

Study of Cephalic Index in North Indian Population: Anthropometric Analysis and Comparison with Previous Studies

Shalini Singh, Mumal Nagwani, Geetanjali Srivastava, Vineeta Tewari, P. K. Sharma

Received on: 28-03-2026

Published on: 30-08-2026

ABSTRACT

Introduction: Cephalic Index (CI), defined by the ratio between maximum cranial breadth and length is an important anthropometric measure for racial determination, sex difference, craniofacial surgery and forensic identification.

Objective: The present study aims to establish the cephalic index in the North Indian population and correlate the results with national and international studies.

Materials and Methods: A cross-sectional study was performed on 150 medical students (82 males and 68 females; ≥ 18 yrs) at Era University, Lucknow, India. Cranial length and breadth were estimated using Hrdlicka's method. Cephalic index was computed and statistical analysis done using SPSS v 22.0.

Results: Mean cranial length was 18.13 ± 1.05 cm, mean cranial breadth 13.54 ± 0.81 cm and mean cephalic index 74.88 ± 5.20 . The female cephalic index (75.85 ± 5.11) was found to be significantly greater than males (74.07 ± 5.17) ($p=0.036$). Dolichocephaly was the predominant cranial morphology (52.7 %).

Conclusion: Majority of North Indians exhibit dolichocephalic or mesocephalic cranial morphologies. The female group exhibits higher cephalic index establishing the fact of sexual dimorphism.

KEYWORDS: Cephalic Index, Cranial anthropometry, Morphometric Study, Sex Dimorphism, Craniology.

Era's Journal of Medical Research. 13(2);2026 [doi: 10.24041/ejmr.2026.30]

INTRODUCTION

One of the most precise tools for cranial analysis is the cephalic index (CI) developed by Anders Retzius. There are several key factors that affect cephalic index differentiation including genetics, ethnic background, geographic area, and environmental influence. Racial classification, gender dimorphism, forensics, and craniofacial reconstruction are some of the main purposes that call for the use of the cephalic index.^{1,2} The calculation is made by multiplying the maximum cranial breadth by maximum cranial length and dividing it by 100. Based on the result, individuals are divided into one of the following four categories: dolichocephalic ($CI < 75$), mesocephalic ($CI 75-80$), brachycephalic ($CI 80-85$), and Hyperbrachycephalic ($CI > 85$). These categories enable the introduction of a universal criterion to compare the skulls' morphological characteristics.³⁻⁵

Since India is a nation of many ethnicities, there are some significant differences between the cephalic indices in various Indian regions. Studies conducted in Gujarati, Punjab, Madhya Pradesh, and Delhi revealed some regional disparities in the distribution of skull shapes.^{1,6,7} However, there remains a great need for recent data to be gathered and analyzed for the North Indian population.

Department of Anatomy, Era's Lucknow Medical College and Hospital, Era University, Lucknow, UP, India-226003.

Corresponding Author: Shalini Singh

Email: shalinisingh.anatomy@erauniversity.in

How to cite: Singh S, Nagwani M, Srivastava G, Tewari V, Sharma PK. Study of Cephalic Index in North Indian Population: Anthropometric Analysis and Comparison with Previous Studies Era J Med Res. 2026;13(2):155-158.

This study aims to provide normative data on cephalometric values and compare the results with the existing literature on Indian and foreign data.

Cranial anthropometry has been applied widely in physical anthropology, forensic medicine, and clinical settings for quite some time already. Within forensic medicine, the cephalic index can help identify the individual whose remains have been found since it can provide information concerning population affiliation and biological sex.⁷ For clinicians, deviations from normal cephalic ratios could point at some health problems such as craniosynostosis and plagiocephaly.⁹⁻¹¹ Therefore, having normative data on certain ethnic groups is highly clinically relevant.

It has long been known that sexual dimorphism plays its part when it comes to skull morphology. Men tend to have larger cranial parameters, while women usually have relatively shorter craniums in comparison with their width, which makes cephalic index higher.^{2,8} In forensic anthropology, one of the most frequent tasks is determining the gender of the remains. Thus, the current study aimed to calculate and compare cephalic indices among men and women in the North Indian university sample.

AIM

Cranial morphology along with cephalic index will be determined in order to make a comparison between North Indian population and other nationalities and nations.

OBJECTIVES

1. To measure the length and breadth of cranium in North Indian population.
2. To calculate the cephalic index.
3. To classify the head shapes.
4. To make comparisons between genders and already published data.

MATERIALS & METHODS

Study design: Cross-sectional observational study.

Place: Era University, Lucknow.

Sample size: 150 medical students (82 males, 68 females), aged ≥ 18 years, belonging to cosmopolitan backgrounds.

Exclusion criteria: History of cranial deformity, trauma, or congenital anomalies.

Instrumentation: Spreading calipers with rounded tips.

Procedure:

Cranial length: Glabella to inion (maximum length).

Cranial breadth: Maximum transverse diameter between euryon points.

Measurements were taken following Hrdlička's protocol.

Cephalic Index formula: "CI" = ("Max cranial breadth" / "Max cranial length") $\times 100$

Statistical analysis:

Data analyzed using SPSS v22.0; independent t-test and ANOVA applied; significance set at $p < 0.05$.

RESULTS

- Mean age: 23.25 ± 7.50 years.
- Head shape distribution:
- Dolichocephalic: 52.7%
- Mesocephalic: 36.7%
- Brachycephalic: 7.3%
- Hyperbrachycephalic: 3.3%
- Gender differences:
- Males: larger cranial length and breadth.
- Females: significantly higher cephalic index ($p = 0.036$).

Significant ANOVA differences among head shapes ($p < 0.001$). Overall, the population leans toward dolichocephalic morphology.

Table 1: Distribution of subjects according to different shapes of head

Shape of Head	Number	Percentage (%)
Dolichocephalic	79	52.7%
Mesocephalic	55	36.7%
Brachycephalic	11	7.3%
Hyper brachycephalic	5	3.3%

Table 2: Age distribution of subjects

Group	Mean Age (years)	SD	Total Subjects
Male	23.80	7.51	82
Female	22.57	7.48	68

Table 3: Comparison of Cephalometric Parameters between Males and Females

Parameter	Male (Mean $\pm$ SD)	Female (Mean $\pm$ SD)	t-value	p-value	Significance
Cranial Length (cm)	18.53 ± 1.00	17.65 ± 0.89	5.601	<0.001	Significant
Cranial Breadth (cm)	13.69 ± 0.74	13.37 ± 0.86	2.469	0.015	Significant
Cephalic Index	74.07 ± 5.17	75.85 ± 5.11	-2.117	0.036	Significant

DISCUSSION

The incidence of dolichocephaly agrees with earlier investigations carried out on north Indians.² This CI value (mean of 74.88) is slightly lower compared to the Punjabi populace (CI 80–85);⁶ however, it is comparable with that reported for Delhi, Sri Lanka, and some regions of Central India.^{7,8}

The higher values of CI in females across several studies, including the present study, are suggestive of sexual dimorphism in cranial anatomy.⁸ Factors such as nutrition, environmental influence, and gene drift may help explain variations in cranial morphology between different geographic regions.²

This paper highlights the importance of the study of regional cranial anthropometry, which can be useful in forensics, craniofacial surgery, ergonomic assessment, and evolutionary biology.^{1,2}

For example, Shah et al.¹ found a CI mean value of 76.² in Gujarati medical college students. In contrast, Mahajan et al.⁶ have described a predilection for brachycephaly in the Punjabi populace. On the contrary, dolichocephaly was prevalent in this study, possibly owing to differences in genetic makeup and migratory history. Furthermore, significant dimorphism was observed by Anil Kumar et al.⁸ in the case of cranial parameters of the North Indian forensic population, while Mishra et al.⁷ recorded statistical significance

at the ANOVA level for groups with differing head shapes in the Vindhya region, both agreeing with our findings.¹⁰⁻¹³

The ANOVA values found in the present study confirmed highly significant variation in cranial dimensions amongst the four groups based on head shape classification ($p < 0.001$). Individuals having Hyperbrachycephalic morphology had minimum cranial length but maximum cranial width, whereas the converse was true for those with dolichocephaly, in agreement with their definitions.^{14,15}

This cross-sectional survey design with a university-based sample is subject to several limitations. The students represent an educated section of the society and hence do not fully represent North Indians. Further studies may include more extensive age groups, rural/tribal communities, and longitudinal designs. The inclusion of three-dimensional photogrammetry or CT scanning-based techniques could provide more precise measurements in comparison to traditional spreading calliper technique.^{13,16,17}

CONCLUSION

The current study reveals dolichocephaly and mesocephalic in the heads of North Indians. Female subjects demonstrate statistically higher cephalic index compared to the male participants. This information serves as an update of normal values for anthropologists, forensic examiners, anatomists, and physicians conducting cranio-facial measurements.

Table 4: Comparison of Cephalometric Parameters among Various Head Shapes (ANOVA)

Parameter	Brachycephalic (Mean $\pm$ SD)	Dolichocephalic (Mean $\pm$ SD)	Hyperbrachycephalic (Mean $\pm$ SD)	Mesocephalic (Mean $\pm$ SD)	p-value
Cranial Length (cm)	17.22 $\pm$ 0.68	18.52 $\pm$ 0.92	16.62 $\pm$ 1.94	17.88 $\pm$ 0.88	<0.001
Cranial Breadth (cm)	14.22 $\pm$ 0.62	13.19 $\pm$ 0.67	14.96 $\pm$ 0.88	13.79 $\pm$ 0.71	<0.001
Cephalic Index	82.85 $\pm$ 1.52	71.23 $\pm$ 2.59	90.48 $\pm$ 5.51	77.11 $\pm$ 1.48	<0.001

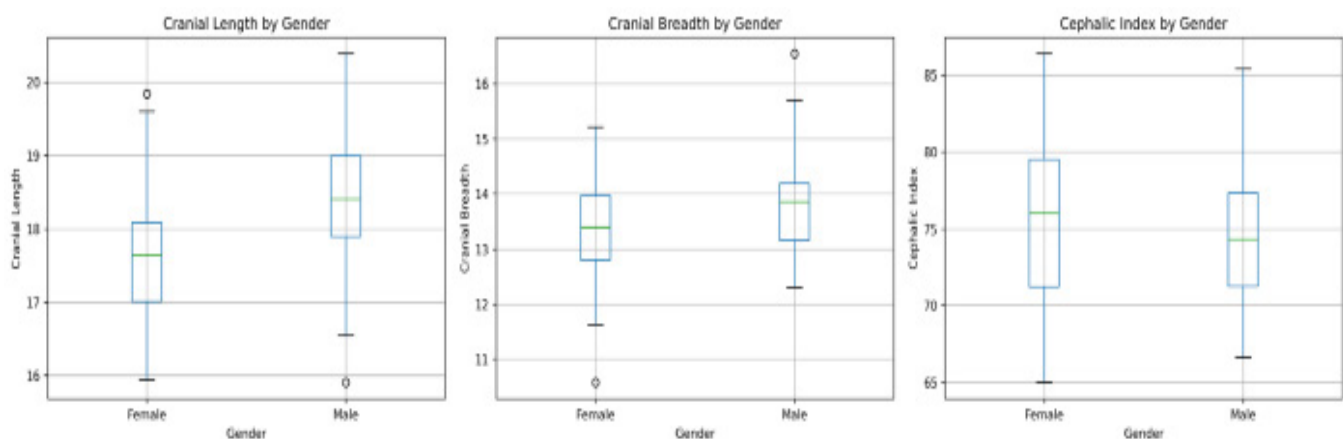


Figure 1: Cranial breadth, cranial length, and cephalic index by gender

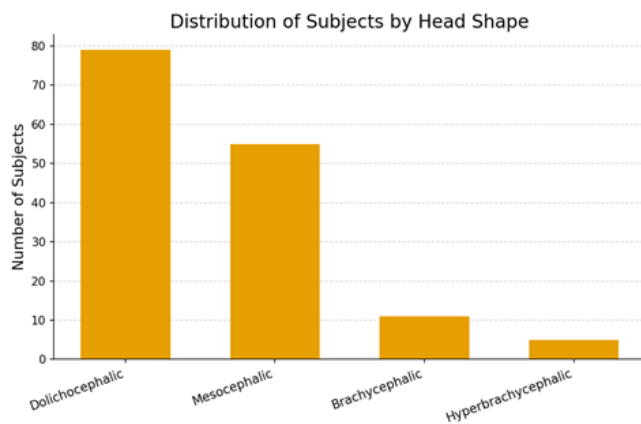


Figure 2: Distribution of subjects by head shape

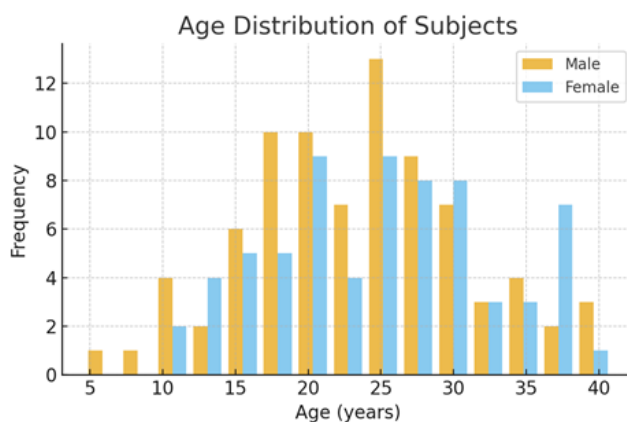


Figure 3: Age distribution of subjects

REFERENCES

- Shah GV et al. Cephalic index in medical students of Gujarat. *J Anat Soc India*. 2004;53(1):25–27.
- Nagar M. Cephalic index in North Indian population. *J Anthropol*. 2013; 2013:1–5.
- Retzius A. Om formen af nordboernes cranier. *Förhandlingar vid de Skandinaviska Naturforskarnas*. 1842;5:157–201.
- Hrdička A. *Practical Anthropometry*. 4th ed. Philadelphia: Wistar Institute of Anatomy and Biology; 1952.
- Garba ZN, Ahmed A. Morphometric analysis of the cephalic index of Hausa ethnic group in Zaria, Nigeria. *Int J Morphol*. 2008;26(3):559–62.
- Mahajan A et al. Cephalometric characteristics in Punjabi population. *J Anat Soc India*. 2009;58(2):123–26.
- Meghana Mishra et al. Cephalic index study in Vindhya region, MP. *Int J Med Res Rev*. 2014;2(5):419–23.
- Anil Kumar et al. Sex determination from cranium in North Indian population. *J Forensic Sci*. 2013;58(3):606–12.
- Oladipo GS, Okoh PD, Hart JS. Cephalic indices of adult Ijo and Ikwerre ethnic groups in Nigeria. *Asian J Med Sci*. 2010;2(3):93–96.
- Golalipour MJ, Jahanshahi M, Haidari K. Morphological evaluation of head in 17–20 year old males in Gorgan, north of Iran. *J Anat Soc India*. 2003;52(1):28–31.
- Natsis K, Piagkou M, Lazaridis N, et al. Cephalic index in the modern Greek population. *Folia Morphol (Warsz)*. 2016;75(4):483–90.
- Mehta M, Nair S, Kulkarni PR. Cephalic index in Maharashtra population. *J Evol Med Dent Sci*. 2015;4(79):13783–87.
- Baral P, Sigdel B, Baral S, et al. Cephalic index in medical students of Nepalese population. *Kathmandu Univ Med J*. 2007;5(3):393–97.
- Desai SK, Shaik M. Cephalic index measurement in medical students of Gulbarga, Karnataka. *Int J Biol Med Res*. 2012;3(2):1637–39.
- Kaul MK, Bakshi SK, Kaur R. Cephalic index in a Kashmiri population. *J Anat Soc India*. 1985;34(2):69–72.
- Kanchan T, Krishan K, Prusty D, Machado M. Stature estimation from foot length using universal regression formula in a North Indian population. *J Forensic Sci*. 2014;59(5):1304–8.
- Prasanna LC, Abhilash PR, Thomas HR, et al. Cephalic index of south Indian population: a study in a medical college in Karnataka. *Biomed Res*. 2016;27(2):537–40.

Orcid ID:

Shalini Singh - <https://orcid.org/0009-0008-5931-8810>

Mumal Nagwani - <https://orcid.org/0000-0001-9904-940X>

Geetanjali Srivastava - <https://orcid.org/0000-0002-8096-9158>

Vineeta Tewari - <https://orcid.org/0000-0003-1695-0230>

P. K. Sharma - <https://orcid.org/0000-0001-5185-2746>