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Research Article

Gender Determination from Radiological Assessment of the Sacrum in Urhobo People of Nigeria

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Abstract

Background: Anthropometric measurements have been known to vary with race, sex and age. It is therefore important to establish reference values for any given population. This study was undertaken to access morphometric differences of sacrum between male and female Urhobo people using radiographs and to determine its usefulness in sex determination.

Methods: This retrospective study examined 402 anteroposterior digital radiographs comprising of 201 males and 201 females, from Delta State University Teaching Hospital Oghara. Nigeria. Sacral length, sacral breadth, transverse diameter of S1 vertebrae and ala length were measured. Sacral index, ala index and corpora-basal index were then calculated.

Results: Mean sacral length and mean corpora-basal index were higher in males (105.59 ± 12.35; 36.99 ± 10.93) respectively, while the mean sacral breadth; the mean transverse diameter of S1 vertebrae and the mean ala length were higher in females when compared with males respectively. (129.50 ± 9.20; 46.46 ± 10.23; 40.99 ± 6.18) The mean sacral index was also observed to be higher in females (128.08 ± 15.13). $P < 0.05$.

Conclusions: This study has established sacral index as the most reliable parameter in sex determination using anteroposterior radiographs. This data will be of importance to obstetricians, physical anthropologists and forensic scientists.

Keywords: *Gender; Anthropology; Sacrum; Radiology*

Introduction

Identification of individuals is a major task to forensic anthropologist and investigators. With recent and steady increase in death across the nation due to accidents, terrorist invasion and attacks, ethnic and religious clashes, identification of victims with mutilated body parts becomes necessary. Anthropometric measurements are known to vary with race, sex and age due to genetic variation and geographical distribution; therefore it is necessary to establish reference values for each population [1].

The pelvic bone is one of the most important skeletal elements in sex determination and identification of humans [2]. In forensic medicine, identification of human skeletal remains involves the determination of sex with a prime focus on the pelvic region due to the clear cut differences observed in the pelvis of both sexes such that even fragments of pelvic girdle are useful in sex determination [3]. Studies by Arora., *et al.* in Punjab [4], Shreekrishna., *et al.* in Tamil Nadu [5], Sushma., *et al.* in Western Rajasthan [6], Anterpreet., *et al.* in Punjab [7] and Sibani., *et al.* in Eastern Indian [8] respectively, revealed that sacral parameters are useful in sex determination.

Other methods of personal identification include, finger prints, foot prints, lip prints, ear print, use of long bones and DNA testing which can be very expensive. The sacrum is a large triangular-shaped bone at the base of the spine that is formed by the fusion of sacral vertebrae S1-S5. It is a wedged shaped vertebra that forms the solid base of the spinal column where it intersects with the hip bones to

form the pelvis [9]. The sacrum serves several important functions in the skeletal, muscular, nervous and female reproductive systems. Like many other bones in the body, the sacrum which itself is a part of the pelvis, can also be used to determine sex of skeletal remains [2]. Various parameters and indices are available through which sex can be determined using sacrum. These parameters and indices vary region wise [8]. This study was therefore undertaken to access morphometric differences of sacral parameters between male and female Urhobo people using radiographs and to determine its usefulness in sex determination.

Materials and Methods

This retrospective study examined anteroposterior pelvic radiographs on PACS (VitaCR System) of male and female subjects (ages 20 - 60 years). Clear radiographs were evaluated using clear canvas workstation version 2.0 after rejecting radiographs showing any form of pathology, developmental anomaly and poor quality. The purposive sampling technique was used for this study. Araoye formula was used to determine sample size (10) and it comprised of four hundred and two (402) adult human pelvic radiographs which includes two hundred and one (201) males and two hundred and one (201) females from the radiology department, PACS (Picture Archiving Communication System) unit of Delta State University Teaching Hospital, Oghara. The following parameters were measured; sacral length, sacral breadth, transverse diameter of S1 vertebrae, ala length. Ala index, corpora-basal index and sacral index were afterwards calculated. Ethical approval was sought for and obtained from the Delta State University Teaching Hospital Oghara. Approval number: Health Research Ethics Committee/PAN/2018/003/0278. The data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20.0. The t-test was used for comparing difference in mean value between male and female.

Measurements

Maximum length of sacrum (Wilders mid-ventral straight length): This measurement was taken along the mid-line of sacrum from middle of anterior superior margin of promontory to middle of anterior inferior margin of the last sacral vertebra in millimeters [8].

Maximum breadth of sacrum: It was measured by taking two points at the upper part of auricular surface anteriorly (or lateral most part of ala of sacrum), thus maximum breadth was measured on anterior aspect of sacrum [8].

Transverse diameter of the body of S1 vertebrae (Maximum transverse diameter of sacral basis): This was measured by taking the lateral most point on each side of the superior surface of the body of S1 vertebrae [6].

Ala length (transverse width of the wing): This was measured by taking one point on the lateral margin of the base (i.e. from the most lateral point on the superior surface of body of S1 vertebrae) to the most lateral border of the wing or ala of sacrum [7]. All measurements in this study were taken once by same researcher.

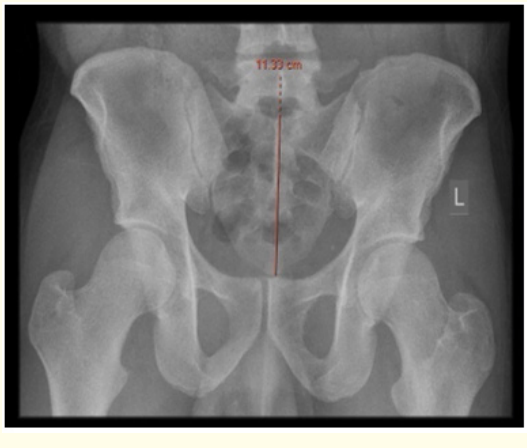

Figure 1: *Maximum length of sacrum.*

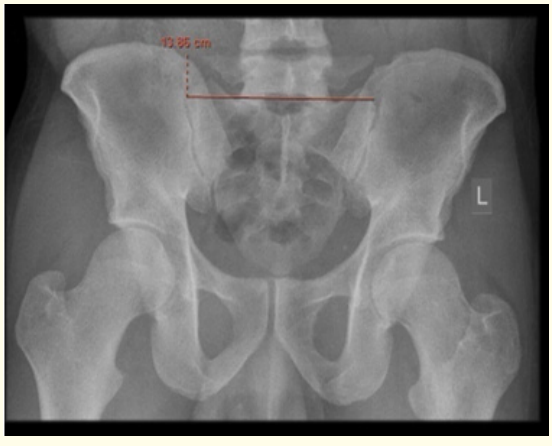

Figure 2: *Maximum breadth of sacrum.*

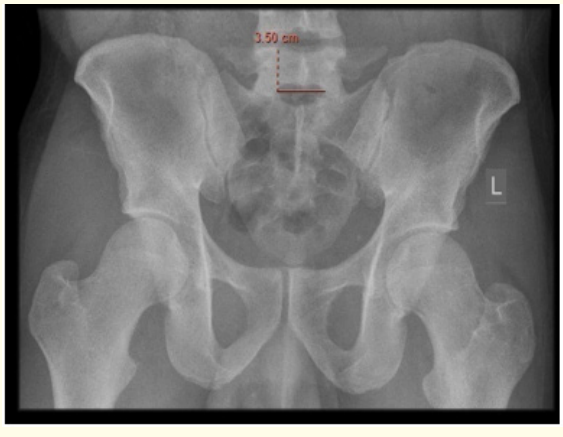

Figure 3: *Transverse diameter of S1 vertebrae.*

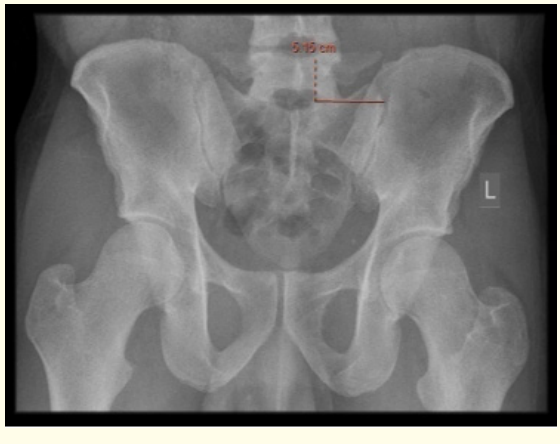

Figure 4: *Ala length.*

Ala Index: $\frac{Length\ of\ ala}{Transverse\ diameter\ of\ body\ of\ S1\ vertebrae} \times 100$ [7]

Corpora-basal Index: $\frac{Transverse\ diameter\ of\ body\ of\ S1\ vertebrae}{Sacral\ breadth} \times 100$ [6,11]

Sacral Index: $\frac{Sacral\ breadth}{Sacral\ lenght} \times 100$ [6]

Result

Male					Female				P-value	95% CI
Parameters	**Range**	**Mean**	**SD**	**Std Error**	**Range**	**Mean**	**SD**	**Std Error**		
Sacral Length	79.50-142.90	105.59	12.37	0.873	72.70-132.40	102.21	12.50	0.882	0.007	105.121
Sacral Breadth	89.80-158.90	124.44	12.65	0.892	103.50-156.90	129.50	9.20	0.649	0.001	128.079
Transverse diameter of S1 Vertebrae	28.30-140.30	45.52	11.01	0.776	26.40-71.10	46.46	10.23	0.722	0.374	47.031
Ala Length	20.10-55.90	39.32	6.65	0.469	38.32-167.50	93.15	27.11	0.436	0.010	40.787
Ala Index	40.52-180.57	91.45	27.68	1.952	38.32-167.50	93.15	27.11	1.913	0.534	94.981
Corpora-basal Index	20.95-140.74	36.99	10.93	0.771	22.41-53.53	35.79	7.52	0.530	0.201	37.309
Sacral Index	78.76-169.18	119.26	15.74	1.111	96.81-169.11	128.08	15.13	1.007	0.001	125.246

Table 1: *Statistical values for all studied parameter.*

N = 201 (for male and female respectively)

df = 200

p ≤ 0.05.

Of the 402 radiographs examined, mean sacral length and mean corpora-basal index were higher in males (105.59 ± 12.35; 36.99 ± 10.93) as shown in table 1 above, while the mean sacral breadth, the mean transverse diameter of S1 vertebrae and the mean ala length were higher in females when compared with males (129.50 ± 9.20; 46.46 ± 10.23; 40.99 ± 6.18). The mean sacral index was also observed to be higher in females (128.08 ± 15.13). There was a significant difference between mean sacral length (P = 0.007), sacral breadth (P = 0.001), ala length (P = 0.01) and sacral index (P = 0.001) but no significant differences existed between mean transverse diameter of S1 vertebrae (P = 0.37), corpora-basal index (P = 0.20) and ala index (P = 0.53) between sexes.

Discussion

Gender determination from skeleton is a vital component in forensic and archaeological settings. When skeletal materials are discovered, one of the prime features that an anthropologist seeks is to identify the individual's sex. Anthropologist has found human pelvis to be an important skeletal element in view of gender determination due to its clear cut difference with respect to gender.

In this study, sacral length and corpora-basal index was higher in males while sacral breadth, transverse diameter of S1 vertebrae, ala length, ala index and sacral index was lower in males. Also, there was statistical significance difference between male and female sacra length, sacral breadth, ala length and sacral index but no statistical significant difference existed between male and female transverse

diameter of S1 vertebrae, ala index and corpora-basal index. It is also evident from this study that among the indices, sacral index was the best parameter for gender determination following its statistical significant difference between males and females.

Sacral breath, transverse diameter of S1 vertebrae, ala length, ala index and sacral index were found to be higher in females in this study. This observation corresponds to those of Renuka., *et al.* [2], Arora., *et al.* [8], Poornima., *et al.* [9] (they found sacral breath to be higher in females), Kanika., *et al.* [11], Renuka., *et al.* [2], Davivong [12], Raju., *et al.* [13], Mishra., *et al.* [14] (all found transverse diameter of S1 vertebrae to be higher in females). Mishra., *et al.* [14] found ala length to be higher in female. Mishra., *et al.* [14] and Shreekrishna., *et al.* [15] found ala index to be higher in females. Shreekrishna., *et al.* [15], Mazumdar., *et al.* [6], Davivong [12], Mishra., *et al.* [14], Renuka., *et al.* [2], Raju., *et al.* [13], Kanika., *et al.* [11], Jyothinath., *et al.* [16] found sacral index to be higher in female. However, observations by Mazumdar., *et al.* [6], Davivong [12] and Renuka., *et al.* [2], do not correspond to our findings for sacral breath. Renuka., *et al.* [2] also observed ala length to be higher in males which contradicts our findings.

Sacral index and corporal basal index were found to be higher in males in this study. This finding agrees with studies of Mazumdar., *et al.* [6], Davivong [12], Mishra., *et al.* [14], Renuka., *et al.* [2], Sushma., *et al.* [17], meanwhile Shreekishna., *et al.* [15] and Raju [13] observed only corporal basal index to be higher in females. However, the finding of Poornima., *et al.* [9] contradicts our findings, they found sacral length to be higher in females.

Despite the agreement in our findings, we observed differences in our mean values when compared with those of other authors. This could be due to racial and regional variations. Hence the need for reference values for each population [1].

Since sacrum is a component of the pelvic girdle with functional differences between males and females, it becomes important for gender determination in the human skeletal system. This research has used a retrospective approach to study the sacrum using radiographs from Delta State Teaching Hospital, Oghara.

Conclusion

Gender determination is therefore possible from radiological assessment of the sacrum. Data from this study will be useful in forensic medicine, radiology and anthropology. It is therefore recommended that further study be carried out using adult dry human sacrum or other radiologic tool like computed tomography with age consideration.

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