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Comparison of Cephalometric Indices Between the Hausa and Yoruba Ethnic Groups of Nigeria

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Abstract: Anthropometry is a series of systemized measuring techniques that express quantitatively the dimensions of the human body and skeleton. Anthropometry is the study of the science of measurement basic to physical anthropology. It is often viewed as a traditional and perhaps the basic tool of biological anthropology. Satisfactory characterization has been established for some racial groups and especially for Caucasian and Negroes where a number of measurements are treated by discriminant analysis, an accuracy of over 90% expected. The aims of this research are to establish cephalometric indices of Hausa and the Yoruba ethnic groups of Nigeria and to compare these indices among the two ethnic groups. Eight indices were calculated, compared and discussed based on proposal by Bass. These indices are cephalic, nasal upper facial, cephalic modules, cephalic Length-Height (L-HI), cephalic Breadth-Height (B-HI), Mean Height (M-HI) and Mean Basion Height (M-BHI) indices. Hausa and Yoruba have mesocephalic heads. Hausa have the highest value for cephalic length height index, cephalic breadth height index, mean height index and mean basion height than the Yoruba All show the high skull characteristics of Negroes skull.

Key words: Cephalometric indices, Hausa, Yoruba, human body, skeleton, Nigeria

INTRODUCTION

Anthropometry is a series of systemized measuring techniques that express quantitatively the dimensions of the human body and skeleton. Anthropometry is the study of the science of measurement basic to physical anthropology. It is often viewed as a traditional and perhaps the basic tool of biological anthropology. It started as not only a science that utilizes measurable parameters to define physical characteristics of different tribes but it has a long tradition of use in forensic sciences and it is finding increased use in medical sciences especially in the discipline of forensic medicine. All human beings in this world belong to the same species, *Homo sapiens*. No two individuals are the same in all their measurable traits, even genetically identical twins, differ in some respects. Since a number of factors producing differences in skeletal proportions between different geographical areas influences skeletal development, it is desirable to have some means of giving quantitative expression to variations which such traits exhibit. Anthropometry constitutes that means as it is the technique of expressing quantitatively the form of the human body. In other words, anthropometry means the measurement of human beings, whether living or dead or on skeletal material. Anthropometric data are believed to be objective and they allow the forensic examiner to go beyond subjective assessments such as similar or different. With measurement data, the examiner is able to quantify the degree of difference or similarity and state how much confidence can be placed in this interpretation (Adams and Bryd, 2002). Satisfactory characterization has been established for some racial groups and especially for Caucasian and Negroes where a number of measurements are treated by discriminant analysis, an accuracy of over 90% expected. Variations in the Cl have little utility in distinguishing skulls from different geographic regions and mostly reflect interactions between the width of the cranial base and the volume of the brain (Lieberman *et al*., 2002). Hence the need to include other indices in the differentiation.

Several major studies have assessed variation in cranial shape among and between populations (Howells, 1973; Lahr, 1996). All the somatometric measurements (including measurements of the head and face) and standard procedures described by Oliver (1969), Weiner and Lourie (1969), Lohman *et al*. (1988) and Hall *et al*. (2003) can be used for estimating stature from different body segments. Using a strictly skull based categorization method; anthropologists organized three to four racial groups. Caucasoids were characterized by a doliocephalic shape with rceded zygomas, large browridge and a narrow nasal aperture. Secondly, Negroids were characterized by a mesocephalic head shape, with receded

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zygomas and wide nasal aperture. Third, Mongoloids were characterized as a brachycephalic head shape, absent browridges, small nasal aperture and projecting zygomas. Additionally, Australoids whose craniofacial type fell between Negroids and Caucasoids was added. With the addition of this category, Thomas Huxley considered India to fall in this group's craniofacial measurements (Huxly, 2006). As with the genotype, variation in human cranial shape is far greater within than between populations (Relenford, 1994).

Summarizing the studies by (Howells, 1973; Lahr, 1996), there is more variation in Africa than elsewhere with marked differences between Bushmen, Bantu and other groups. On average, African crania are broader, with taller upper faces; more inferiorly positioned nasal regions and more prognathic mandibular and maxillary arches than crania from other parts of the globe.

European skulls tend to be narrow, with concomitantly narrow faces, retracted zygomatic arches, tail nasal regions and prominent midlaces. Europeans and American Indians share many cranial similarities. Asian skulls are typically wide (brachycephalic), with wide faces, a high degree of facial flatness and flat supranasal regions.

Australian aborigines are often characterized by narrow skulls (dolichocephaly) and large, low projecting faces with prominent subnasal regions. Attempts to differentiate crania by region of geographic origin using multivariate methods such as discriminant function analysis can have accuracies of over 90%. The study of this research are:

- To establish the cephalometric indices of Hausa and the Yoruba ethnic groups of Nigeria for forensic purpose
- To compare these indices among the two ethnic groups
- To compare these results with other studies done elsewhere

MATERIALS AND METHODS

The study was carried out in two locations in 2006. Kano, this is state in Nigeria with highest population of the Hausa. Ilorin, this is a capital of Kwara state in Nigeria with a Yoruba as the dominant ethnic group. In both cases each subject must have his or her grandparents all of same ethnic group. The following instruments were used:

- Weighing machine (Essential China with accuracy 0.60 kg ±1.2 digits and 60-125 kg ±2.0 digits
- Measuring tape
- Sliding and spreading calipers
- Transparent graded ruler

The following parameters were measured and recorded:

- Tribe
- Age
- Sex
- Height
- Weight
- Head length
- Head width
- Bizygomatic distance
- Upper facial height (nasal length)
- Lower facial length
- Total facial length
- Nose width

These measurements were recorded with the subjects sitting in upright Frankfurt horizontal position. The measurements and other parameters were the entered in the form head length (Fig. 1) is the maximum dimension of the sagittal axis of the skull head width (Fig. 2) is the

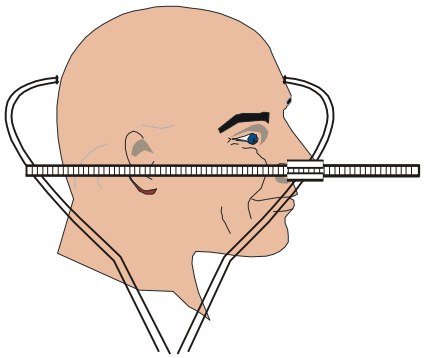

Fig. 1: Measurement of head length

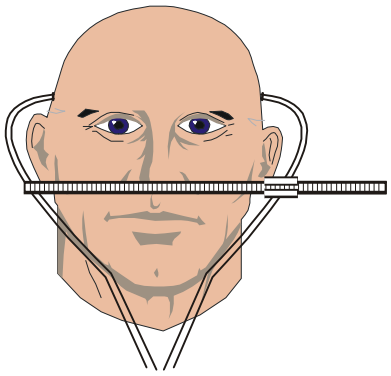

Fig. 2: Measurement of head width

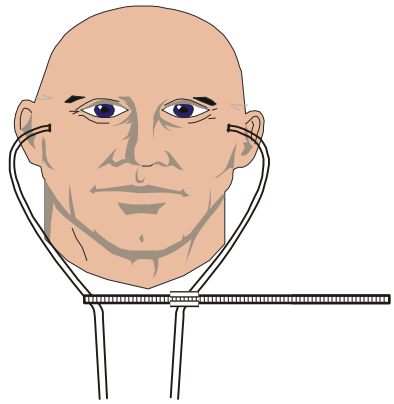

Fig. 3: Measurement of bizygomatic distance

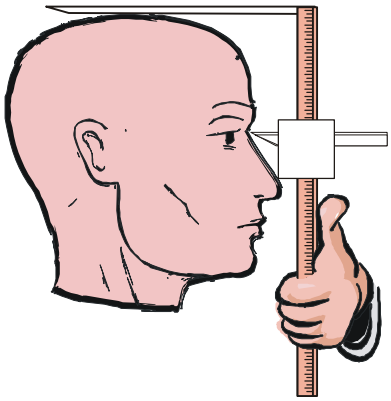

Fig. 4: Measurement of skull height

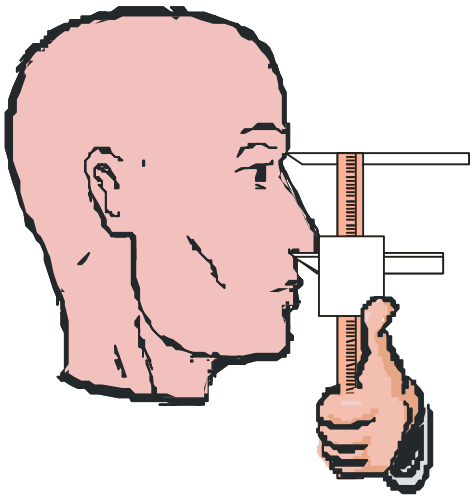

Fig. 5: Measurement of upper facial height (Nasal length)

maximum biparietal diameter Bizygomatic distance (Fig. 3) is the maximal distance between the most lateral points of the zygomatic arches (zygion). Skull height (Fig. 4) is the distance from the root of the nose (nasion) to the highest

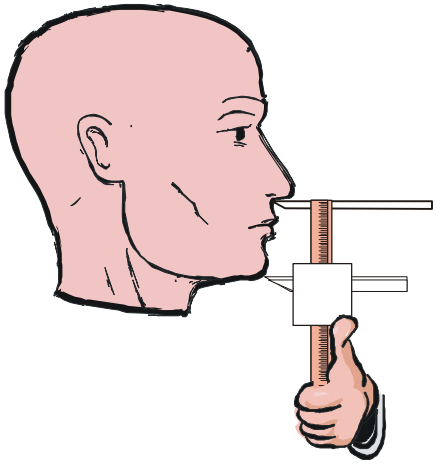

Fig 6: Measurement of lower facial height

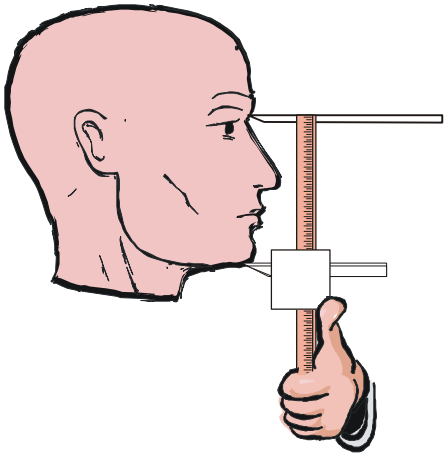

Fig. 7: Measurement of facial height (Total) distance

point of the head (vertex). Upper facial height (Fig. 5) this is the distance from the root of the nose (nasion) to the base of the nose (sub nasion), Lower facial height (Fig. 6) this is the length of the lower one third of the craniofacies, Total Facial height (Fig. 7) is the distance from the root of the nose to the lowest median landmark on the lower border of the mandible. Nose width (Fig. 8) is the distance between the alae of the two nostrils.

Head length: It is the maximum dimension of the sagittal axis of the skull.

Land marks: Measure between the glabella and the opithocranuim (the most prominent portion of the occiput, close to the midline on the posteriorim of the foremen magnum.

Instrument: Wide spreading calipers.

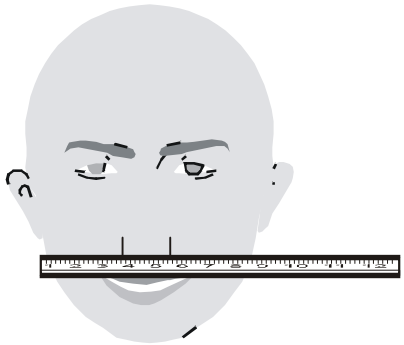

Fig. 8: Measurement of nose width

Head width: This is the maximum biperietal diameter.

Land marks: Measure between the most lateral points of the parietal bones (eurion on each of the head).

Instrument: Wide spreading calipers.

Bizygomatic distance: This is the maximal distance between the most lateral points of the zygomatic arches (zygion).

Land marks: Measure between the most lateral points of the zygomatic arches (zygion) localized by palpation.

Instrument: Wide spreading calipers.

Skull height: This is the distance from the root of the nose (nasion) to the highest point of the head (vertex).

Land marks: Measure from the depth of nasal roots to the superior most point the skull in the vertical plane.

Instrument: Sliding calipers.

Upper facial height (nasal length): This is the distance from the root of the nose (nasion) to the base of the nose (sub nasion).

Land marks: Measure from the deepest part of the nasal root to the deepest point of cavity at the base of the nose (subnasion) in a vertical plane.

Instrument: Sliding calipers.

Lower facial height: This is the length of the lower one third of the craniofacies.

Land marks: Measure from the base of the nose (subnasion) to the lowest median landmarks on the lower border of the mandible (mentron).

Instrument: Spreading calipers.

Remarks: This measurement can also be obtained from the lateral radiograph.

Facial height (total): This is the distance from the root of the nose to the lowest median landmark on the lower border of the mandible.

Instrument: Sliding calipers.

Nose width: This is the distance between the alae of the two nostrils.

Land mark: Measure the distance between the alae of the two nostrils in a straight line.

Instrument: The graduated transparent ruler.

RESULTS AND DISCUSSION

A total of 820 were used. This is made up 410 each for Hausa and Yoruba with age range between 13 years and 30 years. Mean weight 56.6 kg for the Hausa and 56.4 kg for the Yoruba.

Mean height range 169.50 cm for the Hausa cm and 164.84 cm for the Yoruba. Calculation of the various Cephalometric indices is carried out using the following equation.

$$\text{Cephalic index} = \frac{\text{Head breath}}{\text{Head length}} \times 100$$

$$\text{Upper facial index} = \frac{\text{Nasion-Prosthion(upper facial height)}}{\text{Bizygomatic distance}} \times 100$$

$$\text{Nasal index} = \frac{\text{Nasal breath}}{\text{Nasal length}} \times 100$$

$$\text{Cranial (cephalic module)} = \frac{\text{Length+breath+height}}{3}$$

Cranial (cephalic) Length-Height Index:

$$[\text{L-H I}] = \frac{\text{Basion-Bregma height}}{\text{Maximum length}} \times 100$$

Cranial (cephalic) Breath-Height Index:

$$[\text{B-H I}] = \frac{\text{Basion Bregma height}}{\text{Maximum breath}} \times 100$$

Mean-Height Index:

$$[\text{M-HI}] = \frac{\text{Basion-bregmaheight}}{\text{Mean of cephalic [head] length+breath}}$$

$$\text{Mean basion-height index} = \frac{\text{Basion} - \text{bregma height}}{\text{½ of mean of cephalic [head] length+breath}}$$

Hausa:

$$\text{Cephalic index} = \frac{150.01}{197.78} \times 100 = 75.85\%$$

$$\text{Upper facial height} = \frac{44.23}{68.13} \times 100 = 64.92\%$$

$$\text{Nasal index} = \frac{39.83}{44.23} \times 100 = 90.05\%$$

$$\text{Cephalic module} = \frac{197.78+150.01+103.64}{3} = 150.47$$

$$\text{Cephalic Length-Height index (L-H)} = \frac{103.64+107.10}{220} \times 100 = 95.80\%$$

$$\text{Cephalic Breath-Height Index (B-HI)} = \frac{103.64+107.10}{180} \times 100 = 117.08\%$$

$$\text{Mean-Height Index (M-HI)} = \frac{103.64+107.10}{197.78+150.01} \times 100 = 60.60\%$$

$$\text{Mean Basion Height Index (MB-HI)} = \frac{103.64+107.10}{\text{½}197.78+150.01} \times 100 = 121.25\%$$

Yoruba:

$$\text{Cephalic index} = \frac{158.55}{199.38} \times 100 = 79.52\%$$

$$\text{Upper facial height} = \frac{42.53}{82.34} \times 100 = 51.65\%$$

$$\text{Nasal index} = \frac{40.09}{42.53} \times 100 = 94.26\%$$

$$\text{Cephalic module} = \frac{199.38+158.55+07.05}{3} = 154.99$$

Table 1: Summary of the calculated indices of both Hausa and Yoruba

	Value (%)	
Index	Hausa	Yoruba
Cephalic index	76	78
Upper facial index	65	52
Nasal index	90	94
Cephalic module	151	155
L-H index	96	86
B-H index	117	116
M-H index	61	58
MB-H index	121	116

$$\text{Cephalic Length-Height index (L-H)} = \frac{107.05+99.99}{240} \times 100 = 86.27\%$$

$$\text{Cephalic Breath-Height Index (B-HI)} = \frac{107.05+99.99}{180} \times 100 = 115.47\%$$

$$\text{Mean-Height Index (M-HI)} = \frac{107.05+99.99}{199.38+158.55} \times 100 = 58.07\%$$

$$\text{Mean Basion Height Index (MB-HI)} = \frac{107.05+99.99}{\text{½}199.38+158.55} \times 100 = 116.13\%$$

Eight indices were calculated, compared and discussed based on proposal by Bass (1995). These indices are cephalic, nasal upper facial, cephalic modules, cephalic Length-Height (L-HI), cephalic Breadth-Height (B-HI), Mean Height (M-HI) and mean basion height (M-BHI) indices Ethnicity is a variable that affects craniofacial dimension. Again specifically variables that affect for instance nose shape include race, tribe, environment and climatic conditions with narrower noses in warm, moist climate (Last, 1981). Cephalic index is an important parameter for deciding the race and sex of an individual whose identity is unknown (Shah and Jadhav, 2004).

In this study the cephalic index for the Yoruba, 79.52% (Table 1) is higher than the Hausa with value of 75.85%. Table 1 which compares favorably with what Taura (2002) obtained in Kano for the Hausa which is 75.40%. Both Hausa and Yoruba therefore have mesocephalic crania. Hausa and Yoruba have mesocephalic crania.

As for nasal index Yoruba have value of 94.26% but Hausa have value of 90.05% (Table 1). The values obtained by Taura (2002) was 68.87% and Umar *et al.* (2006) obtained 67.14% in Jos. These values for the Hausa are typically leptorrhine which is close to Europeans which have long and narrow nose. The reason for the values in Jos could be climatic wherein it is close to a temperate climatic condition. The upper facial height

obtained by tribe showed that the Hausa have the higher value of 64.92% than Yoruba with value of 51.65% (Table 1).

The value for the Hausa obtained in this study lower than what Taura (2002) got for the same Hausa with value of 71.00%. Again the reason is that though the Hausa have the highest upper facial height but they have the lowest bizygomatic distance (Table 2). The Yoruba have the highest bizygomatic distance but about the same upper facial height (Table 3).

We first calculated the following indices amongst Nigerians (Umar *et al*., 2006). These indices are cephalic module, Cephalic Length-Height Index (CL-HI), Cephalic Breath-Height Index (CB-HI), Mean cephalic Height Index (M-HI) and Mean Basion-Height Index (M-BHI). These indices when calculated give a description of the shape of head and its characteristic features as proposed by Bass (1995).

Cephalic module indicates the numerical value for the size of the cranial vault Cephalic Length-Height Index (CL-HI), Cephalic breath-Height Index (CB-HI), Mean Cephalic Height Index(M-HI) and Mean basion-Height Index (M-BHI) are interpreted as either low, average or high skull.

In this study the cephalic module obtained for all the two tribes showed a high skull with the Yoruba having a higher value than the Hausa with values 154.99 and 150.47, respectively (Table 1). This compares favorably with what Umar *et al*. (2006) obtained, 151.47 for general population of Nigerians. This is because for the Yoruba, the values of all the three parameters in the calculation of cephalic module are highest as compared with the Hausa (Table 2 and 3).

For cephalic length height index the Hausa have higher value than the value obtained for Yoruba. These values are 95.80 and 86.27%, respectively (Table 1). The reason is that the Hausa have highest total facial height than the Yoruba (Table 2). However, the Yoruba with the lower cephalic length height index has the highest maximum head length (Table 3).

Regarding cephalic breath height index the Hausa have higher value of 117.08% than the Yoruba with value 115.47% (Table 1). The reason was that the Hausa has the higher value of total facial height (Table 2). Calculation of mean height index showed that the Hausa have higher value as compared with Yoruba values 60.60 and 58.07%, respectively (Table 1).

This is because the Hausa have the highest total facial height as compared with the other two tribes (Table 2). The same explanation for mean height index also applies for mean basion height.

With these results obtained for various tribes in respect to the indices calculated, (cephalic module, Cephalic Length-Height Index (CL-HI), Cephalic Breath-Height Index (CB-HI), Mean Cephalic Height Index (M-HI) and Mean Basion-Height Index (M-BHI). All show the high skull characteristics of Negroes skull, Bass (1995). Except for mean height index, this showed a medium value for the two tribes. When these eight indices were subjected to t-test, it was found out that there is no statistical difference, $p<0.05$ (Table 4).

Table 2: Cephalometric variables used in calculating the indices-Hausa ethnic group

Variables	N	Min.	Max.	Mean (mm)	SD
Head length	410	160	220	197.78	1.202
Head width	410	120	180	150.14	0.807
Bizygomatic distance	410	60	140	68.13	0.569
Skull height	410	75	120	103.64	0.730
Upper facial height (NL)	410	35	60	44.23	0.418
Lower facial height	410	50	70	61.70	2.452
Facial height	410	90	110	107.71	4.750
Nose width	410	32	50	39.83	0.258

Table 3: Cephalometric variables used in calculating the indices-Yoruba ethnic group

Variables	N	Min.	Max.	Mean (mm)	SD
Head length	410	170	240	199.380	0.732
Head width	410	130	180	158.550	0.753
Bizygomatic distance	410	60	160	82.340	2.893
Skull height	410	90	120	107.050	0.702
Upper facial height (NL)	410	30	60	44.232	0.403
Lower facial height	410	45	70	56.650	0.393
Facial height	410	85	112	99.990	1.812
Nose width	410	30	51	40.090	0.310

Table 4: The t-test for Hausa and Igbo

Group statistics	Tribe	N	Mean	SD	SE mean
Value	Hausa	8	97.003	30.9411	10.939
	Yoruba	8	94.568	33.86924	11.975

	Levene's test for equality of variances		The t-test for equality of mea					95% confidence interval of the difference	
Independent samples test	F (lower)	Sig. (upper)	t (lower)	df (upper)	Sig. (2-tailed) (lower)	Mean difference (upper)	SE difference (lower)	Upper	Lower
Value									
Equal variances assumed	0.021	0.887	0.15	14.000	0.883	2.435	16.21911	-32.3515	37.2215
Equal variances not assumed	-	-	0.15	13.887	0.883	2.435	16.21911	-32.3781	37.2481

CONCLUSION

It is therefore, concluded that these two Nigerian tribes belong to the Negroids skull Bass (1995). Future studies on discriminant function could be carried out as the two conditions necessary (normal distribution and no significant difference in the variances of the two tribes) are fulfilled.

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