Journal of Natural Sciences Research
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.3, No.6, 2013

The Discriminant Formula for the Determination of Sex of Adults in A Nigerian Population (Using Pelvic Radiographs)

*Osunwoke, Emeka A (PhD- corresponding author)
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, PMB 5323 Port Harcourt- Nigeria.
E-mail: aeosunwoke@yahoo.com. Tel: +2348055160338.

Olotu, Emamoke J (PhD)
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, PMB 5323 Port Harcourt- Nigeria.
E-mail: olotujoy@yahoo.com. Tel: +2348037752394.

Allison Theodore A (MBBS)
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, PMB 5323 Port Harcourt- Nigeria.
E-mail: doctheo4real@gmail.com. Tel: +2348096027053.

Oriji Christiana N (B.sc)
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, PMB 5323 Port Harcourt- Nigeria.
E-mail: Angel_k4real@yahoo.com. Tel: +2348101631807.

Mbadugha Christopher C (M.sc)
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Uyo, Akwa Ibom. Nigeria.
E-mail: christophermbadugha@rocketmail.com. Tel: +2348037736770.

ABSTRACT

Identification of sex in human skeletal remains is an important component and frequently the starting point of many forensic anthropological investigations. This study was carried out to document the determination of sex by discriminant formula using the pelvic radiographs of Nigerian adults. Measurements were carried out on the pelvis. Pelvic radiographs of 500 adult Nigerians of known sex, age range 18-75 years (comprising 250 males and 250 females) were measured in the antero-posterior position using a digital vernier calliper. The data was analysed using z-test. The results showed that the mean values for the Ischial length and Pubic length in males were 86.82±8.25mm and 76.41±8.91mm respectively while in females the Ischial length and Pubic length were 80.62±7.66mm and 84.58±8.80mm respectively. 4% males and 19% females were identified for ischial length and 15% males and 42% females were identified for pubic length. The mean value for pelvic height in males and females were 236.70±12.51mm and 223.02±12.18mm respectively, the demarking points identified 29% males and 32% females, while the mean value for midpubic width in males and females were 25.94± 4.54mm and 30.09± 3.67mm respectively, the demarking points identified 40% and 65% females. The mean values for ischiopubic and pelvic height/midpubic width were statistically significant ($P<0.05$). The mean values of the pelvic height/midpubic index were 9.35 ± 1.38 in males and 7.49 ± 0.82 in females. The demarking points identified 72% males and 75% females. While the mean values of the ischiopubic index in males and females were 88.46±9.26 in males and 114.67±99.28 in females, the demarking points identified 56% males and 84% females. It was observed that the males had higher pelvic height and ischial length than females, while the females had longer pubic length and mid pubic width which contributed to the females having wider pelvis.
The accurate determination of sex and race are important tools to forensic Scientists and physical anthropologists.

Keywords: Pelvis, Radiographs, Sex determination, Nigerian population.

INTRODUCTION

Ascertaining a biological profile from the skeleton is a vital component in both forensic and archaeological settings. When skeletal material is discovered, one of the prime attributes that an anthropologist seeks to identify is the individual's sex (Washburn S.L 1948). Sexual dimorphism, or size and or shape differences between the males and females of a species can be best observed primarily on the cranium and pelvis of humans. Reliable methods of sex determination for adult skeletal material have existed for decades; cranial features include the mandibular angles, orbital area, and mastoid processes, while pelvic features include the sciatic notch, subpubic angle, and obturator foramen (Ali and MacLaughlin 1991; Anderson 1990; Bruzek 2002; Coleman 1969; Davivongs 1963; Day and Pitcher-Wilmott 1975; Dibennardo and Taylor 1983; Krogman 1962; Phenice 1969; Hoyme and Iscan 1989; Stewart 1954; Thieme and Schull 1957). The pelvis, the most sexually dimorphic area of the body, is essential for biological sex determination of the adult skeleton.

Even though several pelvic traits are sexually distinguishable throughout the developmental process, the skeletal remains of infants and children have been primarily excluded from sex determination analyses as researchers believed that sex determination does not occur until an individual has reached puberty (Boucher, 1955; Boucher, 1957; Rosing, 1983; Thomson, 1899). For forensic cases, only genetic testing can positively identify the sex of the skeleton for law enforcement agencies. Testing can be time consuming, and many government labs currently experience backlogs (Nelson, 2011). For bio-archaeological research, genetic testing is also time consuming and destructive to skeletal material. Issues of sample contamination also create problems for researchers in both bio-archaeological and forensic situations (Roberts and Ingham, 2008). The expression of sexual dimorphism in the sacroiliac complex is visible during the fetal period. The fourth and fifth characters (ischio-pubic complex) reflect the adaptation of the female pelvic canal to the requirements of reproduction. The manifestations of sexual dimorphism in the ischio-pubic complex do not begin until puberty (Bruzek, 2002). Ekanem *et al*., (2009) conducted a study on the

radiographic determination of sex differences in ischio-pubic index of a Nigerian population, and their results revealed that the sex differences of the pubic length, ischial length and ischio-pubic index was found to be significant. The ischio-pubic index of the females was discovered to be higher than that of males. The index varied from 71-123 with a mean of 94.2±9.9 in males while in females it varied from 79-154 with a mean of 118.8±12.3. The identification point for the males was 84 and that of the females was 123 and this assigned sex to 61% males and 64% females. On a study carried out on the comparison of the sub-pubic angles of adult Igbos and Ijaws, the results showed that the females from both ethnic groups had significant wider sub-pubic angle than the men ($P<0.05$). The Ijaw and Igbo males had a mean sub-pubic angle of $109.38^0 \pm 10.0$ and $95.29^0 \pm 10.5$ respectively, while the Ijaw and Igbo females had a mean sub-pubic angle of $119.48^0 \pm 12.1$ and $111.44^0 \pm 12.9$ respectively (Oladipo *et al*., 2009). Oladipo *et al*., (2010) also carried out another study to determine and compare the pubic length and ischiopubic indices of eastern Nigerians. Results showed that the mean pubic length was significantly longer in females than in males ($P<0.05$) and the mean ischial length was significantly higher in females than in males ($P<0.05$). The mean values of pubic length, ischial length, and ischiopubic index of males were 71.0mm, 84.4mm and 84.0 respectively while for the females, it was 85.0mm, 83.0mm and 102.0.Using the radiographs, sex could be assigned to 78% of the eastern males and 91% 0f eastern females. Igbigbi and Msamati (2000) on a study carried out on the ischiopubic index in adult black Malawians, results showed that the mean ischiopubic index of females was significantly greater than that of males ($P<0.001$) while the length of the female pubis was longer than that of males ($P<0.001$). The mean length of the ischium in males was significantly longer than that of females ($P<0.001$).

This study is aimed at the determination of sex of adults using pelvic radiographs and to demark male pelvis from female pelvis with the use of reliable parameters.

MATERIALS AND METHODS

The study investigated 500 antero-posterior radiographs of the pelvis comprising 250 males and 250 females aged from 18 to 75 years from the Radiology Departments of the University of Port-Harcourt Teaching Hospital (UPTH) and Braith-waite Memorial Hospital (BMH) Port Harcourt. The radiographs were normal, showed no underlying bone disease which could have affected the intact pelvic bone. Only radiographs with complete alignment at the inferior margins of the pubic bones at the pubic symphysis were measured because determination of misalignment is best made at the inferior margins (Lusted and Keats, 1978). Measurements were carried out by choosing 3 points on the radiographs: points A, B and C. Points A were the acetabular point where the three pelvic bones meet. Points B and C were the ischial tuberosity and pubic tubercle respectively. A marker was used to mark these points for clear visualization. The distance between these points were then measured with the aid of vernier calliper. Distance AB

gave the ischial length while AC gave the pubic length. Each distance was measured twice and the average recorded as the actual distance to ensure accuracy. The distance AC was divided by the distance AB, the result was then multiplied by 100. This gave the ischiopubic index. (IP = AC/AB X 100). Radiographs were placed on an X-ray view box for clear visualization. All radiographs were taken at a distance of 100cm. Data analysis was done using z text. Sex was determined by using the demarking point method. This method involves calculating the maximum and minimum limit of range of the ischiopubic index by using the formula, Mean + 2SD (standard deviation).

RESULTS

Table1. Table showing the mean and standard deviation of the measured values for males and females. Table 2. Table showing the mean values for demarking points for various parameters of the pelvis in males and females.

DISCUSSION

Sexual differences in adult pelvis has been studied and measured extensively, these studies involved metrical and non-metrical characteristics whose range overlap between the sexes. In the present study the pubic length, ischial length, pelvic height, midpubic width, the pelvic height/midpubic width and ischiopubic index were determined. The pubic length, ischial length, pelvic height and mid-pubic width could not identify reasonable percentage of pelvis in both sexes, though the mean values of these parameters were statistically significant ($p<0.05$). The ischio-pubic and pelvic height/midpubic width index however were observed to be useful in the sex determination, their mean values were statistically significant ($P<0.05$). It was observed that the males had higher pelvic height and ischial length than females, while the females had longer pubic length and mid-pubic width which contributed to the females having a wider pelvis.

The observation in this present study is in line with earlier reports from previous authors such as Igbigbi and Msamati, (2000) on ischio-pubic index of black Malawians with a mean of 85.0 for males and 104.6 for females; Oladipo *et al,* (2009) on pubic length, ischial length, ischio-pubic index eastern Nigerians with a mean of 71.0mm, 84.4mm and 84.0 for males respectively while in females it was 85.0mm, 83.0mm and 102.6 respectively and Ekamen *et al,* (2009) who reported that the mean pubic length was significantly longer in females than males, whereas the mean ischial length was significantly higher in males than females in Cross river people of Nigeria.

CONCLUSION

In conclusion, this study has established the presence of sexual dimorphism in pelvic height/mid-pubic width index and Ischio-pubic index from adult Nigerian pelvis. It is therefore stated that, pelvic height/mid-pubic width and Ischio-pubic index could be used as discriminant formula for sex determination.

These measurements can be applied in surgical practice, forensic investigations and anthropology.

ACKNOWLEDGEMENT

We wish to thank the members of staff of the department of radiology of the university of Port Harcourt and Braithwait Memorial Hospital, Port Harcourt, Nigeria for their assistance in successful completion of this study.

REFERENCES

Ali R, MacLaughlin S. (1991). Sex identification from the auricular surface of the adult human ilium. *International Journal of Osteoarchaeology*. Vol.1(1); Pp 57-61.

Anderson B (1990). Ventral arch of the os pubis: anatomical and developmental considerations. *American Journal of Physical Anthropology*. Vol.83(4); Pp 449-458.

Boucher B.J (1955). Sex differences in the foetal sciatic notch. *Journal of forensic sciences*; vol 2: pp51-54.

Boucher B.J (1957). Sex differences in the foetal pelvis. *American Journal of Physical Anthopology* vol 15; pp 581-600.

Bruzek J. (2002). A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology* Vol.117; Pp 157-168.

Coleman W.H (1969). Sex differences in the growth of the human bony pelvis. *American Journal of Physical Anthropology*. Vol.31(2); Pp 125-151.

Davivongs V. (1963). The pelvic girdle of the Australian Aborigine: Sex differences and sex determination. *American Journal of Physical Anthropology.* Vol.21(4); Pp 443-455.

Day M, Pitcher-Wilmott R. (1975). Sexual differentiation in the innominate bone studied by multivariate analysis. *Annals of Human Biology.* Vol.2(2); Pp 143-151.

Dibennardo R, Taylor J.V (1983). Multiple discriminant function analysis of sex and race in the postcranial skeleton.

American Journal of Physical Anthropology. Vol.61(3); Pp 305-314.
Ekanem T, Udongwu A, Singh (2009). Radiographic determination of sex differences in ischiopubic index of A Nigerian population. The *internet journal of Biological Anthropology*. Vol.3(2); Pp 32-37.
Hoyme L.E and Iscan M.Y (1989). Determination of sex and race: Accuracy and assumptions. Reconstruction of Life from the Skeleton: *Alan R. Liss, Inc*. Pp 53-93.
Igbigbi P.S, Msamati B.C, (2000). Ischio-pubic index in adult Malawians. *East African medical journal*. Vol.77 (9); Pp 514-516.

Krogman W.M. (1962). The human skeleton in forensic medicine. *International Journal of Anthropology*. Vol.3; Pp 267-283.

Lusted L.B. and Keats T.E. (1978): The lower extremity. In: Atlas of Reontgenographic Measurements. Lusted, L.B.; Keats, T.E. (Eds.), 2nd edition, London, England, Yearbook Medical Publishers, P. 165.
Oladipo G.S, Okoh P.D, Suleiman. (2010). Radiologic studies of Pubic length, Ischial length, and ischiopubic index of Eastern Nigerian. *Research journal of medical sciences*. Vol.5(2); Pp 117-120.
Phenice T.W. (1969). A newly developed visual method of sexing the os-pubis. *American Journal of Physical Anthropology*. Vol.30 (2); Pp 297-302.
Roberts C, Ingham S (2008). Using ancient DNA analysis in palaeopathology: A critical analysis of published papers with recommendations for future work. *International Journal of Osteoarchaelogy. Vol 18: pp 600-613.*
Rosing F.W (1983). Sexing immature human skeletons. *Journal of Human Evolution*. Vol 12: pp 149-155.
Steyn M. and Iscan, M. Y. (1998). "Sexual dimorphism in the crania and mandibles of South African whites". *Forensic Sciences International*. Vol.98: Pp 9-16.
Stewart T.D (1954). Sex determination of the skeleton by guess and measurement. *American journal of physical anthropology*. Vol 12: pp 385-392.
Thieme F. and Schull W (1957). Sex determination from the skeleton. *Human Biology*. Vol.29; Pp 242-273.
Thomson A (1899). The sexual differences of the foetal pelvis. *Journal of Anatomy and physiology*. Vol 33; pp 359.
Singh S and Potturi B. (1978). Greater sciatic notch in sex determination. *Journal of Anatomy*. Vol.125; Pp 619-624.

Table 1: Table showing the mean and standard deviation of the various parameters measured in Nigerian males and female pelvis.

Males	Mean±SD (mm)				
Ischial(L)	Pubic(L)	Pelvic(H)	Mid-pubic (L)	Ischiopubic Index	Pelvic(H)/Mid-pubic(W)
86.61±8.25	76.41±8.91	236.70±12.5	25.94±4.54	88.46±9.26	9.35±1.38
Females					
80.62±7.66	84.58±8.80	223.02±12.2	30.09±3.67	114.67±99.3	7.49± 0.82

Key: L = length, W = width, SD = Standard deviation.

Table 2: Table showing the mean values for demarking points for various parameters of the pelvis in males and females.

Parameter	No.	Mean + S.D	Demarking points (D.P)	% of sex identified
Males	(250)			
Ischial length		86.61±8.25	> 96.1	4%
Pubic length		76.41±8.91	< 67.4	15%
Pelvic height		236.70±12.51	> 247.1	29%
Mid-pubic width		25.94±4.54	< 22.9	40%
Ischiopubic index		88.46±9.26	< 86.3	56%
$\frac{\text{pelvic height}}{\text{midpubic width}}$		9.35±1.38	> 9.04	72%
Females	(250)			
Ischial length		80.62±7.66	< 72.3	19%
Pubic length		84.58±8.80	>85.5	42%
Pelvic height		223.02±12.18	< 219.3	32%
Mid-pubic width		30.09±3.67	> 30.0	65%
Ischiopubic index		114.67±99.28	> 97.3	84%
$\frac{\text{pelvic height}}{\text{midpubic width}}$		7.49±0.82	< 7.75	75%