



## Sexual Dimorphism In Crania From Uttar Pradesh

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### Abstract

Sexual Dimorphism exists in the morphology for males and females. The differences are mainly due to internal, genetic or hereditary factors, but they sometimes may be due to external factors, as in case of many tribes where they alter the structure of skull and body parts through various methods, which is their hallmark. Differences in skull is not only helpful in delineating the population variation and racial classification, but is also useful in individual identification and age assessment.

The present study was conducted to observe sexual dimorphism in male and female crania of Uttar Pradesh. For the study a total of 64 crania belonging to both male and female were taken into considerations from the department of anthropology of Lucknow university and the department of anatomy KGMU. The study reveals significant sexual dimorphism in almost all features of cranial morphology, except frontal index. The measurements, when subjected to t - test, showed significant variations between the two sexes, and the probability values oscillating between .001 to .002, with confidence level of 99.9%.

**Key words:** - Sexual dimorphism, Anthropometry, Cranium, Males, Females.

### Introduction

At the very beginning or say before the advent of genetics in anthropology, physical anthropology mainly laid emphasis on morphological features, as a criterion for studying variations in humans. Every organism or substance that came into existence is subject to change, leading to variations. These variations are found universally and in order to understand them anthropologists take help of different markers. During the course of evolution, organisms many times retain some of their ancestral characteristics, which act as markers for common descents. These variations may either be meristic or substantive, and are an interplay of many factors – effect of environment, mutation, hybridization, natural selection and many more (Bauer et al. 1931). Certain features of extinct genus Homo, may be found in the contemporary humans, but cannot be reproduced to exactness in further generations. Of all the organs in a human body, head or skull has been studied extensively. The growth of skull is regulated by the secretion of hormones, and is modified by the changes in secretion and functioning of endocrine gland, which in turn affects the shape of skull. Apart from internal factors, certain external factors play important role (artificial changes made in head, may alter the shape as in case of many tribes of the world). Likewise, the external influences also affect facial regions, their soft parts and the structure of bones as well. For instance, speech influences the shape of lower half of the face, through the pull of masticatory muscles upon the growing jaw bones (Hrdlikca, 1920)

Many studies have been conducted since years on cranium and other post cranial bones to study sexual differences between the two sexes. Some of the other studies on cranium include that of Garson (1885), Knight (1915), Wilder (1920), Hanihara (1958), Deshmukh et al (2006)., Vidya et al. (2012), Desai et al. (2013), Talokar et al. (2015) to name a few.

### Objective

Careful observations of skulls convince us of the fact that hereditary factors are of supreme importance in this respect. Apart from the shape of cranium, the shape of face, shape of teeth, shape of orbits, nasal cavity and shape of the palate determine the overall structure of skull and are the determinants of heredity and vary accordingly. Thus, variations in skull play a significant role in population variation and racial classification. Not only this, variations in skull are also evident in males and females, resulting in sexual dimorphism. The present study thus wants to focus on whether sexual dimorphism is also observed in the skulls of Uttar Pradesh, and whether these differences between the two sexes are significant or not.

### Methodology

For the present study 64 original human crania were examined all together- 32 males and 32 females. The study was conducted with the help of department of anthropology, Lucknow University and anatomy department, KGMU, Uttar Pradesh. Six cranial measurements and two indices were calculated for these crania. For taking the measurements

spreading calliper and tape were used. The indices were calculated by the values derived from these measurements. The indices were calculated on the basis of Garson (1885) and Martin & Saller (1957).

Landmarks used for the measurement are: -

- Maximum Cranial Length - glabella to opisthocranium
- Maximum Cranial Breadth - euryon to euryon
- Minimum Frontal Breadth – fronto-temporale to fronto-temporale
- Maximum Frontal Breadth – Coronale to Coronale

The above measurements were taken through spreading caliper.

- Horizontal Circumference of Cranium - glabella to opisthocranium to glabella (tape measurement)
- Cranial Capacity – through Volumetric cylinder.

Indices

- Cranial Index=  $\frac{\text{Maximum cranial breadth} \times 100}{\text{Maximum cranial length}}$

- Frontal index =  $\frac{\text{Minimum frontal breadth} \times 100}{\text{Maximum frontal breadth}}$

Certain statistical consideration like mean, coefficient of variations, standard deviation, standard error of mean and standard error of standard deviation were also done for the above measurements. To make the study more relevant, t – test and p values were obtained. Apart from this, the data collected was also compared with few researches made by other researchers on various other populations.

## Results

A complete picture of six measurements and two indices for both male and female crania has been presented through tables 1 & 2 for the present study. Tables delineates that sexual dimorphism does exists for the two groups. Differences are observed in all the measurements for the two groups, but significant differences are evident in cranial length, cranial breadth, minimum frontal breadth and maximum frontal breadth, horizontal cranial circumference & cranial capacity. All the measurements, when subjected to t - test, showed significant variations between the two sexes, and the probability values oscillating between .001 to .002, for table no.1 and 2, except for the p value of frontal index, that has non-significant differences between the two sexes.

**Table No.- 1 Measurements of Crania from Uttar Pradesh**

| Name of Measurement      | Sex | Mean (x) (mm) | Standard Error of x $\pm$ | Coefficient of Variation (C.V.) | Standard Deviation (S.D.) $\pm$ | S.E. of S.D. $\pm$ | t - test & p value              |
|--------------------------|-----|---------------|---------------------------|---------------------------------|---------------------------------|--------------------|---------------------------------|
| Maximum Cranial Length   | M   | 183.1         | 1.30                      | 4.01                            | 7.30                            | .912               | t = 9.877<br>p $\leq$ .001 (S)  |
|                          | F   | 167.0         | 1.00                      | 2.89                            | 5.71                            | .71                |                                 |
| Maximum Cranial Breadth  | M   | 128.0         | 0.10                      | 3.50                            | 4.48                            | .70                | t = 6.1538<br>p $\leq$ .001 (S) |
|                          | F   | 122.0         | 0.08                      | 2.64                            | 3.22                            | .06                |                                 |
| Minimum Frontal Breadth  | M   | 93.71         | 0.80                      | 5.26                            | 4.93                            | .60                | t = 6.2276<br>p $\leq$ .001 (S) |
|                          | F   | 85.34         | 1.03                      | 6.78                            | 5.79                            | .72                |                                 |
| Maximum Frontal Breadth  | M   | 110.8         | 0.98                      | 4.98                            | 5.52                            | .69                | t = 5.5714<br>p $\leq$ .001 (S) |
|                          | F   | 103.0         | 1.01                      | 5.51                            | 5.68                            | .71                |                                 |
| Horizontal Circumference | M   | 448.0         | 10.99                     | 12.47                           | 5.59                            | .69                | t = 9.7560<br>p $\leq$ .001 (S) |
|                          | F   | 434.3         | 11.05                     | 13.38                           | 5.89                            | .73                |                                 |
| Cranial Capacity         | M   | 1223.38 cc    | 21.60                     | 9.88                            | 120.0                           | 15.10              | t = 3.0249<br>p $\leq$ .002 (S) |
|                          | F   | 1132.64 cc    | 15.12                     | 10.67                           | 120.85                          | 21.58              |                                 |

The value for maximum cranial length for male crania is 183.1 mm, while that for females it is 167.0 mm, the value of probability (p)  $\leq$  .001, with confidence level of 99.9%. Maximum cranial breadth for male crania is 128.0 mm, while for females it is 122.0 mm. The value of p  $\leq$  .001, with confidence level of 99.9%. Similarly, minimum frontal breadth for male crania is 93.71 mm, while for female crania it is 85.34 mm, the value of p  $\leq$  .001, with confidence level of 99.9%. Maximum frontal breadth has the value of 110.8 mm for male crania, while 103.0 mm for females, the value of p  $\leq$  .001, with confidence level of 99.9%. Horizontal circumference is 448.0mm in males and 434.3mm in females, the value of p  $\leq$  .001, with confidence level of 99.9%. Cranial capacity exhibits the value of 1223.8 cc in males, while 1132.64 cc in females, the value of p  $\leq$  .002, with confidence level of 99.8%.

**Table No.- 2 Indices of Crania from Uttar Pradesh**

| Name of Measurement | Sex | Mean (x) (mm) | Standard Error of Mean (S.E. of x) $\pm$ | Coefficient of Variation (C.V.) | Standard Deviation (S.D.) $\pm$ | S.E. of S.D. $\pm$ | t- test & p value               |
|---------------------|-----|---------------|--|---------------------------------|---------------------------------|--------------------|---------------------------------|
| Cranial Index       | M   | 71.9          | 0.68                                     | 5.29                            | 3.81                            | .47                | t = 3.1304<br>p $\leq$ .002 (S) |
|                     | F   | 75.5          | 0.97                                     | 7.01                            | 5.30                            | .66                |                                 |
| Frontal index       | M   | 84.8          | 0.71                                     | 6.29                            | 5.14                            | .54                | t = 0.4237<br>p $\geq$ 50 (NS)  |
|                     | F   | 85.4          | 0.79                                     | 7.37                            | 6.15                            | .48                |                                 |

S= significant difference, NS = Non-significant difference

Table no. 2 presents the two indices of cranium. An index is a ratio between two measurements. It is seen from the table, that the female cranial index has higher values than males. The mean of cranial index value for male is 71.9, which means that on an average the crania from Uttar Pradesh are mostly dolichocranial, but hyperdolichocranial and mesocranial are also found. The females exhibit a mean value of 75.5, this indicates that most of Uttar Pradesh female crania belong to mesocranial group. Apart from this dolichocranial, hyperdolichocranial and few brachycranial crania are also found. Only 3.1% of male and female crania were found to be ultradolichocranial. The value of  $p \leq .002$ , with confidence level of 99.8%. Frontal index is also on higher side for females. The mean value for males is 84.8, while that for females it is 85.4, the value of  $p \geq 50$ , with confidence level of less than 50%. It means that the difference is non-significant.

### Discussion

From the present study it is revealed that sexual dimorphism does exist between the two sexes, but for one of the variables, the differences of non-significant nature existed. The values derived from the six measurements showed higher values for male crania than the females, but the two indices reported higher values in females than that of males. The data of crania of the present study were further compared with some other populations available like studies by Knight, 1915 (93 skulls), Desai et al., 2013 (125 dry skulls), Talokar et al., 2015 (89males & 61 females), Deshmukh et al., 2006 and Vidya et al., 2012 (41 males & 39 females) Table no. 3 shows the compared data with other populations.

**Table No.: - 3 comparative measurements with other populations**

| Name of measurement      | sex | Knight (mm) | Desai et al. | Deshmukh et al (mm) | Vidya et al. (cm) | Talokar et al. (mm) | Present study(mm) |
|--------------------------|-----|-------------|--------------|---------------------|-------------------|---------------------|-------------------|
| Maximum Cranial Length   | M   | 182.2       | --           | 173.0               | 16.81±1.61        | 174.31±3.32         | 183.0±7.30        |
|                          | F   | 175.5       | --           | 166.0               | 16.77±1.73        | 163.63±4.07         | 167.0± 2.08       |
| Maximum Cranial Breadth  | M   | 134.0       | --           | 131.0               | 13.29±1.93        | 133.05±3.62         | 128.0±4.48        |
|                          | F   | 132.0       | --           | 127.0               | 13.28±1.45        | 124.85±4.93         | 122.0± 3.02       |
| Minimum Frontal Breadth  | M   | 93.2        | --           | ---                 | --                | --                  | 93.70±4.93        |
|                          | F   | 90.0        | --           | ----                | --                | --                  | 85.34±5.79        |
| Horizontal circumference | M   | --          | --           | 496.0               | --                | 495.75±14.79        | 448.0±5.59        |
|                          | F   | ---         | --           | 479.0               | --                | 471.44±10.76        | 434.3±5.58        |
| Cranial index            | M   | ---         | 79.98±2.16   | ---                 | 78.4±7.13         | ---                 | 71.9±3.81         |
|                          | F   | ---         | 75.35± 2.56  | ---                 | 79.13±5.87        | ---                 | 75.5±5.30         |

The values for the maximum cranial length are higher for the male (183.0mm ± 7.30) crania of Uttar Pradesh than those of Knight (182.2mm), Talokar et al (174.31mm ± 3.32), and the Vidya et al (16.81 ± 1.61cm). But when females were compared, it was noticed that female crania from Uttar Pradesh for the present study (167.0mm ± 2.08) were higher from crania studied by Talokar et al (163.63 ± 4.07), and had lower values for cranial length than those of M.V. Knight (175.5mm). the female crania show almost similar values with least difference from Vidya et al (16.77cm ± 1.73). Both the male and female crania from Uttar Pradesh show lower values for maximum cranial breadth than those crania studied by Knight, Talokar et al, and Vidya et al. Thus, the differences for this parameter are significant amongst the crania of different populations. Almost no differences are evident amongst the male crania of Uttar Pradesh and those studied by Knight, as for the female groups, differences are evident for minimum frontal breadth with that of Uttar Pradesh crania. For the horizontal cranial circumference of the three populations compared, the present study shows sexual dimorphism for both the sexes (448.0mm ± 5.59 for males & 434.3mm ± 5.58 for females). Differences are very much prominent with the other compared populations. Talokar et al (495.75± 14.79 for males, while 471.44 ± 10.76 for females) and Deshmukh et al (496.0 for males and 479.0 for females).

A comparative chart for cranial index and categorization is according to Garson (1885). Cranial index is the simplest and efficient way, to exhibit facial differences in populations. It is seen that the male crania from Uttar Pradesh are mostly dolichocranial, while the male crania studied by Vidya et al exhibit preponderance of mesocranial and crania studied by Desai et al are also mostly mesocranial, for this index. While the female crania of present study, Vidya et al. and Desai et al. are mostly mesocranial. Although other types of crania are also seen among the two sexes.

### Conclusion

Craniometry is of utmost importance when it comes to study the human growth variations in osteometry for different populations and races. As rightly said by William et.al (1973), human skull shows less sexual dimorphism between the two sexes, than other primates. The present study constituted of 64 crania from both the sexes of Uttar Pradesh, and it is clear that the two sexes differ significantly in most of the cranial features, but in one (frontal index) variable, the differences are non-significant, which was further confirmed by t tests and probability values.

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