

## ORIGINAL ARTICLE

## Study of Cephalic Index and its correlation with Sex and Race in Central India

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### Abstract:

The technique of expressing quantitatively the form of the human body, living or dead and also skeleton is anthropometry. In the world, all human beings belong to the same species, *Homo sapiens*. Any two individuals are not the same in all their measurable traits, even there are differences in the genetically identical twins in some respects. For estimating sex and race, cephalofacial measurements and indices are useful like the cephalic index or cranial index. 3-4 racial groups are organized by anthropologists based on skull categorization methods. India falls in this craniofacial measurements group's as considered by Thomas Huxley. Asian skulls are brachycephalic with wide faces having flat supranasal regions and facial flatness. Craniofacial type of Australoids fall between Negroids and Caucasoids. The study was conducted on 196 medical students (92 males and 104 females). Hardlika's method was used to measure the cephalic index. The mean cephalic index was  $79.71 \pm 4.55$  in males and in females it was  $83.14 \pm 7.69$ . Irrespective of gender the mean cephalic index of overall study was found to be  $81.53 \pm 6.62$ . Based on cephalic index, 45.65% males were dolicocephalic, 31.52% mesocephalic, 15.22% brachycephalic and 7.61% hyperbrachycephalic. In females, 46.15% were dolicocephalic, 33.65% mesocephalic, 10.58% brachycephalic and 9.62% hyperbrachycephalic.

**Keywords:** Race; Anthropology; Cephalic index; Head length; Head breadth.

### Introduction:

*Homo sapiens* is the species to which all the human beings in the world belong. Any two individuals are not the same in all their measurable traits, even there are differences in the genetically identical twins in some respects. Many factors which influence development of skeleton are responsible for producing differences in skeletal proportions between different geographical areas. Therefore, for quantitatively assessing such variations exhibited by such traits, some means are required. As anthropometry can indicate quantitatively the form of the human body, living or dead and skeleton, it constitutes that means and the anthropometric data is believed to be objective.<sup>1</sup>

Swedish professor of Anatomy Anders Retzius (1796–1860) defined the cephalic index and first he used it in physical anthropology in Europe for classifying the ancient human remains.<sup>2</sup> Anthropologically for finding racial and sexual differences also, cephalic index is very helpful.<sup>3</sup> Information about the cephalic index is helpful in living for comparing the skulls of different populations having various crucial differences in nutritional status, race, ethnicity, geography etc.<sup>4</sup> Cephalic index is one parameter amongst many used in the science of anthropology which is measurable and comparable to distinguish an individual, either into race or sex or even for identification.<sup>5</sup>

By comparing the changes in cephalic indices of parents, off springs and siblings we can get a clue to genetic transmission of inherited characters. For designing various equipment of standard sizes like helmets, head phones, goggles etc. also anthropometric study of head is important.<sup>6</sup> Sexual dimorphism which is a key in individual identification is important for forensic anthropologists. For identification of unknown persons cephalic indices can be very important evidence. Such data can be useful in forensic anthropology, for comparative studies and during surgeries also. Due to variations in genetic factors, nutritional growth and habitat there are significant differences in these indices. In forensic science and medicolegal cases, differences in cephalic indices act as markers of ethnicity and sex.<sup>7</sup>

### Material and method:

This was an observational and cross-sectional study conducted at dept. of Anatomy, JNMC, Wardha after obtaining approval from institutional ethics committee. The population selected were the medical students between age group 18-25 years regardless of their caste, religion, socio-economic status and dietary habits and were born and brought up in Central India. Informed consent was obtained. Subjects with significant growth disorders, deformities, bony anomalies, craniofacial malformations were excluded from the study.

The cephalic index was measured using Hardlika's method.<sup>8</sup> Students were seated in relaxed state, with back straight and looking forward. Spreading caliper was used for measuring head length and head breadth (Photo no.1). The head length or maximum antero-posterior diameter was measured by keeping one point of the two arms of spreading caliper at glabella and the

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other point at inion (Photo no.2). Maximum transverse diameter or head breadth was measured as the distance between the two most lateral points on the side of the head (Photo no.3). Cephalic index was calculated by dividing maximum head breadth by maximum head length and then multiplying it by 100. Depending upon the value of cephalic index the head types were classified as:

- Dolicocephalic- < 74.9
- Mesocephalic- 75-79.9
- Brachycephalic- 80-84.9
- Hyperbrachycephalic- >85

Collected data was analyzed using SPSS version 28 software.

**Observations and results:**

The results of the study are presented in the tables below:

**Table 1. Cephalic index in males (n=92).**

	Minimum	Maximum	Mean
Head Length	16.40	19.80	18.30
Head Breadth	13	16.20	14.58
Cephalic Index	66.67	89.01	79.71

Mean head length in males was 18.30 cm, mean breadth 14.58 cm and a mean cephalic index was 79.71.

**Table 2. Cephalic index in females(n=104).**

	Minimum	Maximum	Mean
Head Length	13.60	19	16.90
Head Breadth	12.20	17	14
Cephalic Index	69.66	98	83.14

Mean head length in females was 16.90 cm, mean breadth 14 cm and a mean cephalic index was 83.14.

**Table 3. Comparison of cephalic index in males and females.**

Gender	N	Mean	Std. Deviation	Std. Error Mean	Range	p-value
Male	92	79.71	4.55	0.47	66.67-89.01	3.73
Female	104	83.14	7.69	0.75	69.66-98	P= 0.0001,
Total	196	81.53	6.62	0.47	66.67-98	S

The mean cephalic index of overall study was 81.53. In our study, the mean cephalic indices were 79.71 and 83.14 in males and females respectively. The minimum cephalic indices were 66.67 and 69.66 in males and females respectively. The maximum cephalic indices were 89.01 and 98 in males and females respectively. The difference in the cephalic index of males and females was significant.

**Discussion:**

Our study was an observational and cross-sectional study, conducted in dept. of Anatomy, JNMC, Wardha. In our study regardless of gender the mean cephalic index was 81.53 ± 6.62. Mean cephalic index for male subjects was 79.71 ± 4.55 and for

**Table 4. Frequency and percentage of head phenotype (92- M, 104-F).**

Head Shape	Range of cephalic index	Male	Female	Total
Dolicocephalic	<74.9	42(45.65%)	48(46.15%)	90(45.92%)
Mesocephalic	75-79.9	29(31.52%)	35(33.65%)	64(32.65%)
Brachycephalic	80-84.9	14(15.22%)	11(10.58%)	25(12.76%)
Hyperbrachycephalic	>85	7(7.61%)	10(9.62%)	17(8.67%)
Total		92(46.94%)	104(53.06%)	196(100%)

45.92 % subjects had dolichocephalic phenotype followed by mesocephalic in 32.65% subjects. 12.76% were brachychocephalic and 8.67% were hyperbrachycephalic.

**Table 5. Comparison of cephalic index (mean) with other studies.**

S. No.	Research workers	Population	Mean Cephalic index
1.	Bhargava & Kher, 1960	Bhils of central India	76.98
2.	Shah GV, Jadhav 2004	Gujarat population	80.81
3.	Anupama et al. 2009	Medical students of Punjab	85.53
4.	Jadav et al. (2011) Gujarat population 80.20	Jadav et al(2011) Gujarat population 80.20	80.20
5.	Anitha MR et al. (2011)	North Indian	79.7
6.	Yagain VK et al. (2012)	Indian students	80.85
7.	Babatunde OA (2014)	Nigerian Population	76.56
8.	Present Study	Central India	81.53

females it was 83.14 ± 7.69 and the difference was found statistically significant. The dominant head type in central Indian males was dolicocephalic (45.65%) followed by mesocephalic (31.52%). 15.22% were brachycephalic and 7.61% were hyperbrachycephalic. The dominant head type in females was also dolicocephalic (46.15%) followed by mesocephalic (33.65%), 10.58% were brachycephalic and 9.62% were hyperbrachycephalic.

Anjankar et al. in their study in central India recorded the mean cephalic index as 81.21 ± 3.68 which correlates with our study but they mentioned mesocephalic as the dominant head type in their study followed by brachycephalic whereas we found dominant head type as dolicocephalic.<sup>2</sup> In our study mean head length in males was 18.30 cm ranging from 16.4 to 19.8 cm and mean head breadth was 14.58 cm with range of 13 cm to 16.2 cm. Mean head length in females was 16.90 cm with range of 13.6 cm to 19 cm and mean head breadth was 14 cm with range of 12.2 cm to 17 cm. In the study conducted by Shah GV et al., they recorded 18.26 cm as the mean head length in males and the range was from 16.5 cm to 20.1 cm. In females the mean head length was 16.5 cm with range from 14.1 cm to 18.9 cm. In males the mean head breadth was 14.56 cm ranging from 12.7 cm to 16.4 cm, whereas in females the mean head breadth was 14.1 cm ranging from 12.7 cm to 15.6 cm, which corresponds with our study but the mean cephalic indices noted in their study were 80.42 and 81.20 for males and females respectively which were slightly higher than our study.<sup>3</sup> Pandey N et al. reported dominant head type in Nepalese males as dolicocephalic followed by mesocephalic while in Nepalese females it was mesocephalic followed by dolicocephalic. In males they mentioned the mean cephalic index as 75.82 (range 74.43–80.69), while it was 78.36 in females (range 75.15-81.15) which is lesser than our study.<sup>4</sup> Anitha MR and Mahesh Kumar et al. in their studies on Cephalic Index in North Indian Population and Haryanvi population respectively, reported dolichocephalic as dominant head type in both males and females followed by mesocephalic and then brachycephalic, which correlates with our study.<sup>5, 6</sup> Twisha Shah et al. observed that in Gujarati males, mesocephalic was the dominant head type followed by dolicocephalic and the dominant head type in females was dolicocephalic followed by mesocephalic and they noted that the mean cephalic index of gujarati was 77.2.<sup>7</sup> Anupama Mahajan et al. in her study on Punjabi population reported the mean cephalic index of 81.34 and 85.75 for males and female respectively which corresponds with our observations.<sup>9</sup> Wirginia Likus et al. in his study noted that in girls



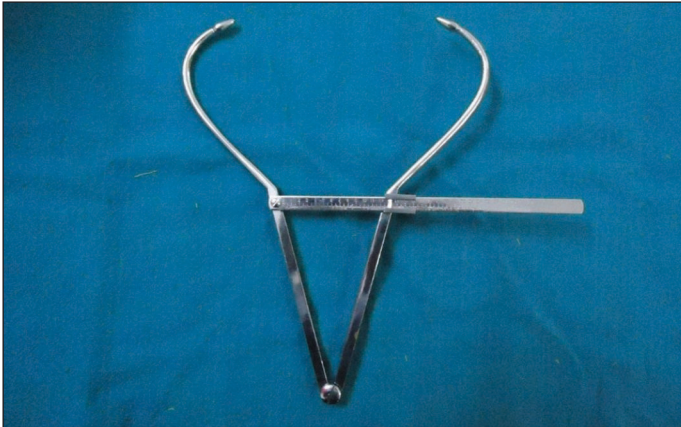


Figure 1. Spreading caliper.



Figure 3. Measuring the head breadth.



Figure 2. Measuring the head length.

under 3 years of age, the average cephalic index was  $80.54 \pm 7.20$ , while it was  $82.22 \pm 6.87$  in the boys of the same age group and the difference was not found to be significant. In both sexes the dominating head type was mesocephalic (34%). Hyperbrachycephalic type was found in 26% and dolichocephalic in 22% of the children while 18% were brachycephalic.<sup>10</sup>

Yagain VK et al. in their study in Karnataka reported mean head length of 18.76 cm in males and mean head breadth of 14.59 cm and in females mean head length of 17.67 cm and mean head breadth of 14.17 cm which is higher than our study. The mean cephalic index in males was recorded to be  $77.92 \pm 5.2$  and in females was  $80.85 \pm 7.71$ , which is slightly less than our study. Dolichocephalic and brachycephalic were the dominant head shapes recorded each in 33%, followed by mesocephalic in 27% and hyperbrachycephalic in 6% males. Among females majority skull types were brachycephalic (33%), 29% each of dolichocephalic and hyperbrachycephalic and mesocephalic was least common (9%). In our study we found that dolichocephalic phenotype was dominant followed by mesocephalic and brachychocephalic.<sup>11</sup> Babatunde in his study on older children and adolescent population of Nigeria recorded the mean cephalic index as 76.56, 77.21 and 76.50 were the cephalic indices in males and females respectively. They found that 78.68% individuals were mesocephalic, 11.4%, 9.0% and 0.43% were dolichocephalic, brachycephalic and hyperbrachycephalic

respectively. They observed that mesocephalic phenotype was predominant in school students. The head shape variations observed in different studies may be due to heredity factor and environmental factors have secondary effects. The presence of dominant head shape is also influenced by the kind of diet a person takes and also from one generation to the other.<sup>12</sup> Priti A. Nemade et al. noted mean cephalic index of Maharashtrian population as 78.25. Males had mean cephalic index of 77.96 and females had 78.53 which is lower than our study, also predominant skull shape was mesocephalic followed by brachycephalic.<sup>13</sup> Khanduri et al. in a study by Computed Tomography in a North Indian population showed mean cephalic index as  $76.67 \pm 3.18$ , and dominant head shape was dolichocephalic in Northern India which correlates with our study.<sup>14</sup> Seema & Verma PT in their study on North Indian population recorded the mean cephalic index as 85.53. The mean cephalic index was 80.52 and 84.32 in males and females respectively which is higher than our study. There is evidence of continuous growth of brain more in lateral direction which is called as "brachycephalisation". This can be seen when we compare previous records with recent works on cephalic index. The head shape in tropical zones is dolichocephalic but in temperate zones it is mesocephalic or brachycephalic.<sup>15</sup> Isurani Ilayperuma in her study on Shrilankan medical students found mean cephalic index in males to be 78.04 and 79.32 in females which is lower than our study and the dominant type of cephalic phenotype was dolichocephalic in males and brachycephalic in females.<sup>16</sup> In a study by Ujwala Bhanarkar et al. on medical students of West Bengal, most of the subjects were found mesocephalic. Mean cephalic index in male was  $78.45 \% \pm 2.44$  and for female was  $77.65 \% \pm 3.58$  which is lower than our study and mean cephalic index irrespective of gender was found to be  $80.5 \% \pm 3.67$  which is also lower than our study.<sup>17</sup>

#### Conclusion:

In our study, mean cephalic index for males was  $79.71 \pm 4.55$  and for females was  $83.14 \pm 7.69$ . Overall mean cephalic index in our study was found to be  $81.53 \pm 6.62$ . Based on cepcorresponds with our studyhalic index, 45.65% males were dolichocephalic, 31.52% mesocephalic, 15.22% brachycephalic and 7.61% hyperbrachycephalic. In females, 46.15% were dolichocephalic,

33.65% mesocephalic, 10.58% brachycephalic and 9.62% hyperbrachycephalic. So predominant head shape was dolicocephalic for both males and females. The observations in our study may be useful for similar extended cephalometric studies based on various geographical zones. It may also be useful for anthropologists and forensic science persons.

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