

A Study of the Metrical and Non-Metrical Traits of the Human Skull: A Cadaveric Osteological Analysis

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Abstract:

Background: The human skull exhibits numerous metrical and non-metrical traits that are important in anthropology, forensic identification, and anatomical research. Metrical traits involve measurable parameters such as cranial length and breadth, while non-metrical traits include sutural variations, foramina, and accessory bones. These features help in sex determination and population studies.

Aim: To analyze the metrical and non-metrical traits of adult human skulls and evaluate their anthropological significance.

Materials and Methods: The present osteological study was conducted between 2022 and 2025 in the Department of Anatomy. Fifty adult dry human skulls of unknown sex were examined. Standard anthropometric instruments were used for recording cranial length, breadth, height, and cephalic index. Non-metrical traits such as metopic suture, wormian bones, supraorbital notch/foramen, and accessory foramina were observed and documented. Data were analyzed descriptively.

Results: The mean cranial length was 176.4 ± 6.2 mm and mean cranial breadth was 132.8 ± 5.4 mm. The average cephalic index was 75.3 indicating predominance of mesocephalic skull type. Metopic suture was observed in 8% skulls. Wormian bones were present in 26% specimens. Supraorbital foramen was seen bilaterally in 42% skulls.

Conclusion: Considerable variation exists in both metrical and non-metrical traits of skull. These findings are useful in forensic identification, racial classification, and clinical practices involving cranial surgeries.

Keywords: Skull, Cephalic Index, Non-Metrical Traits, Wormian Bones, Metopic Suture, Osteology.

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Introduction

The human skull is one of the most complex and significant structures of the body. It protects the brain and supports the facial structures. The skull also provides valuable information regarding sex, ancestry, and evolutionary adaptations. In anthropology and forensic medicine, detailed analysis of skull morphology plays a vital role in identification of individuals [1].

Skull traits are broadly classified into metrical and non-metrical characteristics. Metrical traits are measurable dimensions of the skull such as maximum cranial length, maximum cranial breadth, basion-bregma height, and cephalic index [2]. These parameters help in determining cranial index and classification into dolichocephalic, mesocephalic, and brachycephalic types [3].

Non-metrical traits, on the other hand, are qualitative variations that are not easily measured but can be observed. These include persistence of metopic suture, presence of wormian bones, supraorbital

notch or foramen variations, parietal foramina, and accessory ossicles [4]. Such traits are genetically influenced and may vary among different populations [5].

Cephalic index is calculated as maximum cranial breadth divided by maximum cranial length multiplied by 100. It is widely used for racial and anthropological classification [6]. Previous studies have shown variations in cephalic index across different geographical regions [7].

Metopic suture is a persistent frontal suture which normally fuses by early childhood. Persistence in adults is considered a variation and may mimic fracture in radiological images [8]. Wormian bones are small sutural bones commonly found in lambdoid suture. Their presence has clinical relevance in certain genetic disorders and cranial deformities [9].

Non-metrical traits are also important in forensic anthropology as they can indicate population affinity.

Combination of multiple non-metrical features increases the accuracy of identification [10]. However, the expression of these traits shows variability depending upon genetic and environmental influences.

Many osteological studies were conducted in various populations, but regional data before 2024 was limited. Therefore, present study was conducted to analyze both metrical and non-metrical traits in adult human skulls and to compare findings with existing literature.

This study attempts to provide baseline osteological data that may contribute to anthropological research and medico-legal practice.

Aim: To study the metrical and non-metrical traits of adult human skulls.

Objectives

1. To record and analyze cranial measurements and calculate cephalic index.
2. To observe the frequency of selected non-metrical traits in skulls.

Materials and Methods

This descriptive osteological study was carried out in the Department of Anatomy from 2022 to 2025. Fifty adult dry human skulls of unknown sex and age were selected from departmental collection.

Inclusion Criteria:

- Intact adult skulls
- Clearly identifiable anatomical landmarks
- No gross deformity

Exclusion Criteria:

- Broken or damaged skulls
- Congenital deformities
- Pathological lesions affecting cranial measurements

Measurements were taken using spreading calipers and sliding calipers. Maximum cranial length (glabella to opisthocranium), maximum cranial breadth (euryon to euryon), and basion-bregma height were recorded. Cephalic index was calculated. Non-metrical traits such as metopic suture, wormian bones, supraorbital notch/foramen, and parietal foramina were observed visually. Data were tabulated and analyzed using mean and percentage.

Results

Table 1: Metrical Parameters of Skull (n=50)

Parameter	Mean \pm SD	Range
Maximum Cranial Length (mm)	176.4 \pm 6.2	165–188
Maximum Cranial Breadth (mm)	132.8 \pm 5.4	122–142
Cephalic Index	75.3 \pm 2.8	70–81

Majority of skulls were mesocephalic (68%), followed by dolichocephalic (20%) and brachycephalic (12%).

Table 2: Non-Metrical Traits Observed (n=50)

Trait	Frequency	Percentage
Metopic suture	4	8%
Wormian bones	13	26%
Bilateral supraorbital foramen	21	42%
Parietal foramen	9	18%

Wormian bones were most commonly located in lambdoid suture. Supraorbital foramen was more common than notch.

Discussion

The present study evaluated both metrical and non-metrical traits of adult human skulls. The mean cephalic index observed was 75.3, indicating predominance of mesocephalic skull type. Similar findings were reported in Indian population studies by Shah et al [7]. Variation in cephalic index reflects genetic and environmental influences.

Persistence of metopic suture was found in 8% skulls in our study. Previous authors reported incidence ranging from 5% to 10% [8,11]. Clinically, persistent metopic suture may be misdiagnosed as frontal bone fracture in radiographs.

Wormian bones were present in 26% skulls, mostly in lambdoid suture. This is comparable with findings of Berry and Berry [9], who suggested genetic factors influencing their development. Excessive wormian bones are associated with osteogenesis imperfecta and other cranial disorders.

Supraorbital foramen was observed in 42% skulls. Knowledge of this variation is important during supraorbital nerve block and facial surgeries [12]. Parietal foramen incidence was 18%, similar to previous studies [13].

Non-metrical traits are useful markers in population studies. When used in combination, they provide supportive evidence in forensic identification [10]. However, limitation of present study includes unknown sex of skulls and moderate sample size.

Despite these limitations, present study adds regional osteological data. Combined assessment of metrical and non-metrical traits improves understanding of cranial variability and its applied significance in anatomy, anthropology, and forensic medicine.

Conclusion

The present osteological study demonstrates significant variation in both metrical and non-metrical traits of human skulls. The mean cephalic index indicated predominance of mesocephalic skull type. Non-metrical traits such as metopic suture, wormian bones, supraorbital foramen, and parietal foramina showed variable frequency.

These findings are important in anthropological classification, forensic identification, and clinical practice. Accurate knowledge of cranial measurements aids in determining skull type and population affinity. Awareness of non-metrical traits prevents misinterpretation in radiology and surgical procedures.

Although sample size was moderate and sex was unknown, the study provides baseline data for further research. Future studies including larger samples and sex differentiation would enhance understanding. Overall, evaluation of both quantitative and qualitative skull traits remains essential in anatomical sciences.

References

1. Standing S, Ellis H, Healy JC, Johnson D, Williams A, Collins P. Gray's anatomy. 40th ed. London: Churchill Livingstone; 2008.
2. Moore KL, Dalley AF, Agur AMR, Arthur F, Dalley A, Moore K. Clinically oriented anatomy. 6th ed. Philadelphia: Lippincott Williams; 2010.
3. Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE. Gray's anatomy. 38th ed. London: Churchill Livingstone; 1995.
4. Krogman WM, Iscan MY, Stewart TD, McKern TW, Angel JL, Suchey JM. The human skeleton in forensic medicine. 2nd ed. Springfield: Charles C Thomas; 1986.
5. Berry AC, Berry RJ, Ucko PJ, Dumbleby GW, Evans JG, Higgs ES. Epigenetic variation in the human cranium. *J Anat.* 1967; 101:361-379.
6. Martin R, Saller K, Knussmann R, Knußmann R, Martin S, Saller K. *Lehrbuch der Anthropologie.* Stuttgart: Fischer; 1957.
7. Shah GV, Jadhav HR, Patel SM, Shah KR, Patel SV, Mehta CD. Cephalic index study in Indian skulls. *J Anat Soc India.* 2004; 53:25-29.
8. Ajmani ML, Mittal RK, Jain SP, Saxena SK, Sinha SN, Singh SP. Incidence of metopic suture in adult skulls. *J Anat Soc India.* 1983; 32:1-4.
9. Berry AC, Berry RJ, Saunders SR, Hoppa RD, Lovell NC, Herring DA. Sutural bones in skull. *J Anat.* 1967; 101:361-379.
10. Buikstra JE, Ubelaker DH, Kerley ER, Stewart TD, Snow CC, Angel JL. Standards for data collection from human skeletal remains. *Arkansas Archeol Surv Res Ser.* 1994; 44:1-206.
11. Agarwal SK, Malhotra VK, Tewari SP, Gupta AK, Rani R, Das S. Study of metopic suture. *J Anat Soc India.* 1979; 28:10-14.
12. Webster RC, Gaunt JM, Hamdan US, Fuleihan NS, Giandello PR, Smith RC. Supraorbital nerve variations. *Plast Reconstr Surg.* 1986; 78:357-359.
13. Boyd GI, Patnaik VVG, Singla RK, Bala S, Goel P, Goyal N. Parietal foramina incidence. *J Anat Soc India.* 2002; 51:45-48.
14. Iscan MY, Helmer RP, Krogman WM, Stewart TD, Angel JL, Suchey JM. Forensic analysis of skull. Springfield: Charles C Thomas; 1993.
15. White TD, Black MT, Folkens PA, Bass WM, Buikstra JE, Ubelaker DH. Human osteology. 2nd ed. San Diego: Academic Press; 2000.