

External Ear Anthropometry and Sexual Dimorphism among Students of Bayelsa Medical University, Nigeria: A Cross-Sectional Study

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Abstract—External ear dimensions show population, age, sex and side-related variation, making auricular anthropometry relevant to forensic identification, reconstructive surgery, ergonomic design and biometric research. This cross-sectional study assessed selected external ear parameters among 308 students of Bayelsa Medical University, Yenagoa, Nigeria, comprising 160 males and 148 females. A digital vernier caliper was used to measure left and right ear length, ear width, lobular length and lobular width. Ear index was calculated as ear width divided by ear length multiplied by 100. Data were summarised using descriptive statistics and sex-based comparisons were performed with the independent samples t-test at a significance level of $P < 0.05$. Males had significantly greater left and right ear length than females, with both sides measuring 60.42 ± 4.78 mm in males and 59.08 ± 3.38 mm or 59.08 ± 3.36 mm in females ($P = 0.005$). Ear width showed a larger sex difference, with males recording greater left ear width than females (35.78 ± 2.16 mm versus 31.82 ± 2.88 mm, $P < 0.001$) and greater right ear width than females (35.77 ± 2.16 mm versus 31.84 ± 2.89 mm, $P < 0.001$). Ear index was also significantly higher in males on both sides ($P < 0.001$), indicating broader auricular proportions. Lobular length did not differ significantly between sexes, while lobular width was significantly greater in females on both sides ($P < 0.001$). These findings demonstrate measurable sexual dimorphism in the external ear of the study population, particularly for ear width, ear index and ear length. The study provides population-specific reference values for young adult students in Bayelsa State and supports the use of auricular measurements as supplementary variables in forensic, anatomical and clinical contexts.

Index Terms—auricle, anthropometry, external ear, forensic anthropology, Nigeria, sexual dimorphism

I. Introduction

Anthropometry is the systematic measurement of human body dimensions. In anatomical and forensic research, it supports the description of normal variation, the development of population-specific reference values and the comparison of physical traits across sex, age and ancestry groups. The external ear, or auricle, is useful in this context because it is visible, measurable, relatively accessible and structurally variable among individuals.

The auricle consists of cartilaginous and non-cartilaginous components, including the helix, antihelix, tragus, antitragus, concha and lobule. Its complex surface anatomy creates measurable differences in length, width, lobular dimensions, protrusion and overall shape. These features have attracted interest in forensic anthropology and personal identification because the external ear shows individual variation and may assist

identity assessment when used with other anatomical and biometric variables (Krishan et al., 2019; Rani et al., 2021).

Auricular measurements also have clinical value. Normative data guide reconstructive and aesthetic ear surgery, congenital anomaly assessment, prosthetic design and the fitting of hearing-related devices. In ergonomic design, population-specific ear data support the development of earphones, headsets, hearing protection devices and medical equipment that fit intended users more accurately (Lu et al., 2021). These applications require local data because auricular dimensions vary across populations.

Sexual dimorphism is one of the most frequently reported patterns in external ear anthropometry. Studies in different populations have often found larger auricular length and width in males, although lobular traits and side-related patterns vary across groups (Brucker et al., 2003; Bozkir et al., 2006; Sforza et al., 2009; Boesoirie et al., 2022; Hiware et al., 2024). Nigerian studies also show that ear morphology and morphometry differ across ethnic and regional groups, supporting the need for more local databases (Edibamode et al., 2019; Fakorede et al., 2021).

Bayelsa Medical University draws students from Bayelsa State and other parts of Nigeria. Although auricular anthropometry has been studied in selected Nigerian populations, specific reference data for students of Bayelsa Medical University are limited. Such data may be useful for anatomy education, forensic comparison, otoplastic planning and biometric research. This study therefore assessed selected external ear dimensions among students of Bayelsa Medical University and examined whether these parameters differ between males and females.

II. Materials and methods

Study design and setting

This was a descriptive cross-sectional anthropometric study conducted among students of Bayelsa Medical University, Yenagoa, Bayelsa State, Nigeria. The design was selected because the study aimed to measure external ear dimensions at a single point in time and compare measured parameters by sex.

Study population and sample size

The study involved 308 students, comprising 160 males and 148 females. The sample size was determined using Cochran's formula for sample size estimation with a 95% confidence level, an assumed prevalence of 50%, a 5% margin of error and a finite population correction based on the student population available to the researchers. Stratified random sampling was used to obtain male and female participants.

Eligibility criteria

Eligible participants were male and female students of Bayelsa Medical University who were willing to participate. Students were excluded if they reported a history of craniofacial trauma, congenital ear abnormality, ear disease or ear surgery, or if they declined participation.

Anthropometric measurements

Measurements were taken with a digital sliding vernier caliper. Participants were positioned in the Frankfort horizontal plane before measurement. The following variables were assessed separately on the left and right ears: ear length, ear width, lobular length and lobular width. Ear length was measured as the distance between the supaurale and subaurale. Ear width was measured as the distance between the preaurale and postaurale. Lobular length was measured as the distance between the incisura intertragica inferior and subaurale. Lobular width was measured as the distance between the anterior and posterior margins of the lobule. Ear index was calculated as ear width divided by ear length multiplied by 100. All ear measurements were recorded in millimetres.

Data management and statistical analysis

Data were entered into Microsoft Excel 2013 and analysed using IBM SPSS Statistics version 20.0. Continuous variables were summarised using mean, standard error of the mean, standard deviation, minimum and maximum values. Sex-based comparisons were performed using the independent samples t-test. Statistical significance was set at $P < 0.05$. Values previously reported as $P = 0.000$ were corrected to $P < 0.001$ because a P value cannot be exactly zero.

Ethical considerations

Participants received an explanation of the study purpose and measurement procedure before participation. Confidentiality and anonymity were maintained by excluding participant names from the data collection record. Approval was obtained from the Ethical Committee of Bayelsa Medical University.

III. Results

A total of 308 students participated in the study, including 148 females and 160 males. Female participants had a mean age of 20.57 ± 3.06 years, while male participants had a mean age of 23.50 ± 3.60 years. The mean height was 165.54 ± 8.45 cm in females and 173.27 ± 8.78 cm in males.

Sex-based comparisons showed significant differences in most auricular measurements. Males had significantly greater left and right ear length than females ($P = 0.005$ for both sides). The strongest differences were observed in ear width, with males having wider ears than females on both sides ($P < 0.001$). The ear index was also significantly higher in males for both ears ($P < 0.001$), indicating broader relative ear shape. Lobular length did not differ significantly between males and females, but lobular width was significantly greater in females on both sides ($P < 0.001$).

The left and right side measurements showed similar mean values for ear length, ear width and ear index. This suggests broad bilateral similarity in the summary data. A definitive test of bilateral asymmetry would require paired left-right analysis using the raw dataset, which was not available in the source tables.

Table 1. Demographic and external ear measurements by sex. Values are mean +/- standard deviation.

Variable	Female (n = 148)	Male (n = 160)	P value
Age (years)	20.57 +/- 3.06	23.50 +/- 3.60	<0.001*
Height (cm)	165.54 +/- 8.45	173.27 +/- 8.78	<0.001*
Left ear length (mm)	59.08 +/- 3.38	60.42 +/- 4.78	0.005
Left ear width (mm)	31.82 +/- 2.88	35.78 +/- 2.16	<0.001
Left lobular length (mm)	15.89 +/- 1.79	15.59 +/- 2.29	0.199
Left lobular width (mm)	23.14 +/- 4.00	21.22 +/- 1.80	<0.001
Left ear index	54.03 +/- 5.74	59.59 +/- 6.04	<0.001
Right ear length (mm)	59.08 +/- 3.36	60.42 +/- 4.78	0.005
Right ear width (mm)	31.84 +/- 2.89	35.77 +/- 2.16	<0.001
Right lobular length (mm)	15.91 +/- 1.82	15.48 +/- 2.53	0.096
Right lobular width (mm)	23.08 +/- 3.96	21.22 +/- 1.80	<0.001
Right ear index	54.05 +/- 5.73	59.59 +/- 6.04	<0.001

**Age and height comparisons were calculated from the summary means, standard deviations and sample sizes supplied in the source table. Ear measurement P values are from the independent samples t-test reported in the source table.*

Table 2. Overall descriptive statistics for the total study population. Values are mean +/- standard deviation.

Variable	Total n	Mean +/- SD
Age (years)	308	22.09 +/- 3.65
Height (cm)	308	169.56 +/- 9.44
Left ear length (mm)	308	59.77 +/- 4.21
Left ear width (mm)	308	33.88 +/- 3.21
Left lobular length (mm)	308	15.74 +/- 2.07
Left lobular width (mm)	308	22.15 +/- 3.21
Right ear length (mm)	308	59.77 +/- 4.20
Right ear width (mm)	308	33.88 +/- 3.21
Right lobular length (mm)	308	15.69 +/- 2.23
Right lobular width (mm)	308	22.11 +/- 3.17
Left ear index	308	56.92 +/- 6.51
Right ear index	308	56.93 +/- 6.51

IV. Discussion

This study examined selected external ear measurements among students of Bayelsa Medical University and found clear sex-related differences in several auricular parameters. Male students had significantly greater ear length, ear width and ear index than female students, while female students had wider lobules. Lobular length did not differ significantly between the sexes. These results indicate that the external ear shows measurable sexual dimorphism in the study population, especially in ear width and ear index.

The greater ear length and width observed among males are consistent with reports from several populations where male auricular dimensions exceeded female values (Brucker et al., 2003; Bozkir et al., 2006; Sforza et al., 2009; Boesoirie et al., 2022; Hiware et al., 2024). This pattern may reflect broader sex-related differences in craniofacial growth, body size and soft tissue dimensions. In the present study, males were also taller and older on average than females. This is important because age and general body size may influence external ear dimensions. Future analysis should adjust for age and height through regression modelling to determine whether sex remains an independent predictor of auricular dimensions.

Ear width produced the largest sex difference in this study. The difference was observed on both the left and right sides and was accompanied by a higher ear index in males. Because ear index expresses width relative to length, the finding suggests that male participants had broader auricular proportions rather than only

longer ears. This agrees with studies that view auricular ratios as useful in describing external ear shape rather than size alone (Purkait & Singh, 2007; Sforza et al., 2009).

The finding that female students had greater lobular width differs from the general pattern observed for ear length and ear width. Lobular traits may respond to different biological, cultural or mechanical influences. For example, habitual earring use and stretching of the lobular soft tissue may affect lobular dimensions in some female populations, although this study did not collect data on earring history or lobular piercing practices. Future studies should include these variables because they may improve interpretation of lobular variation.

The present findings contribute to Nigerian auricular anthropometry. Edibamode et al. (2019) reported external ear dimensions among adult Ijaws in Bayelsa State and emphasised the value of local data for reconstructive surgery and anthropometric research. Fakorede et al. (2021) also showed that ear morphology and morphometry have forensic relevance among Hausa, Igbo and Yoruba populations in Nigeria. The present study adds data from a university student population in Bayelsa State, where participants may represent a mixture of ethnic backgrounds and young adult age groups.

The study has practical relevance. In forensic contexts, external ear measurements may serve as supplementary indicators in sex estimation and personal identification when used with other physical traits. In clinical practice, local normative data may assist otoplasty planning, auricular reconstruction and prosthetic design. In product design, the data may support better fitting of ear-related devices for young adult users. These applications should be approached cautiously because the study did not develop a predictive model for sex classification and did not test the accuracy of ear measurements in individual identification.

V. Conclusion

External ear measurements among students of Bayelsa Medical University show significant sexual dimorphism. Male students had greater ear length, ear width and ear index, while female students had greater lobular width. Lobular length did not show a significant sex difference. The findings provide local reference data for young adults in Bayelsa State and may support forensic, anatomical, clinical and ergonomic applications.

VI. Declarations

Supplementary materials: None.

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