



The Role of Normal Anterior posterior Pelvic Radiographs in Determination of Sex Difference in Nigeria Population

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ABSTRACT: Introduction: The pelvis is essential for biological sex determination of the adult skeleton. This is because one of the major differences between men and women is child bearing as such it largely determines the shape of that part of the body. Various studies have shown that the hip bone is an ideal bone for sex determination because it reflects not only the general differences between the sexes but also the special adaptation of the female hip bone for child bearing recognized as one of the best skeletal indicators of sex in an adult individual. **Aims and Objectives:** To provide landmarks in the pelvis for determining sexes of various individuals using normal pelvic radiographs. **Methodology:** The pubic length was measured by drawing a straight line on the radiograph from centre of the triradiate cartilage (acetabulum) to the medial end of pubic symphysis and it was expressed in millimeters. The ischial length was measured by drawing a straight (vertical) line on the radiograph from triradiate cartilage (acetabulum) perpendicular to the line joining the bilateral lower ischial tuberosities and it is expressed in millimeters. Ischiopubic index was determined from pubic length divided by ischial length and then multiplied by 100. Length of pubic bone /Length of Ischial bone \times 100. **Results:** there were 133 normal subjects, 75 males and 58 females with the age ranging from 18 years old up to 70 years old and a mean age of 37.97 years. Patient's age, gender, pubic length, ischial length and ischiopubic index were recorded. Mean ischial length was 95.21 \pm 3.8mm for male and 85.47 \pm 5.6mm for female. **Conclusion:** The mean pubic length for male was found to be 84 \pm 9.3 \pm 4.5mm and 95.03 \pm 4.5mm for female. The ischial and pubic lengths showed statistically significant differences between males and females ($p < 0.05$) and therefore have dimorphic potential. In males and females, the mean ischiopubic index were 89.32 \pm 4.8 and 111.5 \pm 6.7 respectively. This may explain the significant higher sexual differences in ischiopubic

index observed in the females when compared with that of male counterparts.

Keywords: Gender determination, Normal Anterior - posterior Pelvic Radiographs, Sex differences,

I. INTRODUCTION

The pelvis being the most sexually dimorphic area of the body is essential for biological sex determination of the adult skeleton [1]. This is because one of the major biological differences between men and women is child bearing as such it largely determines the shape of that part of the body [2]. Various studies have shown extensively that the hip bone is an ideal bone for sex determination because it reflects not only the general differences between the sexes but also the special adaptation of the female hip bone for child bearing [1]. The innominate bone has long been recognized as one of the best skeletal indicators of sex in an adult individual [2]. The ischiopubic index is useful in sex differentiation. [3] The sexual differences in the pelvis are of interest to forensic radiographers, anatomist, gynecologist, and even anthropologist [1]. The extent of sex determination is so important to females with narrow cavity which find it more difficult to deliver babies naturally than those with wide pelvic cavity [3]. The growth of the pelvis is in the width resulting to wide pelvic inlet; as such this study will determine the sex difference using the ischiopubic index of patients radiograph with no sign of pathology and bony deformities [2].

The ischiopubic index is the measurement of the distance between the triradiate cartilage (acetabulum) and the pubic tubercle of the pelvic bone divided by the distance between the triradiate cartilage (acetabulum) and the ischial tuberosity of the pelvic bone, multiplied by hundred [3]. This study reflects not only the general differences between the sexes but also the special adaptation of female hip bone for child bearing [1]. It has been observed that the size of the ischiopubic index



determines the size of the birth canal, which is an important criterion in vaginal delivery [4]. This may be of value in physical anthropology, anatomy, gynecology to estimate the extent of labor, archeological analyses and in solving medico legal cases. [3]. A retrospective study was conducted by [2] on Radiographic Determination of Sex Differences in Ischiopubic Index of a Nigerian Population by using 214 normal adult anterior-posterior radiographs of the pelvis (114 males and 100 females) that were fully screened from any pathology revealed that, 65.8mm and 75.8mm are the mean pubic lengths of males and females respectively. While 70.1mm and 64.5mm are the mean ischial lengths of males and females respectively. In males and females the mean ischiopubic indices were found to be 94.2 and 117.3 respectively. The mean values of this index were found to be statistically significant ($p < 0.001$) and percentage identified by demarking point was 69% for males and 81% for females. In conclusion, this explained significant higher sexual differences in ischiopubic index observed in the females when compared with that of the male counterparts.

II. MATERIALS AND METHODS

A retrospective cross-sectional was adopted for this research. Secondary source of data was used. The study population was normal AP pelvic and KUB radiographs performed in Radiology Department UDUTH, Sokoto from January 2010- June 2019.

The materials used included the following items; Viewing box, Normal anteriorposterior (AP) pelvic and KUB radiographs from Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto and Meter rule.

A convenient sampling technique was used to obtain a sample size of 200 anteriorposterior pelvic and KUB radiographs. 200 adult patients belonging to the age group of 18-70, referred to radiology department (UDUTH), Sokoto for anteriorposterior (AP) pelvic and KUB

radiography reported normal by radiologists were recruited.

Inclusion criteria are normal adult anterior-posterior radiographs of the pelvis and KUB taken in supine position that were fully screened from any pathology and aged between 18 – 70 years irrespective of patient sex. Exclusion criteria are trauma of pelvis and underlying bone disease which could affect the normal integrity of the pelvic bone. This also excludes all pelvic and KUB radiographs of patients below the age of 18 years.

The pubic length was measured by drawing a straight line on the radiograph from centre of the triradiate cartilage (acetabulum) to the medial end of pubic symphysis and it was expressed in millimeters [2]. The ischial length was measured by drawing a straight (vertical) line on the radiograph from triradiate cartilage (acetabulum) perpendicular to the line joining the bilateral lower ischial tuberosities and it is expressed in millimeters [2]. Ischiopubic index was determined from pubic length divided by ischial length and then multiplied by 100. Length of pubic bone /Length of Ischial bone \times 100 [2]

Ethical approval was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto.

Data obtained was analyzed using statistical package for social sciences software SPSS (version 20) and by using INDEPENDENT sample t-test to determine the significant sex differences by using P Value

III. RESULTS

133 normal patients were involved, 75 males and 58 females with the age ranging from 18-70 years with mean age of 37.97 years. Patient's age, gender, pubic length, ischial length and ischiopubic index were recorded. The detailed results are shown in the tables and figures are presented below:

Gender	Frequency	Percentage
Male	75	56.4%
Female	58	43.6%
Total	133	100%



Table 2: Pubic length of male and female pelvis

Gender	Mean (mm)	Standard Deviation (mm)	Maximum (mm)	Minimum (mm)	Range (mm)
Male	84.9333	4.47918	94.00	72.00	22.00
Female	95.0345	4.47984	108.00	84.00	24.00

Table 3: Test of significance difference between male and female pubic length

Parameter	Mean Difference (mm)	T	df	P
Pubic Length	-10.1012	-12.896	131	0.000

The mean values of pubic length for males in pelvic radiograph were found to be 84.93 ± 4.5 mm with the maximum being 94.00 mm and minimum 72.00 mm and that of female were found to be 95.03 ± 4.5 mm with the maximum being

108.00 mm and minimum 84.00 mm [Table 2]. The pubic length in females was observed to be higher than in males. These differences were observed to be statistically significant ($p < 0.05$) [Table 3].

Table 4: Ischial length of male and female pelvis

Gender	Mean (mm)	SD (mm)	Max (mm)	Min (mm)	Range (mm)
Male	95.2133	3.8107	102.00	87.00	15.00
Female	85.4655	5.5889	99.00	72.00	27.00

Table 5: Test of significance difference between male and female ischial length

Parameter	Mean Difference (mm)	T	df	P
Ischial Length	9.7478	11.941	131	0.000

The mean values of ischial length for males in pelvic radiograph were found to be 95.2 ± 3.8 mm with the maximum being 102.00 mm and minimum 87.00 mm and that of female were found to be 85.47 ± 5.6 mm with the maximum being

99.00 mm and minimum 72.00 mm [Table 4]. The ischial length in males measured more than that of females. These differences were observed to be statistically significant ($p < 0.05$) [Table 5].

Table 6: Ischiopubic index of male and female pelvis

Gender	Mean	Standard Deviation	Maximum	Minimum	Range
Male	89.3173	4.8430	97.80	78.60	19.20
Female	111.4983	6.6697	134.70	101.00	33.70

Table 7: Test of significance between male and female ischiopubic index

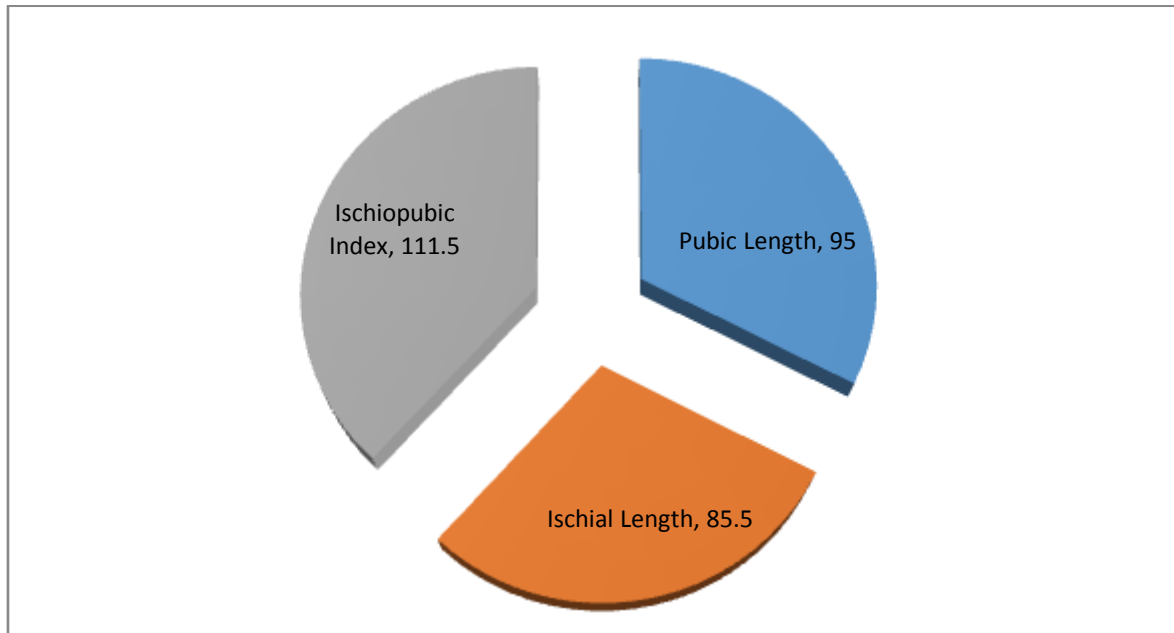
Parameter	Mean Difference (mm)	T	df	P
Ischiopubic Index	-22.1810	-22.215	131	0.000

The mean values of ischiopubic index for males in pelvic radiograph were found to be 89.32 ± 4.8 with the maximum being 97.80 and minimum 78.60 and that of female were found to be 111.50 ± 6.7 with the maximum being 134.70 and

minimum 101.00 [Table 6]. The ischiopubic index of the females was higher than that of males. These differences were observed to be statistically significant ($p < 0.05$) [Table 7].

Table 8: Male and Female Ischiopubic Index

Subject	Number	Mean \pm S.D	Median	Range	95% Confidence Interval	
					Lower	Upper
Male	75	89.32 ± 4.84	89.20	78.6-97.8	88.17	90.41
Female	58	111.50 ± 6.67	110.55	101.0-134.70	109.84	113.20



Bar-chart of different parameters according to gender

IV. DISCUSSION

The objective of this study was to measure the pubic length, ischial length and ischiopubic index. The sample consisted of 133 subjects with different genders, 75 males (56.4%) and 58 females (43.6%). The mean values of pubic length for males were found to be 84.93 ± 4.5 mm with range 6.80 to 10.48 mm and that for females were found to be 95.03 ± 4.5 mm with the range of 72.00 to 94.00 mm. The mean values for ischial length for males were found to be 95.21 ± 3.8 mm with range of 87.00 to 102.00 mm and for females were found to be 85.47 ± 5.6 mm with 72.00 to 99.00 mm range. The mean values of ischiopubic index for males were found to be 89.32 ± 4.8 with 78.60 to 97.80 range and that of female were found to be 111.50 ± 6.7 with range 101.00 to 134.70. It was observed that the males had higher ischial length than females while the females had longer pubic length and higher ischiopubic index in the present study.

In the study of [5] in Cross River State in Nigeria, the mean pubic length was 65.8 mm and 75.7 mm in male and female respectively. The mean ischial length was 70.1 mm and 64.5 mm in men and women respectively and the ischiopubic index was 94.2 mm in men and 117.3 mm in women. The values for male ischiopubic index 94.2 and female ischiopubic index 117.3 are higher than ours. Nevertheless, the sex difference of pubic length, ischial length and ischiopubic index were found to be statistically significant when male and female x-ray films were compared ($p < 0.001$). This study

supports our study even when the sex differences of pubic length, ischial length and ischiopubic index were found to be statistically significant at ($p < 0.05$). [6] revealed that the mean pubic length was 74.99 mm in male and 84.48 mm in female and the mean ischial length was 85.03 mm in male and 79.52 mm in female. Additionally, values of the ischiopubic index were 88.65 and 106.45 in men and women respectively and the outcome of our study supports the same. In a study by [6] the mean values for the pubic length, ischial length and ischiopubic index were 78.51 ± 12.4 mm, 85.58 ± 11.6 mm and 91.66 ± 5.86 respectively for Urhobo men while 92.39 ± 7.08 mm, 81.97 ± 12.00 mm and 114.93 ± 18.14 respectively for Urhobo women. Furthermore, the mean values for the pubic length, ischial length and ischiopubic index were 82.20 ± 10.62 mm, 83.84 ± 10.82 mm and 98.40 ± 9.37 respectively for Itsekiri males while 92.05 ± 6.36 mm, 85.03 ± 14.59 mm and 111.03 ± 18.37 for their women counterparts respectively, which shows a significant difference among the sexes. Another study by [4] reported that the mean values for the pubic length, ischial length and ischiopubic index were 91.99 ± 17.76 mm, 101.16 ± 18.53 mm and 90.88 ± 5.52 for male respectively while 103.12 ± 13.11 mm, 90.07 ± 12.19 mm and 114.87 ± 8.08 for female respectively. In the study conducted by [8] the mean values for the pubic length, ischial length and ischiopubic index were 8.3 ± 0.82 cm, 9.05 ± 0.73 cm and 91.73 ± 5 respectively for male while 9.21 ± 0.8 cm, 8.92 ± 0.72 cm and 110.9 ± 7 respectively for female.



Results of previous studies and that of the current study have determined that the ischial length is higher in male while the pubic length is higher in female and the mean value of the ischiopubic index was significantly higher in women. In the present work, the mean values of ischial length and pubic length were almost similar with that of the study by [7] and were lower than the [5] study. The mean ischiopubic index of different parts of Nigerian population was also different. This may be as a result of regional variation of the ischiopubic index. A study among Portuguese subjects conducted by [8] showed a reversal of this pattern which reported that the mean ischiopubic index of 78.2 ± 6.2 in males which was greater than in females whose mean ischiopubic index was 71.3 ± 3.1 . This dispersion might be related to genetic and environmental factors which are known denominators for intra and inter-population variability.

Measurement of ischiopubic index should be taken at reproducible anatomic landmarks if measurements are taken by radiograph and CT pelvis that may provide high accuracy. CT pelvis may provide better anatomic landmarks for the measurement of pubic length, ischial length and ischiopubic index, thus providing better results.

[6] conducted a study on Radiologic Study of Ischiopubic Index of Urhobos and Itsekiris ethnic groups of Nigeria. The study was designed to determine and compare the pubic length, ischial length and ischiopubic indices amongst Urhobos and Itsekiris. The parameters were measured from radiographs obtained from the Radiology Department of Delta State University Teaching Hospital (DELSUTH), Oghara and Capitol Hill Clinic, Warri both in Delta State, Nigeria. Normal anterior-posterior radiographs of 93 adult pelvis (age range of 18 years and above) that are free from pathological changes were evaluated. 66 of the radiographs were those of Urhobos (36 males and 30 females), while 27 were those of Itsekiris (13 males and 14 females). The mean values for pubic length, ischial length and ischiopubic index for Urhobo males were 78.51 ± 12.4 mm, 85.58 ± 11.6 mm and 91.66 ± 5.86 respectively while those of their females were 92.39 ± 7.08 mm, 81.97 ± 12.00 mm and 114.93 ± 18.14 respectively. The mean values for pubic length, ischial length and ischiopubic index of Itsekiri males were 82 ± 10.62 mm, 83.84 ± 10.82 mm and 98.40 ± 9.37 respectively while those of their females were 92.05 ± 6.36 mm, 85.03 ± 14.59 mm and 111.03 ± 18.37 respectively. The demarking point of ischiopubic index was more useful in sex determination, assigning sex to 78.6% Itsekiri

females ($p < 0.005$). In conclusion, this study has established the presence of sexual dimorphism in the ischiopubic index of Urhobos and Itsekiris of Nigeria and also racial and regional variation. Thus, the value of ischiopubic index in Urhobo males and females overlaps with those Itsekiri males and females respectively.

[4] conducted a study on Ischiopubic Index of a Nigerian Population Residing in Rivers State, Nigeria. 674 normal anterior-posterior pelvic radiographs (268 males and 406 females) aged between 18 and 75 years were used for this study. The study was conducted in the following hospitals; Bonny General Hospital in Bonny Island, Opo General Hospital in Opo Town, University of Port Harcourt Teaching Hospital, Rivers State and Braithwaite Memorial Hospital, Port Harcourt, Rivers State. The mean pubic length of males and females in Rivers State were 91.99 ± 17.76 mm and 103.12 ± 13.11 mm respectively. The mean ischial length of the males and females were 101.16 ± 18.53 mm and 90.07 ± 12.19 mm respectively. The mean ischiopubic indices observed for males and females were 90.88 ± 5.52 and 114.87 ± 8.08 respectively. It was observed that the males had higher ischial length than the females while the females has longer pubic length and higher ischiopubic index in this study. These differences were observed to be statistically significant ($p < 0.05$). In conclusion, the relevance of the use of ischiopubic index in identification of sex cannot be over emphasized. Data gained from this study will serve as a reference value for the people of Rivers State.

[7] Conducted a study on Measurement of Ischiopubic Index in Pelvic Radiographs. This prospective study was conducted in a tertiary hospital in Nepal from June 2018 to September 2018 with the total of 120 patients (60 males and 60 females). Inclusion criteria were normal anterior-posterior Pelvic and KUB radiographs aged between 18 to 70 years of male and female patients. Exclusion criteria were trauma of pelvis and underlying bone disease which could affect the intact pelvic bone. The mean values of pubic length for males in pelvic radiographs were found to be 8.3 ± 0.82 cm with the range of 6.80 – 10.48cm while that of females were found to be 9.21 ± 0.8 cm with the range of 7.70 - 11.04cm. The mean values of ischial length for males in pelvic radiographs were found to be 9.05 ± 0.73 cm with the range of 7.75 - 11.36cm while that of females were found to be 8.32 ± 0.72 with the range of 7.07 - 10.04cm. The mean values of ischiopubic index for males in pelvic radiographs were found to be 91.73 ± 5.00 with the range of 81.78 - 103.16 while



that of females were found to be 110.90 ± 7.00 with the range of 100.43 - 134.23. It was observed that the males had higher ischial length than females while the females had longer pubic length and higher ischiopubic index in this study. These differences were observed to be statistically significant ($p < 0.05$). In conclusion, the mean ischiopubic index for males and females were 91.73 ± 5.00 and 110.90 ± 7.00 respectively. This may explain the significant higher sexual differences in ischiopubic index observed in the females when compared with that of the male counterparts.

[9] Conducted a study on Sex Determination Using Ischiopubic Index in Gwalior Region of Madhya Pradesh, India (anthropometric analysis). A total of 100 human (50 males and 50 females) dry hip bones were obtained from the Department of Anatomy, Gwalior Region Medical College and Gwalior M.P. All the bones were fully ossified adult bones without any pathological or congenital defect. The mean ischiopubic index came out to be 121.059 ± 8.013 with a range of 105.97 - 137.34 in males and 138.41 ± 9.936 with a range of 117.89 - 153.99 in females. The differences between the two sexes were observed to be statistically significant ($p < 0.001$). In conclusion, the ischiopubic index can be used as an aid for sex determination. Therefore, they can aid in identifying a person from hip bones.

V. CONCLUSION AND RECOMMENDATIONS

The mean pubic length for male was found to be 84.93 ± 4.5 mm and 95.03 ± 4.5 mm for female. Mean ischial length was 95.21 ± 3.8 mm for male and 85.47 ± 5.6 mm for female. The ischial and pubic lengths showed statistically significant differences between males and females ($p < 0.05$) and therefore have dimorphic potential. In males and females, the mean ischiopubic index were 89.32 ± 4.8 and 111.5 ± 6.7 respectively. This may explain the significant higher sexual differences in ischiopubic index observed in the females when compared with that of male counterparts.

There is need for further research on pelvic radiographs in case of disasters and forensic cases, and other circumstances in which other portion typically used to determine sex are not present or not adequately preserved.

There is need for further research to the molecular level on bones around the pelvic region so as to have positive identification of a deceased for his family to have confirmation that is their relative that is dead in cases of manmade mass disasters, genocides or aircraft accidents.

There is need for further research on sex determination using normal pelvis and a higher imaging modality like CT Scan so as to compare the outcome with the present findings.

There is need to create Genebank, which may help in identification of individuals during bio-archaeological and forensic investigations.

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