*Original Article*

Indian Journal of Dental Education
Volume 12 Number 4, October - December 2019
DOI: https://dx.doi.org/10.21088/ijde.0974.6099.12419.3

# Evaluation of Anthropometric Studies of Cephalic Indices: A Clue for Gender Diversity

**K Srinivasan[1], Muppuri Sai Malavika[2]**

**Author's Affiliation:** [1]Reader, [2]CRRI, Department of Pedodontics and Preventive Dentistry, CKS Theja Institute of Dental Sciences, Tirupati, Andhra Pradesh 517506, India.

**Corresponding Author: K Srinivasan,** Reader, Department of Pedodontics and Preventive Dentistry, CKS Theja Institute of Dental Sciences, Tirupati, Andhra Pradesh 517506, India.

**E-mail:** skskskpedo@gmail.com

**Received on** 13.11.2019; **Accepted on** 06.12.2019

**How to cite this article:**
K Srinivasan, Muppuri Sai Malavika. Evaluation of Anthropometric Studies of Cephalic Indices: A Clue for Gender Diversity. Indian J Dent Educ. 2019;12(4):131-138.

**Abstract**

*Study background:* Anthropometric measurements, especially craniofacial measurements, are essential for determining various head and face shapes. These anthropometric studies are conducted on age, sex, and racial/ethnic groups in specific geographical zones. *Objectives:* This study aimed to assess the cephalic indices, to classify the type of cranium, and to determine the relationship between the horizontal cephalic index and cranial parameters among dental students. *Method:* This is a descriptive and cross-sectional study on 143 dental students (73 males and 70 females) with an age range of 18–23 year-old. Head length, head breadth measured by using a standard spreading caliper. Then cephalic indices were calculated for the classification of cranial type. All the collected data were summarized using statistical package for social sciences (SPSS) 21.0 versions, and their significance was tested by student *t* test. *Results:* The results of this study showed that the mean of the horizontal, cephalic index in male and female were 17.55 ± 0.92 and 16.54 ± 1.53 cm, respectively. The cephalic index varied from the range of 69.8 to 94.7 in male and 68.5% to 94.4% in the female. The dominant type of head shape in our study was Hyperbrachycephalic (36.8%, followed by brachycephalic (24.6%) in male and brachycephalic (16.7%) followed by mesocephalic (12.5%) respectively. *Conclusion:* The data of the present study can be beneficial in craniofacial reconstruction, clinical diagnosis, and Forensic applications.

**Keywords**: Anthropometry; Head length; Head breadth; Cephalic indices.

## Introduction

Cranial dimensions are not stable during earlier years of life due to further development such as the closure of anterior and posterior fontanelle but are stable over time (between 20–80 years).[1]

The first classification based on cranial morphology is attributed to the professor of Anatomy Anders Retzius (1840). Retzius described as gentes dolichocephalae those individuals who had an elongated skull shape, and gentes brachycephalae those whose skulls were short but he never, at that time, assigned numerical values to distinguish one category from the other.[2]

An application of Retzius's measures to living individuals is known as the Cephalic index, while the application to the dry skulls is known as a Cranial index. Either way, the indices are calculated as the ratio of maximum width and a maximum length of the head or skull.[2–4]

The post-natal craniofacial growth and development increase the width and length of bones of both face and skull. These development changes also result in insignificant alteration in the proportions of these bones, which further result in the morphologic variation in the vertical, transverse, and anteroposterior plane of the space till the point of skeletal maturity.[5]

Anthropometry of soft tissue is categorized under the heading of direct quantitative methods. It is non-invasive and uses areas that are covered by hair or areas that would be observed distorted through indirect anthropometry.[6,7]

The word anthropometry is derived from a Greek word that refers to the measurement of the human individual (Anthropos-man, Metron-measurement).[8]

Anthropometric parameters serve as an essential indicator of dietary, health conditions, forecasts health, survival, and race identification.[8]

The physical variations among humans can be assessed by measuring various parameters and based on race and sexual dimorphism.[9]

Cephalometry is one of the essential parts of anthropometry in which dimensions of head and face are measured. Cephalometric results are used in Pediatrics, Forensic medicine, Plastic surgery, Oral surgery, Dentistry, Orthopedic and/or Orthodontic diagnosis and treatment planning, and diagnostic comprehension between patient and healthy populations.[10]

The head dimensions are influenced by factors such as natural climates, geographical, sex, and ethnic factors.[11]

Data on the cephalic index is also very useful in designing various Orthopedic instruments and Physiotherapic types of equipment of head and face region like cranial remodeling band (helmet), headphones, goggles, etc. after fixing.[10]

The aim of this study was to analyze cephalometric data, to classify the cranial types, and to determine the relationship between the cephalic index and head length, head breadth among dental students. Also, cephalic indices were compared between males and females.

## Materials and Methods

A pre-tested structured questionnaire comprising the demographic profile and other necessary information was used to match the pre-requisites of the subjects for their inclusion and to obtain the necessary information to keep records and data analysis. This helped to obtain a "pure" subject of a respective community fulfilling all pre-requisites.

The study was carried out with protocol presentation and followed by ethical committee clearance.

The written consent was obtained from every student before taking the measurements.

***Type of study:*** Descriptive and Cross-sectional.

### *Subjects and Sample Size*

The present study was carried out with one hundred and forty three (143) dental students (73 male and 70 female students) of a private dental college. Dental students were selected because of easy availability. The age of the students ranged from 17 to 23 years.

Two variables, namely cephalic length, and breadth were analyzed through physical procedures in the present study (Table 1). Convenience sampling was used.

### *Inclusion Criteria*

Students with a healthy Craniofacial skeleton (as visually assessed by the lead investigator).

### *Exclusive Criteria*

Any students having a physical deformity of a cranial bone, vitamin D deficiency, fluorosis, metabolic disorders previous history of craniofacial trauma and craniofacial surgery.

### *Sample Collection*

Before the beginning of the study, intra- and inter-observer standardization was carried out among the three researchers who were to assess students with the researcher leader, in order to identify anthropometric points, visual assessment, and measurement using an instrument.

Besides, a pilot test was conducted to calibrate the measuring instrument, the data collection form, as well as the whole assessment process, in order to make corrections where required.

### *Materials Used*

(a) Manual spreading caliper: A device for measuring the head length and head breadth with two rounded tips to touch the cranial points.

(b) Measuring scale.

(c) Pencil.

(d) Anthropometer data sheet.

(e) Consent form.

Calipers were manufactured in India by UNA and CO, scale reading up to 60 cm.

### *Somatometric Measurements* (Table1)

(a) Glabella (g).

(b) Opisthocranion (op).

(c) Euryon (eu).

(d) Gnathion (gn)

(e) Head length (glabella-opisthocranion; g-op).

(f) Head breadth (euryon-euryon; eu-eu).

### *Procedures for Measuring the Variables Studied*

Two female experimenters were trained to become accustomed to the measurements' tools and procedures.

The subjects were fully informed of the measurement procedure and the purpose of the study. Features are initially identified as skeletal landmarks on the head. The points were marked with a surgical marker before measurement. Finally, the measurements are taken using calipers.

Usually, the investigators worked in a private room to provide the subject with the most preferable environment. All subjects were provided with a non-disclosure agreement to preserve their names.

All measurements were made by one person to ensure uniformity of measurement.

All measurements were taken on the subject (student) sitting on a chair in a relaxed mood.

Head was kept in Frankfurt-horizontal plane, i.e., infraorbital margin and tragion lie in same horizontal plane in order to decrease postural stress while taking the measurement and make the features more accessible to the experimenter. Linear measurements were taken to the nearest millimeter and were recorded in centimeters and to an accuracy of 0.10.

All the measurements of head length and head breadth were taken following the techniques of Martin and Saller (1957) and Singh and Bhasin (1989) (Table 1).

Based on the International classification of the cephalic index (Williams et al., 1995), the head shape was classified based on the range of the cephalic index (Table 1).

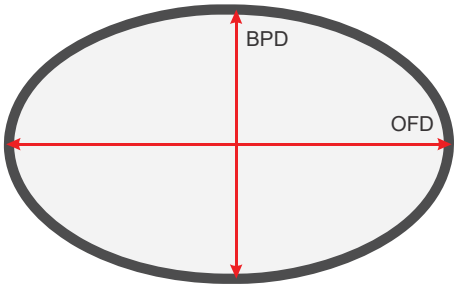
The method used for assessing the cephalic index is Hrdlicka's method.[12]

All measurements were taken twice to control the measurement error. The final value that was used for the study was the average of the two obtained values. A third reading was taken if the initial two measurements showed a significant discrepancy, and the two closer readings were used.[13]

**Table 1:** Anthropometric dimensions—craniofacial indexes

| **Cephalic Index (CI).** | | | | | |
|---|---|---|---|---|---|
| **International Descriptions (Williams et al., 1995).** | | **Head length and breadth (Martin & Saller -1957** | | | |
| **Head types based on Horizontal Cephalic index** | | **Classification of Head shape** | | **Range (cm)** | |
| **Head shape** | **Cephalic index (Range) %** | | | **Male** | **Female** |
| Hyperdolichocephalic (very long narrow head) | 65.5–69.9 | **Head Length** | Very short | X–16.9 | X–16.1 |
| Dolicephalic (long and narrow) | 70–74.9 | | Short | 17–17.7 | 16.2–16.9 |
| Mesocephalic (average shape) | 75–79.9 | | Medium | 17.8–18.5 | 17–17.6 |
| Brachycephalic (broad and short) | 80–84.9 | | Long | <19.3 | 17.7–18.4 |
| Hyperbrachycephalic (very broad and short) | 85–89.9 | | Very long | >19.4 | >18.5 |
| Ultabrachycephalic | 90.0 > 90 | **Head Breadth** | Very narrow | X–13.9 | X–13.4 |
| | | | Narrow | 14–14.7 | 13.5–14.1 |
| | | | Medium | 14.8–15.5 | 14.2–14.9 |
| | | | Broad | 15.6–16.3 | 15–15.7 |

EU-EU /BPD = Biparietal diameter or, side to side
G-Op/OFD = Occipitofrontal diameter or front to back




CI = Maximum head Breadth (EU-EU) × 100 Maximum head Length (G-OP) (Martin and Saller).

**Somatometric Measurements**

(a) *Euryon (eu):* It is the most laterally placed point on the sides of the head.

(b) *Glabella (g):* A point above the nasal root between the eyebrows and intersected by mid-sagittal plane.

(c) *Gnathion (gn):* It is the lowest point on the lower margin of the lower jaw intersected by the mid-sagittal plane. This point can be palpated on the lower jaw from behind and slightly anterior to the chin.

(d) *Head breadth (euryon-euryon; eu-eu):* Maximum head breadth—it is defined as the maximum transverse diameter between two euryons.

(e) *Head length (glabella-opisthocranion; g-op):* Maximum head length—it is defined as the maximum anteroposterior diameter from glabella to inion.

(f) *Opisthocranion (op):* It is the most posterior point on the posterior protuberance of the head in the mid-sagittal plane.

**Hyper Dolichocephalic**

**Doli cephalic**

**Mesocephalic**

**Brachycephalic**

Instrument/Material Used

i. Scale
ii. Measuring tape
iii. Sliding vernier caliper/Gliding vernier caliper

### *Data Processing and Analysis*

After the collection of the data, their frequency distributions, central tendencies, and dispersions were determined, and results were prepared in terms of frequency distributions, ranges, means, and standard deviations (SD) and students' *t* test at significance level of 0.05. Using SPSS version 21.0.

## Results

As described in the methodology, the measurements were taken into account for 143 subjects participated in the present study (Table 2).

From the available data of anthropometric variables of the study population, the mean, standard deviation (SD) were calculated for the range values of head length, head breadth, and cephalic index.

After analyzing the data statistically, a summary of observations and results were presented in the following tables and graphical representations.

Table 3 shows the head length of males ranged from 17.5 cm to 19.1 cm (mean 18.47 ± 0.744), while that of females ranged from 17.3 cm to 18.9 cm (mean 18.07 ± 2.2) with a statistically significant difference between both means ($p < 0.001$).

The head breadth of males ranged from 13.3 cm to 17.6 cm (mean 16.63 ± 11.8), while that of females ranged from 12.8 cm to 15.1 cm (mean 15.01 ± 0.8) with a statistically significant difference between both means ($p < 0.001$). The mean Cephalic Index for the male was 82.6, and for female, it was 81.8

In the present study, Table 4 shows frequencies of head types according to the cephalic phenotype in a different gender. Hyperbrachycephalic head type was the most prevalent (36.8%), and the Ultabrachycephalic type was the least prevalent (1.4%) in the male group.

The brachycephalic head type was the most prevalent (16.7%), and Hyperdolichocephalic type was the least prevalent (1.7%) in the female group.

The cephalometric dimensions measured directly showed statistically significant differences between females and males ($p < 0.02$), with males having higher mean values than females (Tables 3 and 5).

**Table 2:** Social-demographic variables of respondents ($n$ = 143).

| Individual Scenario | | | |
|---|---|---|---|
| **Variables** | **Respondents** | **Responses ($n$)** | **Frequency (%)** |
| The total number of respondents. | | 143/150 | 95.3 |
| Age. [Mean ± SD]. | | 21.7 ± 2.1 | |
| **Gender.** | Male. | 73 | 48.6 |
| | Female. | 70 | 46.6 |

**Table 3:** Descriptive statistics of the study population

| **Variables (cm)** | **Descriptive statistics** | **Individual Scenario.** | | | | |
|---|---|---|---|---|---|---|
| | | **Male** | | | **Female** | |
| | **Mean (cm) ± SD** | **Z value** | ***p* valve** | **Mean (cm) ± SD** | **Z value** | ***p* valve** |
| **Head Length** (Antero-posterior diameter) | 18.4 ± 0.7 | 73.29 | $p$ <0.0001 HS | 18.07 ± 2.2 | 23.60 | $p$ < 0.0001 HS |
| **Head Breadth** (Bi-parietal diameter) | 16.63 ± 11.8 | 4.86 | $p$ <0.0001 HS | 15.01 ± 0.8 | 67.88 | $p$ < 0.0001 HS |
| **Total** | 17.55 ± 0.92 | 60.27 | $p$ <0.0001 HS | 16.54 ± 1.53 | 34.94 | $p$ < 0.0001 HS |
| Cephalic Index | | 82.6% | | | 81.8% | |

Statistical Inference: HS—Highly significant SS—Statistical significant

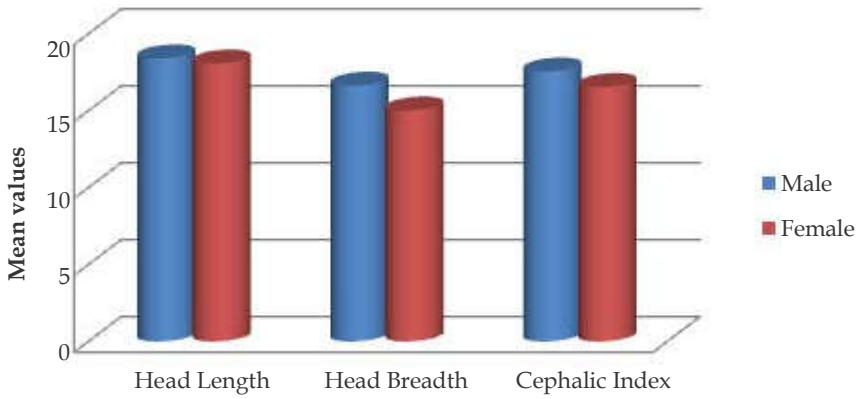



**Fig. 1:** Descriptive statistics of the study population.

**Table 4:** Different types of cephalic phenotypes of males and females.

| **Individual Scenario. ($n$ = 143)** | | | | | | |
|---|---|---|---|---|---|---|
| | **Cephalic index** | | | | | |
| **Cephalic phenotypes** | **Male ($n$ = 73)** | | **Female ($n$ = 70)** | | **Total ($n$ = 143)** | **Responses $n$ (%)** |
| | ***Responses* $n$ (%)** | **Cephalic index** | **Responses $n$ (%)** | **Cephalic index** | | |
| Hyperdolichocephalic | 4 (5.4) | 69.8% | 2 (1.3) | 68.5% | 6 | 4.1 |
| Dolicephalic (long and narrow) | 16 (21.6) | 74.8% | 9 (6.2) | 74.5% | 25 | 17.4 |
| Mesocephalic (average shape) | 5 (6.8) | 79.2% | 18 (12.5) | 79.8% | 23 | 16 |
| Brachycephalic (broad and short) | 18 (24.6) | 83.4% | 24 (16.7) | 82.6% | 42 | 29.3 |
| Hyperbrachycephalic (very broad and short | 27 (36.8) | 88.5% | 14 (9.7) | 87% | 41 | 28.6 |
| Ultabrachycephalic | 3 (4.1) | 94.7% | 3 (2.09) | 94.4% | 6 | 4.1 |

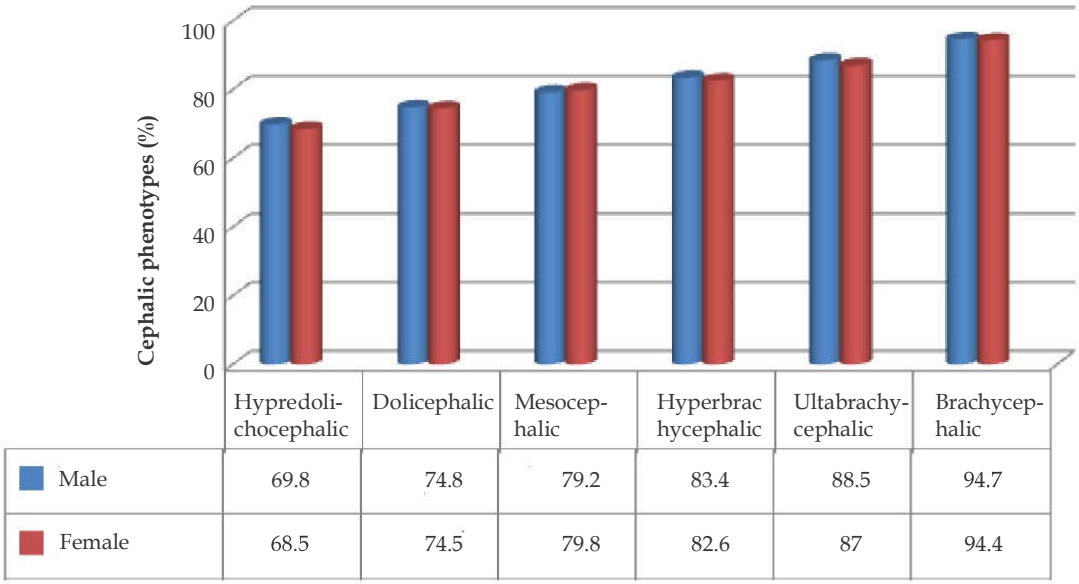



**Fig. 2:** Different types of cephalic phenotypes of males and females.

**Table 5:** Sex differences in cephalic phenotype

| Variables (cm) | Individual Scenario | | | |
|---|---|---|---|---|
| | Descriptive statistics | | | |
| | Mean ± SD | df | Unpaired *t* test | *p* valve |
| Male | 17.55 ± 0.92 | 141 | *t* = 4.87 | *p* <0.0001 HS |
| Female | 16.54 ± 1.53 | | | |

Statistical Inference: HS-Highly significant SS- Statistical significant

## Discussion

For the determination of racial traits, various methodologies have been used in the past, which utilized various cranial capacities, cranial indices, and observations such as craniometry.[14,15]

In the field of physical anthropology, the cephalic index was first used for the classification of the ancient human remains, which were found in Europe.[16]

In the 19th and late 20th centuries, the theory became closely associated with the racial anthropological development.[17]

Hence, we planned the present study to assess cranial anthropometric indices in a known population of dental students in Tirupati.

In the present study, the mean cephalic index in males [(88.5) (Hyperbrachycephalic)] was higher than the studies of Vishal Salve et al.[18] (75.68); Vaishali Kiran et al.[19] (77.92); Mishra Meghna et al.[20] (75.84); and Patro Sunita et al.[21] (77.28); which shows Mesocephalic range in the above studies.

In the present study, the mean cephalic index in females [(82.6) Brachycephalic] was higher than the studies of Salve Vishal et al.[18] (78.20); Sunita Patro et al.[21] (78.38); and Swapnil Khair et al.[22] (75.22); which shows Mesocephalic range in the above studies

In the present study the Mean Cephalic Index in overall study sample (82.2) was higher than the studies of Vishal Salve et al.[18] (76.94); Meghna Mishra et al.[20] (77.79); Sunita Patro et al.[21] (77.75); and Swapnil Khair et al.[22] (78.48); which shows the mesocephalic range in the above studies, whereas, it was similar in Shema Nair et al.[23] (81.21); and Kanan Uttekar et al.[24] (81.00); which shows the Brachycephalic range.

The variations of head shape may be due to hereditary factors or environmental, which may act as secondary effect.[25]

The kind of diet taken could also play a role in influencing the dominant head shape. Head shapes can also change from one generation to the other.[26]

## Conclusion

To conclude among dental students from the above results, the authors concluded that in males, comparatively, more head length, breadth, and cephalic index in comparison with females who exhibit sexual dimorphism.

The present study showed the anthropometrical variations in the cephalic index. The most dominant head shape was found to be Hyperbrachycephalic in males Brachycephalic among female students.

This research work provides valuable diagnostic and prognostic information that can be used for anthropology for comparative and evolutionary studies.

### *Limitations*

Future studies are recommended for better exploration of this field in different population groups.

### *Abbreviations*

mm—millimeters, cm—centimeters, CI—cephalic index, HL—head length, HB—head breadth, SD—Standard deviation.

***Ethical Approval:*** non-invasive study.

***Ethical disclosures:***

- *Protection of human and animal subjects:* The authors declare that no experiments on humans or animals for this study.
- *Confidentiality of data:* The authors declare that no patient data appear in this article.
- *Right to privacy and informed consent:* The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author owns this document.

### *Conflict of Interest and Source of Funding*

The author declares that there is no exceptional financial support for this research work from the funding agency and there is no conflict of interest among all authors.

### *Acknowledgment*

All the authors express sincere gratitude to all respondents whose honest attention help and support, and the participants of the study lead the Research project to the worthful outcome.

## References

1. Maina MB, Mahdi O, Kalayi GD. Craniofacial forms among three dominant ethnic groups of Gombe state, Nigeria. Int J Morphol 2012;30(1):211–6.
2. Franco FCM, Araujo TM, Voge CJ, et al. Brachycephalic, dolichocephalic, and mesocephalic: Is it appropriate to describe the face using skull patterns? Dental Press J. Orthodontics 2013;18(3):159–63.
3. Safikhani Z, Afzali N, Bordbr H. Determination of anatomical type of head and face in children under six years in Ahwaz. Acta Medica Iranica 2007;45(1):43–45.
4. Torres-Restrepo AM, Quintero-Monsalve AM, Giraldo-Mira JF, et al. Agreement between cranial and facial classification through clinical observation and anthropometric measurement among envigado school children. BMC Oral Health 2014;14:50.
5. Farkas LG, Posnick JC, Hreczko TM. Growth patterns of the face: A morphometric study. Cleft Palate Craniofac J 1992;29:308–15.
6. Farkas LG, Deutsch CK. Anthropometric determination of craniofacial morphology. Am J Med Genet 1996;65:1–4.
7. Farkas LG, Tompson BD, Katic MJ, Forrest CR. Differences between direct (anthropometric) and indirect (cephalometric) measurements of the skull. J Craniofac Surg 2002;13:105–8.
8. Alabi A, Oladipo G, Didia B, et al. Regression Equations for Stature Prediction in Nigerian Hausas, Igbos and Yorubas From Toe Length and Toe-Length Ratios. Anthropology 2017;5:1–5.
9. Lobo SW, Chandrasekhar TS, Kumar S. Cephalic index of Gurung community of Nepal—an anthropometric study. Kathmandu Univ Med J 2005;3:263–5.
10. Singh P, Purkit R. A cephalometric study among sub-caste groups Dangi and Ahirwar of Khurai Block. Anthropol 2006:8(3):215–17.
11. Raji J, Garba S, Numan A, et al. Morphological evaluation of head and face shapes in a North-Eastern Nigerian population. Aust J Basic Appl Sci 2010;4:3338–41.
12. Williams P, Dyson, M Dussak JE, et al. Gray's anatomy. In: Skeletal system. 38th Ed. London: Elbs with Churchill Livingston; 1995:607–12.
13. Ngeow WC and Aljunid ST. Craniofacial anthropometric norms of Malaysian Indians. Indian Journal of Dental Research 2009;20(3):313–19.
14. Kasai K, Richards LC and Brown T. Comparative

study of craniofacial morphology in Japanese and Australian aboriginal population. Hum Biol 1993;65(5):821–34.

15. Hossain MG Saw A, Ohtsuki F, Lestrel PE, et al. Change in facial shape in two cohorts of Japanese adult female students twenty years apart. Singapore Med J 2011;52:818–23.
16. Akhter Z, Begum JA. Stature estimation using head measurements in Bangladeshi Garo adult females. Bangladesh J Anat 2009;7:101–4.
17. Nagle E, Teibe U. Craniofacial anthropometry in a group of healthy Latvian residents. Acta Med Litu 2005;12:47–53.
18. Salve VM, Thota NR, Patibandla A. The study of the cephalic index of the Andhra region (India). Asian Journal of Medical Sciences 2011;2:53–55.
19. Kiran Vaishali, Pai S, Kalthur S, et al. Study of cephalic index in Indian students. Internet J. Morphol 2012;30(1):125–29.
20. Mishra M, Tiwari A, Naik DC. Study of cephalic index in the Vindhya region of Madhya Pradesh. Int J Med Sci Health 2014;3:1464–65.
21. Patro Sunita, Sahu R, Rath S. Study of cephalic index in Southern Odisha population. J. Dental and Med. Sci 2014;13:41–4.
22. Swapnil Khair et al. Study of Cephalic Index among the students of the Mumbai region. Ind J of Applied Research 2013;11(3):64–66.
23. Shema K. Nair, Vaibhav P. Anjankar, Sandeep Singh, et al. The Study of Cephalic Index of Medical Students of Central India. Asian Journal of Biomedical and Pharmaceutical Sciences 2014;04(28):48–50.
24. Kanan Uttekar. Study of Cephalic Index in South Gujarat. International Journal of Recent Trends in Science and Technology 2013;8(2):87–89.
25. Golalipour MJ, Jahanshahi M and Haidari K. Morphological evaluation of head in Turkman males in Gorgan-North of Iran. Int. J. Morphol 2007;25:99–102.
26. Heravi F & Zieaee H. Assessing the importance of cephalic and facial indices in a group of 12-year-old boys in Mashhad. Beheshti Univ. Dent. J 2002;20:119–24.