

# Morphometric Estimation of Cranial Index in Mahakaushal Region of Madhya Pradesh: Craniometrics Study

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## Abstract

**Background:** Craniometrics is an important tool for an anthropologist and forensic experts for identification of the racial and sexual differences, offsprings and siblings towards their genetic transmission of inherited characteristics and also to a great extent for the facial reconstruction of disputed identity.

**Aim:** The purpose of this study was to establish specific standard data for sex determination from the cranium in Mahakaushal region of Madhya Pradesh.

**Material and Methodology:** The present study was carried out with 140 (90 male & 50 female) dry human skull procured from Department of Anatomy, N.S.C.B. medical college, Jabalpur, Madhya Pradesh. Cranial measurements were taken; data was tabulated and statistically analyzed

**Results:** The study showed that the mean cranial index was  $77.89 \pm 3.55$ . The mean cranial index for male was  $77.65 \pm 3.34$  and for female was  $78.13 \pm 3.76$ . The difference between male and female cranial index was statistically significant ( $p < 0.001$ ). The result of present study shows that majority of Mahakaushal population are Mesocephalic followed by Dolichocephalic.

**Conclusion:** This study will serve as basis for comparison with future studies on other geographical region population and to achieve a more objective racial and sex assessment.

**Keywords:** Cranial index, Maximum Cranium length, Maximum Cranium breadth, Dolichocephalic, Mesocephalic, Head shape

## INTRODUCTION

Identification of human remains is an essential element in medico-legal investigations. One of the key tasks for the forensic anthropologist is the identification of dismembered, mutilated, and fragmentary remains.<sup>[1]</sup> It is important here that accurate sexing of the human remains has the potential to primarily narrow down the search to a particular sex thereby giving a sense of direction to the ongoing forensic investigation. There is a need for regional

studies in the process of identification of human remains as the human species inhabit diverse environments all over the earth and exhibit a lot of racial and ethnic variation.<sup>[2,3]</sup> Human cranium is regarded as the best indicator of sex second to the pelvis.<sup>[4]</sup> Many cephalic indices are widely used for racial and sex differences and they provide a recording of sizes and proportions of cranial features.<sup>[5]</sup> These recordings yield a numerical expression which is important in evaluating population by comparison of head form.<sup>[6]</sup> Human skulls have been studied both metrically and non-metrically earlier and these studies have thrown light on the functional and morphological aspect of skull. Craniometrics is an important tool for an anthropologist and forensic experts for identification of the racial differences, sexual differences, offsprings, and siblings toward their genetic transmission of inherited characteristics and also to a great extent for the facial reconstruction of disputed identity.<sup>[7]</sup> The craniometric results can also be of great assistance

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while evaluating patients in various fields of medicine such as medical imaging, pediatrics, and craniofacial surgery and also for studying growth trends in various castes/races within a defined geographic zone. Anthropometric study of the head is useful in designing various equipment of head and face such as helmets, headphones, and goggles by formulating standard sizes. The cranial index (CI) is one of the important craniometric indices. The cephalic index was defined by Swedish professor of Anatomy Anders Retzius (1796–1860) and first used in physical anthropology to classify ancient human remains found in Europe.<sup>[8]</sup> Retzius described as *gentes dolichocephaly* to those individuals who had an elongated skull shape, and *gentes brachycephaly* to those whose skulls were short but he never, at that time, assigned numerical values to distinguish one category from the other.<sup>[9]</sup> The measures used by Retzius when applied to living individuals are known as a cephalic index, and when referring to dry skulls, CI.<sup>[10,11]</sup> The cranial indices were calculated by multiplying the head breadth with 100 and dividing it with the head length. Cephalometry pertains to be the most versatile technique in the investigation of the craniofacial skeleton, because of its simplicity, acceptability, and practicality.<sup>[12,13]</sup>

Variation between and within the population is attributed to the complex interaction between genetic and environmental factors.<sup>[14]</sup> It is also used to analyze the evolution of human species in archeology. It is especially important in forensic practice where cranial remains are compared with existing photograph and radiologic records.<sup>[5]</sup>

## MATERIALS AND METHODS

The present study was carried out with 140 (90 male and 50 female) dry human skull procured from the Department of Anatomy, N.S.C.B. Medical College, Jabalpur, Madhya Pradesh. All the skulls were normal, fully mature, devoid of any fractures or damages. Instruments used for the measurement were spreading caliper, scale, and marker. All parameters were measured independently by two different observers, with a predetermined methodology to prevent interobserver and intraobserver error. The method used for assessing the CI was Hrdlicka’s method.<sup>[15]</sup> The anatomical landmarks, Glabella (g), Inion (I), and Euryon (eu) were marked.

The anatomical landmarks were defined as follows:

- Glabella: A point above the nasal root between the eyebrows and intersected by mid sagittal plane.
- Inion: The distal-most point placed on the external occipital protuberance in the mid sagittal plane.
- Euryon: The lateral-most point placed on the side of the head.

The head length was measured with a spreading caliper from Glabella to Inion. Head breadth was measured as the maximum transverse diameter between the two Euryon using a spreading caliper.

All measurements were taken in centimeters and to an accuracy of 0.10. The cranial indices were calculated by multiplying the head breadth with 100 and dividing it with the head length.

Depending on these indices the types of head shapes were classified as given by William *et al.*, 1995 [Table 1].<sup>[16]</sup>

## Statistical Analysis

The data were analyzed by Microsoft Excel, and all the statistical tests and calculations were performed using the software GraphPad Prism Version 5.

## OBSERVATION AND RESULTS

From the collected data, the mean values and standard deviation (SD) were calculated for maximum head length, maximum head breadth, and CI. From the observations of the present study, the parametric data were analyzed using independent sample *t*-test.

Males’ cranial length ranged from 16.2 cm to 19.7 cm with

**Table 1: Types of head shapes**

Type of skull	Cephalic index range
Dolichocephalic	<74.9
Mesocephalic	75–79.9
Brachycephalic	80–84.9
Hyper brachycephalic	85–89.9

**Table 2: Descriptive statistic showing various parameters of the present study**

Variables	n	Range	Mean±SD	P value
CI (male)	90	65.00–80.25	77.65±3.34	0.000
CI (female)	50	68.31–88.82	78.13±3.76	
CI (both)	140	65.26–83.44	77.89±3.55	
Cranial length (male)	90	16.20–19.70	19.78±1.12	0.000
Cranial length (female)	50	16.80–20.62	18.52±1.23	
Cranial length (both)	140	15.70–19.70	19.15±1.17	
Cranial breadth (male)	90	13.90–15.45	15.36±0.56	0.000
Cranial breadth (female)	50	12.70–15.31	14.47±0.47	
Cranial breadth (both)	140	11.70–14.30	14.91±0.51	

CI: Cranial index

a mean of  $19.78 \pm 1.12$  and cranial breadth from 13.9 cm to 15.45 with a mean of  $15.36 \pm 0.56$ . In female's cranial length ranged from 16.8 cm to 20.6 cm with a mean of  $18.52 \pm 1.23$  and cranial breadth ranged from 12.7 cm to 15.3 cm with a mean of  $14.47 \pm 0.60$  [Table 2].

The mean CI was higher in females compared to males in the present study. Among the male skulls, the mean CI recorded to be  $77.65 \pm 3.34$  whereas in females it was  $78.13 \pm 3.76$ . There was a statistically significant difference in the mean of the cranial indices in male and female skulls [Table 1]. Head shape was classified by cephalic index in which dominant type was mesocephalic (66.66%) and dolichocephalic (31.11%), followed by 1.11% each of brachycephalic and hyper brachycephalic in male skulls. The mean CI in female was  $78.13 \pm 3.76$  which showed that majority were mesocephalic (68%), 28% of dolichocephalic, and 4% of brachycephalic and no hyper brachycephalic skulls were noted in females [Table 3].

## DISCUSSION

Human species inhabit diverse environments all over the earth and exhibit a lot of racial and ethnic variation.<sup>[2,3]</sup> Therefore, there is a need for regional studies in the process of identification of human remains pertaining to cranium. Variation between and within the population is attributed to the complex interaction between genetic and environmental factors.<sup>[14]</sup> The most popular and widely anthropometric measurement used in the differentiation of race and ethnicity is cephalometry through which cranial dimensions can be determined. The most important of cephalometric dimensions are length and breadths of head that are used in cephalic index determination.<sup>[17]</sup> Craniometry can be used to classify people according to race, intelligence, and capacity for moral behavior. Variations of the shape and size of the human skull have gained much attention, and continuous efforts are been made to associate these variations to characterize different races.<sup>[18]</sup> Several studies have been conducted on the measurement of cephalic index in different geographical zones and have classified head shapes into four internationally accepted categories that include dolichocephalic (<74.9), mesocephalic (75–75.9), brachycephalic (80–84.9), and hyper brachycephalic (85–89.9) Kondo *et al.* showed that head breadth reaches to maximum at the age of 14 and head length will increase even after the age of 14. They also showed that in Japanese population, brachycephalization and secular changes in head length occur. Australian aborigines and native South Africans are dolichocephalic, Europeans and Chinese skull are Mesocephalic, and Mongolians and the Andaman islanders have brachycephalic skull.<sup>[19]</sup> The comparative study of the present cranial measurements

**Table 3: Classification of head shape based on cephalic indices in the present study**

Head shape	Male n=90 n (%)	Female n=50 n (%)
Dolichocephalic	28 (31.11)	14 (28)
Mesocephalic	60 (66.66)	34 (68)
Brachycephalic	01 (1.11)	02 (4)
Hyper brachycephalic	01 (1.11)	00 (00)

**Table 4: Comparison of studies on cephalic index among various population groups**

Name of workers	Population studied	Mean cephalic index
Oladipo and Olotu, 2006 <sup>[24]</sup>	Ijaw males	80.98
	Ijaw females	78.24
Oladipo and Olotu, 2006 <sup>[24]</sup>	Igbo males	79.04
	Igbo females	76.83
Oladipo and Olotu, 2009 <sup>[25]</sup>	Ogonis males	111.18
	Ogonis females	75.09
Odokuma <i>et al.</i> , 2010 <sup>[26]</sup>	West African males	77.67
	West African females	78.14
Ilayperuma, 2011 <sup>[21]</sup>	SriLankan males	78.04
	SriLankan females	79.32
Anitha <i>et al.</i> , 2011 <sup>[8]</sup>	North Indian males	79.14
	North Indian females	80.74
Salve and Chandrashekhar, 2011 <sup>[27]</sup>	Andhra Pradesh males	75.68
	Andhra Pradesh females	78.20
Kumar and Gopichand, 2012 <sup>[28]</sup>	Haryanvi males	66.72
	Haryanvi females	72.25
Vidhya <i>et al.</i> , 2012 <sup>[29]</sup>	South Indian males	78.40
	South Indian females	79.13
Gujaria and Salve, 2012 <sup>[20]</sup>	Marathi males	77.08
	Marathi females	79.02
Gujaria and Salve, 2012 <sup>[20]</sup>	Andhra males	76.28
	Andhra females	78.16
Gujaria and Salve, 2012 <sup>[20]</sup>	Gujarati males	80.42
	Gujarati females	81.20
Jeremiah <i>et al.</i> , 2013 <sup>[30]</sup>	Kenyan males	71.04
	Kenyan females	72.37
Kumar and Nagar, 2015 <sup>[31]</sup>	North Indian males	73.75
	North Indian females	75.22
Present study	Mahakaushal males	77.65
	Mahakaushal females	78.13

with the other workers studies is shown in Table 4. In our study, mean cephalic index of male skull was found to be  $77.65 \pm 3.34$  and that of female skull was  $78.13 \pm 3.76$

so, according to Siewerts classification this population belongs to mesocephalic variety. The results of our study were similar to the study on Andhra males and females by Gujaria and Salve, 2012 in which the mean cephalic index in males was 76.28 and in females was 78.16. The dominant head type in males and female was Mesocephalic followed by dolichocephalic and then by brachycephalic and ultrabrachycephalic.<sup>[20]</sup> The findings of our study were also similar to that on SriLankan males and females by Ilayperuma in 2011 in which mesocephalic was the dominant head shape in both males and females.<sup>[21]</sup> Bhargava and Kher in 1960 found mean cephalic index as 76.9 in Bhils population.<sup>[22]</sup> Further, Bhargava and Kher in 1961 found it to be 79.80 in Barelas population in central India.<sup>[23]</sup> As previously reported, genetic and environmental factors are largely responsible for variation in head shapes. We postulate based on our observations that the head type observed in the population of Mahakaushal region in comparison with other population is a true reflection of their location. The knowledge obtained from this study can be of great importance to a plastic surgeon when reconstructive surgery is essential.

## CONCLUSION

Cephalic morphometry marks its identity in anthropology for the study and comparison of crania of a different population of different ethnic, racial, dietary, geographical, and genetic backgrounds. The differences in metrical dimensions of the human head among the different population are greatly valuable, and this suggests the strength of cephalic morphometry in the assessment of sex and races. This helps in better understanding of frequency distribution of human morphologies and comparison of different races. The significance and practicality of CI were less studied in a population of Mahakaushal region, and thus a research design was framed to study, analyze and report the head shapes and cephalic index of this population.

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