Original Article

DOI: 10.7860/IJARS/2022/55472.2823

Anatomy Section

Morphometry of the Crania and the Cranial Capacity in Dry Human Skull Bones- A Descriptive Analytical Study

S SATHIYA[1], A KARTHIKEYAN[2], B SHWETHA[3]

ABSTRACT

Introduction: The crania constitute the skull bones that are held together by sutures which determines the brain size and an individual's mental ability. The present study would help the forensic anthropologist differentiate sex and predict brain development by measuring the cranial capacity of an unknown skull.

Aim: To determine the cranial morphometry and the endocranial capacity in dry human skull bones.

Materials and Methods: This descriptive analytical study included 100 adult male and female dry human skull bones, procured from the Department of Anatomy, Annapoorana Medical College and Hospitals, Salem, Tamil Nadu, India, from July 2021 to December 2021. The linear parameters like cranial length and breadth were measured using a spreading caliper, and cranial height was measured using an anthropometric rod. The cranial volume was measured by direct and calculated methods. Using Statistical Package for Social Sciences (SPSS) software version 25.0, the data obtained were analysed and a descriptive statistical analysis was done. The significance of parameters of male and female skulls was compared using the unpaired Student 't' test and Pearson's correlation test.

Results: The cranial length, cranial capacity, and cephalic index showed statistically significant ($p<0.05$) differences between male and female skulls. The mean cranial length in male and female skulls were 174.11±7.07 mm, 168.84±9.36 mm, respectively, whereas the mean cranial breadth were 131.61±7.52 mm, 130.14±8.99 mm, respectively and the mean cranial height were found to be 126.53±6.59 mm, 125.12±8.17 mm, respectively. Using the direct method, the mean cranial capacity in male and female skulls was 1246.67±116.60 cc, 1191.63±83.23 cc, respectively. The mean cranial capacity in male and female skulls was found to be 1300.91±112.35 cc and 1245.51±79.93 cc, respectively obtained using the calculated method.

Conclusion: The cranial capacity in the male skulls was significantly greater than the female skulls. This knowledge would help the anthropologists and forensic experts to use the anthropological examination in medicolegal cases to determine the sex, stature, and cranial capacity to expose the growth and development of the brain of an unknown individual.

Keywords: Anthropology, Cephalic index, Intelligence, Microcephalic, Sexual dimorphism, Skull phenotype

INTRODUCTION

The cranial cavity formed by the cranial bones forms a protective braincase which encloses the brain and its coverings called meninges [1]. The anthropometric study on crania is important as the cranial capacity was influenced by age, gender, environmental and genetic factors [2]. The larger brain size in sperm whales does not implicate their higher intelligence, but it benefits them to control their massive body and assist them in adapting to the colder atmosphere [3]. Whereas in human beings, the cranial capacity helps predict a person's mental ability and identify the sex of an unknown individual [4]. The cephalic measurements in both male and female sex help access the brain volume; hence the endocranial capacity indirectly relates to brain volume [5].

The growth of the calvaria in infants provides enough space for the brain to grow until it reaches standard size; hence the head circumference in foetuses plays a crucial role as it helps in the early diagnosis of craniosynostosis, causing misshapen crania [6]. The craniometry of the skull also determines the cephalic index, which helps to classify the skull into Dolichocephalic, Mesocephalic, and Brachycephalic [7]. The skull configuration is a reliable indicator for estimating the stature of an individual and the cranial capacity that helps to access brain development [8]. The present study would help the anatomist, forensic anthropologist identify the sex, stature, and intelligence of an unknown individual. Very few studies were done in the Tamil Nadu population, which requires further exploration to evaluate the existence of sexual dimorphism among the crania in this population [9]. So, the cranial dimensions and the endocranial volume plays a crucial role in medicolegal cases to differentiate the sex and the skull development in an unknown skull [9,10]. The cephalic index was calculated to classify the skull phenotypes to specify the common type seen in South Indian population as the previous studies were focused to determine the sex of the skull by calculating the cranial capacity [9,10]. Hence; present study was conducted not only to determine the cranial dimensions and cranial capacity in adult (male and female) human skull bones but also to estimate the cephalic index to categorise the skull phenotypes which gives us additional information about the population to which the skull belongs to.

MATERIALS AND METHODS

This descriptive analytical study was conducted in the Department of Anatomy, Annapoorana Medical College and Hospitals, Salem, Tamil Nadu, India. The study was conducted for a period of 6 months from July 2021 to December 2021. Institutional Ethical Clearance was obtained (AMC/IEC/Proc.No.2/2020).

Inclusion criteria: Skulls with intact cranial bones and foramina were included in the study.

Exclusion criteria: Cranial bones with damaged foramina were excluded from the study.

Sampe size calculation: using the formula: $n=4s^2/d^2$ where d (error allowed)- 0.05 and s (Standard deviation)- 5.2 was taken from previous study [11].

n=4×5.2×5.2/0.05×0.05; n came out to be 43 in each group

Male=43 and Female=43. So, total 86 skulls were adequate for this study.

Finally, a total sample of 100 adult dry human skull bones (57 male, 43 female) were utilised for this study.

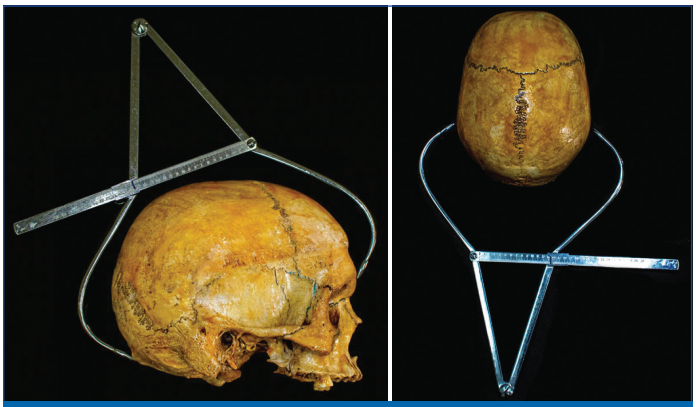
Procedure

The various parameters like cranial length and breadth was measured using a spreading caliper, whereas cranial height was measured using an anthropometer rod. The cranial volume was measured by packing the interior of the skull with grains (Direct method) and the Lee- Pearson formula (Indirect method). To calculate the cranial capacity, direct method was more accurate and precise compared to the calculated method as the endocranial volume remains unchanged even with the atrophied brains [12,13].

The linear parameters used to calculate the cranial volume were [12,13].

1. Maximum anteroposterior length-Measured between glabella and the inion.
2. Maximum breadth (biparietal diameter)-Measured between two parietal eminences.
3. Cranial height (auricular head height)-Measured between the external acoustic meatus and the highest point of the vertex, i.e., the bregma.

[Table/Fig-1,2,3] shows the cranial length, cranial breadth measurement using spreading caliper and cranial height measurement using anthropometric rod.



[Table/Fig-1]: Cranial length measured from glabella to the inion using a spreading caliper. **[Table/Fig-2]:** Cranial breadth measured between two parietal eminences using a spreading caliper. (Images from left to right)

Cranial capacity: The cranial capacity was measured (Direct method) as shown in [Table/Fig-4] by packing the skull internally, preferably using millet grains as the size, shape and density of particles influences the rate of packing of the skull as it covers the endocranium uniformly without any gap. All the foramina, namely superior and inferior orbital fissure and foramina at the base of the skulls, were plugged with cotton balls except foramen magnum via millet seeds were poured using the funnel. Once the millet seeds reached the rim of the foramen magnum, the skull was shaken side to side and after filling the endocranium with millet seeds, the foramen magnum was gently pressed with the thumb. Now the seeds were poured via the foramen magnum into a graduated measuring jar, and the values were noted directly [12].

[Table/Fig-3]: Cranial height measured from external acoustic meatus to the bregma using a spreading caliper using anthropometer rod.
[Table/Fig-4]: Endocranium filled with millet seeds through the foramen magnum (Direct method). (Images from left to right)

The cranial capacity was calculated using the Lee- Pearson formula (Indirect method) [12,13].

Males: 359.34+0.000365×Length×Breadth×Height (cc)

Females: 296.40+0.000375×Length×Breadth×Height (cc)

Based on the cranial capacity, skulls were classified into three types to evaluate the percentage distribution in each type using both direct and indirect methods [13,14].

1) Microcephalic <1350 cc

2) Mesocephalic 1350 cc-1450 cc

3) Megacephalic >1450 cc

Cephalic index (C.I) was also calculated using the formula as given below [13,14]:

Cephalic index (C.I)= Breadth/Lengthx100

Based on the cephalic index, skulls were classified as [13,14].

1) Dolichocephalic <74.9 mm

2) Mesocephalic 75 mm-79.9 mm

3) Brachycephalic 80 mm-84.9 mm

4) Hyperbrachycephalic 85 mm-89.9 mm

The various parameters of the skulls were taken twice to avoid observer error, and their mean values were noted. The cranial capacity (Indirect method) and cephalic index for male and female skulls were calculated using the above formula. With the obtained results, the skulls were categorised into various types.

STATISTICAL ANALYSIS

Using Statistical Package for the Social Science (SPSS) software version 25.0, the data obtained were analysed, and a descriptive statistical analysis was done. The significance of parameters of male and female skulls were compared using the unpaired student 't' test and Pearson's correlation test. The mean±standard deviation of the results was tabulated. The p-value <0.05 was considered significant.

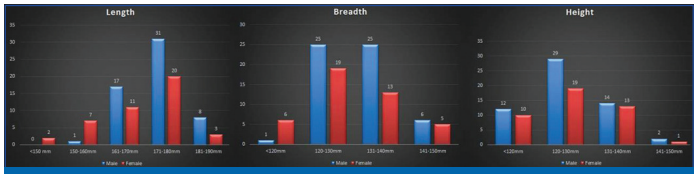
RESULTS

The various parameters of the crania with mean and standard deviation are shown in [Table/Fig-5,6]. The mean cranial length in male and female skulls were 174.11±7.07 mm, 168.84±9.36 mm, respectively. The mean cranial breadth in male and female skulls were 131.61±7.51 mm, 130.14±8.99 mm, respectively. The mean cranial height in male and female skulls were 126.53±6.59 mm, 125.12±8.17 mm, respectively. The cranial length, breadth, and height were comparatively higher in male skulls compared to female

S. No.	Parameters	Male skulls (N=57)		Female skulls (N=43)		Total mean	p-value
		Mean	SD	Mean	SD		
1	Cranial length (mm)	174.11	7.07	168.84	9.36	171.47	0.002
2	Cranial breadth (mm)	131.61	7.51	130.14	8.99	130.87	0.374
3	Cranial height (mm)	126.53	6.59	125.12	8.17	128.33	0.342
4	Cranial capacity (cc) (Direct method)	1246.67	116.60	1191.63	83.23	1219.15	0.010
5	Cranial capacity (cc) (Indirect method)	1300.91	112.35	1245.51	79.93	1273.21	0.007
6	Cephalic index (%)	75.56	2.22	77.05	2.34	76.30	0.002

[Table/Fig-5]: Descriptive statistical analysis for various parameters in male and female skulls.
p-value <0.05 considered significant

skulls, but the p-value was found to be significant in the case of cranial length when compared to cranial breadth and height. The measurement of cephalic index shows a statistically significant difference with p-value=0.002 as shown in [Table/Fig-5].



[Table/Fig-6]: Distribution of mean cranial length, breadth, height in male and female skulls.

The majority of skulls were microcephalic found in 44 male skulls (77.2%) and 42 female skulls (97.7%), followed by mesocephalic observed in 12 male skulls (21.1%) and 1 female skull (2.3%). Only one male skull with 1.8% were megacephalic whereas, in female skulls, it was absent using the direct method, as shown in [Table/Fig-7].

Skull types	Male skulls (N=57)		Female skulls (N=43)	
	Direct method n (%)	Indirect method n (%)	Direct method n (%)	Indirect method n (%)
Microcephalic (<1350 cc)	44 (77.2%)	38 (66.7%)	42 (97.7%)	40 (93%)
Mesocephalic (1350 cc-1450 cc)	12 (21.1%)	17 (29.8%)	1 (2.3%)	2 (4.7%)
Megacephalic (>1450cc)	1 (1.8%)	2 (3.5%)	0	1 (2.3%)

[Table/Fig-7]: Percentage distribution of skull types using direct and indirect methods.

[Table/Fig-8] shows the phenotypes of male and female skulls using the cephalic index. The majority of the skulls were mesocephalic, found in 36 male skulls (63.2%) and 21 in the female skulls (48.8%). The least was hyperbrachycephalic found in 1 male skull (1.7%) and 1 female skull (2.3%).

Skull type (Cephalic index)	Male skulls (N=57)		Female skulls (N=43)	
	Number (n)	Percentage (%)	Number (n)	Percentage (%)
Dolichocephalic (<74.9 mm)	17	29.8%	16	37.2%
Mesocephalic (75 mm-79.9 mm)	36	63.2%	21	48.8%
Brachycephalic (80 mm-84.9 mm)	3	5.3%	5	11.7%
Hyperbrachycephalic (85 mm-89.9 mm)	1	1.7%	1	2.3%

[Table/Fig-8]: Classification of skull phenotypes using cephalic index in male and female skulls.

[Table/Fig-9] shows the correlation between cranial capacity, cephalic index with cranial length, breadth and height with a statistically significant difference (p<0.05).

Pearson correlation	Cranial length (mm)		Cranial breadth (mm)		Cranial height (mm)	
	r-value	p-value	r-value	p-value	r-value	p-value
Cranial capacity (cc) (Direct method)	0.890	<0.001**	0.936	<0.001**	0.929	<0.001**
Cranial capacity (cc) (Indirect method)	0.894	<0.001**	0.942	<0.001**	0.938	<0.001**
Cephalic index (%)	0.134	>0.001	0.611	<0.001**	0.567	<0.001**

[Table/Fig-9]: Correlations of cranial capacity, cephalic index with cranial length, cranial breadth and cranial height.
Pearson's correlation test; **Correlation is significant (2-tailed); p-value <0.05 considered significant

DISCUSSION

In the present study, the mean cranial length, cranial breadth and cranial height in male and female skulls were 174.11±7.07 mm, 168.84±9.36 mm, 131.61±7.51 mm, 130.14±8.99 mm and 126.53±6.59 mm, 125.12±8.17 mm respectively. The mean cranial capacity using the direct and calculated method in male and female skulls were 1246.67±116.60 cc, 1191.63±83.23 cc and 1300.91±112.35 cc, 1245.51±79.93 cc respectively. The cranial length, breadth, and height were comparatively higher in male skulls compared to female skulls.The phenotypes of the skull using the cephalic index falls under mesocephalic with 63.2% seen in 36 male skulls and 48.8% seen in 21 female skulls. The least was hyperbrachycephalic with 1.7% found in 1 male skull and 2.3% found in 1 female skull.

Arathi MS et al., [9] in 2018 analysed 100 first year MBBS students belonging to Chennai (Tamil Nadu) and measured the mean cranial capacity in males and females of 17-19 years. The result showed that the mean cranial capacity in males was 1420±85 cc, and in females, it was 12270±120 cc. The p-value <0.001 indicates a significant difference exists among the two groups. The comparison between cranial capacity and Body Mass Index (BMI) shows a positive correlation, whereas cranial capacity and marks show a negative correlation. The present study reveals a significant difference between males and females as the samples belong to the South Indian population. The males have a more rapid growth rate during puberty and exhibit a more extended growth period responsible for the sexual dimorphism in crania.

Rasidi Q and Kumar S [10] in 2016 utilised 38 male and female skulls belonging to Chennai (Tamil Nadu) to estimate the mean capacity by using the calculated method. In male skulls, it was 1030.05±35.65 cc (range 963 cc-1099 cc), whereas, in female skulls, it was 850.24±40.95 cc (range 757 cc-890 cc). Based on the values of cranial capacity, it was found that the majority of skulls belong to microcephalic as the cranial capacity was less than 1350 cc in both sexes, which correlates with the present study. Even though the study was done in the South Indian population, the mean cranial capacity in both sexes was less than the present study as the measurement of cranial capacity was done using Lee- Pearson formula with limited samples (N=38 skulls).

Sangeetha K and Sathya Murthy B, [11] in 2018 studied the cranial capacity in 100 adult male and female skull bones belonging to Bengaluru (Karnataka). The mean cranial capacity in males and females was 1275.33± 124.68 cc, 1213±138.66 cc by using the direct method. In the calculated method, the mean cranial capacity was 1344.10±106.62 cc in male skulls and 1276.26±68.72 cc in female skulls. Based on cranial capacity, most of the skulls are microcephalic (63.3% male and 92.5% in female skulls), followed by mesocephalic (31.7% in male and 5% in female skulls). The least type was megacephalic seen in 5% males, 2.5% in female skulls. The present study also shows similar results as the study was carried out in dry human skull bones where similar methods (filling and calculated methods) were used to compare the cranial capacity in both sexes, and also the selected samples belong to the same South Indian population.

Gupta S et al., [15] in 2013 done a study in the Faridkot district of Punjab with a sample of 600 male and female adults. The authors observed the mean cranial breadth and length in male skulls was 139.51 mm, and 186.88 mm which was comparatively higher than female skulls with 136.19 mm 177.74 mm, respectively. A significant difference was observed among male and female skulls with p<0.001. The skull type in males was dolichocephalic, whereas, in females, it was the mesocephalic type. The findings were in accordance with the present study, except for the skull type in the male. It was mesocephalic, indicating moderate head as the sample belongs to the South Indian population as an individual's nutritional status and environmental factors may play a role in such difference.

Bali S [16] studied 400 adult male and female subjects in Dehradun (Uttarkhand) during 2016. The mean cranial length in male and female subjects were 185.72±7.49 mm and 175.48±7.93 mm, respectively, whereas mean cranial breadth in male and female subjects were 140.13±6.85 mm and 136.73±7.02 mm, respectively. The percentage distribution of cephalic index was found to be 74.11% in males and 77.59% in females. The predominant type of phenotype in males was dolichocephalic (58%), whereas in females, it was mesocephalic (49%), and the rarest type was hyperbrachycephalic which correlates with the present type, except the typical phenotype observed in male skulls were mesocephalic. Hence in the present study, the skull was slightly broader as the phenotype of the skull was influenced by genetic and ecological factors.

Maina MB et al., [17] conducted a study in Maiduguri (Nigeria) during 2011 with 300 adult male and female subjects. The author found that males' mean cranial length and cranial height showed significantly higher values than females with p-value <0.001. However, the mean cranial length in males and females was 191.11±6.4 mm, 183.53±9.9 mm respectively, which is comparatively lesser than the values obtained in the present study, which is 174.11±7.07 mm and 168.84±9.36 mm, respectively. The cranial capacity in males and females was 1424.4±137.9 cc and 1331.3±201.8 cc respectively, which correlates with the present study. The variation in the phenotypes of the skull is influenced by age, gender, genetic, ecological, racial and nutritional factors.

Nzotta ON and Ezejindu DN [18] conducted a study in 18 to 30 years male and female individuals of Nnewi campus, Anambra State (Nigeria) in the year 2014. The cranial length exhibits significant sexual dimorphism compared to the cranial breadth and cranial height, and a positive correlation was observed between cranial capacity and cranial dimensions. The mean cranial capacity in males and females were 1636.33±109.94 cc and 1632.59±149.44 cc, respectively. This study, even though done in the Nigerian population, correlates with the present study as the cranial capacity of female skulls was always 10% lesser than male skulls as females have a slower rate of growth when compared to males.

Pooza et al., [19] conducted a study in 2016 using 400 adult male and female subjects of Faridkot district (Punjab), and observed a statistically significant difference between male and female cranial parameters, including cranial length, breadth, and height. Out of the three parameters, cranial height has the highest correlation with cranial capacity. The mean cranial capacity in males and females was 1421.62±93.46 cc, 1276.78±92.74 cc respectively, with p-value <0.001 specifying the existence of sexual dimorphism, which correlates with the present study. Nevertheless, the cranial breadth and height did not show such a significant difference as the population-specific difference may be a reason for such a result.

Gohiya VK et al., [20] conducted a study in 400 adult male and female population belonging to 20-25 years in 2010 at Indore (Madhya Pradesh). The mean cranial capacity of 1380.52±94.63 cc and 1188.75±91.16 cc respectively, was observed among male and female subjects. A statistically significant difference was observed among male and female groups with p-value <0.05. This study correlates with the present study as, in general, the cranial capacity was influenced by the gender of an individual as the mean dimensions were comparatively higher in males than females.

Ali S et al., [21] in 2014 observed a statistically significant difference among male and female skulls by measuring the cranial capacity with a total sample of 200 skulls belonging to Kanpur (Uttar Pradesh). The mean cranial capacity in male skulls was 1260.48±75.15 cc, which is higher than the female skulls with 1164.52±89.43 cc. The cranial capacity in males and females was slightly less than the present study as the endocranial capacity was influenced by ecological factors showing such regional variation.

Muralidhar PS et al., [22] studied the mean endocranial capacity using 150 skull bones belonging to Davangere (Karnataka) in the year 2014 and the results were 1367.3±127.8 cc in male skulls and 1255.2±113.3 cc in female skulls. The mean cranial capacity in males was higher than in female skulls, which is in accordance with the present study. The sample of skulls used was of a similar race showing the same endocranial capacity as it might have one ancestral origin.

Satapathy K and Sahoo B [23] examined 83 male and female skulls in the year 2018 belonging to Bhubaneswar (Odisha). The mean cranial capacity in the male skull was 1329.42±154.38 cc, and in the female skull, it was 1235.61±135.94 cc with a significant difference among the two sexes with p-value <0.01. Most skulls were microcephalic in type with 66.27%, mesocephalic type seen in 20.48% and the least megacephalic with 13.25%. The result was in accordance with the present study both in cranial capacity and skull types as the cranial capacity exhibit sexual dimorphism in the human adult skull as the body dimensions in the male are generally greater than the female due to the hormonal events that occur at the time of puberty. [Table/Fig-10], compares the mean cranial capacity between the present and previous studies [9-11,17-23].

Authors and year of the study	Sample size	Population	Cranial capacity (cc) Male	Cranial capacity (cc) Female	Methods used
Arathi MS et al., (2018) [9]	100 adults	Tamil Nadu (Chennai)	1483.22±82.91	1236±113.25	L-P formula
Rasidi Q and Kumar S (2016) [10]	38 skulls	Tamil Nadu (Chennai)	1030.05±35.65	850.24±40.95	L-P formula
Sangeetha K and Sathya Murthy B (2018) [11]	100 skulls	Karnataka (Bengaluru)	1275.33±124.68	1213±138.66	Filling method
			1344±106.62	1276.26±68.72	L-P formula
Maina M.B et al., (2011) [17]	300 subjects	Nigeria (Maiduguri)	1424.4±137.9	1331.3±201.8	L-P formula
Nzotta ON and Ezejindu DN et al., (2014) [18]	500 subjects	Nigeria (Nnewi campus, Anambra State)	1636.33±109.94	1632.59±149.44	L-P formula
Pooza et al., (2016) [19]	400 adults	Punjab (Faridkot District)	1421.62±93.46	1276.78±92.74	L-P formula
Gohiya VK et al., (2010) [20]	400 adults	Madhya Pradesh (Indore)	1380.52±94.63	1188.75±91.16	L-P formula
Ali S et al., (2014) [21]	200 skulls	Uttar pradesh (Kanpur)	1260.48±75.15	1164.52±89.43	Filling method
Muralidhar PS et al., (2014) [22]	150 skulls	Karnataka (Davangere)	1367.3±127.8	1255.2±113.3	Filling method
Satapathy K and Sahoo B, (2018) [23]	83 skulls	Odisha (Bhubaneswar)	1329.42±154.38	1235.61±135.94	Filling method
Present study	100 skulls	Tamil Nadu (Salem)	1246.67±116.60	1191.63±83.23	Filling method
			1300.91±112.35	1245.51±79.93	L-P formula

[Table/Fig-10]: The comparison of cranial capacity in male and female skulls of the present study with other related studies L-P: Lee- Pearson formula [9-11,17-23].

Limitation(s)

The study was done in human skull bones which require further detailed research to be carried out in living subjects to correlate the mental ability and cranial capacity. The comparison of skull bones of various regions should be made to provide a concluded statement to prove the existence of phenotypic difference as samples for the present study belongs only to the South Indian population.

CONCLUSION(S)

The cranial capacity in male and female skulls shows a significant difference in exhibiting sexual dimorphism. The present study helps forensic anthropologists to differentiate the sex and the mental ability of an unknown individual with the help of the available skeletal remains. This anthropometric study on the cranial cavity would help the clinicians to predict early the deformities of the skull due to premature synostosis.

Acknowledgement

Authors acknowledge the scholars' tremendous guidance through their articles cited and included in the manuscript as references. The authors were pleased to thank the editors/publishers for reviewing and publishing the article.

Authors contributions: SS helped with manuscript preparation, data collection, interpretation, analysis of the data and submission of the manuscript for publication. AK helped with manuscript preparation, data collection, interpretation and data analysis. BS helped with drafting the manuscript, manuscript preparation, data collection and interpretation.

REFERENCES

[1] Dutta AK. Essentials of Human Anatomy, Head and Neck. 2009; 5th Edn: 3-4.
[2] Konishi M, Kimura K. Estimation of brain volume from physical measurements. Anthropol Sci. 1995;103(3):279-90.
[3] Cranial capacity. http:// en.wikipedia.org/wiki/ (Accessed on 6.3.2022).
[4] Ruta N, Ramteerthakar, Umarji BN. Cranial capacity: A useful parameter in sexing of crania. Indian J Forensic Med Pathol. 2013;6(3):135-37.
[5] Eboh DE, Okoro EC, Iteire KA. A cross-sectional anthropometric study of cranial capacity among Ukwuani people of South Nigeria. Malays J Med Sci. 2016;23(5):72-82.
[6] Acer N, Usanmaz M, Tugay U, Ertekin T. Estimation of cranial capacity in 17-26 years old university students. Int J Morphol. 2007;25(1):65-70.
[7] Chakrabarti JS, Choudhury P, Chakraborty PN. A study of the cephalic index of Bengali subjects of Tripura for determination of race. J Med Soc. 2018;32(2):91-97.
[8] Mathur A, Saini R. Correlation of skull size and brain volume with age, weight, height and body mass index of medical students. Paripex Indian J Res. 2019;8(3):60-61.
[9] Arathi MS, Durga Devi G, Sreelekha D, Archana R, Anandi MS, Subramanian M. Comparative analysis of cranial capacity with body mass index and academic performance of first-year medical students. J Clin Diagn Res. 2018;12(10):01-04.
[10] Rasidi Q, Kumar S. Sexual dimorphism from cranial capacity of adult South India skulls. Research J Pharm and Tech. 2016;9(9):1389-92.
[11] Sangeetha K, Sathya Murthy B. Estimation of the cranial capacity in dry human skull bones. Int J Anat Res. 2018;6(2.2):5181-85.
[12] Agarwal S, Jain SK, Agarwal SK. Evaluation of cephalic index in females of Western up region by simple regression analysis. J Evol Med Dent Sci. 2014;3(3):718-25.
[13] Manjunath KY. Estimation of cranial volume-an overview of methodologies. J Anat Soc India. 2002;51(1):85-91.
[14] Desai SD, Shaik HS, Muralidhar PS, Thomas ST, Mavishettar GF, Haseena S. A craniometric study of South Indian adult dry skulls. J Pharm Sci and Res. 2013;5(2):33-34.
[15] Gupta S, Patnaik G, Kaushal S, Chhabra S, Garsa V. Cranial anthropometry in 600 North Indian adults. Int J Anat Res. 2013;1(2):115-18.
[16] Bali S. Study of cranial anthropometric indices in adult population of Uttarakhand, India. Int J Med Res Prof. 2016;2(3):267-70.
[17] Maina MB, Shapu YC, Garba SH, Muhammad Garba AM, Yaro AU, Omoniyi ON. Assessments of cranial capacities in a North-Eastern adult Nigerian population. J Applied Sci. 2011;11(14):2662-65.
[18] Nzotta ON, Ezejindu DN. Estimation of cranial capacity of students of Nnamdi Azikiwe University. Int J Med Health Prof Res. 2014;1(1):15-22.
[19] Pooza, Chaudhary P, Singh Z. Estimation of cranial capacity of the adult population in Faridkot District of Punjab and its correlation with cranial and body dimensions. Int J Anat Res. 2016;4(1):2021-28.
[20] Gohiya VK, Shrivastava S, Gohiya S. Estimation of cranial capacity in 20-25 year old population of Madhya Pradesh, a State of India. Int J Morphl. 2010;28(4):1211-14.
[21] Ali S, Sinha AP, Jethanis SL, Rohatgi RK, Anamika K. Study of cranial capacity of adult North Indian Human skulls & its sexual dimorphism. Int J Sci study. 2014;1(5):29-31.
[22] Muralidhar PS, Magi M, Nanjundappa B, Pavan P, Gogi P, Saheb SH. Morphometric analysis of endocranial capacity. Int J Anat Res. 2014;2(1):242-48. https://www.ijmhr.org/ijar_articles_vol2_1/IJAR-2014-411.pdf.
[23] Satapathy K, Sahoo B. Estimation of endocranial capacity and identification of sex from adult human skull of Eastern India. Trial Trib. 2018;7(1):01-05.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Anatomy, Annapoorana Medical College and Hospitals, Salem, Tamil Nadu, India.
2. Assistant Professor, Department of Anatomy, Annapoorana Medical College and Hospitals, Salem, Tamil Nadu, India.
3. Assistant Professor, Department of Anatomy, Annapoorana Medical College and Hospitals, Salem, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
A Karthikeyan,
Assistant Professor, Department of Anatomy, Annapoorana Medical College and Hospitals, NH-7 Shankari Main Road, Salem-636308, Tamil Nadu, India.
E-mail: panacea.ak@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Feb 09, 2022
- Manual Googling: Apr 13, 2022
- iThenticate Software: May 28, 2022 (8%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval Obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Feb 05, 2022**
Date of Peer Review: **Mar 03, 2022**
Date of Acceptance: **Apr 14, 2022**
Date of Publishing: **Oct 01, 2022**