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Morphometric Study of the External Ear of Ikwerre Indigenes in Rivers State, Nigeria

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Abstract- ***The external ear is a morphologically complex structure that captures, concentrates, and amplifies sound waves to the inner ear. Morphometry of the external ear is essential in anthropological studies, forensic identification, and clinical applications. This study aimed to evaluate the external ear morphology among adult Ikwerre indigenes of Rivers State, Nigeria. A cross-sectional descriptive design was employed, and 200 healthy participants (100 males and 100 females) aged 18–50 years were selected using simple random sampling. Measurements of auricular height (AH), auricular width (AW), auricular index (AI), lobular height (LH), lobular width (LW), and lobular index (LI) were obtained bilaterally using standardized anthropometric methods. Paired sample t-tests were used to assess right-left differences, while independent t-tests compared male and female measurements. Results revealed that in males, auricular height (right: 54.70 ± 3.65 mm; left: 54.38 ± 2.64 mm; p = 0.02), auricular width (right: 32.93 ± 1.47 mm; left: 32.88 ± 1.48 mm; p < 0.001), and lobular height (right: 16.13 ± 1.07 mm; left: 16.04 ± 1.07 mm; p = 0.001) showed significant bilateral asymmetry, whereas auricular index, lobular width, and lobular index were symmetrical. In females, auricular width, lobular height, lobular width, and lobular index demonstrated right–left differences, while auricular height and auricular index were symmetrical. Comparison between sexes showed that males had significantly larger auricular width, auricular index, and lobular height than females, whereas auricular height and lobular index showed no significant sex differences. In conclusion, the study highlights population-specific patterns of auricular and lobular dimensions, with notable sexual dimorphism and mild bilateral asymmetry. These findings provide essential anthropometric reference data for the Ikwerre population, which may be applied in forensic identification, clinical evaluation, and ergonomic design.***

Index Terms- ***External Ear, Morphometry, Variations, Ikwerre, Rivers State.***

I. INTRODUCTION

The human external ear is a morphologically complex structure that captures, concentrates, and amplifies sound waves for transmission to the tympanic membrane and inner auditory apparatus (Chatra, 2011; Standring et al., 2008). Commonly referred to as the auricle or pinna, the external ear comprises multiple distinct substructures, which includes; helix, antihelix, tragion, antitragion, lobule, cymba concha, cavum concha, triangular fossa, intertragic incisure, and the external auditory meatus, which together produce the characteristic eminences and depressions of the lateral auricular surface and contribute to its functional role in hearing and stimulus modification (Lee et al., 2018; Deopa et al., 2013).

Beyond its auditory role, the external ear has long served as an individualizing anatomical feature and has been used in personal identification since the late nineteenth century (Rani et al., 2020). The external ear shows wide interindividual and interpopulation variation in shape (for example, oval, round, triangular, and rectangular), size, elevation, and other morphological attributes, making ear anthropometry valuable to physical anthropologists, forensic scientists, plastic and reconstructive surgeons, clinicians who diagnose congenital and acquired ear conditions, and designers of ear-related products (Rani et al., 2020; Jan et al., 2023; Irozulike et al., 2024; White et al., 2012; Tsuno et al., 2022).

The lobule, or earlobe, is a soft-tissue region at the inferior margin of the auricle that lacks cartilage but contains nerves and blood vessels; its attachment pattern varies between individuals as either attached or free (detached) and is influenced by both genetic and environmental factors (Deep et al., 2016; Purkait,

2015; Irozulike et al., 2024). Population studies within Nigeria report mixed patterns of earlobe prevalence: attached earlobes predominate in some groups (for example, Ika and other southern Nigerian samples), whereas other populations have reported higher frequencies of free earlobes or sex-related differences in attachment (Ese et al., 2021; Asiwe et al., 2021; Paul et al., 2022; Oyubu et al., 2019; Francis & Okoseimiema, 2022). International data likewise document variable distributions of auricular shapes and earlobe types among different communities (Attalla et al., 2020; Irozulike et al., 2024).

Despite a growing body of anthropometric research on ear morphometry across diverse populations, precise morphometric data for the Ikwerre ethnic group of Rivers State remain limited. The Ikwerre constitute one of the largest ethnic groups in Rivers State and therefore represent an important population for establishing regional anthropometric reference data that have relevance for forensic identification, clinical practice, and ergonomic design. Accordingly, this study evaluates the external ear morphometry of adult Ikwerre participants, with the aim of documenting morphometric characteristics within this population.

II. METHODOLOGY

Research Design

This study employed a cross-sectional descriptive research design to assess the morphometric characteristics of the external ear among Ikwerre indigenes of Rivers State, Nigeria.

Study Area and Population

The study was conducted in Rivers State, Nigeria, and the study population comprised adult male and female participants of the Ikwerre ethnic group aged 18–50 years. The Ikwerre people predominantly inhabit areas within and around Port Harcourt, Obio-Akpor, Ikwerre, and Emohua Local Government Areas, of Rivers State, Nigeria. The Ikwerre ethnic group has an estimated population of approximately 1,390,893 individuals (Eyindah & Obah, 2021). Traditionally, Ikwerre society is organized into clans and villages, with farming, fishing, and trading constituting the principal historical occupations of the people.

Sampling

A simple random sampling technique was employed for this study. A total of 200 participants from the Ikwerre ethnic group were randomly selected, comprising 100 males and 100 females.

Selection Criteria

Participants included in the study were indigenes of the ethnic group under investigation, with lineage traced up to the fourth generation to ensure preservation of the traits of interest, were clinically healthy and physically fit, fell within the age range of 18–50 years, had no alterations in normal external ear morphology, and provided informed consent to participate. Conversely, individuals were excluded if they were non-indigenes of the ethnic group, had physical or mental challenges, were younger than 18 years or older than 50 years, exhibited altered external ear morphology due to congenital anomalies, trauma, tumors, ear infections, previous ear surgery, or the use of accessories that modify ear shape, or declined to give consent for participation in the study.

Method of Data Collection

A digital Vernier calliper of accurate reading of 0.01mm was used to take morphometric measurements of the external ears. To guarantee accuracy, measurements will be taken twice for each parameter, and the average of the two measurements will be taken. All participants were required to remove their earrings before measurements was be taken.

The following parameters were measured;

1. Total Auricular Height (TAH): Measured as the distance from the highest point of the auricle (most superior point of the helix -Supra-aurale) to the inferior most point of the earlobe (Sub-aurale).
2. Total Auricular width (TAW): Measured as the distance from the tragus-ear root (most anterior part of the auricle- pre-aurale) to the maximum convexity of the helix (most posterior part of the auricle-post-aurale).

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3. Lobular Height (LH): Measured as the distance from the deepest point of intertragic notch to the caudal part of the earlobe (sub-aurale).
4. Lobular Width (LW): Measured as the distance from the most anterior part of the earlobe to the posterior part.
5. Lobular Index (LI): It is a numerical ratio used in ear morphometry to describe the shape of the ear lobe. It is a ratio of the lobular height to lobular width multiplied by 100
6. Auricular Index (AI): It is a ratio of ear length to ear width multiplied by 100.

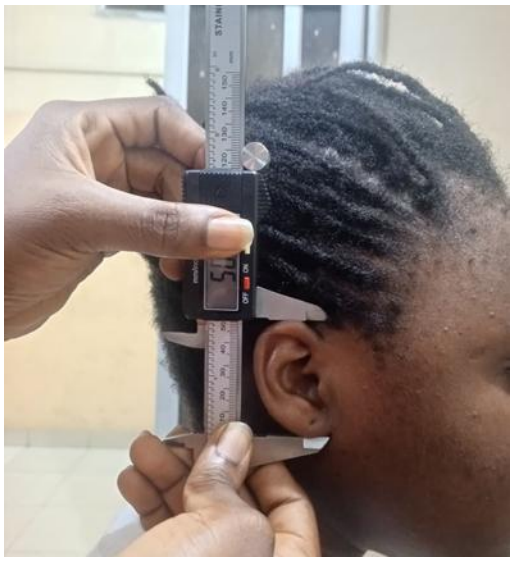

Figure 1: Anthropometric measurements of the external ear; Auricular Height (A), Auricular Width (B), Lobular Height (C), Lobular Width (D).

Statistical Analysis

The data collected was statistically analysed using IBM Statistical Package for the Social Sciences version 25 (IBM-SPSS 25). Descriptive statistics, including mean, standard deviation, standard error,

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were calculated for both male and female groups. For inferential statistical analysis. An independent t-test was conducted to compare the means of the variables between males and females, and paired sample t-test was used for comparing right and left sides. This study employed a statistical significance level of $\alpha = 0.05$ and a confidence interval of 95%.

Ethical Approval

The research and ethics committee at the University of Port Harcourt approved this study. Each participant was provided with information regarding the objectives and procedures involved in the research, and all individuals willingly gave their consent to participate.

III. RESULTS

The results of this study were presented in tables and figures

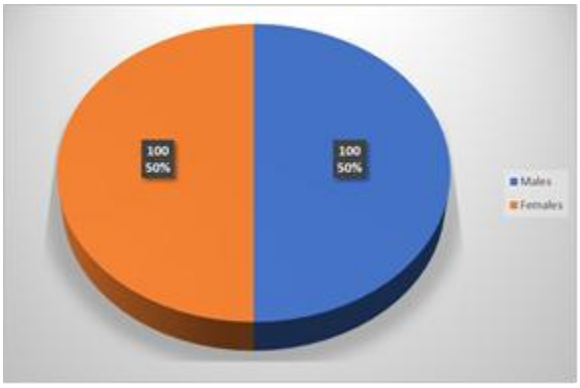

Figure 2: Demographic distribution of study participants.

Table 1: Statistical analysis of the measured variables on the right and left sides of male participants.

Parameters		N	Mean	SD	SEM	t	df	Sig. (2-tailed)	Inference
Pair 1	Right - AH	100	54.70	3.65	0.36	2.366	99	0.02	Significant
	Left - AH	100	54.38	2.64	0.26				
Pair 2	Right - AW	100	32.93	1.47	0.15	4.991	99	0.000	Significant
	Left - AW	100	32.88	1.48	0.15				
Pair 3	Right - AI	100	60.44	4.43	0.44	1.423	99	0.158	Not Significant
	Left - AI	100	60.60	3.91	0.39				
Pair 4	Right - LH	100	16.13	1.07	0.11	3.525	99	0.001	Significant
	Left - LH	100	16.04	1.07	0.11				
Pair 5	Right - LW	100	13.06	1.52	0.15	1.817	99	0.072	Not Significant
	Left - LW	100	13.13	1.54	0.15				
Pair 6	Right - LI	100	81.15	9.81	0.98	-0.46	99	0.646	Not Significant
	Left - LI	100	82.09	10.08	1.01				

AH= Auricular Height; AW= Auricular Width; LH= Lobular Height; LW= Lobular Width; LI= Lobular Index; AI= Auricular Index; N= Sample Size; SD= Standard Deviation; SEM= Standard Error of Mean; df= Degree of Freedom.

In male participants, paired comparison revealed significant right–left differences in auricular height (right: 54.70 ± 3.65 mm vs left: 54.38 ± 2.64 mm; $p = 0.02$), auricular width (right: 32.93 ± 1.47 mm vs left: 32.88 ± 1.48 mm; $p < 0.001$), and lobular height (right: 16.13 ± 1.07 mm vs left: 16.04 ± 1.07 mm; $p = 0.001$), with slightly higher mean values on the right side. Conversely, auricular index (right: 60.44 ± 4.43 vs left: 60.60 ± 3.91; $p = 0.158$), lobular width (right: 13.06 ± 1.52 mm vs left: 13.13 ± 1.54 mm; $p = 0.072$), and lobular index (right: 81.15 ± 9.81 vs left: 82.09 ± 10.08; $p = 0.646$) showed no significant bilateral differences, indicating symmetry in these proportional parameters (Table 1).

Table 2: Statistical analysis of the measured variables on the right and left sides of female participants.

Parameters		N	Mean	SD	SEM	t	df	Sig. (2-Tailed)	Inference
Pair 1	Right - AH	100	54.24	1.92	0.19	1.00	99	0.32	Not Significant
	Left - AH	100	54.14	1.87	0.19				
Pair 2	Right - AW	100	31.99	1.04	0.10	2.34	99	0.021	Significant
	Left - AW	100	31.88	1.02	0.10				
Pair 3	Right - AI	100	59.05	2.83	0.28	-0.67	99	0.504	Not Significant
	Left - AI	100	58.96	2.83	0.28				
Pair 4	Right - LH	100	15.46	0.81	0.08	3.538	99	0.001	Significant
	Left - LH	100	15.39	0.81	0.08				
Pair 5	Right - LW	100	12.75	0.93	0.09	-2.89	99	0.005	Significant
	Left - LW	100	12.7	0.95	0.10				
Pair 6	Right - LI	100	82.63	6.97	0.70	-4.05	99	0.00	Significant
	Left - LI	100	82.71	7.17	0.72				

AH= Auricular Height; AW= Auricular Width; LH= Lobular Height; LW= Lobular Width; LI= Lobular Index; AI= Auricular Index; N= Sample Size; SD= Standard Deviation; SEM= Standard Error of Mean; df= Degree of Freedom.

Among female participants, paired comparison showed significant right–left differences in auricular width (right: 31.99 ± 1.04 mm vs left: 31.88 ± 1.02 mm; p = 0.021), lobular height (right: 15.46 ± 0.81 mm vs left: 15.39 ± 0.81 mm; p = 0.001), lobular width (right: 12.75 ± 0.93 mm vs left: 12.70 ± 0.95 mm; p = 0.005), and lobular index (right: 82.63 ± 6.97 vs left: 82.71 ± 7.17; p < 0.001). In contrast, auricular height (right: 54.24 ± 1.92 mm vs left: 54.14 ± 1.87 mm; p = 0.32) and auricular index (right: 59.05 ± 2.83 vs left: 58.96 ± 2.83; p = 0.504) showed no significant bilateral differences. Overall, females exhibit mild lateral asymmetry in auricular width and lobular dimensions, while auricular height and overall auricular proportions remain bilaterally symmetrical (Table 2).

Table 3: Comparison of the measured variables on the right and left between male and female participants.

Parameters		N	Mean	SD	SEM	t	df	Sig. (2-Tailed)	Inference
Pair 1	Male Right - AH	100	54.70	3.65	0.36	1.15	99	0.252	Not Significant
	Female Right - AH	100	54.24	1.92	0.19				
Pair 2	Male Left - AH	100	54.38	2.64	0.26	0.77	99	0.446	Not Significant
	Female Left - AH	100	54.14	1.87	0.19				
Pair 3	Male Right - AW	100	32.93	1.47	0.15	5.15	99	0.00	Significant
	Female Right - AW	100	31.99	1.04	0.10				
Pair 4	Male Left - AW	100	32.88	1.48	0.15	5.53	99	0.00	Significant
	Female Left - AW	100	31.88	1.02	0.10				
Pair 5	Male Right - AI	100	60.44	4.43	0.44	2.85	99	0.005	Significant
	Female Right - AI	100	59.05	2.83	0.28				
Pair 6	Male Left - AI	100	60.60	3.91	0.39	3.73	99	0.00	Significant
	Female Left - AI	100	58.96	2.83	0.28				
Pair 7	Male Right - LH	100	16.13	1.07	0.11	5.55	99	0.00	Significant
	Female Right - LH	100	15.46	0.81	0.08				
Pair 8	Male Left - LH	100	16.04	1.07	0.11	5.26	99	0.00	Significant
	Female Left - LH	100	15.39	0.81	0.08				
Pair 9	Male Right - LW	100	13.06	1.52	0.15	1.84	99	0.069	Not Significant

	Female Right - LW	100	12.75	0.93	0.09				
Pair10	Male Left - LW	100	13.13	1.54	0.15	2.52	99	0.013	Significant
	Female Left – LW	100	12.70	0.95	0.10				
Pair11	Male Right - LI	100	81.15	9.81	0.98	-1.25	99	0.216	Significant
	Female Right - LI	100	82.63	6.97	0.70				
Pair12	Male Left - LI	100	82.09	10.08	1.01	-0.52	99	0.602	Significant
	Female Left - LI	100	82.71	7.17	0.72				

AH= Auricular Height; AW= Auricular Width; LH= Lobular Height; LW= Lobular Width; LI= Lobular Index; AI= Auricular Index; N= Sample Size; SD= Standard Deviation; SEM= Standard Error of Mean; df= Degree of Freedom.

Comparison between male and female participants revealed no significant sex differences in auricular height on both the right and left sides ($p > 0.05$). However, auricular width, auricular index, and lobular height were significantly greater in males than females on both sides ($p \leq 0.05$), indicating clear sexual dimorphism in these parameters. Lobular width showed a side-specific difference, with a significant sex difference on the left side only, while the right side was not significant. In contrast, lobular index demonstrated no significant sex difference on either side. Overall, males exhibit larger auricular and lobular linear dimensions than females, whereas proportional lobular indices remain comparable between sexes (Table 3).

IV. DISCUSSION

Auricular height (ear height) in the present study showed mild bilateral asymmetry in males, with the right auricular height (54.70 ± 3.65 mm) being significantly greater than the left (54.38 ± 2.64 mm; $p = 0.02$), whereas females demonstrated bilateral symmetry, with no significant difference between the right (54.24 ± 1.92 mm) and left sides (54.14 ± 1.87 mm; $p = 0.32$). Additionally, no significant sexual dimorphism was observed in auricular height on either side, indicating comparable ear height between Ikwerre males and females. These findings partly contrast with Deopa et al. (2013), who reported significantly larger total ear height in males than females, suggesting pronounced sexual dimorphism in their study population. However, the bilateral symmetry observed in females in the current study aligns with Acharya et al. (2025), who reported no significant right–left differences in ear length among females and males. The observed differences across studies may reflect population-specific genetic influences, environmental factors, and methodological variations.

Auricular width in this study demonstrated consistent patterns of asymmetry and sexual dimorphism. In males, auricular width was significantly greater on the right (32.93 ± 1.47 mm) than the left (32.88 ± 1.48 mm; $p < 0.001$), while females also showed a significant right–left difference, with slightly higher values on the right side (31.99 ± 1.04 mm) compared to the left (31.88 ± 1.02 mm; $p = 0.021$). Furthermore, males had significantly wider auricles than females on both the right and left sides ($p < 0.001$). These findings strongly agree with Deopa et al. (2013), who reported significantly larger ear widths in males than females, supporting the presence of sexual dimorphism in auricular width. In contrast, Acharya et al. (2025) reported no significant bilateral differences in ear width in either sex, highlighting interpopulation variability in auricular dimensions.

Lobular height in the present study showed significant bilateral asymmetry in both sexes, with males exhibiting higher values on the right (16.13 ± 1.07 mm) compared to the left (16.04 ± 1.07 mm; $p = 0.001$), and females also showing a significant right-sided predominance (15.46 ± 0.81 mm vs 15.39 ± 0.81 mm; $p = 0.001$). Moreover, males had significantly greater lobular height than females on both sides ($p < 0.001$), indicating clear sexual dimorphism. These results are consistent with Deopa et al. (2013), who reported larger lobular height measurements in males compared to females.

However, Acharya et al. (2025) found no statistically significant bilateral differences in lobular height for either sex, although males generally demonstrated higher mean values. The consistent sexual dimorphism observed in the present study suggests that lobular height may be a reliable parameter for sex differentiation within the Ikwerre population.

With respect to lobular width, the present findings indicate partial asymmetry and limited sexual dimorphism. In males, lobular width did not differ significantly between the right (13.06 ± 1.52 mm) and left sides (13.13 ± 1.54 mm; p = 0.072), whereas females demonstrated significant bilateral differences, with a slightly higher value on the right (12.75 ± 0.93 mm) than the left (12.70 ± 0.95 mm; p = 0.005). Sex comparison revealed no significant difference on the right side, but males had a significantly larger lobular width than females on the left side (p = 0.013). Deopa et al. (2013) similarly reported greater lobular width values in males than females, reinforcing the role of sexual dimorphism. Conversely, Acharya et al. (2025) observed no significant bilateral or sex-related differences in lobular width, again emphasizing population-based variation. Overall, the findings suggest that lobular width demonstrates subtle asymmetry and sex differences among Ikwerre individuals, but these patterns are less consistent than those observed for auricular width and lobular height.

V. CONCLUSION

This study provides a comprehensive analysis of the external ear morphology and earlobe attachment patterns among adult Ikwerre indigenes of Rivers State. The findings indicate that auricular and lobular dimensions exhibit varying degrees of bilateral asymmetry, with males generally displaying larger measurements than females, particularly in auricular width and lobular height. Auricular height showed minimal sexual dimorphism, while lobular width exhibited subtle side- and sex-related differences. Overall, the data highlight both population-specific characteristics and sexual dimorphism in ear morphology, which can serve as valuable anthropometric reference for forensic identification, clinical assessment, and ergonomic design within the Ikwerre population.

VI. ACKNOWLEDGEMENT

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