

## Is the Trend of Brachycephalization More Advanced in Females than Males: An Observational Study on Medical Students in a Rural Medical College of Himachal Pradesh, North West of India

### Abstract

**Introduction:** The cephalic index (CI) was defined by Swedish Professor of Anatomy Anders Retzius as a percentage of width to length in the skull. Head dimension changes follow a pattern in different populations. CI is used to determine the racial variation and sexual difference among the individual whose identity is unknown and to investigate the craniofacial deformities and brain development. **Material and Methods:** Himachali MBBS students of Dr. RPGMC, Tanda who satisfy the inclusion criteria were approached for consent to participate in the study. Detailed history, including birth history (including the place of birth), socio-economic history, and history of migration, was taken, and anthropometric examination was done by the investigator, as per the standard protocol. **Results:** We studied 77 medical students at Dr. RPGMC, Kangra at Tanda Himachal Pradesh, of which 40 (51.94%) were males and 37 (48.05%) were females. The mean age of all the students was 19.05 years. The mean head circumference of all the students was  $54.31 \pm 1.8$  cm and minimum of 49.0 cm and maximum of 58.2 cm. Mean CI of the group was  $77.85 \pm 4.43$ . Male group had the mean CI of  $76.96 \pm 4.00$ . Female group had mean CI of  $78.83 \pm 4.7$ . Most 18 (45%) of the male students had mesocephalic head shape and in female groups, 15 (40.5%) also had mesocephalic head shape. **Discussion and Conclusion:** From this study, we conclude that the dominant head shape is mesocephalic in both male and female, but the tendency of brachycephalization is more advanced in the female adult population of Himachal Pradesh.

**Keywords:** Brachycephalization, cephalic index, mesocephaly

### Introduction

The cephalic index (CI) was defined by Swedish Professor of Anatomy Anders Retzius (1796–1860) as percentage of width to length in the skull and was first used in physical anthropology to classify ancient human remains found in Europe.<sup>[1]</sup> Head dimension changes follow a pattern in different populations. The key factor in the process of head dimension changes is a small increase in the growth rate in a specific direction during infancy and childhood. The increases involve the posterior cranial base and occur in a posterior inferior and lateral direction resulting in significant changes of vault shape.<sup>[2]</sup>

CI is used to determine the racial variation and sexual difference among the individual whose identity is unknown and to investigate the craniofacial deformities and brain development.<sup>[3]</sup> It gives an idea how

genetic characters are transmitted between parents and offspring. Various pathological conditions such as isolated or syndromic craniosynostosis primary mesocephaly and hydrocephalus present as abnormal CI in addition to other features.<sup>[4]</sup>

CI is the ratio of maximum width (Biparietal diameter) to the maximum length (occipitofrontal diameter) multiplied by 100. Where width is the distance between the most projecting points on the sides of the head (euryon) and head length is the distance between the glabella of front andinion on the back of the head.<sup>[5]</sup>

Anthropometry of the head can be divided into two:

1. Cephalometric – Morphological study of all structures present in a human head and is applied in live individuals
2. Craniofacial relations – measurement of bones and teeth in the dry skull.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: [reprints@medknow.com](mailto:reprints@medknow.com)

**How to cite this article:** Sharma V, Yadav S, Kalia V, Dwivedi D, Kumar G, Dhiman P. Is the trend of brachycephalization more advanced in females than males: An observational study on medical students in a rural medical college of Himachal Pradesh, North West of India. *J Anat Soc India* 2019;68:133-7.

Vandana Sharma,  
Suman Yadav,  
Vishal Kalia,  
Daisy Dwivedi,  
Girish Kumar<sup>1</sup>,  
Priyanka Dhiman

Departments of Anatomy and  
<sup>1</sup>Neurology, Dr. Rajendra  
Prasad Government Medical  
College, Kangra,  
Himachal Pradesh, India

### Article Info

Received: 22 March 2019  
Accepted: 20 September 2019  
Available online: 15 October 2019

### Address for correspondence:

Dr. Vishal Kalia,  
Department of Anatomy,  
Dr. Rajendra Prasad  
Government Medical College  
Tanda Kangra, Kangra,  
Himachal Pradesh, India.  
E-mail: [drvishalkalia29@yahoo.com](mailto:drvishalkalia29@yahoo.com)

### Access this article online

Website: [www.jasi.org.in](http://www.jasi.org.in)

DOI:  
10.4103/JASI.JASI\_13\_19

### Quick Response Code:



Cephalometric is a technique that summarizes the anatomical complexities of the head of human being living within a geographic framework.<sup>[6]</sup>

On the basis of CI head shapes can be classified into the four international categories.

1. Dolichocephalic – CI <74.9
2. Mesocephalic – CI between 75 and 79.9
3. Brachycephalic – CI between 80 and 84.9
4. Hyperbrachycephalic – CI above 85.

Head form is longer (dolichocephalic) in the tropical zone, but in temperate zone, head form is more rounded (brachycephalic).<sup>[6]</sup> In the Nigerian population, male had CI of 77.21 and female had 76.50.<sup>[7]</sup> In the Gurung community of Nepal, male had CI of 83.1 and female had CI of 84.6.<sup>[8]</sup>

Since India is partly temperate and partly tropical zone so shows a tendency toward mesocephalization. In India, males are mesocephalic with a mean CI of 77.8 and females are Brachycephalic with CI of 80.85.<sup>[9]</sup> Head shape also changes from one generation to the other. First-generation of Japanese immigrants in Hawaii, it was noticed that they had an increased head breadth a decreased head length and a higher CI than their parents.<sup>[10]</sup>

The present study intends to evaluate the CI of Himachali medical students and also to find out the intergender difference in the CI.

## Material and Methods

MBBS students of Dr. RPGMC, Tanda who satisfy the inclusion criteria were approached for consent to participate in the study.

### Inclusion criteria

1. First year MBBS students of Dr. RPGMC, Tanda
2. Age 18–25 years.

### Exclusion criteria

1. Students who refuse to be part of the study
2. Operated cases of head diseases and anomalies
3. All the forms of syndromic disorders.

Detailed history, including birth history (including place of birth), socio-economic history, and history of migration was taken, and anthropometric examination was done by the investigator, as per the standard protocol.

### Anthropometric examination

1. Each subject included in the study was measured for the following anthropometric body dimensions using standardized anthropometric techniques and instruments<sup>[11]</sup>
2. Head length and head width – Spreading caliper was used to measure head length and head width up to the accuracy of 1 mm

3. Head circumference was measured by using fiberglass tape and height by stadiometer
4. Bodyweight – Using electronic weighing machine with the accuracy up to 10 g
5. In addition to basic measurements the followings was calculated
6. CI = Head width/HEAD length ×100.

### Statistical analysis

Means and standard deviations were computed for all anthropometric measurements. The Student's unpaired *t*-test or Mann-Whitney U-test was applied for parametric and nonparametric data depending on the nature of data obtained to assess the extent of group differences.

## Results

We studied 77 medical students at Dr. RPGMC, Kangra at Tanda, Himachal Pradesh, of which 40 (51.94%) were males and 37 (48.05%) were females. Mean age of all the students was 19.05 years, with minimum of 18 years and maximum of 21.5 years. Most of the students 55 (71.42%) were from the rural background and only 22 (28.57%) were from urban background and among these 70% of males and 73% of females belonged to the rural background and 30% of males and 27% of females belonged to urban background. Only 17 (22.07%) students were from the plains and rest 60 (77.92%) were from hilly areas and of these 7 males and 10 females were from the plains and 33 males and 27 females were from hilly area. Most of the students were from middle-income group, 32 (41.55%) from lower-middle and 30 (38.96%) from upper middle-income group and rest belonged to the upper-income group 9 (11.68%) and 5 (6.49%) from upper lower-income group and 1 (1.29%) was from lower-income group [Table 1].

The mean height of the all the students was  $163.36 \pm 9.14$  cm with the minimum of 145 cm and maximum of 190.6 cm and among males, the mean height was  $169.6 \pm 6.82$  cm and minimum of 151.7 cm to maximum of 190.6 cm and in the females, mean height was  $156.63 \pm 6.00$  cm and minimum of 145 cm and maximum of 171 cm. The mean weight was  $58.13 \pm 10.35$  kg with minimum of 37 kg and maximum of 95 kg, male students have a mean weight of  $61.8 \pm 9.86$  kg with minimum of 41 kg and maximum of 89 kg and in female students, mean weight of  $54.37 \pm 9.65$  kg and minimum of 37 kg and maximum of 95 kg. Facial shape of 60 (77.92%) students was normal, whereas 14 (18.18%) had rounded faces and 3 (3.89%) had triangular faces, and among the male students, 36 (87.5%) had normal faces and 1 (2.5%) had triangular faces and 4 (10%) had rounded faces and in female students, 25 (67.6%) had normal faces and 2 (5.4%) had triangular faces and 10 (27%) female students had rounded faces [Table 2].

The mean head circumference of all the students was  $54.31 \pm 1.80$  cm with minimum of 49.0 cm and maximum

**Table 1: Basic parameters**

Parameters	Male (%)	Female (%)	Cumulative (%)	P
Total students			77	
Sex	40 (51.94)	37 (48.05)	77	
Age				
Mean age (years)	19.10	19.0	19.05	
SD	0.266	0.91	0.95	
Minimum	18	18	18	
Maximum	22	21	21.5	
Back ground				
Urban	12 (30)	10 (27)	22 (28.57)	0.773
Rural	28 (70)	27 (73)	55 (71.42)	
Place of living				
Hilly area	33 (82.5)	27 (73)	60 (77.92)	0.314
Plains	7 (17.5)	10 (27)	17 (22.07)	
Socioeconomic status				
Low income	0	1 (2.7)	1 (1.29)	0.234
Upper lower income	3 (7.5)	2 (5.4)	5 (6.49)	
Lower middle income	18 (45)	14 (37.8)	32 (41.55)	
Upper middle income	12 (30)	18 (48.6)	30 (38.96)	
Upper income	7 (17.5)	2 (5.4)	9 (11.68)	

SD: Standard deviation

**Table 2: General anthropometry**

	Male	Female	Cumulative	P
Height				
Mean height (cm)	169.6	156.63	163.36	0.378
SD	6.82	6.00	9.14	
Minimum	151.7	145	145	
Maximum	190.6	171	190.6	
Weight				
Mean (kg)	61.8	54.37	58.13	0.293
SD	9.86	9.65	10.35	
Minimum	41	37	37	
Maximum	89	95	95	
Faces (%)				
Normal	36 (87.5)	25 (67.6)	60 (77.92)	0.107
Triangular	1 (2.5)	2 (5.4)	3 (3.89)	
Rounded	4 (10)	10 (27)	14 (18.18)	

SD: Standard deviation

of 58.2 cm. Male students had mean head circumference of  $55.4 \pm 1.50$  cm with minimum of 52.0 cm and maximum of 58.2 cm, whereas female students had mean head circumference of  $53.10 \pm 1.28$  cm with minimum of 49.0 cm and maximum of 55.10 cm with the statistically significant difference of  $P = 0.003$ . The mean head length of all students was  $18.52 \pm 0.91$  cm with minimum of 16.1 cm and maximum of 20.5 cm, among the male students, mean head length was  $19.12 \pm 0.69$  cm with minimum of 17.5 cm and maximum of 20.5 cm and in the

female students, the mean head length was  $17.87 \pm 0.64$  cm with minimum 16.1 cm and maximum of 18.9 cm, and the difference was statistically significant with value of  $P = 0.014$ .

The mean head width of the group was  $14.39 \pm 0.63$  cm and minimum head width of 12.9 cm and maximum of 16.5 cm. In the male group, mean head width was  $14.7 \pm 0.58$  cm and minimum width of 13.4 cm and maximum width of 16.5 cm.

Mean CI of the group was  $77.85 \pm 4.43$  and ranging from 67–88.88 and male group had the mean CI of  $76.96 \pm 4.00$  and minimum of 67 and maximum of 87.76 and female group had mean CI of  $78.83 \pm 4.7$  and minimum of 70 and maximum of 88.88 [Table 3].

Among the male students, 18 (45%) had mesocephalic head shape and 14 (36.0%) were dolichocephalic and 7 (17.5%) were brachycephalic and only 1 (2.5%) had hyperbrachycephalic. Among the female students, 15 (40.5%) had mesocephalic head shape and dolichocephalic and brachycephalic were in 8 (21.6%) each, and 6 (16.2%) had hyperbrachycephalic head shape. For the whole group, 33 (42.85%) had mesocephalic head shape, dolichocephalic was the second-most common 22 (28.57%) and 15 (19.48%) were brachycephalic and 7 (9.09%) were hyperbrachycephalic [Table 4].

## Discussion

There are many studies from the different regions of India on CI which have shown the CI to be ranging from 77.08 to 81.34 in males and from 72.15 to 85.75 in females. Gurjaria a study from Maharashtra, Andhra, and Gujarat has shown CI from 78.14, 77.32, to 80.82<sup>[12]</sup> and from Southern Odisha, Patro *et al.* shown mean CI of 77.75<sup>[13]</sup> Shah and Jhadhav<sup>[14]</sup> in Gujarat and Utterkar *et al.*<sup>[15]</sup> in south Gujarat have shown CI of 80.8 and 81, respectively. From Punjab, Mahajan *et al.* have shown CI for both sexes as 85.53<sup>[16]</sup>

In Himachal Pradesh, there is paucity literature on CI on adult; hence, our study will provide useful data on CI from Himachal Pradesh. There was one published study from Himachal on the full-term newborn by Pankaj *et al.* studied CI in newborns which have shown mean CI as  $80.97 \pm 4.8$ .<sup>[17]</sup> In this study, we found the mean CI for the males was  $76.96 \pm 4$ , whereas for females was  $78.83 \pm 4.7$ . Mean CI for the whole group in our study was  $77.85 \pm 4.43$  which was less than that shown by Pankaj *et al.* and the difference might be because the CI keeps on changing till the 18 years and our study is on the adult.

In this study, the dominant type head shape of the whole group was mesocephalic 42.85% and dolichocephalic was the second-most common 28.57% and brachycephalic third 19.48% and hyperbrachycephalic the least common 9.09%. In the male groups, mesocephalic was the most common

45% and dolicocephalic the second common 36% and brachycephalic the third 17.5% and hyperbrachycephalic the least 2.5%, whereas in female group, though the most common head shape was mesocephalic 40.5% and the second common were dolichocephalic and brachycephalic 21.6% each and hyperbrachycephalic the third common

**Table 3: Cephalic anthropometry**

	Male	Female	Cumulative	P
<b>Head circumference</b>				
Mean circumference (cm)	55.4	53.10	54.31	0.003
SD	1.50	1.28	1.80	
Minimum	52.0	49	49.0	
Maximum	58.2	55.10	58.2	
<b>Head length</b>				
Mean length (cm)	19.12	17.87	18.52	0.014
SD	0.69	0.64	0.91	
Minimum	17.5	16.1	16.1	
Maximum	20.5	18.9	20.5	
<b>Head width</b>				
Mean width (cm)	14.7	14.06	14.39	0.074
SD	0.58	0.52	0.63	
Minimum	13.4	12.9	12.9	
Maximum	16.5	15.1	16.5	
<b>Cephalic index</b>				
Mean cephalic index	76.96	78.83	77.85	0.362
SD	4.00	4.7	4.43	
Minimum	67.00	70	67	
Maximum	87.76	88.88	88.88	

SD: Standard deviation

**Table 4: Head shape**

Final diagnosis	Male (%)	Female (%)	Cumulative (%)	P
Dolichocephalic	14 (36.0)	8 (21.6)	22 (28.57)	0.142
Mesocephaly	18 (45)	15 (40.5)	33 (42.85)	
Brachycephaly	7 (17.5)	8 (21.6)	15 (19.48)	
Hyperbrachycephaly	1 (2.5)	6 (16.2)	7 (9.09)	

16.2%. On looking the trend of the head shapes, it shows that in female group, the trend is toward the brachycephalization as brachycephaly and hyperbrachycephaly constitute 37.8%, whereas reverse is true for the males that 36% is dolichocephalic as shown in Figure 1. This suggests that the tendency of brachycephalization is more advanced in females than males. Similar pattern was shown in Indian study in medical students by Yagsin *et al*<sup>[9]</sup>, and in Southern Odisha by Patro *et al*<sup>[13]</sup>, and reverse was found in study from Mumbai by Khair *et al*<sup>[18]</sup>, from West Bengal by Ghose<sup>[19]</sup>, and from central India by Nair *et al*<sup>[20]</sup> as shown in Table-5.

### Conclusion

From this study, we conclude that the dominant head shape is mesocephalic in both males and females, but the tendency of brachycephalization is more advanced in female than male population of Himachal Pradesh.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

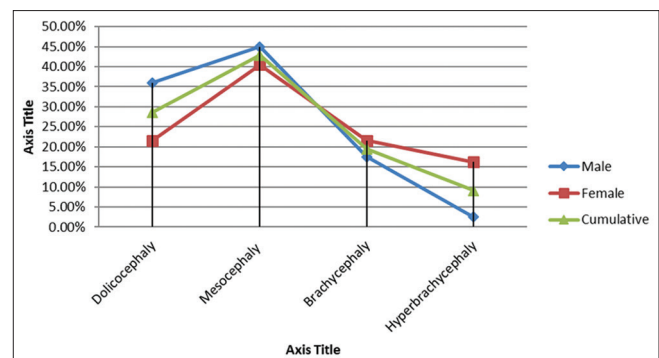


Figure 1: Showing the trend of cephalic index in male and female students

**Table 5: Comparison of present study with previous studies**

Studies	Sample size	Gender	Dolicocephaly (%)	Mesocephaly (%)	Brachycephaly (%)	Hyperbrachycephaly (%)	Mean CI
Mumbai Khair <i>et al.</i> <sup>[18]</sup>	100	Male	7 (14)	20 (40)	10 (20)	13 (26)	81.283
		Female	20 (40)	16 (32)	6 (12)	8 (16)	75.222
West Bengal Ghose <sup>[19]</sup>	200	Male	16/148 (10.8)	47/148 (31.8)	51/148 (34.5)		81.2
		Female	11/52 (21.2)	11/52 (21.2)	17/52 (32.7)		80.76
Central India Nair <i>et al.</i> <sup>[20]</sup>	480	Male	42 (14.1)	129 (43.58)	101 (34.12)	16 (5.41)	81.24
		Female	27 (14.67)	79 (42.93)	52 (28.26)	19 (10.34)	80.31
Indian Medical student Yagain <i>et al.</i> <sup>[9]</sup>	100	Male	33	27	33	6	77.92
		Female	29	9	33	29	80.85
Southern Odisha Patro <i>et al.</i> <sup>[13]</sup>	1030	Male	117 (19.18)	411 (67.37)	71 (11.64)	11 (1.80)	77.28
		Female	84 (20)	194 (46.19)	134 (31.90)	8 (1.90)	78.38
Present study	77	Male	14 (36.0)	18 (45)	7 (17.5)	1 (2.5)	76.96
		Female	8 (21.6)	15 (40.5)	8 (21.6)	6 (16.2)	78.83

CI: Cephalic index

## References

1. Available from: [https://en.wikipedia.org/wiki/Cephalic\\_index](https://en.wikipedia.org/wiki/Cephalic_index). [Last accessed on 2019 Aug 04].
2. Wescot SJ, Jantz RL. Assessing craniofacial secular changes in American black and whites using geometric morphometry. In: Slice DE, editor. *Modern Morphometric in Physical Anthropology*. New York: Kluwer Academic Publisher. 2005. p. 231-45.
3. McIntyre GT, Mossey PA. Size and shape measurement in contemporary cephalometrics. *Eur J Orthod* 2003;25:231-42.
4. Collett BR, Heike CL, Atmosukarto I, Starr JR, Cunningham ML, Speltz ML, *et al.* Longitudinal, three-dimensional analysis of head shape in children with and without deformational plagiocephaly or brachycephaly. *J Pediatr* 2012;160:673-80.
5. Cinthura C, Karthik GM. Cranial index of dry foetal skull in South India population. *J Pharm Sci Res* 2017;9:473-5.
6. Barry KB. Skull and mandible. In: Standring S, Ellis H, Healy JC, Johnson D, Williams A, Collins P, *et al.*, editors. *Gray's, Anatomy*. 39<sup>th</sup> ed. London UK: Elsevier Churchill Livingstone; 2005. p. 487-9.
7. Akinbami BO. Measurement of cephalic indices in older children and adolescents of a Nigerian population. *Biomed Res Int* 2014;527473.
8. Lobo SW, Chandrasekhar TS, Kumar S. Cephalic index of Gurung community of Nepal – An anthropometric study. *Kathmandu Univ Med J (KUMJ)* 2005;3:263-5.
9. Yagain VK, Shakunthala R, Pai, Sneha G, Kalthur, Chethan, P and Hemalatha I. Study of cephalic index in Indian students. *Int J Morphol* 2012;30:125-129.
10. Argyropoulos E, Sassouni V. Comparison of the dentofacial patterns for native Greek and American-Caucasian adolescents. *Am J Orthod Dentofacial Orthop* 1989;95:238-49.
11. Weiner JS, Lourie JA. *International Biological Programme Human Bbiology: A Guide to Field Methods*. Oxford, Edinburgh: Published for International Biological Programme, Blackwell Scientific; 1969.
12. Gurjaria IJ. Comparison of cephalic index of three states of India. *Int J Pharm Bio Sci* 2012;3:1022-31.
13. Patro S, Sahu R, Rath S. Study of cephalic index in Southern Odisha population. *IOSR J Dent Med Sci* 2014;13:41-4.
14. Shah GV, Jhadhav HR. The study of cephalic index in students of Gujarat *J Anat Soc India* 2004;53:25-6.
15. Utterkar K, Deepa S, Gupta S, Adani R, Kubavat D M, Nagar S K *et al.* Study of cephalic index in South Gujarat. *Int J Recent Trends Sci Technol* 2013;8:87-9.
16. Mahajan A, Khurana BS, Seema, Batra AP. The study of cephalic index of Punjabi students. *J Punjab Acad Forensic Med Toxicol* 2009;9:718-25.
17. Pankaj S, Prabhakaran K, Kanchan K. The shape of head and face in normal full term newborn in hills of Himachal Pradesh. *Int J Anat Res* 2016;4:3161-3.
18. Khair S, Bhandari D, Wavhal S. Study of cephalic index of medical students of Mumbai region. *Indian J Appl Res* 2013;3:232-4.
19. Ghose R. A study of cephalic index among the young age group of West Bengal in relation to sex and geographic factors. *Indian J Basic Appl Med Res* 2018;7:239-45.
20. Nair SK, Anjankar VP, Singh S, Bindra M, Satpathy DK. The study of cephalic index of medical students of central India. *Asian J Biomed Pharm Sci* 2014;4:48-50.