



## ESTIMATION OF CRANIAL CAPACITY OF STUDENTS OF A NEPALESE HEALTH UNIVERSITY.

### Anatomy

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### ABSTRACT

**Background:** Cranial capacity and the size of brain correlate naturally and it gives a realistic approximation about the volume of brain and may be helpful in determining the racial differences as well as for sex identification. The average cranial capacity of modern man has been found to vary from 1200cc to 1400cc.

**Objective:** To estimate cranial capacity of healthy adult students of a health university in eastern part of Nepal.

**Methods:** This cross sectional study was carried on 292 adult students (158 male and 134 female) pursuing different courses at B.P. Koirala institute of Health sciences (BPKIHS), Dharan, Nepal. Head length, head breadth and auricular height i.e. head height was measured for each student. All the measurements were taken by using standard measuring devices and applying standard anthropometric techniques.

**Results:** The mean cranial capacity for male was 1342.79 cc and for female was 1135.50 and the difference was 207.29 cc.

**Conclusion:** Cranial capacity of the male students is approximately 18% higher than the female students in present study. This study may serve as basis of comparison for future studies and this data is expected to be of clinical, forensic and anthropological significance.

### KEYWORDS

Cranial Capacity, Head Length, Head Breadth, Auricular Height.

### Introduction

Craniometry is an important branch of anthropometry through which cranial dimensions can be measured. In a living person, information about the cranial capacity is important in the study and comparison of the crania of populations with various essential differences like nutritional, racial, geographic, ethnicity etc. This may also be helpful in pediatrics specialty as an indicator of skull development in both female and male individuals as well as for growth and development and abnormal crania evaluation (Haack and Meihoff-1971).<sup>1</sup> Cranial capacity reflects racial characteristics and thus considered as one of the commonest items in physical and anthropological studies. Determination of sex is a key norm for identification of a human being for medico-legal purposes and it's well agreed that skull and pelvis has great significance in establishing sex of a person.<sup>2,3</sup>

The cranial capacity gives a realistic estimate about the volume of brain and it may varies from 1200cc to 1400 cc. Based on cranial capacity, heads may be classified into microcephalic heads i.e. having cranial capacity below 1300 cc, mesocephalic heads with a cranial capacity between 1300 and 1450 cc and megacephalic heads having cranial capacity over 1450 cc.<sup>4,5,6</sup>

Cranial capacity has been measured by many workers without differentiating male and female skulls. There is a minor little difference between male and female skulls in early life but during the adulthood, female skulls are generally smaller and tender than male skulls (Gray's Anatomy 1935). In this study, an attempt has been made to estimate the cranial capacity of subjects using the dimensions of the heads in 18-23 years old healthy medical university students. The purpose of the study was also to determine if it is a significant parameter for gender differentiation and hence this study was also an effort to determine the possibility of gender identification from cranial capacity.

### MATERIALS AND METHODS

**Subjects:** This cross sectional study was carried on 292 adult students (158 male & 134 female) of the age group 18-23 years pursuing

different courses at B.P Koirala institute of Health sciences (BPKIHS), Dharan, Nepal. Purpose of the study was explained and prior informed consent was obtained from the subjects and the study was carried out after obtaining ethical clearance from the institute ethical committee of BPKIHS.

**Craniometric measurements:** A number of formulae have been devised by Lee-Pearson (1901), for the estimation of cranial capacity from the external measurements of the living heads and skulls. A mean error of 3-4% has been reported while using this method (Haack and Meihoff-1971).

Cranial capacity can be calculated in the living subject by three principal dimensions and as per Lee-Pearson formula, the cranial volume can be computed as following:

**Male :  $0.000337(L-11)(B-11)(H-11) + 406.01cc$**

**Female :  $0.000400(L-11)(B-11)(H-11) + 206.60cc$**

Cranial measurements were performed with subjects in a relaxed condition with head in the anatomical position using standard anatomical landmarks (Lobo *et al.*, 2005). A spreading caliper was used to measure the three head measurements (cranial length, width and height). Cranial length was described as linear length from Glabella to Inion, for Cranial breadth -linear length between parietal eminences and length from external acoustic meatus to the highest point of the vertex was considered as Cranial height. Each measurement was taken to the nearest millimeter at least three times and average was considered for computation. The subjects were classified into microcephalic, mesocephalic and megacephalic.

**Statistical Analysis:** The data for each person was recorded on a recording sheet, and then transferred into SPSS for analysis. The means obtained from this study were subjected to student t-test for assessment of statistical significance with a probability level of less than 0.05 considered as significant.

### Results

**Table 1. Showing parameters of Students**

	MBBS Stream			BDS Stream			B.Sc. Stream		
	1 <sup>st</sup> Year	II <sup>nd</sup> Year	Total	1 <sup>st</sup> Year	II <sup>nd</sup> Year	Total	Nursing	MLT	Total
Male (158)	67	54	121	10	16	26	00	11	11
Female (134)	22	21	43	37	21	58	29	04	33
Total (292)	89	75	164	47	37	84	29	15	44

**Table 2. Cranial Capacity (Cr Ca) of students**

Parameter	Minimum (in cm.)		Maximum (in cm.)		Mean (in cm.)		
	Male	Female	Male	Female	Male	Female	p-Value
Head Breadth	13.1	12.4	16.3	15.5	13.8±0.3	13.4±0.4	<0.05
Head Length	17.6	16.5	20.2	19.1	18.2±0.6	17.1±0.3	<0.05
Head height	11.5	11.2	15.2	14.1	13.9±0.4	12.9±0.4	<0.05
Cranial Capacity (in cc)	1099.96	909.64	1785.52	1554.44	1342.79 ± 64.76	1135.50 ± 66.32	<0.05

**Table 3. Classification of students based on Cranial Capacity (Cr Ca)**

	Microcephalic (Cr Ca ≤ 1300cc)	Mesocephalic (1300 cc < Cr Ca < 1450cc)	Megacephalic (Cr Ca ≥ 1450cc)
Male (158)	113 (71.51%)	38 (24.05%)	07 (04.43%)
Female(134)	129 (96.27%)	03 (02.24%)	02 (01.49%)
Total (292)	242 (82.88%)	41 (14.04%)	09 (03.08%)

Results are presented in analyzed tabulated form for the collected data in Table 1 and 2. The minimum cranial capacity was found to be 1099.96 cc for male and 909.64 cc for female subjects while maximum cranial capacity was found to be 1785.52cc for male and 1554.44cc for female subjects. The mean cranial capacity was 1342.79cc for male and 1135.50 cc for female subjects. The difference between male and female cranial capacity was significant ( $p < 0.05$  & difference 207.29 cc). In males the mean head length was  $182 \pm 6$  mm and the head length varies from 176 mm to 202 mm. In females the head length varies from 165 mm to 191 mm, the mean head length being  $171 \pm 3$  mm. The difference between male and female head length was found to be significant ( $p < 0.05$  and difference 11mm)

In males the mean head breadth was  $138 \pm 3$  mm and the head breadth varies from 131 mm to 163 mm. In females the head breadth varies from 124 mm to 155 mm, the mean head breadth being  $134 \pm 4$  mm. The difference between male and female head breadth was found to be significant ( $p < 0.05$  and difference 4 mm).

In males the mean head height was  $139 \pm 4$  mm and the head height varies from 115 mm to 152 mm. In females the head height varies from 112 mm to 141 mm, the mean head height being  $129 \pm 4$  mm. The difference between male and female head height was found to be significant ( $p < 0.05$  and difference 10 mm).

In the present study, cranial capacity for female skulls was found to be between 909.64 and 1554.44 cc with a mean of 1135.50 cc. For male skulls it varied from 1099.96cc to 1785.52cc with a mean of 1342.79 cc.

Based on their cranial capacity subjects were classified as microcephalic, mesocephalic and megacephalic. Out of total 292 subjects, 242 (male 113 and female 129) were microcephalic, 41 (male 38 and female 3) were mesocephalic, 9 (male 7 and female 2) were megacephalic. Except of 5, all female subjects were microcephalic (129 i.e. 96.27%).

### Discussion

It has been found that the cranial capacity increases with age with most of its growth achieved in the first five years and it peaks at the age of 16-20 years and thereafter it remains near the same for the rest of the life.

Various studies in the past have used different methods to measure cranial capacity. Though, direct measurement which is considered as the most accurate method and includes filling the cranial capacity

with mustard seeds, lead shots, etc and then pouring out into measuring flask to measure cranial capacity but mostly linear dimensions, packing methods or radiological methods were utilized on dry skulls for estimating it.

**Table 4. Cranial Capacity (Cr Ca): Studies compared.**

	Name of Study	Place of Study	Sex	Head length (cm)	Head breadth (cm)	Head Height (cm)	Cr Ca (in cc)
1.	Gohiya VK et al. IJM 2010; 400 subjects	Madhya Pradesh, India	M=200 F=200				1380.52 1188.75
2.	Salve VM. AJMS 2011 320 subjects	320 Andhra Pradesh, India Medical Students	M=160 F=160	18.2 17.2	13.8 13.6	13.6 12.6	1322.78 1129.49
3.	Maina M B, AJSIR 2011. <sup>8</sup> 300 subjects	Nigeria	M=150 F=150	19.1 18.3	13.5 13.5	14.8 13.8	1424.40 1331.30
4.	Sanganya, RJPT 2015. <sup>9</sup> 50 Subjects	Tamil Nadu, India	M=25 F=25				1414.80 1413.00
5.	Present Study; 292 Students	BPKIHS, Dharan. Nepal	M=158 F=134	18.2 17.1	13.8 13.4	13.9 12.9	1342.79 1135.50

In past several authors have determined the cranial capacity of skulls belonging to different races (Hwang et al 1995; Manjunath, 2002; Gopalipour et al.2005; Gohiya et al 2010; Salve 2011; Gupta S et al 2013).<sup>3,34,7,10</sup> Hwang reported that the cranial volume was  $1317 \pm 117$  cm<sup>3</sup> in female skull and  $1470 \pm 107$  cm<sup>3</sup> in males. Manjunath (2002)<sup>11</sup> found that the cranial volume was  $1152.813 \pm 279.16$  cm<sup>3</sup> in males and  $1117.82 \pm 99.09$  cm<sup>3</sup> in females. Gopalipour et al. reported cranial capacity of the Turkman was  $1420.60 \pm 85$  cm<sup>3</sup> in male and  $1227.2 \pm 120$  cm<sup>3</sup> in females, and in native fars group in male and female were  $1369.4 \pm 142$  cm<sup>3</sup> and  $1215.8 \pm 125$  cm<sup>3</sup>, respectively. Gohiya et al found that the cranial capacity was 1380.20cc in males and 1188.75 in female subjects. Similarly, Salve in 2011 reported that the cranial capacity was 1322.78cc in males and 1129.49 in female subjects

In this present study, 292 subjects of the age group 18-23 participated and out of them 158 were male and 134 were female subjects. It was found that on the basis of cranial capacity, most (total 242; male 113 i.e. 71.51% and 129 i.e. 96.27% female) of them could be grouped as microcephalic. 38(24.05%) male and 3(2.24%) female skull were mesocephalic while 7 males (4.43%) and 2 female (1.49%) skulls were megacephalic. Cranial capacity was found to be 1342.79cc (range 1099.96-1785.52 cc) for male and 1135.50 cc (range 909.64-1554.44cc) for female subjects. Our findings are in line with the previous studies where consistently cranial capacity was found to be higher in males when compared to their female counterparts.

In medico-legal and anthropological studies, sexual determination assumes a very important tool for the personal identification especially when the body is found in an advanced stage of decomposition. Findings of this study also establishes sexual dimorphism.

### Conclusion:

In this study, it was found that head length, head breadth, head height and cranial capacity were more in male than female and it confirms the sexual dimorphism. In Forensic investigation sex determination is a convincing standard for identification in various cases. Mean cranial capacity of male skulls was found to be 1342.79 (range 1099.96-1785.52 cc), while in female skulls the mean cranial capacity was found 1135.50 (range 909.64 - 1554.44 cc). Nearly all female were found to be microcephalic while majority of male subjects were also found to be in the same category. The difference in the cranial capacity of male and female skulls was found to be significant ( $p < 0.05$  and difference 207.29 cc) and accordingly it can be established that the cranial capacity is a helpful method for sex identification.

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**Conflict of Interest:** None declared.

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