

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

**The National Ribat University**

**Faculty of Graduate Studies and Scientific Researches**

## **The Subpubic Angle in Adult Sudanese Population**

A thesis submitted in partial fulfillment required for the degree of MSc  
in clinical human anatomy

**By:**

**Abobaker Awad Hussien Khalafalla**

**Supervisor**

**Dr. Kamal ELdin ELbadawi Babiker**

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بسم الله الرحمن الرحيم

قال تعالى:

( إن في خلق السموات و الأرض و إختلاف الليل و النهار لآيات لأولي الألباب\*  
الذين يذكرون الله قياماً و قعوداً و على جنوبهم و يتفكرون في خلق السموات و  
الأرض ربنا ما خلقت هذا باطلاً سبحانك فقنا عذاب النار\*).

سورة آل عمران الآية (190-191).

## **ACKNOWLEDGEMENT**

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All thanks to Atbara Medical Complex especially the imaging and radiology centre for providing these materials which helped me to run this study. Also I would like to thank Dr Ahmed ELqadi.

## **DEDICATION**

To my dear family, friends, colleagues and students.

## الزاوية السفلى لعظم العانة في السودانيين

### مستخلص الدراسة:

كثير من الدراسات والبحوث في العالم قد أجريت لدراسة الفروقات التشريحية بين الجنسين الذكور والإناث. ولها أهمية طبية تطبيقية بالإضافة لإستخدامها في الطب الجنائي و العدلي. و كثير من هذه الدراسات تناولت إمكانية تحديد الجنس من خلال دراسة التركيب الهيكلي للإنسان.

و يعتبر عظم الحوض من أكثر البقايا العظمية التي تم دراستها و خلصت إلي نتائج إحصائية معتبرة لتحديد الجنس من بعض القياسات في عظم الحوض. و تعتبر الزاوية أسفل عظم العانة من الأكثر دراسة و تحليلاً. كما عكست الدراسات بعض الإختلافات العرقية في المناطق المختلفة حول العالم في كل من أمريكا و أوروبا و أفريقيا.

و تهدف هذه الدراسة إلي إلقاء الضوء و دراسة الإختلاف في قياس الزاوية أسفل عظم العانة في السودانيين الذكور والإناث.

تم تجميع عدد 54 عينة من الذكور و 53 عينة من الإناث عبارة عن صور أشعة سينية أمامية خلفية توضح منطقة الحوض و الزاوية أسفل عظم العانة. تم قياس الزاوية في كل فرد في المجموعتين.

**النتائج:** من الدراسة إتضح أن هذه الزاوية أوسع في الإناث منها في الذكور. كانت الزوايا في الذكور تتراوح بين (82 – 128) والمتوسط لمجموع الزوايا في الذكور كان (106) والإنحراف المعياري (10). في مجموعة الإناث كانت الزوايا تتراوح بين (104 – 170) و المتوسط (140) والإنحراف المعياري (14).

**الخلاصة:** في هذه الدراسة تبين وجود فرقاً إحصائياً معتبراً في قياس الزاوية أسفل عظم العانة بين المجموعتين . وهذه النتائج موافقة لبعض الدراسات التي أجريت في بعض المناطق كمصر و ملاوي و نيجيريا مع وجود فارق صغير في القيم الإحصائية ما قد يعكس بعض الفروق العرقية والجغرافية الأمر الذي يحتاج إلي مزيد من البحث و التحليل.

## ABSTRACT

**Background:** Many worldwide studies have investigated the anatomical differences between males and females. One of the most areas was studied is the morphological differences in the bony pelvis. Apart from their medical and anatomical values these information had been used in forensic and anthropological studies.

**Objectives:** This study is held to shed a light in presence of difference in bony pelvis regarding the subpubic angle among Sudanese males and females subjects.

**Methods:** A sample of 54 males and 53 females X-ray pelvises had been collected, examined and the subpubic angle was measured for each individual.

**Results:** The range of the subpubic angle in male was found (128 to 82) and the mean is 106. In females the range was found (170 to 104) and the mean is 140 with significant statistical difference.

**Conclusion:** The anatomical difference of the subpubic angle in males and females was significant in this study. Our results are comparable to that obtained from other regional studies held in Africa with some minor differences that may reflect ethnic variation.

## **List of Abbreviations**

<b>AP:</b>	<b>Anteroposterior</b>
<b>CLI.:</b>	<b>Clinical</b>
<b>Ed.:</b>	<b>Edition</b>
<b>Fig.:</b>	<b>Figure</b>
<b>J:</b>	<b>Journal</b>
<b>Med:</b>	<b>Medicine</b>
<b>SD:</b>	<b>Standard deviation</b>
<b>SPA:</b>	<b>Subpubic angle</b>
<b>IKwe:</b>	<b>Nigerian Ikwerreo ethnic group</b>
<b>Kala:</b>	<b>Nigerian Kalabaris ethnic group</b>
<b>Mala:</b>	<b>Malawian ethnic group</b>

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# CHAPTER (1)

**INTRODUCTION  
AND  
OBJECTIVES**

# 1. Introduction

## 1.1. Definition:

The subpubic angle (SPA) is the angle exists between the inferior rami of the pubic bones. It lies just below the inferior margin of the symphyphysis pubis. <sup>(1)</sup>

## 1.2. Anatomy:

### 1.2.1. The bony pelvis:

Is formed of four bones that articulate together to enclose the pelvic cavity. The sacrum and the coccyx are in the midline posteriorly. Laterally we have two hip bones that articulate in the midline anteriorly at the symphyphysis pubis and posteriorly they articulate with the sacrum at the sacroiliac joint. <sup>(1, 2, 3)</sup>

### 1.2.2. The hip bone:

Is formed of three bones, pubis, ischium and ilium, fused at the acetabulum. The pubis and the ischium form together an incomplete bony wall of the pelvic cavity.

#### 1.2.2.1. The pubis:

Is formed of body, superior and inferior rami. The body of the pubis is being more medial and triangular in shape. The two pubic rami project from it laterally. The superior pubic ramus joins the ilium at the acetabulum and the inferior ramus joins the ischium and enclosed between them the **obturator foramen**. <sup>(1, 2, 3)</sup>

The right and left pubic bones join together at the midline with their symphyseal surfaces which are covered by hyaline cartilage to form a secondary cartilaginous joint (the **symphysis pubis**).

The upper border of the body of the pubis is known as the pubic crest. It is marked laterally by a forward projection, the pubic tubercle. From the pubic tubercle diverge laterally two ridges, the upper one is the pectineal line extends into the superior ramus and joins the arcuate line of the ilium. While the lower one is the obturator crest, passes to join the anterior margin of the acetabular notch. Between the two ridges is the iliopubic eminence. <sup>(1, 2, 3)</sup>

The inner surface of the body of the pubis and the superior ramus is bare bone with no muscular attachment. The inner surface of the inferior pubic ramus gives attachment to the pelvic floor muscles. <sup>(2)</sup>

#### **1.2.2.2. The ischium:**

Is an L-shaped bone formed of body, inferior ramus, ischial tuberosity and ischial spine. The body is the center of the L-shaped bone that supports weight in sitting position. The inferior ramus of the ischium fuses with the inferior ramus of the pubis forming the ischiopubic ramus. The upper part of the body of the ischium joins the ilium and the pubis at the acetabulum. <sup>(1, 2, 3)</sup>

The ischial spine is projecting medially from the posterior border of the ischium forming an important anatomical land mark which, separating the greater and the lesser sciatic notches. In living these notches are the greater and the lesser sciatic foramina.

The ischial tuberosity is rugged prominence, its posterior rough part gives attachment to the muscles of the posterior compartment of

the thigh (the hamstring muscles). The inner surface of the body of the ischium is very gently concave and smooth, gives attachment to the pelvic floor muscles. <sup>(1, 2, 3)</sup>

### **1.2.2.3. The ilium:**

Is a fan-shaped. Its ala resembles the spread of a fan and its body represents the handle. The iliac fossa is a concavity in the ala of the ilium and forms part of the posterior abdominal wall. The ilium forms the superior two-thirds of the hip bone and the superior two-fifths of the acetabulum. <sup>(1, 2, 3)</sup>

The iliac crest is the superior margin of the ilium, has external and internal lips. It ends anteriorly in a rounded anterior superior iliac spine and end posteriorly in a sharp posterior superior iliac spine. In the external lip of the iliac crest 5 cm posterior to the anterior superior iliac spine we find the tubercle of the iliac crest. <sup>(1, 2, 3)</sup>

Also the ilium has a gluteal surface which faces inferiorly in its posterior part and laterally and slightly downwards in front. Is bounded above by the iliac crest and below by the upper acetabular border and by an anterior and posterior borders. It is rough and curved and marked by three gluteal lines. The anterior, posterior and inferior gluteal lines, marking muscle attachment. <sup>(1, 2, 3)</sup>

### **1.2.2.4. The acetabulum:**

Is a concave hemisphere with a deficient inferior margin ( the acetabular notch). Its cavity is wider above than below. It articulates with the head of the femur (at the hip joint), the head of the femur

being inside the acetabulum, but the articular surface of the acetabulum does not reach its floor (the acetabular fossa – no articular surface).<sup>(1, 2)</sup>

The three parts of the hip bone meet here. The pubis and the ilium meet at the anterior pole of the acetabulum (at the iliopubic eminence) the ilium and the ischium meet just above the posterior pole of the acetabulum.<sup>(1, 3)</sup>

### **1.2.3. The pelvic outlet (inferior pelvic aperture):**

Is indented behind by the coccyx and the sacrum, and bilaterally by the ischial tuberosity. Its perimeter consists of three wide arcs. Anteriorly is the subpubic arch. Posteriorly and laterally in both sides are the sciatic notches between the sacrum and ischial tuberosity. These are divided by the sacrotuberous and sacrospinous ligaments into greater and lesser sciatic foramina. Three measures are made for the pelvic outlet. The anteroposterior, transverse and the oblique diameters.<sup>(1,3)</sup>

### **1.2.4. Growth of the hip bone:**

#### **1.2.4.1. Development:**

The hip bone develops in cartilage with three primary ossification centers, one for each part of the bone. First to appear is the primary ossification center of the ilium at the second month of fetal life. Then it is followed by that of the ischium at the third month, then pubis at the fourth month. At birth acetabulum is wholly formed of cartilage. The three bones meet at the acetabulum in a Y-shape cartilaginous

junction. With age the ossification centers grow and enlarge till they fuse. The pubis and ischium fuse at the age of seven years. <sup>(1)</sup>

#### **1.2.4.2. Ossification:**

Ossification of the Y-shape cartilage begins at age of 12 years and is get completed by 15 years of age. The hip bone is completely ossified at about 25 years. <sup>(1, 2, 3)</sup>

### **1.3. Objectives:**

#### **1.3.1. General objectives:**

- To assess the SPA in Sudanese population.

#### **1.3.2. Specific objectives:**

- This research is undertaken to:
  - 1- Determine the average SPA in Sudanese males.
  - 2- Determine the average SPA in Sudanese females.
  - 3- Identify if there is any significant difference in SPA in Sudanese males and females subjects.
  - 4- Compare the SPA in Sudanese population with that of other populations.

## **CHAPTER (2)**

# **LITERATURE REVIEW**

## **2. Literature Review**

### **2.1. Sex determination of skeleton:**

When the entire dead body is available sex can be determined in majority of cases by dissection, or in mutilated remains when the parts bearing sex characteristics are available such as uterus and its appendices, breast and prostate. When soft tissues of sexual characteristics are not available, the determination of sex must be based on bones. <sup>(4)</sup>

Sex determination of human skeletal remains is more accurate and applicable on mature adult skeleton. The degree of accuracy is dependent on skeletal completeness. If complete skeleton is available the accuracy can be reached up to 100%. When the skeleton is incomplete the most reliable and accurate remains are the skull with 90% accuracy and bony pelvis with 95% accuracy. Using both, the skull and the bony pelvis remains accuracy can reach up to 98%. <sup>(4)</sup>

The pelvis shows marked differences in sex than any other bone. These sexual characteristics are established early in development, but become apparent only on puberty (hormonal stimuli from pubertal ovary and active growth). The pelvic parameters used in sex determination of skeletal remains are numerous. <sup>(4, 2)</sup>

#### **2.1.1. The ischiopubic index:**

Is greater in females than in males because the length of the pubic bone is greater in females. This index can be measured by (the length of the pubis/length of the ischium). <sup>(4)</sup>

#### **2.1.2. The subpubic angle/arch (SPA):**

Is the angle between the inferior rami of both sides when they meet at the symphysis pubis. It represents the anterolateral border of the pelvic outlet which is occupied by the fetal head during parturition. Being wider in females increases the diameter of the birth canal. In females the pubic rami are more rounded and slender forming a subpubic arch rather than a subpubic angle as in males.<sup>(1,2,3)</sup>

### **2.1.3. The pelvic brim:**

Is formed by a continuous line from the pubic crest, pectineal line of the pubis, the arcuate line of the ilium, the ala and promontory of the sacrum. In male the outline of the pelvic inlet is heart-shaped due to the sacral promontory that indents the outline posteriorly. There is less indentation in females, so the outline of the pelvic inlet is oval in shape.<sup>(1, 3)</sup>

### **2.1.4. The greater sciatic notch:**

In males is small and generally less than 68 degree. In females is larger and concave in shape, measures in general more than 68 degree. If we examine the superior pubic ramus, the distance from the pubic tubercle to the acetabular margin is greater than the diameter of the acetabulum in female, but equal or less in male bone. Some authors regard this as the surest single feature in non articulated hip bone.<sup>(4)</sup>

### **2.1.5. The ischiopubic ramus:**

Is flat in males and ridged in females, due to the changes occurring during parturition. It becomes irregular and undermined with depressions or pits that believed to be due to trauma during child bearing (scars of parturition). <sup>(1, 2)</sup>

### **2.2. Identification of human skeletal remains:**

Is one of the most important investigations in forensic medicine and forensic anthropological studies. Many different skeletal remains had been used to help sex identification. One of the most frequently used and accurate tools is the bony pelvis. <sup>(4, 5)</sup>

There are many differences in osteometric and morphological studies comparing male and female bony pelvis. These differences are mostly related to physiology of female pelvic which has adapted to house the gravid uterus and facilitate easy passage of the baby during delivery. The diameters of female pelvis are larger than that of the male. <sup>(3)</sup>

The different parts of the bony pelvis had been studied to find out these differences in both sexes and their significance in sex identification. One of the most parameters used is the shape and the contour of the articulated pelvis regarding the shape and diameters of the pelvic inlet and outlet. <sup>(1, 3)</sup>

Other points that noticed to be different between the two groups are the SPA, obturator foramen, ischial spine, acetabulum, and the ischiopubic index. <sup>(1, 2, 3, 4)</sup>

This study concentrates on the SPA to notice the different values between both sexes among Sudanese population and if this difference, (if any) could be statistically significant.

# **CHAPTER (3)**

**MATERIALS  
AND  
METHODS**

## **3. Materials and Methods**

### **3.1. Study Design:**

This is an observational descriptive cross-sectional hospital based study.

### **3.2. Study Area and duration:**

This study was conducted at Atbra Medical Complex. In period from March to August 2014.

### **3.3. Study Population:**

Study population includes patients referred to Atbra Medical Complex for pelvic X-ray. Including plain pelvic X- rays, or X-rays of intravenous urogram (IVU) series.

### **3.4. Sample Size:**

All patients referred to Atbra Medical Complex during the above mentioned period were included with total size of 107 (54 were males and 53 females).

### **3.5. Inclusion Criteria:**

- All pelvic X – rays that clearly showing the subpubic angle.

### **3.6. Exclusion criteria:**

- All X- ray films that showed pelvic or lower limb fracture had been excluded.
- All X-ray films with inappropriate alignment or non satisfactory had been excluded.

### **3.7. Data Collection:**

Data was collected by X-ray films and images of pelvic region taken from patients with no orthopedic or urological diseases. After that the X-ray films were printed out then the SPA was measured.

The SPA was measured by drawing tangential lines along the inferior borders of the both pubic rami which intersected at a point (centered just below the inferior border of the symphysis pubis). Then the SPA was measured by using the goniometer. Data collection sheets were used to include the study variations and to record the results.

### **3.8. Data Analysis:**

Data was analyzed both, manually and with SPSS computer program, version 17.

### **3.9. Data Management:**

Data was analyzed as mentioned above, then presented and described by using the text, tables, and figures.

### **3.10. Ethical Considerations:**

Consents were delivered to the radiology department at the above mentioned medical complex preceding the data collection.

# CHAPTER (4)

## **RESULTS**

## 5. Results

One hundred and seven patients, who attended to Atbara Medical Complex and underwent pelvic X-rays, were included in this retrospective hospital based study. 54 of these patients were males (50.5%) and 53 were females (49.5%), as shown in table (4.1) and fig (4.1)

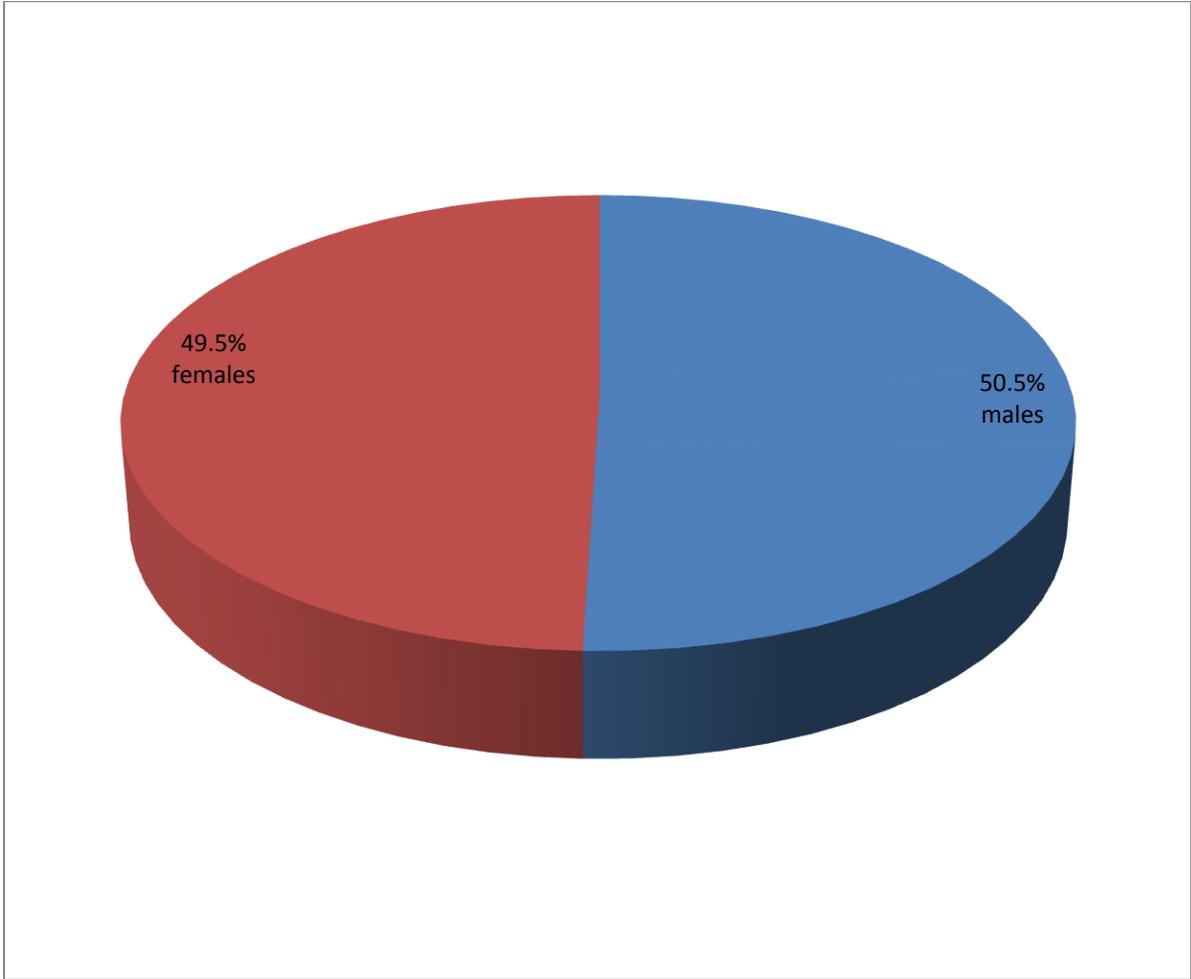
**Table 4.1: Gender distribution**

Sex	Frequency	Percentage %
Male	54	50.5
Female	53	49.5
Total	107	100

A fifty four male pelvic X-ray had been examined with SPA measured, we found that the maximum degree of SPA was 128 and the minimum degree was 82, the mean angle was 106 and the SD was 10, as shown in table (4.2), fig (4.2)

**Table 4.2: Values of SPA in Sudanese males.**

Sex	n	Range	Mean	SD
Male	54	82-128	106	10.00



**Fig 4.1: Gender distribution**



**Fig 4.2: AP male pelvic X-ray shows a narrow subpubic angle.**

After measuring the SPA in fifty three female pelvic X-rays we found that, the maximum degree was 170 and the minimum was 104 with mean value of 140 with +SD 14, as shown in table (4.3), fig (4.3).

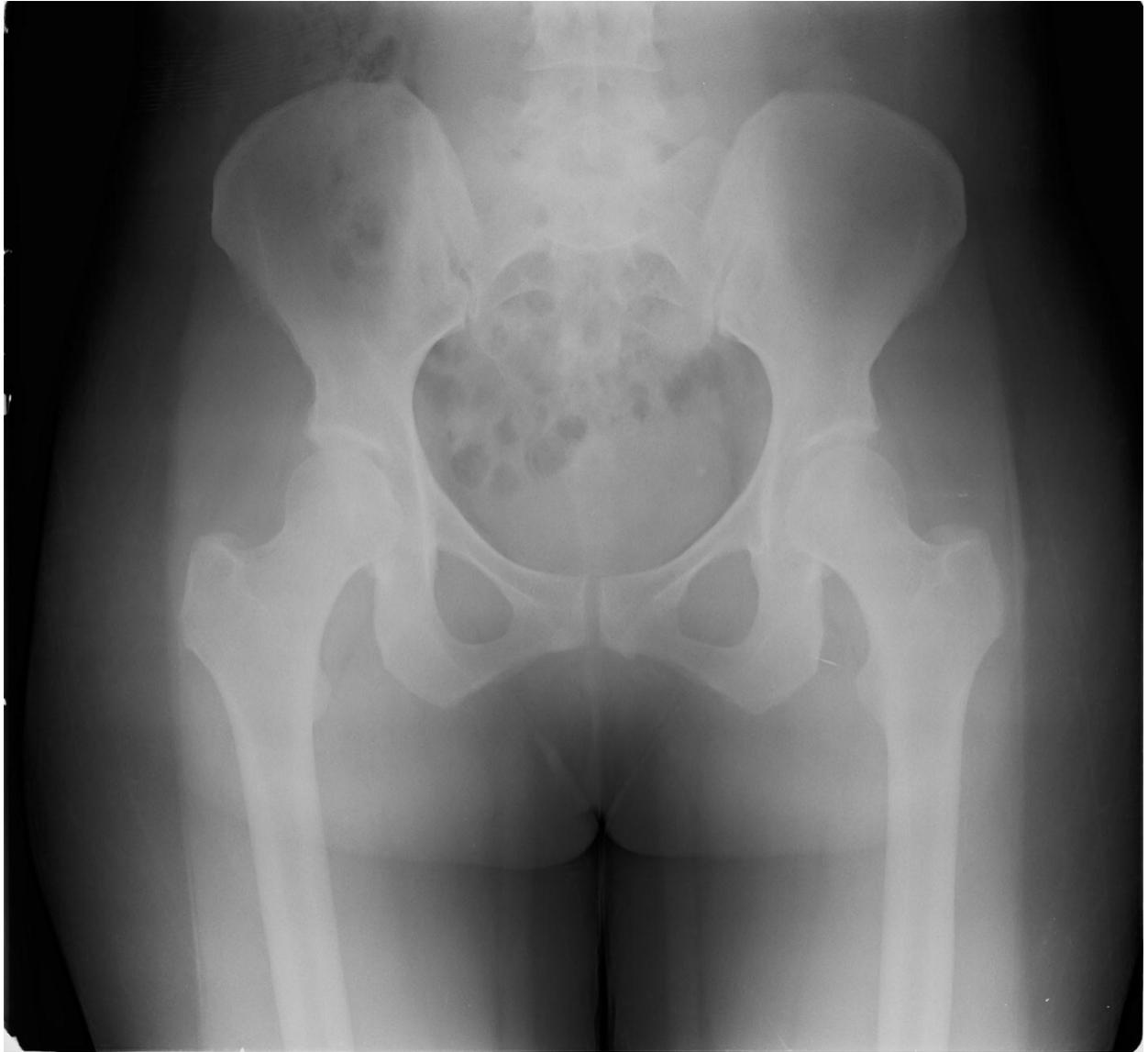
**Table 4.3: Values of SPA in Sudanese females**

Sex	n	Range	Mean	SD
Female	53	104-170	140	14.00

Table 4.4 shows the mean of SPA in both sexes of Sudanese subjects. The females have wider angles than males (140 + 14 and 106 + 10 respectively). The SPA shows significant difference between the both sexes.

**Table 4.4: The mean of SPA in Sudanese males and females**

Subject group	Sex	Mean	SD	P value
Sudanese	Male n=54	106	10	P 0.05
	Female n=53	140	14	



**Fig 4.3: AP female pelvic X-ray shows a wide subpubic arch.**

Comparing the results of SPA values of both sexes in the Sudanese subjects with other populations done in published studies, (e.g. Nigerian, Egyptian and Malawian), there was a significant difference between all of them, as shown in table (4.5).

**Table 4.5: The values of SPA in different subject groups**

Subject group		Sex	Range	Mean	SD
Nig	IKwe	Male n=85	75-176	100.25	7.80
		Female n=173	96-142	119.38	3.00
	Kala	Male n=129	86-128	105.63	3.88
		Female n=213	95-151	125.00	3.17
Egyp		Male n=200	66-126	102.31	12.50
		Female n=200	96-191	143.28	15.82
Malaw		Male n=73	66-150	99.00	15.73
		Female n=46	86-174	129.00	14.19

# **CHAPTER (5)**

# **DISCUSSION**

## 5. Discussion

The present study focuses on the presence of normal anatomical variation on the SPA by analyzing pelvic X-rays of 104 subjects. The results were compared with some published studies in the same continent.

Out of 107 patients 54 were males and 53 were females. The mean of SPA in males was (106) and in females was (140) with significant statistical difference. The maximum angle observed in male was 128 with 82 was the minimum. In females the maximum angle observed was 170 and 104 was the minimum.

In other studies e.g. determination of SPA in Egyptian population done by Saly Y Abd-El-hameed, found that the angle for males ranges from 66 to 126 degree with mean of 102 degree. Female angle ranges from 96 to 191 degree with mean of 143 degree, <sup>(5)</sup> as shown on table (5.1).

**Table 5.1: Comparison of SPA values between Sudanese and Egyptian groups.**

Group	Male			Female		
	Range	Mean	SD	Range	Mean	SD
Sudanese	82 - 128	106	10	104 - 170	140	14
Egyptian	66 -126	102.31	12.5	96 - 191	143.28	15.82

Another study was done in Nigerian Ikwerreo and Kalabaris ethnic groups. They found that the angle in males ranges from 75 to

126 and from 86 to 128 with mean of 100 and 105 for Ikwerreo and Kalabaris respectively. And in females it ranges from 96 to 142 and from 95 to 151 with mean of 119 and 125 for Ikwerreo and Kalabaris respectively, <sup>(6)</sup> as shown on table (5.2).

**Table 5.2: Comparison of SPA values between Sudanese, Nigerian (Ikwerreo and Kalabaris) groups.**

Sex	Male			Female		
Group	Range	Mean	SD	Range	Mean	SD
Sudanese	82 - 128	106	10	104 - 170	140	14
Ikwerreo	75 – 126	100	7.8	96 – 142	119	3
Kalabaris	86 - 128	105	3.88	95 - 151	125	3.17

In a third study which was done by B. C. Msamati in adult Malawian subjects found that the angle in males ranges from 66 to 150 with mean of 99. And in females it ranges from 86 to 174 with mean of 129 degree, <sup>(7)</sup> as shown on table (5.3).

**Table 5.3: Comparison of SPA values between Sudanese and Malawian groups.**

Sex	Male			Female		
Group	Range	Mean	SD	Range	Mean	SD
Sudanese	82 -128	106	10	104 - 170	140	14
Malawian	66 -150	99	15.73	86 - 174	129	14.19

All four studies showed that the SPA is greater in females than in male with significant statistical difference. With some differences in

measurement that may be referred to some extent to the ethnic differences in population of each geographic area.

We can say that from this study in Sudanese population a SPA measures more than 128 belongs to a female skeleton and an angle less than 104 belongs to a male skeleton.

In conclusion the results from this study confirm the existence of regional and sexual variations in SPA among populations of the different countries, in the same continent. Those significant variations allow their use in medico-legal identification of sex and race.

# **CHAPTER (6)**

**CONCLUSION**  
**AND**  
**RECOMMENDATIONS**

## **6.1. Conclusion:**

- In this study 107 X-rays of the pelvic region of Sudanese subjects were reviewed trying to shed some lights on the difference in the SPA of both sexes.
- The anatomical difference in this study was significant.
- The female angles are greater than that of male.
- In comparing the SPA of both sexes in Sudanese subjects with others, there was a high statistical significant racial variation.
- Useful utilization of SPA in forensic medicine to determine the sex of unknown skeletal remains.

## **6.2. Recommendations:**

1. More elaborated studies should be done to study this angle in different ethnic groups in Sudan.
2. Sample size should be as large as possible.
3. Future study should determine the role of age in such research.
4. Cooperative studies should be done with forensic medicine.

## **CHAPTER (7)**

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# **Appendix**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

The National Ribat University

Faculty of Graduate Studies and

Scientific Researches

**Data collection Sheet**

-Date:

-Serial No.

-Gender: Male  Female

-Type of X- ray:

- Plain

-Series of IVU

-Inclusion Criteria

-Exclusion Criteria

-Degree of the subpubic angle

Comments:

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