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Full Length Research Paper

Sex differences in the cranial and orbital indices for a black Kenyan population

Munguti Jeremiah*, Mandela Pamela and Butt Fawzia

Department of Human Anatomy, University of Nairobi, Kenya.

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Craniometric parameters including cranial and orbital indices have been employed to determine the sex of a person in forensic medicine. These parameters are usually population specific. However, they have not been documented for a black Kenyan population. This study aimed at calculating the sex differences in the cranial and orbital indices. The cranial vault height, glabellomaximal length and orbital height and length were measured from 150 crania (80 male and 70 female) using a sliding vernier caliper. Cranial and orbital indices were calculated and the results were analyzed. The cranial index was 71.04 for the male and 72.37 for the female (P=0.095). The orbital index was 82.57 and 83.48 for the male and female, respectively (P=0.472). From these results, although the cranial and orbital indices are within range of previously reported values for an African population, they cannot be used independently in sexing of black Kenyan crania.

Key words: Forensic, index, morphometric, sex determination.

INTRODUCTION

Sex determination from the skeleton can be assessed with reliability when the methods employed take into account a common sexual dimorphism between populations (Williams et al., 1995; Schimmilt and Cunha, 2006). Although, absolute sex differences seldom exist, there are some distinct differences observed in the cranial features of the male and female crania for given a population. Such dissimilarities are also known to occur between various geographical and ethnic groups. This is because the growth of the human skeleton is under the influence of several factors; among them are hormones, nutritional status, cultural differences and environmental factors (Chimmalgi et al., 2007). These morphometric sexual dimorphisms observed in the human crania have traditionally been used in sex determination involving forensic osteology (Parsons and Keene, 1919; Tripathi and Webb, 2007; Jacobs and Fishber, 2002). This has been either by visual techniques based on the evaluation of morphological traits or by statistical tools with bone measurements (Bruzek, 2002). Visual methods, if reliable, are difficult to apply for new applicants and hence the use of metrical methods is preferred. Metric analysis to determine sex involves more than one measurement of the particular bone involved. The method used should employ a limited number of traits since increasing the number of variables does not provide a higher accuracy but rather makes the process time consuming and produces redundant results (Bruzek, 2002).

Different craniometric parameters have been employed to accurately and reliably determine the sex of a person in forensic medicine. These are either ratios of particular cranial lengths or areas of certain parts of the cranium (Parsons and Keene, 1919). Using metric lengths, various indices have been calculated. The ratio of the cranial vault breadth to the glabellomaximal length multiplied by 100 gives the cranial index (CI) (Golalipour, 2006). This index has been known to be higher in females than in males and shows interethnic variability (Parsons and Keene, 1919; Jacobs and Fishber, 2002). The CI is influenced by the shape of the head and hence the facial symmetry. It makes the orbits in dolicephalic individuals tend to look more laterally than in brachycephalic individuals (Patnaik et al., 2001).

The orbital index (OI), the proportion of the orbit height

*Corresponding author. E-mail: donaldjrmh86@gmail.com.

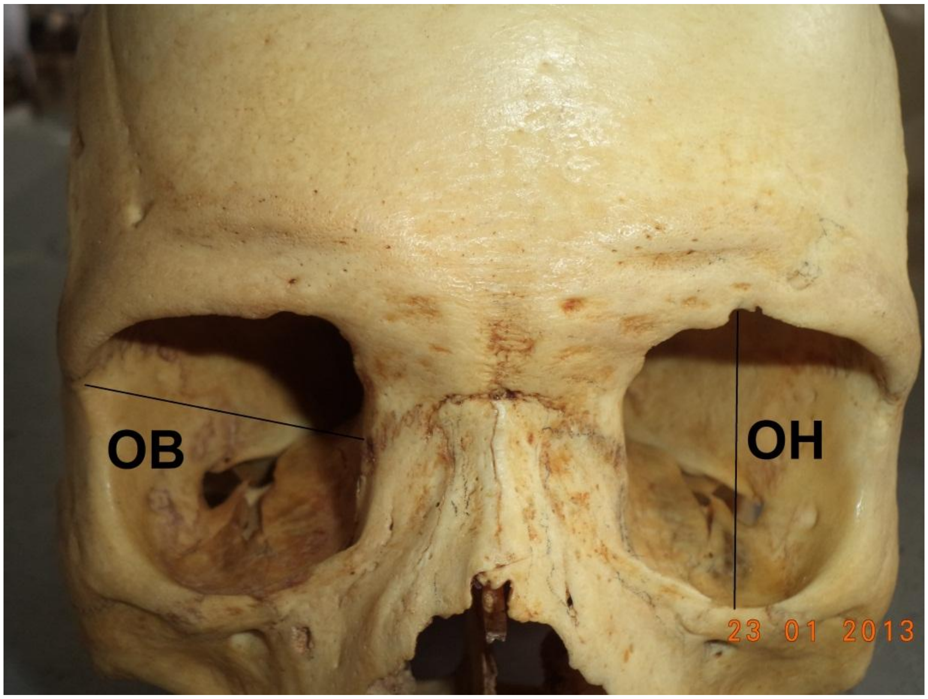

Figure 1. Diagram showing the orbital height, and orbital breadth. OB: Orbital breadth; OH: orbital height.

to its breadth multiplied by 100 (Igbigbi and Ebite, 2010), is determined by the shape of the face and varies with race, regions within the same race and periods in evolution (Miyamoto, 1924; Black, 1928; Harrower, 1928; Shima, 1933). Among the blacks, it is usually higher in females than in males (Miyamoto, 1924).

From literature, the cranial and orbital indices of various communities have been documented and the sex differences have been noted. However, this has not been done for the black Kenyan population. Various natural and accidental circumstances may necessitate the use of anthrometry to identify the sex of a person. These include wars, road and train accidents and deliberate mutilation, disfigurement, pounding, or gauging of the body (Krogman and Iscan, 1986). Documentation of the ranges of these craniometric measurements would assist in skull identification and classification. Therefore, this study was done to compare sex differences in the two indices.

MATERIALS AND METHODS

Adult crania (age ranges between 22 and 67 years) of known sex were obtained from the archives of the Osteology Department, National Museum of Kenya, Nairobi. The bones represent the Central Kenyan ethnic communities and were from casualties of the pre-independence Mau Mau uprising of 1952 to 1963. The sex of the skeletons had been identified from records of slain citizens by the then authorities before being archived. Measurements from 80 male crania and 70 female crania were taken and analyzed. Non-sexed crania and those which had gross defects were excluded from the study. Measurements were taken using a sliding vernier caliper (Franchois™ 2000) with an accuracy of 0.01 cm. Measurements for all crania were taken by the same person twice but at different sittings. Their average was then used in data analysis.

Each cranium was placed on a flat surface and the measurements were taken from a particular landmark. The following measurements were taken: glabellomaximal length, maximum cranial breadth, orbital height and orbital breadth.

The glabella is the most anterior part of the cranium, while the opisthocranium is the instrumentally determined most posterior part of the cranium. The opisthocranium does not lie on the external occipital protuberance (Kelly et al., 1999). These two points were used as the landmarks for the glabellomaximal length. The maximum cranial breadth was taken to be the maximum width of the skull perpendicular to the midsagittal plane, wherever it was located. This width excluded the inferior temporal lines and the area immediately surrounding them as these are inclined towards the midline in comparison to the superior temporal lines. The CI was calculated by dividing the maximum cranial breadth with the glabellomaximal length and multiplying the result by 100.

The ectochion, the intersection of the most anterior surface of the lateral border of the orbit and a line bisecting the orbit along its long axis, was used as a landmark for the most lateral point of the orbit. The sloping distance between the dacryon, the point on the medial border of the orbit at which the frontal, lacrimal, and maxilla bones intersect, and the ectochion was taken to be the orbital breadth (Figure 1). The orbital height was taken as the direct distance between the superior and inferior orbital margins perpendicular to the orbital breadth. The OI was calculated by dividing the orbital height with the orbital breadth and multiplying the result by 100.

All distances were expressed in millimeters and results were analyzed using Statistical Package for Social Sciences (SPSS) version 18. The means between the male and female samples were compared for significance using the Student t-test. The CI of each sex correlated with both the right and left orbital indices for that particular sex using the Pearson's correlation. Confidence interval

Table 1. Orbital index measures among adult Kenyans.

Side	Sex	Range	Mean
Right	Male (n=80)	72.62-92.63	82.72±5.01
	Female (n=70)	70.14-92.29	83.50±5.84
Left	Male (n=80)	72.40-92.38	82.42±3.50
	Female (n=70)	69.82-92.50	83.46±3.50

of 95% was assumed and the differences were considered significant at P≤0.05.

RESULTS

The CI was higher among the female subjects as compared to the males. Among the male subjects, the CI ranged between 58.06 and 78.49 (mean 71.04±3.58). The female CI ranged between 60.60 and 81.13 (mean 72.37±4.34). There was marginal statistically significant difference in the means of cranial indices of the male and female values (P-value 0.095). Of the total population studied, only 9% of the male population had a CI>75, while for the female it was 25%.

In the male subjects, the OI ranged between 72.40 and 92.63 (mean 82.57±5.01). On the other hand, the female OI ranged between 69.82 and 92.50 (mean 83.48±83.50) (Table 1). There were no statistically significant differences in the orbital indices for both the right and left orbits of the two sexes (P-values of 0.472 and 0.389 for the male and female orbital indices, respectively).

The CI positively correlated with the OI for the respective sex. The Pearson correlation coefficient was 0.498 for the right eye and 0.458 for the left eye (P=0.002 and 0.006, respectively) for the male. For the female, the coefficient was 0.162 for the right eye and 0.205 for the left eye (P=0.354 and 0.237, respectively).

DISCUSSION

Craniometric parameters including cranial and orbital indices have been employed to determine the sex of a person in forensic medicine. The prior knowledge of these measures is paramount to their successful application since they are different from one population to another.

The CI is an important feature that is influenced by the shape of the head. It determines how close or apart the orbits will appear to be (Krogman and Iscan, 1986). It usually shows racial and ethnic variations (Parsons and Keene, 1919; Jacobs and Fishber, 2002). The CI was below 75 for both sexes reaffirming previous reports on African crania being dolicephalic (Jacobs and Fishber, 2002; Golalipour, 2006). The difference in the CI between the sexes although statistically marginal, suggests an actual sex difference in the crania of a black Kenyan population. It cannot however be used on its own to sex a cranium. That the CI was higher in females than in males indicates that they have a relatively shorter cranium in relation to the cranial breadth as compared to their male counterparts. The results of this study support prior findings in which the CI was found to be higher for the female crania than for the male crania (Parsons and Keene, 1919; Jacobs and Fishber, 2002). There are however other research works among the African population that have found that male subjects have a larger CI than the female subjects (Oladipo and Olotu, 2006; Oladipo et al., 2009). This points out the much variability seen in the CI of various populations and that a population specific trend cannot be generalized to apply for other communities. Thus, there is a need to consider the group specific parameters when dealing with the CI when determining sex in forensic medicine.

The work of Parsons and Keene (1919) showed that the difference between the female and male cranial indices ranged between 0.4 and 1.6. The difference between the female and male CI in our case was 1.33. This agrees with Parsons and Keene (1919) findings. In the Orhobos of West Africa, the difference was 0.59 (Oladipo and Olotu, 2006). Such a small difference was also observed among the Jews (Jacobs and Fishber, 2002). This further highlights the inter population differences in the CI among various populations and hence the need to compute community specific indices. Since all these studies were done among subjects of different races, this could explain the difference in the CI of male and females in various ethnic groups. This seemingly group specific difference should be determined first before establishing from which sex a given cranium might belong.

Using the OI, three classes of orbits are recognized: megaseme (OI >89) for the Orientals except the Eskimos, mesoseme (OI range between 89 and 83) for the Caucasians and microseme (OI≤83) characteristic of the Africans (Tripathi and Webb, 2007). The higher OI found among orbits of female subjects was similar to what has been reported in previous studies conducted among different populations (Igbigbi and Ebite, 2010). There is however no statistical significance to warrant the use of the OI in sexing the crania from a black Kenyan population.

When the CI was correlated to the orbital indices, there was a greater strength of correlation for the male parameters as compared to those of the females. This was despite the female sex having greater cranial and orbital indices relative to the male sex. This observation seems to point out that a male cranium will have both large cranial and orbital indices when compared with the female cranium. Even though this correlation between the cranial and orbital indices gives the strongest evidence of sex dimorphism, it cannot be surely used to sex a cranium. Further measurements and tests are therefore required.

Conclusion

From the results of this study, although the cranial and orbital indices are within the range of previously documented values for an African population, they cannot be used independently in sexing of black Kenyan crania. A correlation of the two indices might however be useful. We recommend that future studies should consider more measurements and further correlational analysis.

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