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## Morphometric study of dry human adult hip bone

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### Abstract

The human hip bone is a large and irregular bone. Irregularity of the bone makes it an important bone for determination of sex by many variables. It is a bone of interest from anatomical, anthropological and forensic view. This study is aimed to find out the sex from an intact full adult ossified hip bone in North Indian population.

**Keywords:** Human hip bone, sex determination, intact, ossified

### Introduction

The hip bone is a large, irregular bone. It is formed by three independent elements. In the whole skeleton, it is one of the most informative bones, for determination of age and sex <sup>[1]</sup>. It is possible to determine the sex by visual examination of the hip bone as reported by Asala *et al* <sup>[2]</sup>. The sexual dimorphism of hip bone is a special adaptation in the females for child bearing. Therefore, awareness of the average dimensions of the hip bone in both sexes will help in detection of sex by forensic experts disputed cases <sup>[3-5]</sup>. If the sex of unknown skeleton is accessed correctly, then further investigations are likely to be more accurate and separate male and female standards may be then used for estimation of age <sup>[2]</sup>. There is natural anatomical variation to set norms within each sex. These variations are also affected by factors like genetic, ethnic, environment and culture <sup>[6]</sup>. Several metric parameters and non-metric differences in skeletal component among populations are evident, which can be helpful in determination of sex <sup>[7]</sup>. Non metric method for determination of sex is not so relevant. But metric methods used for sex determination of human hipbone have shown high accuracy level <sup>[8]</sup>. Morphometric measurements have indicated asymmetry between right and left side of hip bone <sup>[9-11]</sup>. Therefore the study of sexual dimorphism of bones in human population is a matter of interest not only for Anatomists but also for the Anthropologists and Forensic experts <sup>[12]</sup>.

### Material and methods

Unpaired unknown of sex 57 human ossified adult hip bones were included in this study. Bones included are from the Anatomy and forensic Department of Hind Institute of Medical Sciences, Mau, Ataria, Sitapur. Fully ossified, intact, not broken bones are included in this study. Bones excluded are the deformed bones & malformed bones.

The sex of the hip bones was decided on the basis of visual morphological features like, angle of greater sciatic notch, Ischiopubic ramus, shape of Obturator foramen, prominence of Pre-auricular sulcus and Acetabular diameter. Non metric studies like weight are taken in grams by an electronic weighing machine (Fig. 1). Metric method studies are done by putting the bone over the flat surface of the table against the wall and a wooden board on the other side. Measurements taken are with the help of a metallic scale in cm.

The parameters included in the study:

1. Weight: - Bones are weighed by an electronic weighing machine.
2. Length: - Maximum distance between iliac crest and ischium. (Fig. 2)
3. Width: - Maximum distance between anterior and Posterior ends of iliac crest (Fig. 3)
4. Coxal index, calculated by the formula Width of hip bone / Length of hip bone  $\times 100$



**Fig 1:** Measurement of weight of hip bone



**Fig 2:** Measurement of length of hip bone



**Fig 3:** Measurement of width of hip bone

**Results**

Out of the 57 hip bones 12 are Right Male, 18 are Right Female, 9 are Left Female and 18 are Left male. The mean weight of male hip bone on right and left side is  $138.5 \pm 8.95$  gm and  $142 \pm 19.64$  gm respectively. The mean weight of female hip bone on right side is  $110 \pm 14.52$  gm and on left side  $138 \pm 10.88$  gm. The range of weight of male hip bone varied from 122-147 gm on right side and 100-165 gm on left side. The range of weight of female hip bone varied from 98-125 gm & 119-147 gm on right and left side respectively (Table 1).

**Table 1:** Measurements of Weight (gm) of Hip Bone

Details of measurement	Right Male	Right Female	Left Male	Left Female
Number	12	18	18	9
Mean	138.5	110	142	138
Range	122-147	98-125	100-165	119-147
SD	8.95	14.52	19.64	10.88
SEM	2.58	3.42	4.60	3.62

The mean length of male hip bone on right and left side is  $19.45 \pm 0.88$  cm and  $20 \pm 1.16$  cm respectively. The mean length of female hip bone on right side is  $19.15 \pm 0.98$  cm and on left side  $20.8 \pm 0.58$  cm (Table 2).

**Table 2:** Measurements of Length (cm) of Hip Bone

Details of measurement	Right Male	Right Female	Left Male	Left Female
Number	12	18	18	9
Mean	19.45	19.15	20	20.8
Range	19-20.2	16.9-20.1	17.1-20.9	20.3-21.9
SD	0.88	0.98	1.16	0.58
SEM	0.25	0.23	0.27	0.19

The mean width of male hip bone on right and left side is  $14.15 \pm 0.56$  cm and  $14.15 \pm 0.99$  cm respectively. The mean width of female hip bone on right side is  $13.6 \pm 0.69$  cm and on left side  $14.6 \pm 0.80$  cm (Table 3).

**Table 3:** Measurements of Width (cm) of Hip Bone

Details of measurement	Right Male	Right Female	Left Male	Left Female
Number	12	18	18	9
Mean	14.15	13.6	14.15	14.6
Range	13-14.6	12.1-14.2	12.3-14.9	13.9-15.9
SD	0.56	0.69	0.99	0.80
SEM	0.16	0.16	0.23	0.27

**Discussion**

In medico legal cases, there is necessary to determination of sex and age from the available intact bones or skeletal remains. Anatomists can give expert opinion regarding sex and age of the individual from the skeletal remains found under suspicious conditions. Many osteologists tried to establish the sex by visual impression of the individual bones [13, 141, 5]. In 1891, Matthew and Billings first attempted to use measurements and indices to determine or confirm the sex of pelvises, as mentioned by Hoyme [16]. A general rule is male bones are heavier and more massive than female bones. In this study also, the mean weight of male bone 142 grams is more than the mean weight of female which is 119gms. Mean values of various parameters from different regions show significantly different values and therefore demarking point (DP) has to be calculated

separately for different regions [17]. Out of the three components of hip bone, the ilium has more changes as required for different modes of locomotion, to provide more advantageous leverage for the muscles concerned in locomotion & for stability for weight bearing [18]. The length of male hip bone is found to be longer than the female as found many studies [17, 3]. The left hip bone in both sexes is longer than its counterpart (Table 5). The width of hip bone or total length of iliac crest is also more in male in this study than female & the finding is similar to Singh *et al.* [3] and Kishor Dattatray Khushale *et al.* [17], and Kanika Sachdeva *et al.* [18] Griffith [21] (Table 6) and also in other races (Table 7). But only in study by Joshi *et al.* (2007) [19] who found it to be longer in females. The width of left side hip bone is

larger than the right in both sexes as found out by other studies. The width of hip bone is compared in different races in (Table 7). It is similar to the Japanese population, but smaller than the population of American whites, American blacks, Negroes, French & Belgian.

The coxal index in present study is 71.90 on right side and 70.33 on left side. The values are consistent with values taken by Gursharan Singh Dhindsa *et al.* [20] Garson [16]. These values are slightly larger than the study done by Siddapur KR *et al.* [22] which was 69 on right side and 68.9 on left side when the coxal index considered in male and female in present study, it is 72.09 in male and 70.65 in female & in the study done by Siddapur KR *et al.* [22] which was 67.7 in male and 70.8 in female.

**Table 4:** Comparison of Weight (gm) of hip bone in different Indian studies.

	Present study	Kishor Dattatray Khushale <i>et al.</i>	Gursharan Singh Dhindsa <i>et al.</i>	Singh and Raju <i>et al.</i>
Male Right	138.5	147.22	130.77	134.94
Male Left	142	133.91		
Female Right	110	91.34		
Female Left	138	99.15		

**Table 5:** Comparison of length (cm) of hip bone in different Indian studies.

	Present study	Singh and Raju <i>et al.</i>	Kishor Dattatray Khushale <i>et al.</i>
Male Right	19.45	19.75	18.60
Male Left	20	19.75	18.72
Female Right	19.15	18.13	18.13
Female Left	20.8	18.21	19.23

**Table 6:** Comparison of Width of hip bone (cm) in Indian studies.

	Present study	Singh and Raju <i>et al.</i>	Kishor Dattatray Khushale <i>et al.</i>
Male right	14.15	14.32	13.66
Male left	14.5	14.35	13.62
Female right	13.6	13.78	12.95
Female left	14.6	13.78	13.61

**Table 7:** Comparison of Width of hip bone (cm) in different races.

	Present study	Verneau <i>et al.</i>	Maruyama <i>et al.</i>	Japanese	Americans whites	Americans blacks	Negroes	French & Belgian
male	14.15	16.4	13.6	14.4	15.98	15.3	15.66	15.85
female	14	15.6	13.1	14.1	15.47	15.0	14.12	15.31

## Conclusion

In this study the mean weight of male bone 142 gm is more than the mean weight of female which is 119 gm. The mean weight of hip bone on right side is less than left side in both sexes. The mean length & width of hip bone on left side is also more than right side in both sexes. The values are similar to other Indian studies. The coxal index in present study is 71.90 on right side and 70.33 on left side. The coxal index in male is more than female in present study, which is 72.09 in male and 70.65 in female.

**Conflict of interest:** None

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