IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 7 Ver. 15 (July. 2018), PP 16-19
www.iosrjournals.org

Sex determination from a dried hip bone by measuringthe distance between Posterior Inferior Iliac Spine and Ischial Spine in North Andhra population

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Abstract: *Hip bone is considered as the most sexually dimorphic skeletal elements in humans.The greater sciatic notch is especially valuable because it is resistant to damageand is highly sexually dimorphic.This study was undertaken with a sample size of 44 adult human dried hip bones.A cut off value was defined for the distance between Posterior Inferior Iliac Spine and Ischial Spine (PIIS-IS) to determine the sex of a human hip bone in the North Andhra population.From the present study it was observed that the mean distance of PIIS-IS in females was 46.88mm which is higher than males which was 36.88mm which is statistically highly significant (p=<0.001). The cut-off value obtained is 41.06. This cut-off value is 84.1% accurate in differentiating male and female hip bone which can be considered as an important metric parameter for identifying the sex of an individual.*

Keywords*: Dimorphism ,Hip bone, Ischial Spine,Posterior Inferior Iliac Spine, Sex determination.*

Date of Submission: 13-07-2018 Date Of Acceptance: 27-07-2018

I.Introduction

Sexual dimorphism refers to the difference between male and female in regards to size and appearance. Many bones have often been investigated for sex determination.The os coxae which consist of 3 bones, the ilium, the ischium, and the pubisis considered as the most sexually dimorphic skeletal elements in humans because the female pelvis has toaccommodate the relatively large head of an infant during childbirth .Therefore the pelvic girdle in anthropometry gains its importance, for in addition to the sex differencesof the bones in general, there are additional differences in the girdle relating to reproduction.A narrow pelvis is more suitable for locomotion, but a broader pelvisas in females plays role in forming the birth canal.Thus, female pelvis is typically wider in every dimension than the male pelvis.

There is no standing formula for a metrical data because bones are population-specific, and various populations further differ with regard to general body size and degree of sexual dimorphism. Moreover, the population of origin may not always be known.Therefore with this study an attempt was made for identification of sexof a hip bone in a certain population by findinga cut off value for the parameteri.ethe distance between PIIS-IS of a hip bone.

II.Material and Method

A sample of 44adult human dry hip bones (22 males and 22 females) of unknown sex from the Department of Anatomy GVPIHC&MT,Visakhapatnam was used for this study. All bonestaken were undamaged and showed no pathological defects. Ethical clearance was taken from the institutional ethical review committee before the initiation of the study .

2.1Inclusion criteria

1. Undamaged bones.
2. Completely ossified bones.
3. Bones without any pathological deformity.
4. Bones having intact greater sciatic notch and ischial spine.

2.2Exclusion criteria

1. Damaged bones.
2. Malformed bones.
3. Bones with congenital anomalies.

2.3 Sample size

The total sample taken was 44 (n =44) by using the sample size formula

$$n \geq \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2}$$

Where,
Z =standard normal variate
Alpha =type 1 error
Beta= type 2 error
u1,u2= means of distance between PIIS-IS in male & female.
O1,o2 = standard deviations of the distance between PIIS-IS in male & female.

For each bone the distance between Posterior Inferior Iliac Spine and Ischial Spine (PIIS-IS) was measured using a vernier calliper (figure 1).
Point A – Posterior Inferior Iliac Spine
Point B – Ischial Spine

"Fig 1" Point A – Posterior Inferior Iliac Spine ; Point B – Ischial Spine

2.4Observation
For each observation ,readings were taken twice to reduce the error of measurement. All measurements were recorded in millimetre and entered in the MS Excel work-sheet .The data collected was tabulated. The statistical analysis of the data was done by using SPSS version 22.
The following statistical measures were obtained :

1. Distance between Posterior Inferior Iliac Spine and Ischial Spine (PIIS-IS).
2. Mean.
3. Standard error of the distance between PIIS-IS.
4. T-test calculation was also done to establish the significance of the study.
5. 95% confidence interval for the distance between PIIS-IS.
6. Cut-off value for the distance between PIIS-IS.

2.5Results
In the present study thedistance between Posterior Inferior Iliac Spine and Ischial Spine (PIIS-IS) of human hip bone were calculated in all the bones.The bones were then categorized into male and female by usingestablished non-metrical parameters.Using 95% confidence interval, the range of distance infemale was between 43.83 -49.92 and in male it was between 35.23 - 38.54.The mean of the distance between PIIS-IS calculated infemale was 46.88mm andin male it was 36.88mm.The standard deviation in males was 3.96 and in

females was 7.29. Thus the mean distance in female bones was greater in comparison to male which is highly significant statically (p=<0.001).

III. Figures And Tables

Gender	DISTANCE BETWEEN PIIS-IS in mm							SE	95% CI	
									LL	UL
	N	Minimum	Maximum	Mean	SD	t-value	P-value	1.55	43.83	49.92
Female	22	34.92	65.11	46.88	7.29	5.65	<0.001 Statistically significant	0.84	35.23	38.54
Male	22	30.54	45.03	36.88	3.96					

TABLE 1:Showing the mean distance between Posterior Inferior Iliac Spine and Ischial Spine, S.D and 95% confidence interval in males and females.

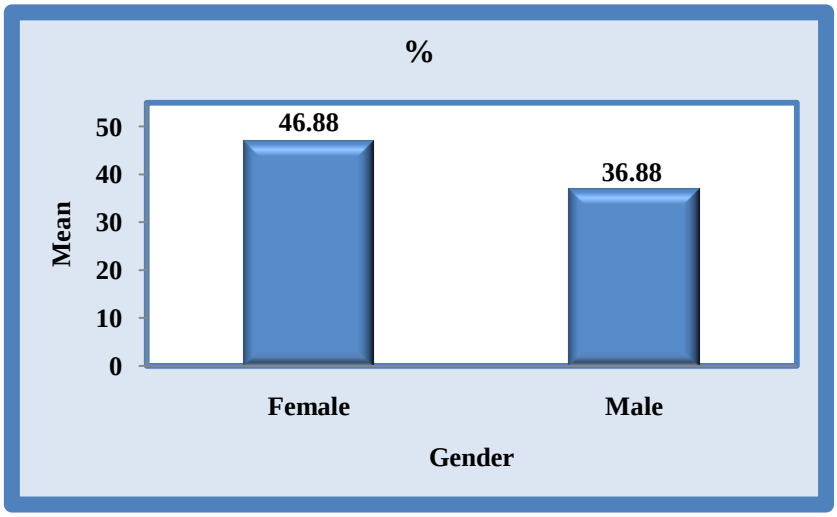

Fig 2: Mean distance between Posterior Inferior Iliac Spine and Ischial Spine

Dist. between PIIS-IS, cut off value = 41.06			
Observed	Predicted		
	Gender		Percentage Correct
Gender	Female	Male	
Female	19	3	86.4
Male	4	18	81.8
Overall Percentage			84.1

TABLE 2**:Cut-off value for the distance between Posterior Inferior Iliac Spine and Ischial Spine**

Cut-off value calculated for the stance between Posterior Inferior Iliac Spine and Ischial Spine was 41.06 which is statistically 84.1% accurate in identifying the sex of a hip bone (table 2).

IV. Discussion

Bones are population-specific, and various populations differ with regard to general body size and degree of sexual dimorphism. Moreover, racial and regional variation exists in skeletal components of bones.The best method for determining sex of adult skeletal remains is from the hip bone[1,2].Sexual differences in adults are divisible into metrical and non-metrical features. The metrical values of the bone been highly accurate[3].

The features of hip bone exhibits maximum sexual dimorphism than any other bonein the bodybut is frequently found to be damaged or missing in exhumed material . Medico-legally hipbone is of immense help even if it is available in fragments [4].The greater sciatic notch is especially valuable in such situations because it is highly sexually dimorphic, is resistant to damage. The greater sciatic notch was found to be significantly wider in females than in males , irrespective of the side of the bone[5].Similar observations have been made earlier by various authors as shown in table 3 (Vemeau, 1875; Thomson, 1899; Derry, 1923; Letterman, 1941;Davivongs, 1963) [6,7,8,9,10].All the previous studies concluded that the width of greater sciatic notch is greater in females than males and the present study also showed similar result .

It is found that the posterior part of the hip bone is usually well preserved in any skeletal remains due to its hardness; hence the present study gains its importance. In this study the mean value recorded was i.e. 36.88mm in males and 46.88mm in females which shows that the difference between the mean value in male and female is statistically highly significant.Cut-off value for the distance between Posterior Inferior Iliac Spine and Ischial Spine is 41.06 which is 84.1% accurate in identifying the sex in hip bone. This study ,thus proves to be relevant and helpful in the population it is done.

Table 3: Study by other authors showing the mean values of males and females (in mm)

Sl.No	Author	Year	Male	Female
1	Davivongs	1963	45.23	50.86
2	Singh et al	1978	44.75	47.83
3	Kelly American White Black Indian	1979	 42.8 39.4 39.0	 46.7 45.3 44.0
4	Maclaughlin& Bruce English Dutch	1986	 38.52 41.93	 42.0 45.88
5	Rajangam et al	1991	41.4	44.1
6	Present Study	2017	36.88	46.88

V. Conclusion

The distance between Posterior Inferior Iliac Spine and Ischial Spine(PIIS-IS)with a cut off value of 41.06 can be used as one of the parameters to determine gender which is statistically proved and could be of immense use in forensic science and anthropology.

Acknowledgement

I would take this opportunity to thank Mr.Hanumanth ,statistician of our institute who has immensely contributed to this research work.

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