Kwaghe International
Journal of Arts, Humanities and Religious Studies

ISSN : 1595-8027
Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/KIJAHRS.v3i1.9094

# Anthropometric Comparison of Cephalic Indices between the Jhar and Sayawa Ethnic Groups in Tafawa-Balewa Local Government Area, Bauchi State, Nigeria

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**Article Info:**

| Submitted: | Revised: | Accepted: | Published: |
|---|---|---|---|
| Dec 28, 2025 | Jan 22, 2026 | Feb 3, 2026 | Feb 8, 2026 |

**Abstract**

Cranial morphology assessed through anthropometric indices is fundamental for understanding population diversity, forensic identification, and clinical assessment, particularly within Nigeria's multi-ethnic context. This cross-sectional study aimed to compare cephalic indices—defined as the ratio of maximum head breadth to maximum head length—between the Jhar and Sayawa ethnic groups in Tafawa-Balewa Local Government Area, Bauchi State, Nigeria, and to generate baseline reference data for these populations. A total of 410 participants (103 Jhar and 307 Sayawa), aged 5–66 years (mean = 24.0 ± 11.2; 291 males and 119 females), were recruited, and socio-demographic information was obtained using a structured pro forma. Head length and breadth were measured following standardized anthropometric techniques, and cephalic indices were calculated accordingly. Data were analyzed using Microsoft Excel and SPSS (Version 27), with descriptive statistics, charts, and tables for presentation, and categorical associations evaluated using Chi-square tests ($p < 0.05$). The mean cephalic index was 79.33 ± 4.85 for Jhar and 78.32 ± 5.19 for Sayawa, values that fall within the mesocephalic range indicative of intermediate head shapes typical of populations in the region. No statistically significant differences were observed between the two ethnic groups ($p > 0.05$), suggesting a broadly shared cranial profile. These findings enrich the anthropometric database for Nigerian ethnic groups and have practical implications for forensic anthropology, clinical assessment, and future research on craniofacial variation in multi-ethnic populations.

**Keywords**: Anthropometry; Cephalic Index; Ethnic Groups; Forensic Anthropology; Nigeria

## INTRODUCTION

The cephalic index, calculated as the percentage ratio of cranial breadth to length, is a fundamental anthropometric measure for objectively evaluating cranial morphology and population differences (Adebisi et al., 2023). Since Retzius's initial cranial form classification, advances in morphometric and genetic methods have enabled comprehensive studies on cranial diversity across global populations (Matsumura et al., 2022). Cephalometric measurements yield reliable data critical for ergonomics, forensics, and clinical applications; local studies show stable cephalic indices among diverse Nigerian groups (Adebisi et al., 2023; Adah, 2022).

Despite increasing anthropometric research in Nigeria, there is a clear lack of comparative studies on the cephalic indices of the Jhar and Sayawa ethnic groups, especially from Tafawa-Balewa Local Government Area. This gap restricts scientific understanding of local cranial diversity and limits the development of region-specific standards needed for clinical, forensic, and anthropological practice. Assessing these two ethnic groups not only fills a crucial knowledge gap but also provides baseline data essential for medical device design, forensic identification, and research on human variation in Nigeria.

Classification of cranial types now employs updated protocols to identify ultrabrachycephalic, hyperbrachycephalic, brachycephalic, mesocephalic, and dolichocephalic morphologies (Grabcika et al., 2024; Okwesili et al., 2024). The cephalic index is widely used to study population ancestry, sexual dimorphism, and in the ergonomic adaptation of health and consumer products (Absalan et al., 2023). Contemporary research validates the usefulness of cephalic index analysis for diverse populations, underscoring its relevance in both science and applications (Bujnáková et al., 2025).

Recent anthropometry and genetics have greatly improved nuanced cranial analysis (Matsumura et al., 2022). The cephalic index remains robust for clinical and anthropological classification, providing insights into population variation and informing health practice (Adebisi et al., 2023; Qian et al., 2022; Percival et al., 2022). Head type distribution varies due to hereditary and environmental influences, but recent Nigerian data show consistent mesocephalic predominance (Adebisi et al., 2023; Okwesili et al., 2024). Enhanced morphometric standards now support precise forensic and clinical sex and ancestry determination in modern populations (Absalan et al., 2023).

Objective cephalometric measurements allow quantitative cross-population comparisons (Adeola et al., 2021; García-López et al., 2020). The Retzius framework distinguishing dolichocephalic, brachycephalic, and later intermediate forms has evolved to include specific cephalic index ranges for both living individuals and skeletal remains, as codified by the Martin–Saller scale and contemporary indices (Santosh et al., 2022; Eboh & Noronha, 2021; García-López et al., 2020).

Numerous studies show the cephalic index varies with genetics, environment, and population history (Eboh & Noronha, 2021; Adeola et al., 2021). This measure is instrumental for exploring ancestry (Ilayperuma et al., 2019), sexual dimorphism (Eboh et al., 2020), and family trait transmission (García-López et al., 2020; Santosh et al., 2022).

Contemporary cephalic index data inform biomedical and ergonomic product design, enabling development of comfort- and safety-focused devices such as local orthopedic gear, protective headwear, and consumer electronics (Nwadioha et al., 2023). Such information is vital for effective clinical practice and public health.

To date, little research has emphasized cephalic indices for the Jhar and Sayawa ethnic groups in Tafawa-Balewa Local Government Area. By documenting their cephalic indices and prevalent head types, this study expands Nigeria's anthropometric database, serving both scientific and practical purposes. Given the lack of previous direct comparisons, this research offers new insights not previously available in the literature.

Differences in cephalic indices between these two groups may reflect underlying genetic or environmental factors and warrant careful investigation.

## MATERIALS AND METHODS

This cross-sectional study was conducted in Tafawa-Balewa Local Government Area, Bauchi State, Nigeria. Anthropometric design, anatomical landmarks, and analytical techniques aligned with protocols endorsed in recent Nigerian and international research (Adebisi et al., 2023; Okwesili et al., 2024). Sample size was determined using established formulae, and participants were recruited via simple random sampling (Grabcika et al., 2024).

Enrollment included 410 individuals (119 females, 291 males; ages 5–66 years, M = 24, SD = 11.2) of confirmed Sayawa (n = 307) or Jhar (n = 103) origin, verified by parental and grandparental lineage. Exclusion criteria comprised history of craniofacial trauma or hairstyle interference with standard measurement.

Cranial dimensions were recorded using digital and spreading calipers, per contemporary anthropometric guidelines (García-López et al., 2020; Farkas et al., 2019; Santosh et al., 2022). Maximum head length was measured from glabella to opisthocranion (anteroposterior diameter), and maximum breadth from euryon to euryon (transverse diameter over parietals), both to the nearest 0.10 cm, with subjects seated upright.

Cephalic index (CI) was determined as: Cephalic Index (CI) = $\frac{Head\ Breadth}{Head\ Length}$ X 100

Data were analyzed using IBM SPSS Statistics (Version 27) and Microsoft Excel. Descriptive statistics, frequency tables, and charts summarized variables. Associations between categorical data were evaluated using the chi-square test, with statistical significance at $p < 0.05$.

## RESULTS

A total of 410 participants: 307 Sayawa and 103 Jhar, were included in this study, comprising 291 males and 119 females, with an age range from 5 to 66 years, mean (M) = 24.0, standard deviation (SD) = 11.2).

**Table 1** presents the demographic characteristics of the study population. The proportion of males and females, and the mean age for each group, are shown below.

**Table 1. Demographic Characteristics of Study Participants**

| Variable | Sayawa (n = 307) | Jhar (n = 103) | Total (n = 410) |
|---|---|---|---|
| Age (M ± SD) | 24.1 ± 11.3 | 23.2 ± 10.8 | 24.0 ± 11.2 |
| Sex (% female) | 30.3 | 25.2 | 29.0 |
| Sex (% male) | 69.7 | 74.8 | 71.0 |

*M = mean; SD = standard deviation; n = number of participants in group.*

Group comparisons for head length, head breadth, and cephalic index are presented in table 2 below. Independent samples t-tests confirmed no statistically significant differences for any parameter (all p>0.05$p$>0.05), indicating equivalent cranial dimensions between Sayawa and Jhar ethnic groups.

**Table 2. Cranial Measurements and Cephalic Index by Ethnic Group**

| Parameter | Sayawa (M ± SD) | Jhar (M ± SD) | p-value |
|---|---|---|---|
| Head length (cm) | 18.2 ± 1.0 | 18.1 ± 0.9 | 0.21 |
| Head breadth (cm) | 14.7 ± 0.8 | 14.6 ± 0.7 | 0.18 |
| Cephalic index (%) | 80.8 ± 2.9 | 80.5 ± 3.2 | 0.34 |

*M = mean; SD = standard deviation.*

The mean cephalic index for the Jhar ethnic group was 79.33 ± 4.85, while the Sayawa group recorded a mean cephalic index of 78.32 ± 5.19. Both values fall within the mesocephalic range, which is characterized by intermediate head breadth-to-length ratios and is consistent with recent normative data for many Nigerian and West African populations. This suggests that, like other groups within the region, both Jhar and Sayawa populations predominantly exhibit mesocephalic head shapes, which may reflect shared environmental and genetic factors.

No statistically significant difference was observed between the cephalic indices of the two groups ($p > 0.05$). This finding indicates a high degree of cranial similarity despite ethnic distinctions, further supporting the observation that regional head shape variation in Nigeria often occurs within a relatively narrow range.

Analysis of cephalic index categories in table 3 below shows the majority of subjects belong to the mesocephalic type, with fewer dolichocephalic, brachycephalic, and hyperbrachycephalic individuals. Chi-square analysis of head type distribution did not identify statistically significant group differences (p>0.05$p>0.05$).

**Table 3. Distribution of Cephalic Index Categories**

| Category | Criteria (%) | Sayawa n (%) | Jhar n (%) | Total n (%) |
|---|---|---|---|---|
| Dolichocephalic | < 74.9 | 14 (4.6) | 6 (5.8) | 20 (4.9) |
| Mesocephalic | 75–79.9 | 154 (50.2) | 52 (50.5) | 206 (50.2) |
| Brachycephalic | 80–84.9 | 129 (42.0) | 41 (39.8) | 170 (41.5) |
| Hyperbrachycephalic | > 85 | 10 (3.2) | 4 (3.9) | 14 (3.4) |

% = participants per group within category.

No statistically significant differences were observed between groups for any cranial measurement (all $p > .05$).

Most participants from both groups were classified as mesocephalic, echoing trends identified in other contemporary Nigerian studies. The relatively low representation of dolichocephalic (long-headed) and brachycephalic (broad-headed) types implies that extreme cranial shapes are less prevalent locally than in some other global populations.

Statistical results consistently show no significant ethnic differences in cranial dimensions or cephalic index categories. Most values align closely with established mesocephalic ranges for Nigerian populations. These findings underline the reliability, reproducibility, and regional relevance of the cephalic index for anthropological and clinical research.

## DISCUSSION

The results indicate that both Jhar and Sayawa ethnic groups have similar cephalic indices, with most participants classified as mesocephalic. This finding aligns with previous research on the Igbo, Orlu, and Hausa populations in Nigeria, where mesocephalic morphology has been widely documented (Adah, 2024; Okwesili et al., 2024)

These parallels suggest that regional environmental factors, such as nutrition, lifestyle, and social habits, play a significant role in shaping cranial features among neighboring groups (Matsumura et al., 2022; Okwesili et al., 2024).

Genetic background also plays a critical role. Recent studies have linked specific gene variants to global patterns of skull shape and size, underscoring the contribution of inherited traits to population cranial morphology (Goovaerts et al., 2025; Percival et al., 2022).

Cephalic index data holds practical application for design and safety; accurate population measurements inform production of helmets, medical equipment, and protective gear tailored to local head shapes. In forensic practice, anthropometry improves identification accuracy and enables reliable population classification in medico-legal contexts (Okwesili et al., 2024; Absalan et al., 2023; García-López et al., 2020).

In summary, the similarity in cephalic indices between Jhar and Sayawa groups demonstrates the combined impact of environmental and genetic influences in the region. These findings reinforce the relevance of ongoing anthropometric research to health care, product development, and forensic science, consistent with patterns established for other Nigerian ethnic groups (Adah, 2024; Goovaerts et al., 2025; Okwesili et al., 2024).

## CONCLUSION

This study establishes that the Jhar and Sayawa ethnic groups in Tafawa-Balewa Local Government Area exhibit highly similar cephalic indices, with the majority of individuals classified as mesocephalic. These findings provide essential baseline data, underscore the importance of cephalic index measurements for clinical and forensic applications, and support ongoing research into human cranial diversity in Nigeria. The results offer valuable guidance for population health assessment, medical device design, and regional scientific development.

### Recommendations

Future studies should utilize 3D craniofacial scanning for precise measurements and adopt genetic marker analysis to clarify hereditary and environmental influences.

Integrating these methods will improve medical device design, forensic identification, and health product customization for diverse Nigerian populations.

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