

## Morphological Variations of the External Ear in Omuma Population Rivers State

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### Abstract

Studies have shown that ear shape and size differ significantly among populations, making it a valuable trait for anthropological and forensic. Was a descriptive and cross-sectional study where 400 participants (219 males and 181 females) aged 16-45 were used. Camera was used to take photographs with a 2cm graph sheet placed behind the ear horizontally and vertically to take reading from the photograph using a computer. The length of the right and left concha was  $2.56 \pm 0.31$  cm and  $1.8 \pm 0.28$  cm, respectively. The breadth of the right and left concha was  $1.63 \pm 0.32$  cm and  $2.45 \pm 0.24$  cm, respectively. The length of the right concha of males and females was  $2.43 \pm 0.22$  cm and  $2.6 \pm 0.3$  cm, respectively. There was a significant difference ( $p=0.045$ ) in the length of the right concha between males and females. The length of the left concha of males and females was  $2.48 \pm 0.2$  cm and  $2.45 \pm 0.2$  cm, respectively. There was a significant difference ( $p=0.039$ ) in the length of the left concha between males and females. The breadth of the right concha of males and females was  $2.38 \pm 0.4$  cm and  $2.24 \pm 0.32$  cm, respectively, there was no significant difference in the breadth of the right concha between males and females. The breadth of the left concha of males and females was  $1.75 \pm 0.31$  cm and  $1.53 \pm 0.3$  cm, respectively, there was no significant difference ( $p=0.102$ ) in the breadth of the left concha between males and females. The length of the right concha of subjects within the ages of 16-25, 26-35, and 36-45 was  $2.55 \pm 0.34$  cm,  $2.63 \pm 0.3$  cm, and  $2.84 \pm 0.53$  cm, respectively. There was a significant difference ( $p=0.03$ ) in the length of the right concha among the age groups. The length of the left concha of subjects within the ages of 16-25, 26-35, and 36-45 was  $2.52 \pm 0.31$  cm,  $2.62 \pm 0.32$  cm, and  $2.46 \pm 0.25$  cm, respectively. There was a significant difference ( $p=0.04$ ) in the length of the left concha among the age groups. The breadth of the right concha of subjects within the ages of 16-25, 26-35, and 36-45 was  $2.18 \pm 0.47$  cm,  $2.25 \pm 0.52$  cm, and  $1.94 \pm 0.48$  cm, respectively. There was no significant difference ( $p=0.263$ ) in the breadth of the right concha among the age groups. The breadth of the left concha of subjects within the ages of 16-25, 26-35, and 36-45 was  $1.64 \pm 0.32$  cm,  $1.65 \pm 0.32$  cm, and  $1.57 \pm 0.31$  cm, respectively. There was no significant difference ( $p=0.832$ ) in the breadth of the left concha among the age groups. Morphology of the helix on the studied population showed that 103 (25.8%) of the subjects had a concave marginal helix, 83 (20.8%) had a round helix, and 97 (24.1%) had a flat helix. The study provides a comprehensive morphometric and morphology profile of the concha and helix within this population. These findings could be useful in fields such as anthropology, forensics, and plastic surgery.

**Keywords:** External Ear, Morphometric, Morphology, Concha, Omuma, Darwin's Tubercle.

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### INTRODUCTION

The human ear is a complex and unique structure that plays a crucial role in hearing, balance, and communication. Its distinctive shape and size make it an attractive feature for biometric identification. Despite its potential, the ear has been understudied in comparison to

other facial features like fingerprints, iris patterns, and facial recognition (Lannarelli 1989).

Morphological variation in the human ear is influenced by genetics, ethnicity, age, sex, and environmental factors. Studies have shown that ear shape and size differ significantly among populations, making

it a valuable trait for anthropological and forensic applications (Islam, S. R. 2017).

In Nigeria, where ethnic diversity is vast, understanding these variations is crucial for developing accurate identification systems and for contributing to global knowledge on human variation. Continued research in this area will not only enhance the application of ear morphology in forensic and biometric fields but also provide deeper insights into the genetic and environmental factors that shape human physical traits (Chukwudi & Ekpo 2015).

The concept of using ear morphology for identification dates back several decades, with early studies demonstrating the potential of ear prints and images for distinguishing individuals. However, the field has gained renewed attention with advancements in imaging technology, computer vision, and machine learning, which have significantly improved the accuracy and efficiency of ear-based biometric systems (Krishan 2016).

Globally, research on ear morphology has been conducted across various populations to document the range of morphological variations. For example, studies have documented differences in ear size, shape, and structure across ethnic groups, and researchers have developed databases of ear images to aid in biometric system development (Verma *et al.*, 2016). Genetic studies have also explored the heritability of certain ear traits, revealing that some morphological features are strongly influenced by genetic factors (Wang & Jin, 2017).

For forensic scientists, the unique nature of ear morphology offers a reliable method of identifying individuals, particularly in cases where other biometric data is unavailable. In the field of bio-metrics, ear recognition technology is increasingly being developed as a non-intrusive and stable method for identifying individuals, complementing other biometric systems like facial recognition and fingerprinting (Verma *et al.*, 2016).

Johnson and Kim (2014) studied the sexual dimorphism of the helix form by analyzing 300 men and women. The researchers used stereophotogrammetry to capture the shape of the helix and other ear structures. Their results revealed that women generally had a more curved, inward-folded helix compared to men, who exhibited a more outward-curved helix. This difference in form was statistically significant, with the curvature in men's ears being broader. The researchers hypothesized that this sexual dimorphism in the helix's form might be linked to subtle differences in hearing sensitivity between the sexes, suggesting that the helix shape could influence the way sound is directed into the ear.

Rodriguez and Lin (2013) examined the relationship between concha length and ear lobe attachment types (free vs. attached) across a diverse sample of 400 participants. Using detailed ear measurements, they found that individuals with free earlobes tended to have longer conchas on average compared to those with attached earlobes. This anatomical variation is thought to be genetically influenced, as the study found a significant correlation with inherited traits. These results underscore the genetic underpinnings of concha length and ear morphology.

Sato and Kwon (2019) investigated concha breadth among populations with different ancestral backgrounds, focusing on adaptation to environmental conditions. Their study included 500 participants from Arctic, tropical, and temperate regions, measured using 3D ear scans. They found that individuals from colder climates, such as the Arctic, tended to have narrower conchas, while those from warmer, tropical regions had broader conchas on average. The researchers suggested that narrower conchas may help retain warmth in colder climates, while broader conchas aid in heat dissipation in warmer environments. This study highlights how concha breadth may be an adaptive trait influenced by climatic factors over generations.

## MATERIALS AND METHODS

A descriptive and cross-sectional design was employed. It is a research methodology that focuses on describing and documenting the characteristics, behaviors, and patterns of the specific population. The population study includes photographed images of the human ear of the indigenous people of Omuma. Participants whose parents, grandparents are indigenous of Omuma were recruited for this research. Data that was obtained or collected were a total sample of 400 Adults comprising of 219 males and 181 females respectively.

**Inclusion Criteria:** Adults males and females from age 16-45 years, persons with normal ears are indigenous of Omuma.

**Exclusion Criteria:** Individuals below 16 years of age, persons with apparent ear deformity and are not indigenous of Omuma.

### Sample and Sampling Technique

Morphological characteristics of the ear were captured in order to develop standards for the unique morphology of the ear in the Omuma population.

**Sample Size Determination:** Sample determination was done using Yamane, (1967) Formula.

Given:

Population size (N) = 100,000

Margin error (e) = 5% (or 0.05)

Yamane's Formula:

$$N = \frac{N}{1 + N \cdot e^2}$$

1. Square the margin of error:  
 $e^2 = (0.05)^2 = 0.0025$   
 Multiply the population size by the squared margin of error:  
 $N \cdot e^2 = 100,000 \times 0.0025 = 250$   
 Add 1 to the result:  
 $1 + N \cdot e^2 = 1 + 250 = 251$   
 Divide the population size by this result:  
 $n = 100,000 / 251 \approx 398.41$

**Method of Data Collection**

The consent of the participants was asked before initiating the data collection, the purpose was explained to each subject.

Participating in the study was voluntary, informed consent was obtained from participants and socio-demographics of each respondent such as age and sex.

In obtaining the digital picture of the subject the head is held high in a stable and anatomical position and

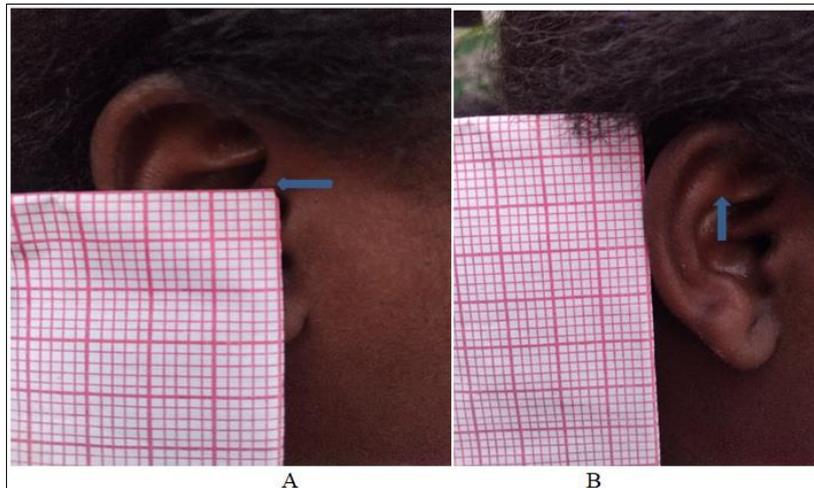
the participants were made to sit in a Frankfort position. A measurement graph is placed by the side of both ears for precise and accurate measurement and was photographed.

The method of data collection was adopted from Sharanbasappa *et al.*, (2018). Graphs 2 by 2 were placed behind the ear of the subject and photograph was taken. The graph was placed vertically behind the auricle and horizontally below the earlobe and pictures were taken,

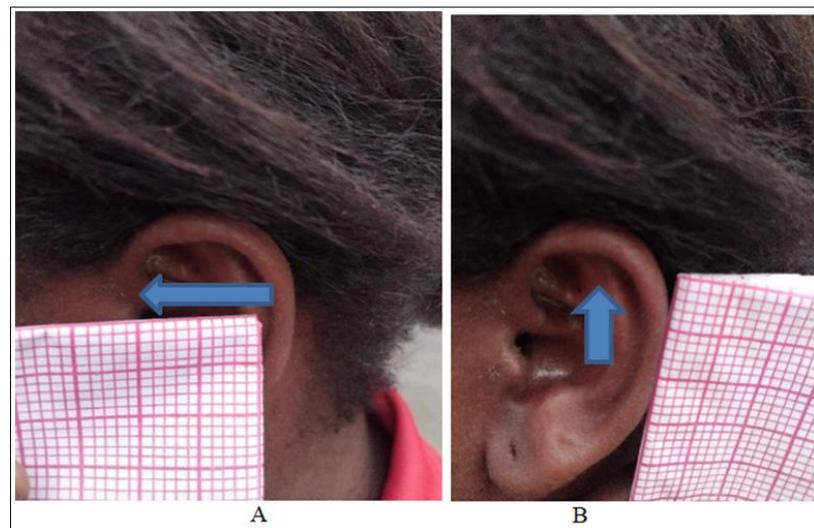
Pictures were transferred to the computer and measurement of Length of the concha and breadth of the concha was read from the graph. A second picture of the ear was also taken for morphological assessment. same procedure was used for both the left and right ear.

Parameters studied are:

1. Length of the concha
2. Breadth of the concha

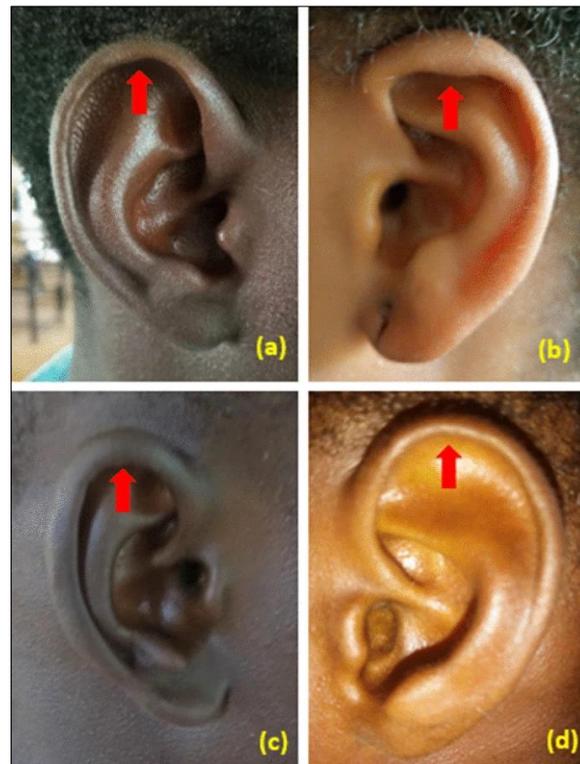


**Fig. 1: Diagram of (A) breadth and (B) length of Right Concha**



**Fig. 2: Diagram of (A) breadth and (B) length of Left Concha**

3. Shape/form of the helix (concave marginal, wide, flat, rolled)



**Fig. 3: Photographs form of the external ear helix (A. Concave marginal, B. wide, C. Rolled D. Flat)**

**Data Analysis**

Data from this study were analyzed using a statistical package for social sciences (SPSS) version 23. P-values less than  $< 0.05$  were considered statistically significant.

**Ethical Considerations**

Ethical clearance was obtained from the research and ethics committee of the faculty of basic medical science, River’s state university Nigeria. Informed consent was obtained from all participants prior to data collection.

**RESULTS**

**Table 1: Demographic Characteristics of Study Population (Omuma LGA)**

Characteristics	Frequency	Percentage (%)
<b>Gender</b>		
Male	219	54.8
Female	181	45.3
<b>Total</b>	<b>400</b>	<b>100</b>
<b>Age</b>		
16-25	133	33.3
26-35	164	41
36-45	103	25.75
<b>Total</b>	<b>400</b>	<b>100</b>

**Table 2: Morphometry of the Concha of the Study Population (Omuma LGA)**

	Mean $\pm$ SD (cm)
Length of the Concha (right)	2.56 $\pm$ 0.31
Length of the Concha (left)	1.80 $\pm$ 0.281
Breadth of the Concha (right)	1.63 $\pm$ 0.32
Breadth of the Concha (left)	2.45 $\pm$ 0.0.24

Key; N=Non-significant  
N=Significant

**Table 3: Comparison of the Morphometry of the External Ear of the Study Population (Omuma LGA) based on sexual variations**

Gender	Length of The Right Concha (cm)	Length of The Left Concha (cm)	Breadth of The Right Concha (cm)	Breadth of The Left Concha (cm)
Male	2.43±0.22	2.48±0.2	2.38±0.4	1.75±0.31
Female	2.60±0.3	2.45±0.2	2.24±0.32	1.53±0.3
p-value	0.043	0.039	0.393	0.102
t-value	1.75	0.26	0.877	1.719
Inference	S	S	NS	NS

Key; N=Non-significant  
N=Significant

**Table 4: Comparison of the Morphometry of the External Ear of the Study Population (Omuma LGA) based on Age**

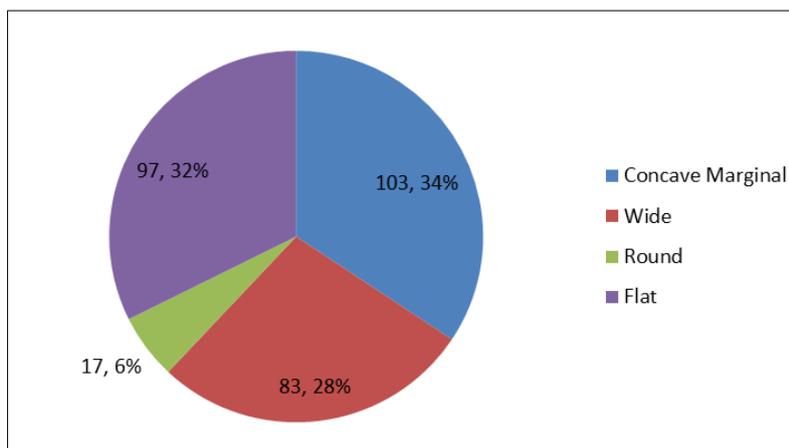
Age	Length of The Right Concha (cm)	Length of The Left Concha (cm)	Breadth of The Right Concha (cm)	Breadth of The Left Concha (cm)
16-25	2.55±0.34 <sup>a</sup>	2.52±0.31 <sup>a</sup>	2.18±0.47	1.64±0.32
26-35	2.63±0.3 <sup>b</sup>	2.62±0.32 <sup>b</sup>	2.25±0.52	1.64±0.32
36-45	2.84±0.53 <sup>c</sup>	2.46±0.25 <sup>c</sup>	1.94±0.48	1.57±0.31
p-value	0.03	0.04	0.263	0.832
t-value	1.812	0.787	1.386	0.184
Inference	NS	NS	NS	NS

Values with different superscripts are significantly different (p<0.05)

Key; N=Non-significant  
N=Significant

**Table 5: Morphology of the External Ear of the Study Population**

Shape of the Helix	Frequency	Percentage (%)
Concave Marginal	103	25.8
Wide	83	20.8
Round	17	29.3
Flat	97	24.1
<b>Total</b>	<b>400</b>	<b>100</b>



**Figure 4: Morphology of the External Ear of the Study Population**

**RESULT ANALYSIS**

Table 1 shows the demographic characteristics of the study population. The number of males and females was 219 (%) and 181(%), respectively. The number of subjects within the ages of 16–25, 26–35, and 36–45 was 133 (33.3%), 164 (41%), and 103 (25.8%), respectively.

Table 2 shows the morphometry of the concha of the study population. The length of the right and left concha was 2.56 ± 0.31 cm and 1.8 ± 0.28 cm, respectively. The breadth of the right and left concha was 1.63 ± 0.32 cm and 2.45 ± 0.24 cm, respectively.

Table 3 shows the comparison of the morphometry of the external ear of the study population

(Omuma LGA) based on gender. The length of the right concha of males and females was  $2.43 \pm 0.22$  cm and  $2.6 \pm 0.3$  cm, respectively. There was a significant difference ( $p=0.045$ ) in the length of the right concha between males and females. The length of the left concha of males and females was  $2.48 \pm 0.2$  cm and  $2.45 \pm 0.2$  cm, respectively. There was a significant difference ( $p=0.039$ ) in the length of the left concha between males and females. The breadth of the right concha of males and females was  $2.38 \pm 0.4$  cm and  $2.24 \pm 0.32$  cm, respectively. However, there was no significant difference in the breadth of the right concha between males and females.

The breadth of the left concha of males and females was  $1.75 \pm 0.31$  cm and  $1.53 \pm 0.3$  cm, respectively. However, there was no significant difference ( $p=0.102$ ) in the breadth of the left concha between males and females.

Table 4 shows the comparison of the morphometry of the external ear of the study population (Omuma LGA) based on age. The length of the right concha of subjects within the ages of 16–25, 26–35, and 36–45 was  $2.55 \pm 0.34$  cm,  $2.63 \pm 0.3$  cm, and  $2.84 \pm 0.53$  cm, respectively. There was a significant difference ( $p=0.03$ ) in the length of the right concha among the age groups. The length of the left concha of subjects within the ages of 16–25, 26–35, and 36–45 was  $2.52 \pm 0.31$  cm,  $2.62 \pm 0.32$  cm, and  $2.46 \pm 0.25$  cm, respectively. There was a significant difference ( $p=0.04$ ) in the length of the left concha among the age groups. The breadth of the right concha of subjects within the ages of 16–25, 26–35, and 36–45 was  $2.18 \pm 0.47$  cm,  $2.25 \pm 0.52$  cm, and  $1.94 \pm 0.48$  cm, respectively. There was no significant difference ( $p=0.263$ ) in the breadth of the right concha among the age groups. The breadth of the left concha of subjects within the ages of 16–25, 26–35, and 36–45 was  $1.64 \pm 0.32$  cm,  $1.65 \pm 0.32$  cm, and  $1.57 \pm 0.31$  cm, respectively. There was no significant difference ( $p=0.832$ ) in the breadth of the left concha among the age groups.

Table 5 shows the morphology of the helix of the study population. One hundred and three (25.8%) of the subjects had a concave marginal helix, 83 (20.8%) had a round helix, and 97 (24.1%) had a flat helix.

## DISCUSSION

The research results present a detailed morphometric analysis of the external ear, specifically the concha and helix, of the study population from Omuma Local Government Area (LGA). The findings cover comparisons based on gender and age, highlighting variations in concha measurements and helix morphology within this group.

The present study results showed that the mean dimensions of the concha indicate noticeable asymmetry in both the length and breadth between the right and left

conchae. The right concha length averaged 2.56 cm, while the left measured 1.8 cm. Conversely, the right concha's breadth (1.63 cm) was smaller than the left (2.45 cm). This asymmetry may point to inherent anatomical variations within individuals that could be influenced by genetic, environmental, or developmental factors. However, in the study by Fakorede *et al.*, (2021), concha length measurements in the Hausa, Igbo, and Yoruba populations were  $29.10 \pm 1.96$  mm and  $29.17 \pm 2.22$  mm in males and females, respectively, for the right ear, while for the left ear, they were  $28.95 \pm 2.06$  mm in males and  $29.23 \pm 2.16$  mm in females.

According to the research results, gender-based analysis shows distinct differences in concha length between males and females. Females had slightly longer right conchae (2.6 cm) than males (2.43 cm), with the difference statistically significant ( $p = 0.045$ ). Similarly, the left concha length was also significantly different between genders ( $p = 0.039$ ). These findings suggest a gender-related variation in conchal length, where females may tend to have slightly longer conchae than males. This is consistent with the research of Fakorede *et al.*, (2021), whose study showed a significant variation in conchal length between males and females. Additionally, the research by Taura *et al.*, (2019) showed significant variation in the morphometry of the external ear between males and females. However, in terms of conchal breadth, no statistically significant differences were found between genders. This suggests that while gender may affect conchal length, it does not significantly influence conchal breadth in this population.

Further analysis in our study reveals insights based on age. The right concha length increased slightly with age, with subjects aged 36–45 showing the longest right concha length (2.84 cm), a statistically significant difference ( $p = 0.03$ ) across age groups. The left concha length also showed a significant age-related variation ( $p = 0.04$ ), though this change was less pronounced on the left concha than the right concha. This pattern may indicate an age-related growth trend in concha length. In contrast, the concha breadth did not show significant variation with age in either ear, indicating that age influences concha length more than breadth in this population. This is consistent with the research of Jan and Saleem (2023), whose study showed that the length of the external parts of the ear increases with age.

The study also examined the morphology of the helix, reporting different helix shapes among the population. The concave marginal helix was the most prevalent (25.8%), followed by the flat helix (24.1%), and then the round helix (20.8%). These variations in helix morphology could be due to genetic diversity, with certain helix shapes potentially more common within specific ethnic or demographic groups. In the research by Fakorede *et al.*, (2021), the wide ear helix was found to be predominant in the Hausa and Igbo ethnicities, while

the rolled helix dominated the Yoruba ethnic group. Singh and Purkait (2009) reported 56–60% rolled helix in Indian populations, and Krishan *et al.*, (2019) found 44–51% normally rolled helix in their subjects.

## CONCLUSION

The study provides a comprehensive morphometric and morphology profile of the concha and helix within this specific population. Gender and age appear to significantly influence concha length, but not breadth, while helix shape presents additional variation likely tied to genetic factors. These findings could be useful in fields such as anthropology, forensics, and plastic surgery, where understanding anatomical diversity is essential.

## RECOMMENDATIONS

- Future studies should examine larger and more diverse populations to validate the observed gender- and age-related differences in concha length and helix morphology.
- Otolaryngologists and plastic surgeons should consider gender- and age-specific variations in concha length during ear surgeries to improve aesthetic and functional outcomes.
- Manufacturers of hearing aids and custom ear devices should use population-specific concha measurements to enhance fit, comfort, and device efficiency.
- Further research should explore genetic and environmental factors that contribute to asymmetry and variation in ear morphology to improve our understanding of ear anatomy development.

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