

## Cephalic index in tribal districts of Himachal Pradesh: Relevance in forensic anthropology

**Nirmal Nagar, MD\***; Yatiraj Singi, MD; Dipen Dabhi, MD

Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences (AIIMS), India.

**\*Corresponding author: Nirmal Nagar**

Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences (AIIMS), Bilaspur 174037, Himachal Pradesh, India.

Email: nagarnirmal4@gmail.com

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### Short commentary

Cephalometry has been a cornerstone of anthropological and forensic sciences for over a century [1]. Among the many craniofacial parameters, the Cephalic Index (CI) continues to hold relevance because of its simplicity, reproducibility, and applicability across diverse fields. Defined as the ratio of maximum cranial breadth to maximum cranial length multiplied by one hundred, the cephalic index has been used to classify human head shapes into dolichocephalic, mesocephalic, and brachycephalic categories [2]. Its application extends from forensic anthropology and personal identification to orthodontics, craniofacial surgery, and studies of population diversity [3-7].

The recently published article “*Cephalic Index Variation in the Indigenous Population of Tribal Districts in Himachal Pradesh*” contributes an important dataset to the growing body of Indian literature. This prospective community-based study, carried out in Kinnaur, Lahaul, and Spiti, examined 413 adult participants with three generations of local ancestry. The findings revealed an overall mean cephalic index of 79.27, with values of 78.90 in males and 79.81 in females, indicating a predominance of mesocephalic head type. District-level analysis showed a higher prevalence of brachycephaly in Kinnaur, while mesocephaly dominated in Lahaul and Spiti. These results are valuable be-

cause they not only add to the reference standards for North Indian populations but also reveal intra-regional variation within a high-altitude tribal setting. The study design ensured reliability by using standard anthropometric protocols. Measurements were recorded using spreading calipers in the Frankfurt horizontal plane, following the recommendations of Vallois. Triplicate readings were taken by a single observer to minimize inter-observer error. The cephalic index was calculated according to the method of Hrdlička. Such methodological rigor ensures comparability with earlier Indian and international studies and strengthens the role of the cephalic index as a reproducible craniofacial measure. Sex differences in cephalic index are a recurring theme across studies. The Himachal Pradesh study found slightly higher values in females, although the difference was statistically insignificant [8]. This finding corresponds with earlier Indian reports from Gujarat, Punjab, Andhra Pradesh, and other regions where female participants showed a tendency toward relatively higher cephalic index values [9-21]. The pattern, observed consistently, can serve as an auxiliary factor in sex estimation during forensic examinations, especially when integrated with other cranial parameters.

The predominance of mesocephaly in the overall population aligns with the majority of Indian studies [9-26]. For instance, populations in Gujarat, Andhra Pradesh, and Maharashtra have

shown similar mean values clustering around the mesocephalic range [9,11,16]. At the same time, regional diversity is evident. Punjabi students were reported to have higher mean values with a brachycephalic tendency [10], while some Haryanvi groups exhibited more dolichocephalic patterns [17]. The Himachal Pradesh dataset adds another dimension by showing a mixture of mesocephaly and brachycephaly across tribal districts. This intra-state variation suggests a combination of genetic and environmental influences.

Anthropological studies indicate that craniofacial morphology is shaped not only by heredity but also by environment, altitude, and lifestyle [9]. The predominance of brachycephaly in Kinnaur may reflect genetic differentiation and historical population structures, as previously demonstrated through genetic studies in the region [28]. In contrast, mesocephalic predominance in Lahaul and Spiti may indicate differing ancestry or ecological adaptation. These findings reinforce the need for region-specific datasets rather than reliance on national averages, which may obscure local variation.

The cephalic index has long been linked to clinical relevance. Cohen and Kreiborg demonstrated its association with craniofacial syndromes such as Apert syndrome [6]. Stolovitzky and Todd linked cranial form with otologic conditions [7]. Such associations show that knowledge of population-specific cephalic index values is not only of anthropological importance but also essential in clinical practice. For surgeons and orthodontists, local cephalometric standards are useful for treatment planning, growth monitoring, and reconstructive procedures [3-5].

From a forensic perspective, the cephalic index continues to assist in personal identification. When skeletal remains are recovered, especially in fragmented or decomposed states, cranial indices help in estimating ancestry, sex, and population affinity. In mass disasters, population-specific cephalometric references can provide valuable leads in narrowing the identity of victims. The Himachal Pradesh data therefore have direct application in forensic anthropology, especially for cases originating from North Indian high-altitude regions. The strengths of the study include its community-based sampling, representation of both sexes across three tribal districts, and adherence to methodological standards. The use of three generations of local ancestry as an inclusion criterion minimized admixture effects. These factors increase the internal validity of the findings and their reliability as reference standards for the region [8].

Some limitations remain. While the study provided robust data for tribal districts, it does not necessarily reflect the entire Himachal Pradesh population. Environmental and nutritional influences were not quantified, although these may affect craniofacial morphology. Future research could incorporate variables such as altitude, diet, and socio-economic status to better understand their role. In addition, the use of three-dimensional imaging technologies in future studies may enhance accuracy and facilitate data sharing across research centers.

### Conclusion

In conclusion, the cephalic index remains a simple yet powerful tool in forensic anthropology and clinical sciences. The recent study from Himachal Pradesh, [8] enriches the Indian reference corpus and provides valuable district-level data that can inform both scientific inquiry and practical application. By documenting variation within a geographically unique population, it demonstrates the importance of continuing anthropo-

metric studies in diverse regions. We commend the authors for their contribution and recommend further multi-center collaborations that integrate cephalometry with genetic and imaging studies to develop a comprehensive understanding of craniofacial variation in India.

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