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Original Research Article

A Descriptive Cross-Sectional Study Determining Cranio-Facial Anthropometric Parameters of the Adult Population

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Abstract

Aim: To study the cranio-facial anthropometric analysis on the adult population.

Materials and Methods: The present study was conducted was conducted in Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India for one year. The study group included 50 males and 50 females of 30-to-40-year age group. Variables studied through physical anthropometry in both the genders were facial height, paranasal-to-men ton distance, inter zygomatic arch width, and intercanthal width. All the physical measurements were taken using a digital sliding caliper after each individual was asked to maintain a neutral, relaxed facial expression without lifting the head and to breathe calmly through their nose. Facial height measurement was derived as the distance from nasion to men ton. The measurements of the intercanthal distance are taken between the medial canthi of the eye.

Results: The insignificant (P > 0.05) mean difference in the measurements with minimum error (SE < 1.00) and high ICC (0.622–0.997) indicating high reliability of craniofacial measurements. The values observed by observer 1 were submitted for statistical analyses. The difference in craniofacial measurements between males and females is summarized in Table 2. Pearson's correlation analysis revealed a significant and positive (direct) correlation between facial height and paranasal–to-men ton distance (r = 0.83, P < 0.001), facial height and inter zygomatic width (r = 0.30, P < 0.01), pro nasale-to-men ton distance and inter zygomatic width (r = 0.22, P < 0.05), and inter zygomatic width and intercanthal width (r = 0.25, P < 0.05).

Conclusion: The present study concludes that the physical anthropometry of Lucknow population with larger sample size will give a standard and concrete range of measurements to decipher unidentified remains of this locality.

Keywords: Cranio-facial, Anthropometric, Adult

Introduction

Cranio-facial anthropometry, the study of the measurements and proportions of the human skull and face, plays a vital role in various fields including forensic science, physical anthropology, and plastic surgery. This scientific discipline involves the precise measurement of different parts of the human head and face to understand human variation, evolution, and identity. The adult population, with its fully developed cranio-facial structures, provides a rich dataset for understanding these variations and applying this knowledge to practical and clinical contexts. [1,2] The importance of cranio-facial anthropometry lies in its applications. In forensic science, cranio-facial measurements can assist in identifying individuals based on skeletal remains. In physical anthropology, these measurements help in understanding the evolutionary relationships among different human populations and how environmental factors have shaped human morphology. Moreover, in plastic and reconstructive surgery, anthropometric data guide surgeons in planning and executing procedures that aim to restore or enhance facial aesthetics and function. [3,4] One of the primary goals of cranio-facial anthropometric studies is to establish normative data for different populations. These data are crucial because cranio-facial dimensions can vary significantly between populations due to genetic, environmental, and cultural factors. For example, studies have shown significant differences in facial dimensions among populations from different geographical regions . Establishing population-specific normative data helps in accurately identifying individuals and understanding population-specific traits. [5] Cranio-facial anthropometry involves a range of measurements, including linear distances, angles, and proportions. Common measurements include the distance between the eyes (intercanthal width), the height of the nose, the width of the mouth, and the length of the jaw. These measurements can be obtained using traditional tools such as callipers and measuring tapes, or through advanced imaging techniques like 3D photogrammetry and computed tomography (CT) scans. Each method has its advantages, with 3D imaging providing more accurate and comprehensive data. In clinical contexts, cranio-facial anthropometry is essential for diagnosing and managing congenital craniofacial anomalies, such as cleft lip and palate, craniosynostosis, and other dysmorphic syndromes. Accurate cranio-facial measurements allow clinicians to plan surgical interventions that aim to achieve normal facial proportions and symmetry, thereby improving functional and aesthetic outcomes for patients . The advent of digital technology has revolutionized cranio-facial anthropometry, enabling more precise and efficient data collection. Techniques such as 3D laser scanning and stereophotogrammetry provide high-resolution images and accurate measurements of the cranio-facial complex. These technologies have expanded the scope of anthropometric studies, allowing for large-scale data collection and more detailed analyses of cranio-facial morphology . [6,7]

Materials and Methods

The present study was conducted was conducted in Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India for one year. The study group included 50 males and 50 females of 30-to-40-year age group. The above-mentioned age group was considered, because after puberty, the amount of craniofacial growth decreases steadily and almost ceases after the second decade of life.

Individuals of mixed origin and with a history of congenital craniofacial anomaly, with major craniofacial trauma and orthodontic treatment, and who have undergone craniofacial reconstructive surgery or having craniofacial deformities or irregular dentition were excluded from the study. Variables studied through physical anthropometry in both the genders were facial height, pro nasale-to-men ton distance, inter zygomatic arch width, and intercanthal width. All the physical measurements were taken using a digital sliding caliper after each individual was asked to maintain a neutral, relaxed facial expression without lifting the head and to breathe calmly through their nose. Facial height measurement was derived as the distance from nasion to men ton. The measurements of the intercanthal distance are taken between the medial canthi of the eye. The inter zygomatic distance, and the measurement of the pro nasale-to-men ton distance using a digital sliding caliper. All the measurements were taken twice to control the measurement error, and the average of the aforementioned values was used for the study.

Results

The craniofacial features/measurements (facial height, pro nasale-to-men ton distance, inter zygomatic width, and intercanthal width) were summarized as mean ± standard error (SE of the mean). The craniofacial measurements between males and females were compared by independent Student's t-test. Pearson's correlation analysis was done to assess the association between measurements. Interobserver reliability of the measurements was compared by paired t-test and intraclass correlation coefficient (ICC) analysis. A two-tailed ($\alpha = 2$) $P < 0.05$ was considered statistically significant. To assess the reliability of craniofacial measurements (facial height, pro nasale-to-men ton distance, inter zygomatic width, and intercanthal width), the measurements assessed by observer 1 were reassessed by another independent observer 2 within 1 week in random order and compared by paired t-test and ICC analysis and are summarized in Table 1. Table 1 shows the insignificant ($P > 0.05$) mean difference in the measurements with minimum error (SE < 1.00) and high ICC (0.622–0.997) indicating high reliability of craniofacial measurements. The values observed by observer 1 were submitted for statistical analyses.

Table 1:

Craniofacial measurements (mm)	ICC value	p-value
Facial height	0.997	> 0.05
Pro nasale-to-men ton distance	0.863	> 0.05
Inte zygomatic width	0.622	> 0.05
Intercanthal width	0.916	> 0.05

To find out that these craniofacial features can be used interchangeably, intercorrelation (association) was done between craniofacial features and is summarized in Table 3. Pearson's correlation analysis revealed a significant and positive (direct) correlation between facial height and pro nasale–to-men ton distance (r = 0.83, P < 0.001) , facial height and inter zygomatic width (r = 0.30, P < 0.01) [F, pro nasale-to-men ton distance and inter zygomatic width (r = 0.22, P < 0.05), and inter zygomatic width and intercanthal width (r = 0.25, P < 0.05).

Table 2: Inter correlation between craniofacial measurements (n=100).

Craniofacial measurements (mm)	Pro nasale-to-men ton distance	Inter zygomatic width	Intercanthal width
Facial height	0.83* (Sig.)	0.30* (Sig.)	(NS)

This high correlation was especially found between facial height and pro nasale-to-men ton distance and facial height and inter zygomatic width.

Discussion

Determination of sex is an important concern to the forensic anthropologist as it is critical for individual identification. The anthropometric study using craniofacial features is probably the most important in this context. [5] In the field of forensic medicine, normally the available materials after sufficiently long period of death are utilized to determine various body characteristics such as age and sex for identification of an individual. Gender has long been determined from skull, pelvis, and the long bones with epiphysis and metaphysis in unknown skeletons. The use of anthropometry may arise under several circumstances, i.e., natural, intentional, and accidental (air crash, train accidents, flood, fire, etc.). The gender of an individual can be identified accurately in 80% of cases using skull alone and 98% cases using pelvis and skull together. [6] Apart from this, the anthropometry of face is important in formulating standard sizes while planning facial surgeries and designing of the facial equipment. Akinbami and Mark Ikpeama demonstrated that genetic, environmental, and hormonal factors play a significant role in growth discrepancies. [7] There are significant differences in hormonal levels at different stages of life, and with such changes, there may be corresponding changes in anthropometric craniofacial parameters. Bazmi and Zahir stated that facial anthropometry is a direct means of facial measurement that uses standard landmarks and instrumentation to compare populations. [8]

In the present study, we observed significantly increased (P < 0.001) facial height with a mean ± standard deviation (SD) of 112.10 ± 5.66 mm in males and 102.15 ± 5.40 mm in females. Our findings are in accordance with the findings of Joy et al. They reported a higher facial height with a mean ± SD of 12.25 ± 2.11 cm in males and 11.19 ± 1.92 cm in females of Igbo ethnic origin.[9] In their study, they also stated that during maturity, there is a natural increase in the cartilaginous tissue of the face causing an increase in certain facial parameters. According to their study, the sexual difference is better projected as one attains adulthood.[9] According to Joy et al., the facial height used to determine sexual dimorphism was significantly higher in males (12.25 cm) compared to females (11.19 cm) of Igbo ethnic group among Nigerians with P < 0.05. [9] Similar findings were reported by Anibor et al. in the age group between 18 and 30 years. They observed that the mean facial height was 11.58 cm in Ijaw males and 10.86 cm in Ijaw females. [10]

In the present study, the inter zygomatic arch width was significantly higher in males (99.83 ± 5.64 mm) as compared to females (96.10 ± 5.83 mm) with P = 0.002. The findings of the present study are in accordance with the findings of Kasaab who reported the inter zygomatic distance in males to be 120.90 ± 6.4 mm, and in females, it was less and was found to be 110.35 ± 5.9 mm, in their study among dental students of University of Mosul. [11]

Agarwal et al. stated that the face can be reconstructed (identifying the dead), superimposed, or compared to facial photographs (mistaken identities or missing persons) based on the dysmorphic characters using anthropological measurements. the diagnosis of many dysmorphic syndromes is based on advanced cytogenetic and molecular techniques. orbit facial anthropometrics have become an important tool used by a genetic counselor and reconstructive surgeons. [12] in the present study, the mean intercanthal width did not differ (p > 0.05) between the two genders. the mean ± sd was observed to be 30.10 ± 3.06 mm in males and 29.80 ± 2.87 mm in females. our findings were similar to the study done by Agarwal et al. who reported the intercanthal width in the age group above 25–40 years; the mean ± sd was 32.50 ± 2.82 mm in males and 32.00 ± 2.67 mm in females among the residents of Chhattisgarh region. the results of our findings are in contrast to the study done by Oladipo et al. who reported that the intercanthal distance was significantly higher in males (3.40 ± 0.14 cm) as compared to females (3.00 ± 0.39 cm) among nigerians. [13] younger population tends to have lower values of intercanthal distance in comparison to older population, and the canthal measurements became constant in the third decade of life. this was in accordance with Fedelis and sluggard and pryor. [14,15] In the present study, pro nasale-to-men ton distance was significantly higher in males (72.24 ± 5.32 mm) as compared to females (62.95 ± 4.29 mm) with P < 0.001. To the best of our knowledge, no such study comparing the pro nasale-to-men ton distance has been done. Hence, we included this parameter in our study to assess the alterations in the middle third of the face and protrusion of men ton region. Further, a significant and high correlation was found in our study, especially between facial height and pro nasale-to-men ton distance (r = 0.83, P < 0.001) and facial height and inter zygomatic width (r = 0.30, P < 0.01), indicating that these craniofacial features can also be used interchangeably.

Conclusion

The craniofacial features may serve as diagnostic markers to discriminate male and female genders and can also be used interchangeably. In the present study, we assessed four parameters though it is not necessary to use all of them to differentiate the genders. Our study depicted significant variation in measurements when both the genders were compared though the intercanthal distance showed minimal variation. Difference of 2–3 mm can be appreciable when measurements are carried out in dry skull which reiterates the role of soft tissue in the same. There are various parameters to determine gender, but physical anthropometry will guide us to determine the gender of unidentified skull remains. The present study concludes that the physical anthropometry of Lucknow population with larger sample size will give a standard and concrete range of measurements to decipher unidentified remains of this locality.

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