

# Study of Cranial Capacity of Adult North Indian Human Skulls & its Sexual Dimorphism

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## Abstract

**Introduction:** Cranial capacity of skull, like other body dimensions are affected by geographical, racial, gender and age factor. This study intended to know the gender variations of cranial capacities in available human skulls of north India.

**Aims and objectives:** To measure the cranial capacities of available skulls and to know its sexual dimorphism which may be helpful to establish the sex of a person from skeletal remains.

**Materials & Methods:** 200 dry human skulls (112 male & 88 female) were obtained from the anthropology museum of the Dept. of Anatomy, GSVM Medical College, Kanpur (U.P) & HIHT University, Jolly Grant, Dehradun (U.K). Filling and packing method was used to measure cranial capacities in which clay and rye seeds were used considering their smaller size to avoid the error. Adult skulls (above 18 years), intact & undamaged were included and while those which were broken or damaged and having ambiguity of sex, were excluded.

**Results:** The mean cranial capacity of male skulls was observed to be  $1260.48 \pm 75.15$  cc (range 1200-1420 cc) and those of female skulls were observed to be  $1164.52 \pm 89.43$  cc (range 1100-1430cc).

**Conclusion:** The mean cranial capacity of males is higher than that of the females. Measuring the cranial capacity of skull for determination of sex, by filling and packing method is one of the most reliable cranio-metric methods to be used.

**Keywords:** Cranial capacity, Filling & packing method, Sexual dimorphism, Anthropology

## INTRODUCTION

Cranial capacity of skull, like other body dimensions are affected by geographical, racial, gender, and age factor.<sup>1,2</sup> There is close relationship between cranial capacity and the size of the brain. Several studies in different countries to estimate the cranial capacities have been carried out which indirectly reflects the brain volume.<sup>3,4</sup>

The female skull has been found to have a capacity about 1/10<sup>th</sup> less than that of the male of the same race. Studies on cranial capacity has been proved to be a useful tool in the field of Forensic Anthropology and Paediatrics, as an indicator of skull development in both male and female individuals.<sup>5</sup> It is also a good determinant of normal or abnormal skull because living humans have a normal cranial capacity ranging from 950-1800 cc with an average of about 1400cc.<sup>6</sup>

This study intended to know the gender variation of cranial capacities in available human skull, by filling and packing method, using clay & rye seeds (considering their smaller size) to avoid errors.

## MATERIALS AND METHODS

200 dry human skulls (112 male & 88 female) were obtained from the anthropology museum of the Department of Anatomy, GSVM Medical College Kanpur (U.P) & HIHT University, Jolly Grant, Dehradun (U.K).

Adult skulls (above 18 years), intact & undamaged were included and sex determination was done by gross anatomical features. Skulls which were broken or damaged and those having ambiguity of sex were excluded.

Thereafter the following steps were carried out.

1. Orbital fissures and major foramina of skulls were plugged by clay so that the seeds do not slip out.
2. Then rye seeds were poured through foramen magnum to fill the cranial cavity. Vigorous shaking of the skull was done at intervals so that the seeds get settled into the frontal part of the skull.
3. More seeds were added up to the rim of the foramen magnum from time to time while shaking the skull till it was full and no more seeds could be added.
4. Then seeds were poured from the skull into a wide glass jar and from there into the glass cylinder of 1000 cc capacity. The volume of seeds was measured & data was recorded and analyzed statistically by using 'Z' test to measure the level of significance ( $p$  value  $<0.05$ ).

## RESULTS

In the present study on 112 male and 88 female adult skulls, the mean cranial capacity of male skulls was observed to be  $1260.48 \pm 75.15$  cc (range 1200-1420 cc) and those of female skulls was observed to be  $1164.52 \pm 89.43$  cc (range 1100-1430) (Table 1). Results were found to be significant with the  $p$  value = 0.025. The differences between mean cranial capacities of male and female skulls were found to be statistically significant within 95% confidence limits.

**Table 1: Mean, Range and Standard Deviation of cranial capacity in male and female skulls**

Gender	Range (cc)	Mean (cc)	Std. Deviation	Observed p-value	Result
Male (112)	1200-1420	1260.48	75.15	0.025	Highly Significant
Female (88)	1100-1340	1164.52	89.43	(<0.05)	

## DISCUSSION

Several investigators have estimated the cranial capacity in the past. Most of these studies were carried out on the dry skulls using linear dimensions, packing methods or radiological methods (Table 2). Direct measurement by filling the cranial cavity with mustard/rye seeds, etc and then pouring out into measuring cylinder is considered to be the most accurate method.

The cranial capacity in population of Madhya Pradesh was measured as  $1380.52 \pm 94.63$  cc (male) and  $1188.75 \pm 91.16$  cc (in female). The mean cranial volume by Lee Pearson's formula was  $1152.815 \pm 279.16$  cc in males and  $1117.82 \pm 99.09$  cc in females. By using Spheroidal formula, values were  $1169.68 \pm 239.98$  cc in males and  $1081 \pm 111.6$  cc in females<sup>7</sup> (Table 2) which is comparable with the present study. This difference may be because the cranial capacity in the study was derived from the formula based on linear dimensions of the skull.<sup>8</sup> The cranial capacity in the male and female students of the Mugla University, (Turkey). By using linear dimensions of head, the mean cranial capacity and SD in males and females were found to be  $1411.64 \pm 118.9$  cc and  $1306 \pm 162.9$  cc, respectively.<sup>9</sup> They found that there was a significant difference in cranial capacity between the two genders ( $p < 0.05$ ). However in present study this difference was also highly significant (Table 2). The cranial capacity in adults resident in Maiduguri North Eastern Nigeria<sup>10</sup> in 300 (150 males, 150 females) using a random stratified method. The Linear measurements of cranial length, width, and head circumference were undertaken and their cranial capacities were calculated. The Mean ( $\pm$ SD) of cranial capacity was significantly ( $p < 0.0001$ ) higher in males ( $1424.4 \pm 137.9$ ) than that in females ( $1331.3 \pm 201.8$ ). Cranial length and height were found to be significantly high in males than in females, which is similar to present study (Table 2). The cranial capacity in Korean adult skulls<sup>11</sup> by filling with rice seeds and the volume of the seeds were measured in a graduated cylinder. The results were  $1470 \pm 107$  in male and  $1317 \pm 117$  cc in female skull. The mean cranial capacity of 100 male and 60 female skulls and found the value as  $1302.95 \pm 108.8$  C.C. (range 1070-1560 C.C.) in male and those of female skulls as  $1179.92 \pm 97.08$  C.C. (range 1000 – 1420 C.C.)<sup>12</sup>. The sexual dimorphism in cranial capacity of male and female skulls (Graph 1) found to be highly significant as the z test was 7.43 ( $p < 0.01$ ).

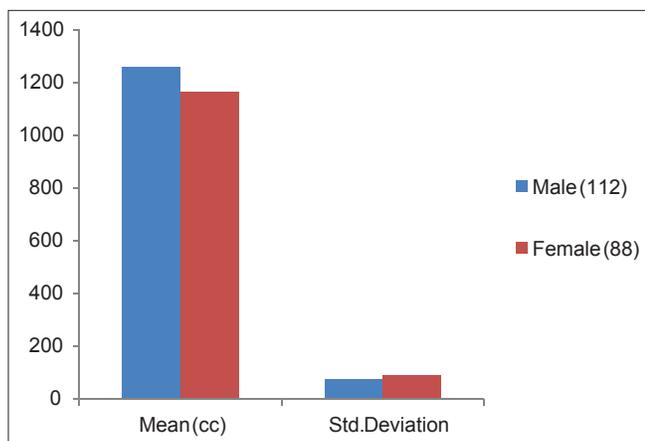
## CONCLUSION

In present study, significant difference was found in the cranial capacities of male and female skulls. The mean cranial capacity of males is higher than that of the females, (Graph 2) that tends to agree with the similar studies conducted earlier. Therefore, estimating cranial

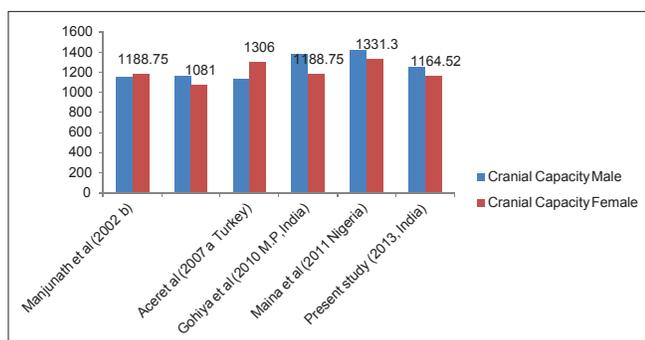
**Table 2: Comparison of studies done by different authors**

Authors	Cranial Capacity		Methods used
	Male (cc)	Female (cc)	
Manjunath et al (2002 b)	$1152.81 \pm 94.63$	$1188.75 \pm 91.16$	Lee- Pearson's Formula
	$1169.68 \pm 239.98$	$1081 \pm 111.6$	Spheroidal Formula
Acer et al (2007 a Turkey)	$1141.64 \pm 118.9$	$1306 \pm 162.9$	Linear Dimensions Measurement
Gohiya et al (2010 M.P, India)	$1380.52 \pm 94.63$	$1188.75 \pm 91.16$	Filling & Packing Method
Maina et al (2011 Nigeria)	$1424.4 \pm 137.9$	$1331.3 \pm 201.8$	Linear Dimensions Measurement
Present study (2013, India)	$1260.48 \pm 75.15$	$1164.52 \pm 89.43$	Filling & Packing Method

capacity of skull is an undisputable criterion for sex determination from skeletal remains and filling & packing method is one of the most reliable cranio-metric methods been used.



Graph 1: Cranial capacity of male and female skulls



Graph 2: Comparison of mean cranial capacity observed by different authors

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