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MORPHOMETRIC ANALYSIS OF THE EXTERNAL HUMAN EAR IN A NIGERIAN POPULATION

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ABSTRACT

Morphologic analysis of the human body has been a useful tool in forensic science, reconstructive surgeries and diagnostic purposes. The human ear with its unique individualistic features has been a very useful tool in personal identification. This study involves investigation into anatomical disparity of the outer human ear (103 males and 83 females) aged 17-26 years amongst the Ijaw population of Nigeria. The biometric variations such as shape and size of the external ear were investigated in all participants. Anatomical landmarks of the ear such as helix, earlobe and thickness of the earlobe were examined in the external ear. In this study, the oval shape is more prevalent in both males and females. Also the other shapes (round, triangular and rectangular) were observed. There is also bilateral asymmetry in both males and females. Normally rolled helix of the ear was common in males (29.1%) and flat helix of the ear was common in females (42.2%), also the other shapes of the helix like concave, wide covering scapha and rolled were observed in both sexes among the study population. This study provides normative baseline data of the external human ear that is of importance in personal identification in the population under study.

KEYWORDS: Forensic science, anthropology, human ear, morphological variations, Ijaws, Nigeria.

INTRODUCTION

The ear, especially the auricle being unique in shape has gained enormous recognition in anthropology and particularly in forensic science (Kumar & Singla 2013). Features of the ear have been acknowledged as an important tool in identification of individuals, gender, and age estimation in Forensic Sciences (Gibelli *et al.*, 1996). Aesthetically, it is crucial that the auricle (or auricula), a component of the external ear (or auris externa), has a natural and beautiful shape. Each auricle's shape, size, and orientation are as unique as fingerprints (Singhal *et al.*, 2016). Humans have a

huge range of biological variety; this variation makes us distinct and separates one individual from another. People differ in shape, size, skin colour, and many other qualities. A trait that is often disregarded is the architecture of the human external ear. The external ear is very variable, to the point where even the two ears of a single individual may be strikingly different. The length and breadth of the ear vary from person to person, and anthropometric points have been described to examine the measures of the external ear (Shireen *et al.*, 2015).

The shape of the ear is influenced by a combination of genetic, environmental and cultural and aesthetic factors (Vanco *et al.*, 1995).

Environmental factors play a significant role in influencing the shape and size of the external ear (Hu *et al.*, 2017). Studies have shown that ear size and shape can differ significantly among ethnic groups (Angelakopoulos, *et al.*, 2023). For example, some populations may have larger or more prominent ears, while others might have smaller or differently shaped auricles (the external part of the ear). The presence and type of ear lobes (attached vs. detached) also vary among ethnic groups.(Sharma, *et al.*, 2007).

The external human ear is a complex and highly variable anatomical structure, crucial for individual identification, particularly in forensic and medical contexts (Krishan *et al.*, 2019). However, identification challenges persist due to the absence of standardized methodologies and comprehensive databases. This hinders the accuracy of identification processes, potentially leading to misidentification or incorrect conclusions. Therefore, this research aims to identify and classify anatomical variations in the external ear structure, develop a standardized methodology for ear anatomy analysis, create a comprehensive database of external ear anatomical variations, and investigate the applications of this knowledge in forensic, medical, anthropometric, and biometric contexts.

The study will add to the existing body of material in the forensic science field with fresh knowledge on the variances and uniqueness of the human ear of both sexes in a Nigerian population and its significance in personal identification. The study therefore aims at determining the Anatomical variations in the external human ear in a Nigerian population.

METHODS

A total of 186 participants made up of 103 males and 83 females aged 16 - 26 years above participated in this study.

All Participants for the study were of the Ijaw ethnicity resident in Bayelsa State. Only subjects with no congenital ear abnormalities or history of ear surgery were recruited for the study in accordance with the Helsinki Declaration on human research.

Ethical approval was gotten from the College ethical board of the university and consent was obtained from all participants before the commencement of the study.

Data collection and measurements

Anatomical variations in the external ear were assessed using visual observation and imaging techniques, including photography.

Measurements of ear dimensions such as length, width, and curvature were taken with specialized tools, establishing criteria based on anatomical norms.

Subjects' ears were photographed using an Android phone camera at a consistent distance, with head position standardized. Ear length was measured from the auricle's highest point to the earlobe's lowest point using vernier calipers with a resolution of 0.01 mm.

Each participants sat in a Frankfort horizontal position and a digital vernier caliper (with an accuracy of 0.01mm) was used to obtain the following ear measurements:

Earlobe Measurement

i. Length: Measure the length of the earlobe from the base (where it attaches to the ear) to the tip.

ii. Width: Measure the width of the earlobe at its widest point.

iii. Thickness: Measure the thickness of the earlobe at its thickest point.

Helix Measurement

i. Length: Measure the length of the helix from the base (where it starts) to the tip.

ii. Width: Measure the width of the helix at its widest point.

iii. Height: Measure the height of the helix from the base to the highest point.

iv. Circumference: Measure the circumference of the helix at its widest point.

v. Curvature: Measure the degree of curvature of the helix (how much it curves inwards or outwards).

Measurement Techniques

i. Calipers: Use digital calipers to take precise measurements of the earlobe and helix.

ii. Protractor: Use a protractor to measure the angles between the earlobe and helix and the ear.

iii. Ruler: Use a ruler to measure the length and width of the earlobe and helix.

iv. Photography: Take photographs of the ear from different angles to capture the shape and dimensions of the earlobe and helix.

RESULTS

Table 1: Descriptive statistics of participants' ear measurements.

Parameters	Mean ± SD (n=186)	Range (mm)
Right helix height (mm)	54.99 ± 4.39	40.33 – 64.44
Left helix height (mm)	54.13 ± 4.53	42.20 – 64.28
Right helix width (mm)	27.90 ± 3.68	20.14 – 39.40
Left helix width (mm)	27.71 ± 2.44	20.21 – 40.67
Right lobular height(mm)	19.10 ± 4.26	11.02 – 30.41
Left lobular height (mm)	19.09 ± 4.23	11.21 – 30.09
Right lobular width (mm)	17.28 ± 2.96	12.41 – 23.40
Left lobular width (mm)	16.87 ± 2.18	12.45 – 21.50

Key: SD= Standard Deviation, mm=millimeters

Table 2: Demographic distribution of subjects.

Age	Male	Female	Percentage %
16 – 21	35	30	35
22 – 25	45	40	46
26 >	23	13	19
Total	103	83	100%

Table 3: Shapes of the human ear.

Variable	Male (N= 103)	Female (N=83)
Oval	40	34
Round	32	14
Triangular	18	20
Rectangular	13	15
Total	103	83

Table 4: Bilateral ear helix shape in males (N = 103) and females (N = 83).

Shape of Helix	Male		Female	
	N= 103	%	N= 83	%
Concave marginal	27	26.2	15	18.1
Normally rolled	30	29.1	12	14.4
Flat	24	23.3	35	42.2
Wide covering scapha	22	21.4	21	25.3

Table 5: Bilateral earlobe shape in males (N = 103) and females (N = 83).

Shape of Earlobe	Male		Female	
	N= 103	%	N= 83	%
Arched	17	16.5	30	36.1
Tongue	42	40.8	20	24.1
Square	12	11.8	15	18.1
Triangular	32	31.1	18	21.7

Table 6: Thickness of the earlobe.

Thickness of Earlobe	Male		Female	
	N= 103	%	N= 83	%
Medium	35	34.0	22	26.5
Thick	44	42.7	32	38.5
thin	24	23.3	29	35.0

DISCUSSION

The biometric variations of the human external ear have varied application both in forensic investigation, face reconstructive surgeries, as well as diagnosis of acquired and congenital abnormalities (Verma *et al.,* 2016; Murgod *et al.,* 2013).

The results of this study indicate that the oval-shaped ear was more in the male population under study, followed by the round, the triangular and then the rectangular shape. While in females, the oval shape was also more in the population, followed by triangular, round, and then rectangular shape. This is in line with previous findings by Krishan *et al.*, (2019) in a north-Indian population and Oladipo *et al.,* (2023) in a Nigerian population who reported that the oval ear shape was more prevalent in their study populations.

Also bilateral asymmetry exists as regards the shape of the ear in both sexes. Normally rolled helix of the ear was common in males (29.1%) and flat helix of the ear was common in females (42.2%), also the other shapes of the helix like concave, wide covering scapha and rolled were observed in both sexes among the study population. The shape and size of the earlobe show variations with regards to sides and sexes. In males it was found that the tongue shape was more, then the triangular, arched and square; while in the female population, the arched came first, then the tongue, triangular and lastly the square. The mean width of the right ear helix was found to be significantly wider than the mean width of the left ear helix in all subjects. Also, the ear helix height and the lobule width were higher for the right

side than for the left side in both sexes. This is in contrast with the study done by Kumar and Selvi (2016) which showed that the Malaysian female total ear length, width and ear lobe height were not significantly different on both sides.

The variability of the external human ear may be likened to not only the unique structure and characteristics but also the influence of genetic and environmental factors affecting the ear.

Some earlier studies by Cameriere *et al.*, 2011; Kumar & Singla 2013 have indicated that the unevenness of the external human ear in individuals is a pointer to make possible individualization in forensic investigations.

When fingerprints and programs for facial recognition are not available, human ear shapes and variations can be helpful for identification. Since the ear reaches its mature height at 13 years for males and 12 years for females, variations in the external ear's shape and size are crucial for the detection of congenital abnormalities, treatment planning, and surgery. The goal of the current investigation was to determine the external ear structural diversity among the Ijaw population that could be helpful for identification.

The current study's findings demonstrate that each ear is distinct in terms of size, shape, and other physical characteristics. The ear's varying anatomy in each individual can be used to assess the ear's uniqueness or individuality. Research has shown that these features exhibit remarkable individual variability in terms of shape and size contributing to the uniqueness of each person's ear (Rani *et al.*, 2021). The complex developmental process contributes to the diverse range of shapes and sizes observed in the ear helix and earlobe, making them ideal features for distinguishing between individuals.

CONCLUSION

This study provides valuable insights into the anatomical variations of the external human ear among the studied population. By examining demographic distribution, ear shapes, earlobe thickness, helix and earlobe parameters (which were measured), the prevalence of specific ear shapes were observed amongst the present studied population. The research sheds light on the diverse nature of ear anatomy, and the findings underscore the multifactorial influences on ear morphology. These influences highlight the importance of comprehensive assessments in understanding human anatomy.

The study's results have important implications across various fields. Therefore, moving forward, continued research should explore additional factors affecting ear morphology, enhancing our understanding of this intricate anatomical feature and its far-reaching implications.

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