ORIGINAL RESEARCH PAPER
Volume - 10 | Issue - 12 | December - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF CRANIAL CAPACITY IN DRIED HUMAN SKULL BONES OF BIHAR

Anatomy

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ABSTRACT

Background: Cranial capacity is a measure of the volume of the interior of the cranium, which is used as a rough indicator of the size of brain. Craniometric study is an important fractions of anthropometry that can be employed in the determination of cranial study of an individual. Cranial capacity like several bodily dimensions are affected by environmental, ecological, biological, geographical, racial, gender and age factors. **Materials And Methods:** The study will constitute 100 dried human skulls belonging to both sexes in the department of Anatomy at, Darbhanga medical college and Hospital, Laheriasarai, Bihar. The skull was placed on the rubber ring and the length of the skull was measured from glabella to inion, breadth by the distance between the two parietal eminences above zygomatic arch and the height from the basion [anterior margin of foramen magnum in the median plane) to bregma by spreading caliper and measuring tape respectively. **Conclusion:** There was a significant difference between genders ($p < 0.001$). The mean, SD of cranial length, cranial breadth and cranial height of male skulls were more compared to female skulls. In the present study, the significant difference is found in the cranial capacities of male and female skulls. The mean cranial capacity of male skulls is higher than that of female skulls, that tends to agree with similar studies conducted earlier.

KEYWORDS

Anthropometry, Cranial capacity, Breadth, Height.

INTRODUCTION

Cranial capacity is a measure of the volume of the interior of the skull (also called the braincase or brainpan) of those vertebrates who have both a skull and a brain. Cranial volume is often used as a general estimate for the size of a vertebrate's brain. Cranial capacity is used as a rough indicator of the size of brain. Craniometric study is an important fractions of anthropometry that can be employed in the determination of cranial study of an individual. Cranial capacity like several bodily dimensions are affected by environmental, ecological, biological, geographical, racial, gender and age factors. The cranial capacity has been used indirectly to reflect the volume of the brain and to predict the mental ability. This information is useful in correlating cranial capacity with other cranial measurements and in the studies of primate phylogeny. Medically, an analysis of cranial capacity exposes another aspect of growth and development and permits critical evaluation of unusually large, small, or mis-shaped crania Determination of sex is an important criterion, for identification of an individual for the medico-legal purposes. Skull and pelvis assume great importance in establishing sex of an individual. A number of dimensions and indices have been reported to be of valuable indicator in the differentiation of male and female skulls. It is well known that cranial capacity which is in correlation with brain volume which reflects the racial characteristics and has been thought to be one of the commonest factors in physical anthropological studies, Cranial capacity which has close correlation with brain volume reflects racial characteristics. This was thought to be one of the most presenting situations in human physical anthropological studies4. Diverse methodologies have been employed in estimating the cranial capacity of different populations both in the past and present. Vertebrate skull is the most modified part of skeleton. It is a skeletal complex adapted to support brain and organs of special senses. This concentration of functions is linked with elaboration of cranial free end of nervous system into a brain whose size and dominance have increased throughout the vertebrate evolution. The most commonly used unit of measure is the 'cubic centimeter' or cc. The volume of the cranium is used as a rough indicator of the size of the brain, and this in turn is used as a rough indicator of the potential intelligence of the organism. Neurological functions are determined more by the organization of the brain rather than the volume. Knowledge of the volume of the cranial cavity of either the dry skull or of a living being may be important to the study and comparison of the crania of populations with various fundamental differences like geographical, racial, ethnic, etc. This information is useful in correlating cranial capacity with other cranial measurements and in the study of primate phylogeny. Hence the present study of cranial volume correlating it with the craniometric studies has been taken up not only because of its racial, sexual, forensic importance, study of fossil skull and clinical importance but also to evolve and confirm the existing formulae correlating the various indices with the cranial capacity.

OBJECTIVES

Cranial capacity is an important predictor in the study of racial differences, sex and clinically the analysis of cranial capacity exposes another aspect of growth and development and permits critical evaluation of unusual large, small or mis-shaped crania.

Review of Literature

Most studies carried out to determine the cranial capacity in a population are done with the aim of detecting the effect of various fundamental parameters such as racial, geographic, ethnic and dietary factors etc. Lee and Pearson formula stated by Todd 1923, the most consistent results are obtained only when the skulls of same race are used. Pearson 1899 also cautioned that formula may be affected by such characters as age, sex and amount of drying of skull. This formula cannot be used on fresh skull. Shukla 1966, had said that great amount of variations exists among Indian skulls. His series had mean capacity 1370 ml with S.D 5.16 Thomas et al1980, studied the various methods of estimating cranial capacity. Measurement of cranial capacity of an individual is of both anthropological and clinical interest. Such measurements are necessary as they indicate indirectly the brain volume. There are so many methods, Golalipour etal, in 2006, has done the anthropological measurements, brain weight and cranial capacity of healthy newborns They studied normal female newborns. They found that cranial capacity 418 and 438 for Turkman and Natifare respectively and they concluded that ethenical factor could influence brain weight and cranial capacity. In 2007 Acer N. Usanmaz, estimated CC in 17-22years old university students, There was a significant difference between the genders. Their study showed, the CC is larger in males, Obaje S.G etal, in 2015, study was undertaken due to lack of adequate cephalometry among Nigerians. Four hundred and twenty five subjects were used for the study of which 158 were Igede tribe and 267 were Idoma tribe with mean age of 22.5 and 23.0 year respectively. The anthropometric variables measured were head length, head width, bizygomatic distance, upper facial length, lower facial length, total facial length, nose width and skull height from which the cephalometric indices were calculated. The result showed that there were statistically significant differences ($P<0.05$) in some of the measured variables between the Igede and Idoma of Benue State in head length & head width. Anthropology is a science of study of humans, past and present, which deals with the origins, physical, biological characteristics, social customs and beliefs of humankind. Applications of Anthropology is numerous & are as follows:

Anthropology covers all investigations which relate the methods and data of pure science to any other kinds of problems whether academic or practical. Vertebrate skull is most modified part of skeleton. It is a skeletal complex adapted to support brain and organs of special senses. This concentration of functions is linked with elaboration of free end of nervous system into a brain whose size and dominance have increased throughout the vertebrate evolution.

MATERIAL AND METHODS

The study will constitute 60 dried male human skulls and 40 dried female human skulls belonging to both sexes in the department of Anatomy, at Darbhanga medical college and Hospital, Darbhanga Laheriasarai, Bihar. Duration of two and half years. The sex of the skulls was determined by examining the superciliary arches, mastoid process, frontal and parietal eminence, muscular ridges. Spreading calipers.

Material used: Vernier caliper, Channa dal (Bengal gram) to fill into the skull, 2 liters measuring beaker to measure the quantity, Rubber ring as a bed to place the skull during the procedure, The skulls were placed on the rubber ring and the length of the skulls were measured from glabella to inion, the breadth by the distance between the two parietal eminences above the zygomatic arch and the height from the basion [anterior margin of foramen magnum in the median plane) to bregma by spreading calipers.

Collecting data: The cranial volume is calculated by using three principle dimensions of the cranium: Maximum cranial length (antero-posteriorlength-L): One point at the glabella, and another point at the inion is taken and the maximum cranial length is measured using spreading caliper. Maximum cranial breadth, This is measured using spreading caliper at right angles to the mid sagittal plane where ever maximum breadth is found, above the level of the supra mastoid crests or distance between two parietal eminences above the zygomatic arches (Biparietal diameter).

Inclusion Criteria

Complete adult crania of both sexes

Exclusion Criteria

Atrophied /decomposed/deformed crania, he most elderly skulls in which skull vault suture showing complete closure

RESULTS

Gender distribution of the skulls studied

Gender	No. of skulls	%
Male	60	60.0
Female	40	40.0
Total	100	100.0

Length (mm) distribution of the skulls studied

Length (mm)	Gender		Total
	Male	Female	
<150	1(1.7%)	3(7.5%)	4(4%)
150-160	1(1.7%)	6(15%)	7(7%)
161-170	18(30%)	11(27.5%)	29(29%)
171-180	28(46.7%)	16(40%)	44(44%)
181-190	12(20%)	4(10%)	16(16%)
Total	60(100%)	40(100%)	100(100%)

Breadth (mm) distribution of the skulls studied

Breadth (mm)	Gender		Total
	Male	Female	
<120	0(0%)	3(7.5%)	3(3%)
120-130	28(46.7%)	19(47.5%)	47(47%)
131-140	27(45%)	15(37.5%)	42(42%)
141-150	5(8.3%)	3(7.5%)	8(8%)
Total	60(100%)	40(100%)	100(100%)

Breadth (mm) distribution of the skulls studied

Height (mm)	Gender		Total
	Male	Female	
<120	1(1.7%)	2(5%)	3(3%)
120-130	13(21.7%)	18(45%)	31(31%)
131-140	44(73.3%)	20(50%)	64(64%)
141-150	2(3.3%)	0(0%)	2(2%)
Total	60(100%)	40(100%)	100(100%)

Height (mm) distribution of skulls studied

Direct cranial volume (ml)	Gender		Total
	Male	Female	
Microcephalic	38(63.3%)	37(92.5%)	75(75%)
Mesocephalic	19(31.7%)	2(5%)	21(21%)
Megacephalic	3(5%)	1(2.5%)	4(4%)
Total	60(100%)	40(100%)	100(100%)

Direct cranial volume (ml) distribution of skulls studied

Comparison of Direct cranial Volume and Calculated Cranial Volume in male and female skulls studied

	Gender		Total	P value
	Male	Female		
Direct cranial volume (ml)	1275.33±124.68	1213.00±138.66	1250.40±133.34	0.021*
Calculated cranial volume (ml)	1344.10±106.62	1276.26±68.72	1316.96±98.74	0.001**

Correlations Direct cranial volume with length, breadth, height, Circumference

Correlations Direct cranial volume with length, breadth, height, Circumference

Pearson Correlation	r value	P value
Direct cranial volume (ml) **v/s** Length (mm)	0.426	<0.001**
Direct cranial volume (ml) **v/s** Breadth (mm)	0.604	<0.001**
Direct cranial volume (ml) **v/s** Height (mm)	0.558	<0.001**
Direct Cranial Volume (ml) v/s calculated (mm)	0.638	<0.001**

Comparison of direct cranial volume with length, height & breadth Comparison of direct cranial volume with length breadth height circumferences showed statistically Significant.

DISCUSSION

The sexual dimorphism in the cranial capacity of male and female skulls found are highly significant with 'p' value 0.001. In the present study, it is observed that, on the basis of overall mean of the cranial capacity of both sexes by direct method, the skulls could be classified as 63.3% of male and 92.5% of female skulls are microcephalic. 31.7% of male and 5% of female skulls are mesocephalic, while 5% of male and 2.5% of female skulls are megacephalic. Thus, based on calculated cranial capacity, the skulls can be classified as, 53.3% of male and 92.5% of female skulls are microcephalic. However, 40% of male and 5% of female skulls are mesocephalic and while 6.7% of male and2.5% of female skulls are megacephalic. The mean cranial capacity(cc) by using direct method is 1275.33cc± 124.68cc in males and 1213.00cc ± 138.66cc in female skulls, with significant difference in the cranial capacity between two genders with 'p' value 0.021. The mean cranial capacity (cc) using Lee- Pearson formula is 1344.10cc ± 106.62cc in males and 1276.26cc ± 68.72cc in female skulls. However, this difference is also highly significant between two genders with 'p' value 0.001. In the present study, the sexual dimorphism in cranial capacity of male and female skulls (table 1) found to be highly significant as 'p' value is 0.001.The studies were carried out on the dry skulls using linear dimensions, packing methods and radiological methods. In our present study CC is estimated by filling method and by Lee-Pearson's method. It is natural that there exists some relationship between the head size and the size of the brain. Several investigators have estimated the cranial volume in the past which indirectly reflects the brain volume. Most of these studies have been made on the dry skulls using linear dimensions, packing methods or occasionally radiological methods. The estimated mean cranial volume was as follows: by Lee- Pearson's formula: Males : 1152.813 ± 279.16 cc; Females : 1117.82 ± 99.09cc.; by spheroid formula: Males-mean: 1169.68±239.98; Females-mean 1081±111.6. The length, breadth and height is also similar to our Results. In 2007 Acer. N. Usanmaz estimated CC in 17-22years old from university students of Turkey. They studied 226 males and 140 female health students and found that CC is 1411 and 1306 respectively. There was significant difference between genders. Their study showed CC is larger in males which is similar to our study. In 2010 Gohiya etal, estimated CC in the 20-25 years old population. They studied 200 males and female by using linear dimensions of the head. The mean CC in males and females 1380cc and 1189cc respectively. This study has shown significance

difference between male and female population, male bein VINEET K. GOHIYA etal, in 2011, reveals that the study was carried out by using linear dimensions of head (Lee Pearson's formula) on 800 healthy, 20 - 25 years old subjects (of which were 400 males and 400 females) from Keer tribe and Non- tribal population. The mean cranial capacity and SD in Non-tribal males and Non-tribal females were 1380.524 ± 94.633 cc and 1188.758 ± 91.164 cc respectively. The mean cranial capacity and SD in Keer males and Keer females were 1252.857 ± 70.989 cc and 1094.441 ± 81.289 cc respectively. This study has shown significant (p) difference between the same gender populations of Keer tribe and Non-tribal population, g heigher than in female. These results are also similar to our study, Sadakat Ali in 2104, has done a study on adult North Indian human skulls. They studied 112 male and 88 female dry skulls. In their study they used filling and packing method to know the CC which is 1260cc and 1164cc respectively in male and female, which was similar to our study. Most of the anthropologists while studying crania of various races on the basis of morphological and metrical features have concluded that the population of a country is no more formed by one homogeneous element but instead is constituted by heterogeneous elements (Shukla-1966). This explains that there can be a wide range of variation of cranial capacity within a population.

CONCLUSION

Most of the anatomists and anthropologists while studying crania of various races on the basis of morphological metrical features concluded that the population of a country is no more formed by one homogenous element but instead constituted by heterogenous elements. This explains how there can be s wide range of variation of cranial capacity within a group of population. There was a significant difference between genders ($p < 0.001$). This study has shown a significant ($p<0.001$) difference between males and females with CC of male larger than female.

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