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# Study of Cranial Capacity & Its Sexual Dimorphism in Adult Human Skulls

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## ABSTRACT

**Background:** Like other body dimensions, Cranial capacity of skull are affected by geographical, racial, gender and age factor. Intention of this study is to know the gender variations of cranial capacities in available human skulls of north Indian region. Aims and objectives: To measure the cranial capacities and its sexual dimorphism in the available skulls which may be helpful to establish the sex of a person from remains of skeletal?. **Methods:** 200 dry human skulls (110 male & 90 female) were obtained from the anthropology museum of the Dept. of Anatomy, GSVM Medical College, Kanpur (U.P) & SGRR institute of medical &Health Sciences, Dehradun (U.K). Cranial capacity was measured by filling and packing method in which mustard seeds were used to avoid the error as their smaller size clay was used as a packing material to avoid the spillage of seeds from any aperture or foramina. Intact & undamaged Adult skulls were included while those which were having ambiguity of sex, broken or damaged were excluded. **Results:** The mean cranial capacity of male skulls was observed to be 1280.28 ± 68.20 cc (range 1200-1410 cc) and those of female skulls were observed to be 1167.32± 42.18 cc (range 1150-1380cc). **Conclusion:** The mean cranial capacity of males is higher than that of the females. Filling and packing method is one of the most reliable Cranio-metric methods to be used for measuring the cranial capacity of skull and determination of sex.

***Keywords:*** Cranial capacity, Cranio-metric, Filling & packing method, Sexual dimorphism.

## INTRODUCTION

Like other body dimensions cranial capacity of skull, is affected by geographical, racial, gender, and age factor,[1,2] as there is close relationship between cranial capacity and the size of the brain. Several studies have been carried out in different countries to estimate the cranial capacity which indirectly reflects the brain volume.[3,4]

In the same race, female skull has been found to have a capacity about 1/10th less than that of the male skull. Studies on cranial capacity has been proved to be a useful tool in the field of Forensic Anthropology and Pediatrics, as an indicator of skull development in both male and female individuals.[5]

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

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## MATERIALS AND METHODS

200 dry human skulls (110 male & 90 female) were obtained from the anthropology museum of the Department of Anatomy, GSVM Medical College, Kanpur. & SGRR institute of medical and sciences Dehradun & Adult skulls 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.

**Following steps were carried out to measure the cranial capacity:**

1. All fissures and foramina of the skulls were plugged by moist clay and by cotton wool, so that the seeds do not spilled out.
2. Through the foramen magnum mustard seeds were poured to fill the cranial cavity than vigorous shaking of the skull was done at some short

intervals so that the seeds get settled into the all parts of the skull.

3. While shaking, time to time more and more seeds were added up to the rim of the foramen magnum of the skull till it was full and no more seeds could be accommodated.
4. All the seeds were poured into a wide glass jar from the skull and then 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<0.5)

## RESULTS

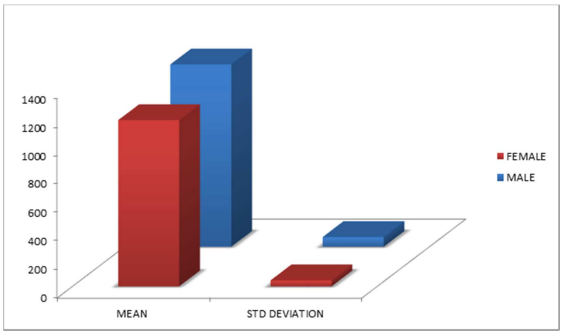
In the present study on 110 male and 90 female adult skulls, the mean cranial capacity of male skulls was observed to be 1280.28 ± 68.20 cc (range 1200-1410 cc) and those of female skulls was observed to be 1167.32 ± 42.18 cc (range 1150-1380) (Table 1). Results were found to be significant with the 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. As in previous study.

**Table 1: Range, Mean, and SD Of Cranial Capacity In Male And Female Skulls**

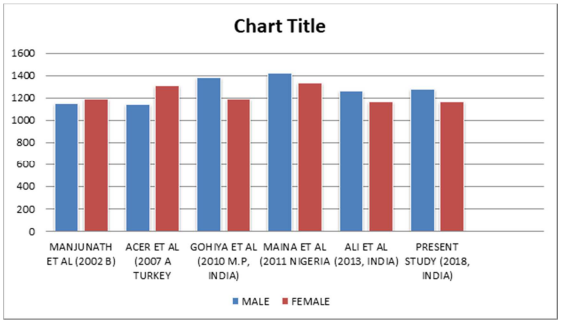
| Gender | Male | Female |
|---|---|---|
| Range (cc) | 1200-1410 | 1150-1380 |
| Mean (cc) | 1280.28 | 1167.32 |
| Std. Deviation | 68.20 | 42.18 |
| Observed p value | 0.025 | (<0.05) |
| Result | Highly Significant | |

**Table 2: Comparison With Previous Studies**

| Authors | Cranial Capicity | | Method Used |
|---|---|---|---|
| | Male (cc) | Female (cc) | |
| Manjunath Et Al (2002 B) | 1152.81+/−94.63 | 1188.75+/−91.16 | Lee- Pearson's Formula |
| | 1169.68+/−239.98 | 1081+/−111.6 | Spheroidal Formula |
| Acer Et Al (2007 A Turkey | 1141.64+/−118.9 | 1306+/−162.9 | Linear Dimensions Measurement |
| Gohiya Et Al (2010 M.P, India) | 1380.52+/−94.63 | 1188.75+/−91.16 | Filling & Packing Method |
| Maina Et Al (2011 Nigeria | 1424.4+/−137.9 | 1331.3+/−201.8 | Linear Dimensions Measurement |
| Ali Et Al (2013, India) | 1260.48+/−75.15 | 1164.52+/−89.43 | Filling & Packing Method |
| Present Study (2018, India) | 1280.28+/−68.20 | 1167.32+/−42.18 | Filling & Packing Method |




**Graph 1: Sexual Dimorphism.**




**Graph 2: Comparison with different studies.**

## 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 ± 94.63 cc(male) and 1188.75 ± 91.16 cc(in female). The mean cranial volume by Lee Pearson's formula was 1152.815 ± 279.16cc in males and 1117.82 ± 99.09cc in females. By using Spheroidal formula, values were 1169.68 ± 239.98 cc in males and 1081 ± 111.6 cc in females [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.[7,8] 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 ± 118.9 cc and 1306 ± 162.9 cc, respectively. They found that there was a significant difference in cranial capacity between the two genders (p<0.05).[9] However in present study this difference was also highly significant [Table 2]. The cranial capacity in adults resident in Maiduguri North Eastern Nigeria, 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 (±SD) of cranial capacity was significantly ($p<0.001$).[10] Higher in males (1424.4±137.9) than that in females (1331.3±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 by filling with rice seeds and the volume of the seeds were measured in a graduated cylinder. The results were 1470 +/- 107 in male and 1317 +/- 117 cc in female skull.[11] The mean cranial capacity of 100 male and 60 female skulls and found the value as 1302.95 +/-108.8 C.C. (range 1070-1560 C.C.) in male and those of female skulls as 1179.92 +/- 97.08 C.C. (range 1000 – 1420C.C.).[12] 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 ($p<0.01$). The mean cranial capacity of north Indian population of male skulls was observed to be 1260.48 ± 75.15 cc (range 1200-1420 cc) and those of female skulls was observed to be 1164.52 ± 89.43 cc (range 1100-1430).[13] Results were found to be significant with the p value = 0.025.

## CONCLUSION

In present study, the mean cranial capacity of males is higher than that of the females, significant difference was found in the cranial capacities of male and female skulls, [Graph 2]. That tends to agree with the similar studies conducted before. Therefore, estimating cranial capacity of skull is an undisputable criterion for sex determination from skull remains and filling & packing method is one of the most reliable cranio-metric methods been used.

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