0.66 | 0.44 |
| CH6 (mm) | 100 | 3.95 | 5.81 | 9.76 | 7.73 | 0.08 | 0.78 | 0.62 |
| BL7 (mm) | 100 | 5.71 | 4.20 | 9.91 | 5.89 | 0.08 | 0.85 | 0.72 |
| MD7 (mm) | 100 | 3.96 | 5.11 | 9.07 | 6.57 | 0.07 | 0.72 | 0.52 |
| CH7 (mm) | 100 | 5.14 | 5.05 | 10.19 | 7.81 | 0.09 | 0.89 | 0.79 |
| BL8 (mm) | 100 | 3.90 | 5.28 | 9.18 | 7.23 | 0.08 | 0.83 | 0.70 |
| MD8 (mm) | 100 | 4.39 | 4.80 | 9.19 | 7.39 | 0.07 | 0.72 | 0.52 |
| CH8 (mm) | 100 | 5.52 | 5.53 | 11.05 | 8.72 | 0.10 | 0.99 | 0.98 |
| BL9 (mm) | 100 | 4.48 | 5.46 | 9.94 | 8.08 | 0.09 | 0.87 | 0.76 |
| MD9 (mm) | 100 | 3.89 | 6.09 | 9.98 | 7.53 | 0.08 | 0.83 | 0.69 |
| CH9 (mm) | 100 | 5.77 | 4.19 | 9.96 | 7.89 | 0.10 | 0.98 | 0.97 |
| BL10 (mm) | 100 | 4.15 | 6.46 | 10.61 | 8.36 | 0.08 | 0.78 | 0.61 |
| MD10 (mm) | 100 | 3.37 | 6.25 | 9.62 | 7.51 | 0.07 | 0.74 | 0.55 |
| CH10 (mm) | 100 | 5.16 | 5.18 | 10.34 | 6.97 | 0.10 | 0.96 | 0.93 |

TABLE II: DESCRIPTIVE STATISTICS OF MEASURED PARAMETERS FOR FEMALE VOLUNTEERS

| | N | Range | Minimum value | Maximum value | Mean | | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| HT (m) | 50 | 0.26 | 1.52 | 1.78 | 1.64 | 0.01 | 0.05 | 0.00 |
| Age years | 50 | 5.00 | 15.00 | 20.00 | 16.76 | 0.17 | 1.22 | 1.49 |
| BL1 (mm) | 50 | 3.96 | 4.77 | 8.73 | 6.44 | 0.11 | 0.75 | 0.56 |
| MD1 (mm) | 50 | 2.41 | 7.28 | 9.69 | 8.72 | 0.09 | 0.60 | 0.36 |
| CH1 (mm) | 50 | 4.24 | 6.32 | 10.56 | 9.01 | 0.13 | 0.94 | 0.89 |
| BL2(mm) | 50 | 5.99 | 3.30 | 9.29 | 5.83 | 0.15 | 1.03 | 1.05 |
| MD2(mm) | 50 | 3.23 | 5.57 | 8.80 | 7.17 | 0.10 | 0.73 | 0.54 |
| CH2 (mm) | 50 | 3.90 | 5.88 | 9.78 | 7.88 | 0.13 | 0.90 | 0.81 |
| BL3 (mm) | 50 | 4.02 | 5.38 | 9.40 | 7.50 | 0.14 | 0.97 | 0.94 |
| MD3 (mm) | 50 | 4.43 | 5.50 | 9.93 | 8.08 | 0.11 | 0.75 | 0.57 |
| CH3 (mm) | 50 | 5.53 | 5.49 | 11.02 | 8.49 | 0.15 | 1.07 | 1.14 |
| BL4 (mm) | 50 | 2.90 | 7.55 | 10.45 | 9.22 | 0.09 | 0.63 | 0.39 |
| MD4 (mm) | 50 | 2.58 | 6.22 | 8.80 | 7.56 | 0.07 | 0.53 | 0.28 |
| CH4 (mm) | 50 | 2.89 | 6.01 | 8.90 | 7.41 | 0.10 | 0.72 | 0.52 |
| BL5 (mm) | 50 | 3.92 | 6.87 | 10.79 | 8.72 | 0.14 | 0.99 | 0.99 |
| MD5 (mm) | 50 | 4.86 | 4.92 | 9.78 | 6.71 | 0.12 | 0.82 | 0.67 |
| CH5 (mm) | 50 | 4.79 | 4.30 | 9.09 | 6.20 | 0.13 | 0.92 | 0.85 |
| BL6 (mm) | 50 | 2.99 | 3.70 | 6.69 | 5.27 | 0.10 | 0.71 | 0.50 |
| MD6 (mm) | 50 | 4.92 | 3.39 | 8.31 | 5.86 | 0.11 | 0.76 | 0.57 |
| CH6 (mm) | 50 | 3.90 | 5.81 | 9.71 | 7.67 | 0.13 | 0.94 | 0.89 |
| BL7 (mm) | 50 | 5.71 | 4.20 | 9.91 | 5.82 | 0.13 | 0.94 | 0.89 |
| MD7 (mm) | 50 | 3.78 | 5.29 | 9.07 | 6.48 | 0.12 | 0.83 | 0.69 |
| CH7 (mm) | 50 | 5.14 | 5.05 | 10.19 | 7.55 | 0.14 | 0.97 | 0.94 |
| BL8 (mm) | 50 | 3.90 | 5.28 | 9.18 | 7.07 | 0.11 | 0.75 | 0.56 |
| MD8 (mm) | 50 | 4.39 | 4.80 | 9.19 | 7.25 | 0.10 | 0.74 | 0.54 |
| CH8 (mm) | 50 | 4.69 | 5.53 | 10.22 | 8.62 | 0.14 | 0.98 | 0.95 |
| BL9 (mm) | 50 | 4.48 | 5.46 | 9.94 | 7.84 | 0.13 | 0.94 | 0.89 |
| MD9 (mm) | 50 | 2.77 | 6.37 | 9.14 | 7.47 | 0.10 | 0.68 | 0.46 |
| CH9 (mm) | 50 | 4.35 | 5.25 | 9.60 | 7.83 | 0.12 | 0.85 | 0.72 |
| BL10 (mm) | 50 | 3.19 | 6.46 | 9.65 | 8.25 | 0.10 | 0.73 | 0.54 |
| MD10(mm) | 50 | 3.37 | 6.25 | 9.62 | 7.48 | 0.09 | 0.63 | 0.39 |
| CH10 (mm) | 50 | 4.66 | 5.21 | 9.87 | 6.93 | 0.12 | 0.85 | 0.72 |

TABLE III: DESCRIPTIVE STATISTICS OF MEASURED PARAMETERS FOR MALE VOLUNTEERS

| Parameters | N | Range | Minimum value | Maximum value | Mean | | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| HT (m) | 50 | 0.30 | 1.55 | 1.85 | 1.68 | 0.01 | 0.06 | 0.00 |
| Age | 50 | 4.00 | 15.00 | 19.00 | 16.46 | 0.18 | 1.28 | 1.64 |
| BL1 (mm) | 50 | 4.70 | 5.10 | 9.80 | 6.90 | 0.12 | 0.87 | 0.76 |
| MD1 (mm) | 50 | 3.63 | 7.17 | 10.80 | 9.31 | 0.15 | 1.03 | 1.06 |
| CH1 (mm) | 50 | 3.38 | 8.27 | 11.65 | 9.67 | 0.12 | 0.84 | 0.71 |
| BL2 (mm) | 50 | 2.72 | 4.23 | 6.95 | 5.57 | 0.12 | 0.85 | 0.73 |
| MD2 (mm) | 50 | 2.53 | 6.10 | 8.63 | 7.23 | 0.10 | 0.71 | 0.50 |
| CH2 (mm) | 50 | 4.46 | 5.50 | 9.96 | 8.13 | 0.13 | 0.94 | 0.89 |
| BL3 (mm) | 50 | 1.92 | 7.48 | 9.40 | 8.20 | 0.07 | 0.46 | 0.21 |
| MD3 (mm) | 50 | 4.21 | 5.28 | 9.49 | 8.16 | 0.10 | 0.74 | 0.54 |
| CH3 (mm) | 50 | 5.64 | 5.50 | 11.14 | 8.99 | 0.15 | 1.07 | 1.15 |
| BL4 (mm) | 50 | 4.47 | 7.32 | 11.79 | 9.43 | 0.13 | 0.95 | 0.90 |
| MD4 (mm) | 50 | 2.43 | 6.73 | 9.16 | 7.86 | 0.08 | 0.54 | 0.29 |
| CH4 (mm) | 50 | 2.93 | 5.87 | 8.80 | 7.39 | 0.12 | 0.86 | 0.74 |
| BL5 (mm) | 50 | 3.30 | 7.51 | 10.81 | 9.22 | 0.14 | 0.98 | 0.96 |
| MD5 (mm) | 50 | 3.32 | 5.56 | 8.88 | 7.08 | 0.14 | 0.99 | 0.97 |
| CH5 (mm) | 50 | 3.80 | 4.70 | 8.50 | 6.28 | 0.12 | 0.88 | 0.78 |
| BL6 (mm) | 50 | 4.89 | 3.96 | 8.85 | 5.83 | 0.13 | 0.95 | 0.90 |
| MD6 (mm) | 50 | 1.90 | 5.04 | 6.94 | 6.26 | 0.07 | 0.49 | 0.24 |
| CH6 (mm) | 50 | 3.33 | 6.43 | 9.76 | 7.78 | 0.08 | 0.59 | 0.35 |
| BL7 (mm) | 50 | 2.99 | 4.78 | 7.77 | 5.97 | 0.10 | 0.74 | 0.55 |
| MD7 (mm) | 50 | 2.66 | 5.11 | 7.77 | 6.65 | 0.08 | 0.59 | 0.35 |
| CH7 (mm) | 50 | 3.03 | 6.81 | 9.84 | 8.08 | 0.10 | 0.72 | 0.52 |
| BL8 (mm) | 50 | 3.37 | 5.59 | 8.96 | 7.39 | 0.13 | 0.89 | 0.80 |
| MD8 (mm) | 50 | 1.98 | 6.66 | 8.64 | 7.53 | 0.10 | 0.68 | 0.46 |
| CH8 (mm) | 50 | 4.28 | 6.77 | 11.05 | 8.83 | 0.14 | 1.01 | 1.01 |
| BL9 (mm) | 50 | 3.12 | 6.80 | 9.92 | 8.33 | 0.10 | 0.72 | 0.52 |
| MD9 (mm) | 50 | 3.89 | 6.09 | 9.98 | 7.60 | 0.14 | 0.96 | 0.93 |
| CH9 (mm) | 50 | 5.77 | 4.19 | 9.96 | 7.94 | 0.16 | 1.11 | 1.22 |
| BL10 (mm) | 50 | 3.52 | 7.09 | 10.61 | 8.48 | 0.12 | 0.81 | 0.66 |
| MD10 (mm) | 50 | 3.08 | 6.50 | 9.58 | 7.55 | 0.12 | 0.85 | 0.72 |
| CH10(mm) | 50 | 5.16 | 5.18 | 10.34 | 7.02 | 0.15 | 1.08 | 1.16 |

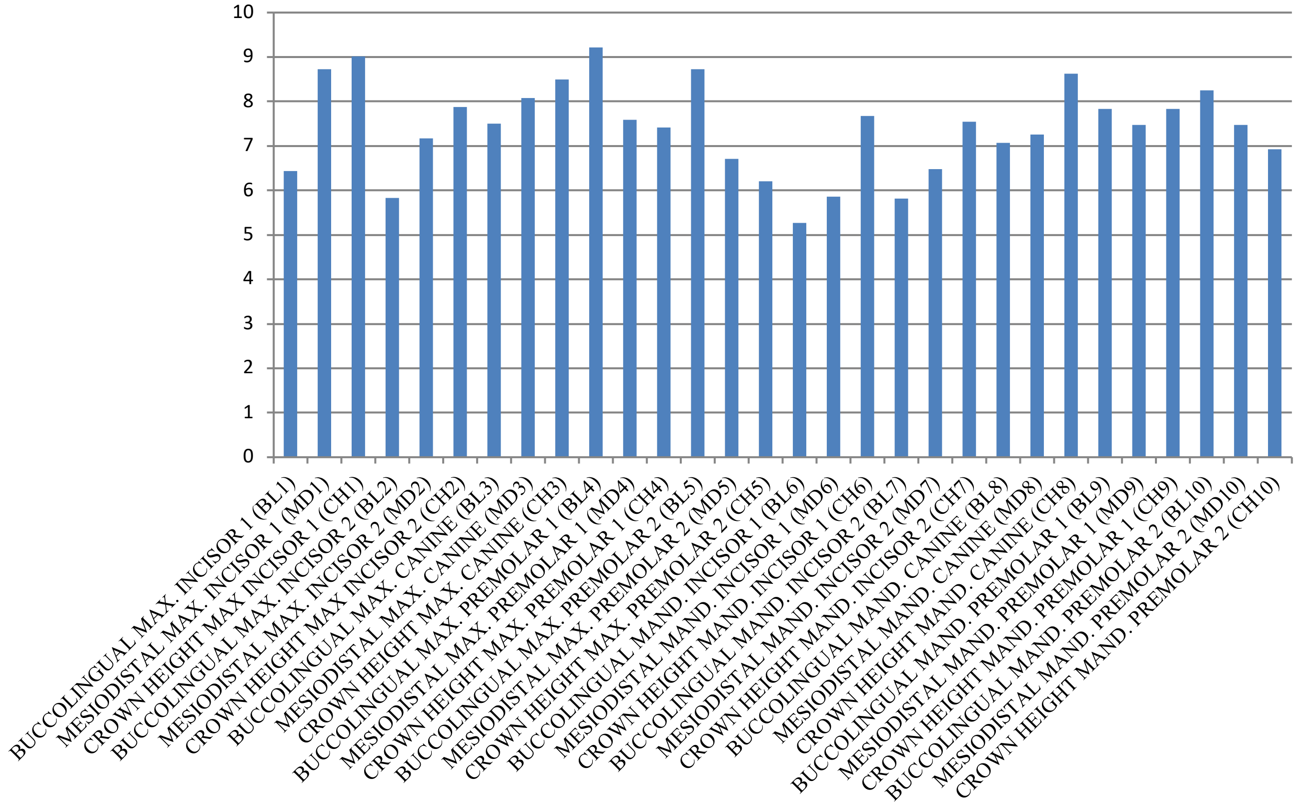


Fig. 4. Mean values of measured parameters for female volunteers.

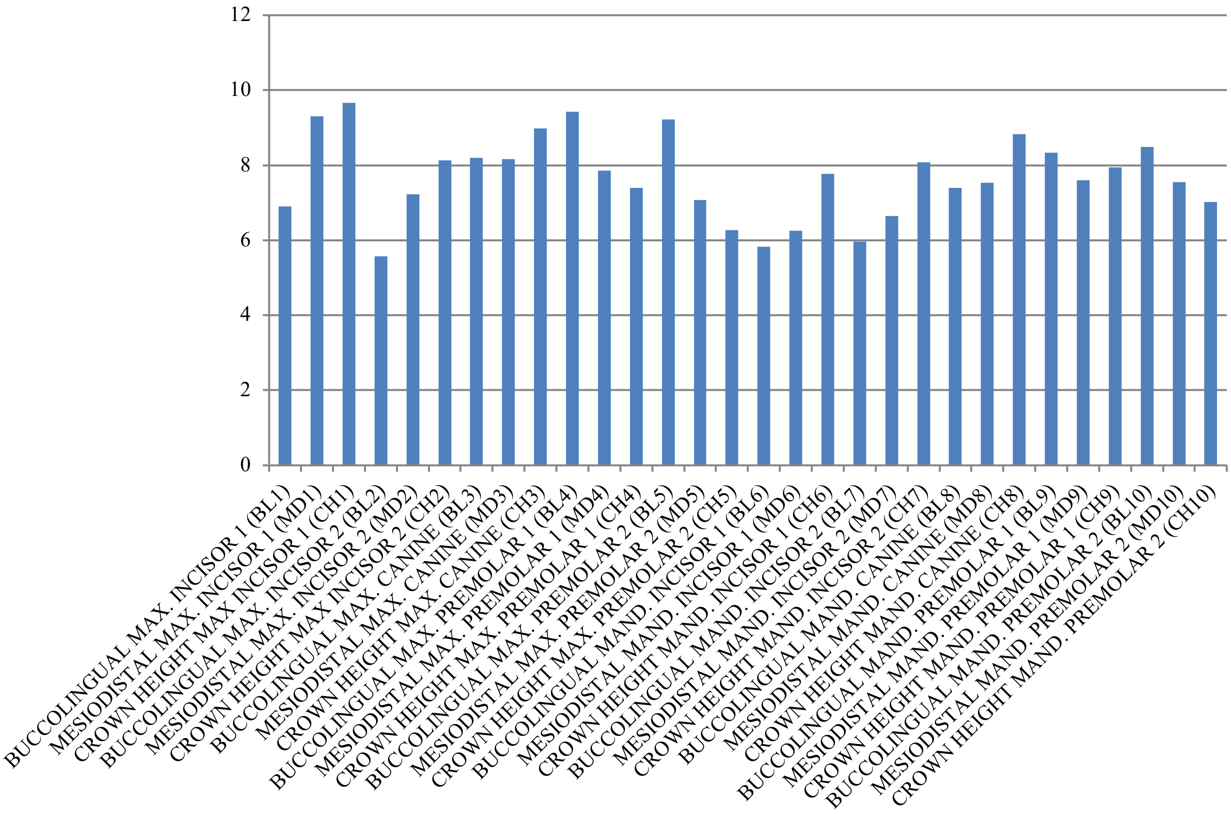


Fig. 5. Mean values of measured parameters for male volunteer

TABLE IV: WILKS LAMBDA TEST FOR SIGNIFICANCE

| Test of Function(s) | Wilks' Lambda | Chi-square | Df | Sig. |
|---|---|---|---|---|
| 1 | 0.463 | 63.972 | 30 | 0.000 |

Wilks Lambda test is significant [p<0.05]. Indication: The data is a good fit for the DFA model

TABLE V: STANDARDIZE CANONICAL DISCRIMINANT FUNCTION

| Parameter | Function 1 | Parameter | Function 1 |
|---|---|---|---|
| BL1 | 0.59 | BL6 | 0.22 |
| MD1 | 0.18 | MD6 | 0.17 |
| CH1 | 0.25 | CH6 | -0.21 |
| BL2 | -0.64 | BL7 | 0.14 |
| MD2 | -0.29 | MD7 | -0.37 |
| CH2 | 0.03 | CH7 | 0.13 |
| BL3 | 0.33 | BL8 | -0.17 |
| MD3 | -0.19 | MD8 | 0.35 |
| CH3 | 0.57 | CH8 | 0.17 |
| BL4 | 0.17 | BL9 | 0.51 |
| MD4 | 0.39 | MD9 | -0.42 |
| CH4 | -0.61 | CH9 | 0.03 |
| BL5 | 0.03 | BL10 | -0.24 |
| MD5 | 0.21 | MD10 | -0.07 |
| CH5 | -0.58 | CH10 | 0.22 |

### *B. Result of Discriminant Function Analysis (DFA)*

Equation for Discriminant Function

Discriminant function [DF] = [0.59×BL1] + [0.18×MD1] + [0.25×CH1]- [0.64×BL2] - [0.29×MD2] + [0.03×CH2] - [0.33×BL3] - [0.19×MD3] + [0.57×CH3] + [0.17×BL4] + [0.39×MD4] - [0.61×CH4] + [0.03×BL5] + [0.21×MD5] - [0.58×CH5] +[0.22×BL6] - [0.17×MD6] - [0.21×CH6] + [0.14×BL7] - [0.37×MD7] + [0.31×CH7] - [0.17×BL8] + [0.35×MD8] + [0.17×CH8] + [0.51×BL9] -[0.42×MD9] + [0.03×CH9] - [0.24×BL10] -[0.07×MD10]+ [0.22×CH10]

The group centroid is shown in Table VI. This showed that the DF score at or close to -1.067 indicates female while value at or close to +1.067 indicates male.

TABLE VI: FUNCTIONS AT GROUP CENTROIDS

| Sex | Function 1 |
|---|---|
| Female | -1.067 |
| Male | 1.067 |

Indication: DF score at or close -1.067 indicate female while 1.067 indicate male

The result in Table VII showed the actual group membership versus the predicted group membership. Out of the 50 female volunteers evaluated, 84% of them were classified as female when the DF score equation was applied while 88% out of the 50 male volunteers were classified male when the DF score was also applied.

Results in Table VIII showed the step-wise statistics for best predictor of sex in Kalabari ethnic group with buccolingual of maxillary canine BL3 (0.822) being the best predictor of sex, followed by crown height of mandibular incisor 2CH7 (0.773), buccolingual diameter of second maxillary incisor (BL2) (0.720), mesiodistal diameter of first maxillary incisor (MD1) (0.686) and crown height of maxillary first premolar CH4 (0.644) respectively. Therefore, the best predictors of sex are BL3, CH7, BL2, MD1 and CH4, respectively.

Table IX showed multivariate regression analysis for female volunteers with correlation value (r) 0.817. The value showed strong correlation of height with the evaluated parameters.

Table X showed multivariate regression analysis male volunteers with correlation value (r) 0.645. The value showed moderate correlation of height with the evaluated parameters.

Therefore the original group membership
= 84% + 88% = 86% 2

This showed that 86% of the original group cases were correctly classified as female or male.

TABLE VII: CLASSIFICATION RESULTS

| Sex | | | Predicted Group Membership: Female | Predicted Group Membership: Male | Total |
|---|---|---|---|---|---|
| Original | Count | Female | 42 | 8 | 50 |
| | | Male | 6 | 44 | 50 |
| | % | Female | 84.0 | 16.0 | 100.0 |
| | | Male | 12.0 | 88.0 | 100.0 |
| Cross-validated | Count | Female | 32 | 18 | 50 |
| | | Male | 13 | 37 | 50 |
| | % | Female | 64.0 | 36.0 | 100.0 |
| | | Male | 26.0 | 74.0 | 100.0 |

86.0% of original group cases correctly classified

TABLE VIII: STEPWISE STATISTICS FOR BEST PREDICTORS OF SEX

| Step | Entered | Wilks' Lambda Statistic | df1 | df2 | df3 | Exact F Statistic | Exact F df1 | Exact F df2 | Sig. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BL3 | 0.822 | 1 | 1 | 98.000 | 21.284 | 1 | 98.000 | 0.000 |
| 2 | CH7 | 0.773 | 2 | 1 | 98.000 | 14.219 | 2 | 97.000 | 0.000 |
| 3 | BL2 | 0.720 | 3 | 1 | 98.000 | 12.431 | 3 | 96.000 | 0.000 |
| 4 | MD1 | 0.686 | 4 | 1 | 98.000 | 10.851 | 4 | 95.000 | 0.000 |
| 5 | CH4 | 0.644 | 5 | 1 | 98.000 | 10.374 | 5 | 94.000 | 0.000 |

Indication: BL3 is the best predictor of sex followed by CH7, BL2, MDI and CH4 respectively

TABLE IX: MULTIVARIATE REGRESSION ANALYSIS FOR FEMALE VOLUNTEERS

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.817 | 0.668 | 0.143 | 0.047 | 0.668 | 1.272 | 30 | 19 | 0.295 | 2.021 |

R = correlation value [very high]

TABLE X: MULTIVARIATE REGRESSION ANALYSIS FOR MALE VOLUNTEERS

| Model Summary | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | | Durbin-Watson |
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change | |
| 1 | 0.645 | 0.416 | -0.506 | 0.07433 | 0.416 | 0.451 | 30 | 19 | 0.975 | 1.966 |

R= correlation value [high but not significant]

*C. Stature Estimation Model and Multivariate Regression Analysis*

Equation for Stature Estimation for Female

$$\text{Height(m)} = 1.48-[0.02\times \text{BL1}]-[0.01\times \text{MD1}]-[0.02\times \text{CH1}]-[0.018\times \text{BL2}]+[0.006\times \text{MD2}]-[0.001\times \text{CH2}]+[0.007\times \text{BL3}]-[0.004\times \text{MD3}]+[0.007\times \text{CH3}]-[0.015\times \text{BL4}]+[0.006\times \text{MD4}]-[0.011\times \text{CH4}]+[0.00\times \text{BL5}]-[0.031\times \text{MD5}]-[0.009\times \text{CH5}]+[0.008\times \text{BL6}]+[0.023\times \text{MD6}]+[0.003\times \text{CH6}]+[0.034\times \text{BL7}]-[0.046\times \text{MD7}]+[0.029\times \text{CH7}]+[0.026\times \text{BL8}]+[0.029\times \text{MD8}]+[0.014\times \text{CH8}]+[0.021\times \text{BL9}]-[0.003\times \text{MD9}]-[0.005\times \text{CH9}]+[0.014\times \text{BL10}]+[0.011\text{MD10}]-[0.12\times \text{CH10}]$$

Equation for Stature Estimation for male Volunteers

$$\text{Height (m)} = 1.308-[0.024\times \text{BL1}]-[0.006\times \text{MD1}]+[0.011\times \text{CH1}]+[0.001\times \text{BL2}]-[0.029\times \text{MD2}]-[0.010\times \text{CH2}]+[0.112\times \text{BL3}]+[0.012\times \text{MD3}]+[0.002\times \text{CH3}]-[0.012\times \text{BL4}]+[0.027\times \text{MD4}]+[0.005\times \text{CH4}]+[0.050\times \text{BL5}]+[0.030\times \text{MD5}]-[0.107\times \text{CH5}]-[0.00\times \text{BL6}]+[0.003\times \text{MMD6}]-[0.034\times \text{CH6}]+[0.024\times \text{BL7}]-[0.011\times \text{MD7}]-[0.025\times \text{CH7}]+[0.018\times \text{BL8}]+[0.00\times \text{MD8}]+[0.059\times \text{CH8}]-[0.037\times \text{BL9}]-[0.155\times \text{MD9}]-[0.012\times \text{CH9}]-[0.074\times \text{BL10}]+[0.011\times \text{MD10}]-[0.00\times \text{CH10}]$$

## IV. Discussion

This study evaluated odontometric parameters and their usefulness in sex and stature estimation in the Kalabaris of Nigeria. Various methods have been used to estimate stature of unknown human skeletal remnant. The reliability of each method varies.

Estimation of stature as part of identification process has a long history in physical anthropology. The introduction of regression formulae developed in the modern population has enhanced the accuracy of stature estimation. The method of using teeth measurements has several advantages as the anatomical landmarks are standard, well defined, and easy to locate. The report of use of odontometric parameters for stature estimation is not common among Nigeria population.

Multivariate regression analysis performed in this study revealed a high to moderate correlation to stature for female (r = 0.817) and male (r = 0.645) respectively. A prediction model for stature estimation for this ethnic group was established. These correlations are moderate suggesting that they are not 100% reliable in estimating stature. The significant level of correlation of teeth to stature is in contrast with moderate to high correlation of individual parameters of long bones [16]. Reference [27] did a study to ascertain the usefulness of tooth crown measurements in stature estimation. The ridge regression revealed a moderate but statistically significant correlation to stature (R = 0.68; P < 0.0001). They concluded that the dentition may be used only as a supplement to more robust indicators of stature.

The buccolingual (BL), mesiodistal (MD) and crown height (CH) of males have greater mean values than those of females. This is in agreement with the reports by other authors [10], [23], [28]. The mean value of male dentition was greater than that of female, except buccolingual diameter of second maxillary incisor (BL2) and crown height of maxillary first premolar (CH4) (see Table II and III). This result is also in line with the study done in Indian population where nine tooth variables exhibited reversed dimorphism, i.e. female dimensions being larger than those of males [11].

The best predictor of sex in Kalabari ethnic group was found to be buccolingual diameter of maxillary canine BL3, followed by crown height of second mandibular incisor CH7, buccolingual diameter of second maxillary incisor BL2, mesiodistal diameter of first maxillary incisor MD1 and crown height of maxillary first premolar CH4 respectively. Therefore the canine is the most sexually dimorphic with the maxillary canine exhibiting the higher sexual dimorphism than the mandibular canine. The canines have conventionally shown to have the greatest degree of sexual dimorphism across many populations. A study carried out by [29] showed the mesiodistal diameter of the lower canine was most sexually dimorphic among Malaysians. Reference [10] studied a population in India and reported that canines were the most sexually dimorphic teeth, followed by molars. Reference [11] showed that mandibular first molar to be most dimorphic tooth, followed by the canine and buccolingual dimensions of first and second maxillary molars.

Our study showed that the mean values of males' odontometric parameters were greater than those of females. The reason for these differences could be attributed to mitotic activity of the cells in the inner dental epithelium and the dental papilla which are believed to be under the influence of the Y-chromosome. They influence the size of the dentino-enamel junction and the thickness of dentine [30]. Dentine thickness is a key determinant of sexual dimorphism as reported by some studies [31], [32]. Generally, skeletal growth in females stops earlier than in males due to the presence of more oestrogen receptors on osteoblasts

Our study showed maxillary canine to be the most sexually dimorphic, a reason could be biological evolutionary trend, as it is used in aggressive functions such as defence and catching of preys in male primates. This is now performed by the arms and fingers in male humans, however, it is reasoned that this important function which canine possessed through evolution is still reflected to some extent in men in the form of larger canines [10]. A study also suggests sexual dimorphism in canine may be influenced by genes involved in the timing of their formation [33]. Some other factors could be the cause of variation in the level of sexual dimorphism. Some authors have explained that such variation could be due to environmental influence on the tooth size, variation in food resources consumed by different populations, the interplay of cultural and biological factors and the complex interactions between a variety of genetic and environmental factors [23].

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## Conflict of Interest

Authors declare that they do not have any conflict of interest.

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**L. E. Oghenemavwe** was born in Port Harcourt Rivers State of Nigeria on May 25, 1978. He attended the prestigious Government College Ughelli for his secondary education. He proceeded to the University of Port Harcourt Medical School where he Obtained PhD (distinction) in Anatomy with specialization in forensics and Microscopic Anatomy. He is currently the Head Department of Anatomy, University of Port Harcourt, Nigeria and Lead Researcher in Human Variation and Identification. He is an Expert Anatomy lecturer with more than 15 years of teaching, research and administrative experience at the university level with consistent track record of motivating and inspiring students to pursue academic and personal excellence for entrepreneurial creativity. He is result-oriented and dedicated to management goals that help promote learning, organization success and community development. Dr Loveday is the leader of Anthropology Group of the Anatomical Society of Nigeria, member Society for Experimental and Clinical Anatomists, member Nigeria Association of Biological Anthropology. He was the recipient of the National Universities Commission award in 2012 for contribution to Medicine and Life Sciences in Nigeria.