



Original Article

## Comparative study on morphometry of external ear among Indian and Nigerian students at Integral University

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### ABSTRACT

**Background:** The external ear is a distinctive anatomical structure contributing to facial aesthetics and individual identity. Its morphology varies with age, sex, and ethnicity, making it important in anthropology, forensic science, and clinical practice.

**Methods:** The present study was carried out on 100 students (50 Indian and 50 Nigerian), aged 18–30 years, with no evidence of congenital ear anomalies or previous ear surgeries. Ear length, ear width, lobule length, and lobule width were measured using a vernier caliper. Ear shape and lobule attachment were also observed and recorded.

**Results:** The mean ear length was higher in Indians compared to Nigerians, while ear width showed no statistically significant difference. Lobular measurements showed highly significant differences, with higher values in Indians. Non-attached lobules were more common (82%), and oval ear shape was predominant (88%).

**Conclusion:** External ear morphometry shows significant variation between populations. Such comparative analysis is important for establishing population-specific reference values and understanding inter-ethnic differences.

**Keywords:** External ear morphometry, auricle, anthropometry, ear length, ear width, lobule.

### INTRODUCTION

The external ear which is also known as the pinna or auricle is an important component of the human face that contributes significantly to facial appearance and its function is hearing [1]. Apart from its functional role, the morphology of the external ear is highly distinctive, with each individual possessing unique auricular features comparable to fingerprints [2]. Because of this individuality, ear morphometry has gained considerable importance in areas of study such as forensic science, plastic and reconstructive surgery, and the design of hearing aids and other ergonomic devices [3].

The dimensions and shape of the external ear including lobule attachment differ according to age, sex, and ethnic background<sup>[4]</sup>. Characteristics such as ear shape and lobule attachment patterns are often influenced by genetic and hereditary factors and may vary significantly between different ethnic populations and racial groups<sup>[5]</sup>. Understanding these variations is therefore essential for anthropometric studies, clinical practice and forensic investigations. However, despite the growing interest in auricular morphometry, comparative data between different ethnic populations are still limited<sup>[6]</sup>. Despite numerous studies on external ear morphometry, significant variations exist among ethnic groups which can be found if comparative studies are performed. While various studies have been conducted on Indian and Nigerian populations independently, there is limited comparative data evaluating these groups within a similar environment and age group<sup>[7]</sup>. Therefore, the present study aims to perform a comparative analysis of the morphometric characteristics of the external ear among Indian and Nigerian students at Integral University.

## MATERIALS AND METHODS

### 1.1 Subjects

The present study was carried out at Integral University Lucknow on 100 students which included 50 Indian students and 50 students of Nigerian origin, with clearly zero evidence of any congenital ear anomalies or previous ear surgeries. The study cohort consisted of 30 females and 70 males, aged 18–30 years. The purpose of study was explained to them. The willingness and cooperation of the subjects to take part in the study was carefully considered. Before starting the work, clearance certificate of institutional ethical committee was obtained.

### 1.2 Measurements

After the consent process was complete the subjects were requested to sit straight on a chair and look forward<sup>[3]</sup>. The vernier caliper was set to zero and the length and breadth of the right ear and left ear was measured<sup>[3,4]</sup> and recorded in the data collection form. The distance from the most superior point of the helix to the most inferior point of the ear lobule<sup>[2,3,4,10]</sup>. Total ear width was determined by measuring along the broadest part of the pinna<sup>[8,11]</sup>. Total lobule length was taken as the distance from the tip of anti-tragus to most inferior point of the lobule and the total lobule width was measured as the horizontal distance at the midpoint<sup>[9]</sup>. The shape of the ear was also observed and recorded both on right and left side. The attachment of lobules was also observed and noted down in the data collection form.<sup>[2,4,11]</sup>

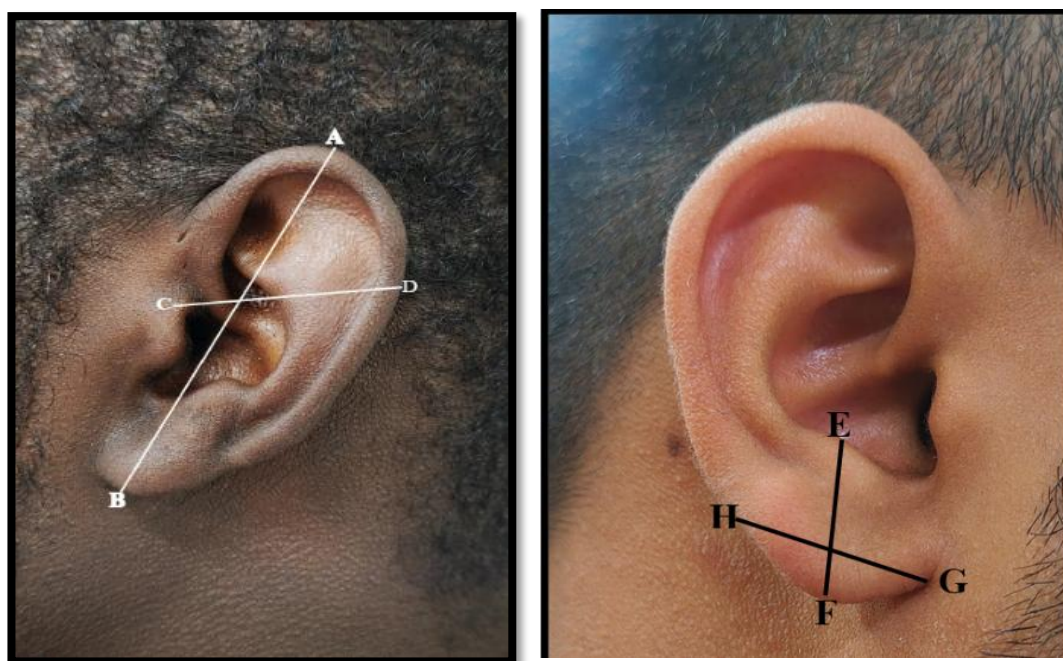


Figure 1: **Ear Length (both ears)** - uppermost point of the helix (A) till the lowermost point of the ear lobule i.e. point (B). **Ear Width (both ears)** – the widest part of the external ear from point (D) to point (C) as depicted in the figure 2.



Figure 2: **Lobule Length (both ears)** - from the tip of anti-tragus i.e. point (E) till the most inferior point of the ear lobule i.e. point (F) and **Lobule width (both ears)** from point (G) to point (H)

## RESULTS

The comparison between Indian and Nigerian participants showed that the mean ear length was higher in Indians compared to Nigerians, while ear width did not show a statistically significant difference. Lobular measurements showed highly significant differences, with Indians having greater lobule length and width on both sides. Indian males showed greater ear length and lobular dimensions, while Nigerian males showed higher ear width. Among females, no statistically significant difference was observed in ear length, while significant differences were present in ear width and lobular parameters. Bilateral comparison showed no statistically significant difference in ear length, while ear width showed a statistically significant difference, with the right ear slightly wider. Non-attached lobules were present in 82% of subjects, while attached lobules were observed in 18%. Oval ear shape was the most common, observed in 88% of subjects.

Table 1: Comparison of overall ear morphometric parameters using Independent Samples t-test (p-value <0.01)

Parameter	Indian (Mean ± SD)	Nigerian (Mean ± SD)	t-value	p-value
R.E.L	58.96 ± 3.49	56.47 ± 5.16	2.819	0.006*
R.E.W	29.31 ± 2.48	28.38 ± 6.62	0.928	0.357
R.Lo.L	20.96 ± 2.66	16.92 ± 4.23	5.715	<0.001*
R.Lo.W	16.43 ± 3.07	13.59 ± 3.35	4.402	<0.001*
L.E.L	58.49 ± 3.45	56.25 ± 4.90	2.645	0.010
L.E.W	28.59 ± 2.39	27.85 ± 5.96	0.819	0.416
L.Lo.L	21.18 ± 3.15	16.30 ± 3.32	7.530	<0.001*
L.Lo.W	15.94 ± 3.37	13.49 ± 3.28	3.686	<0.001*

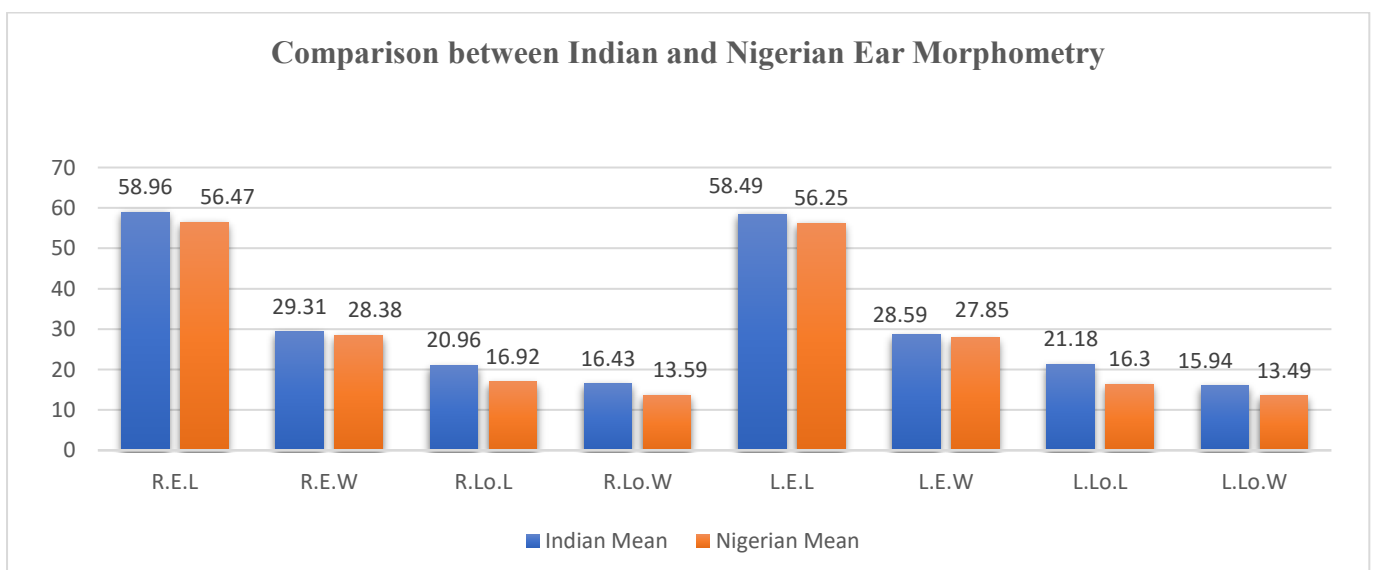
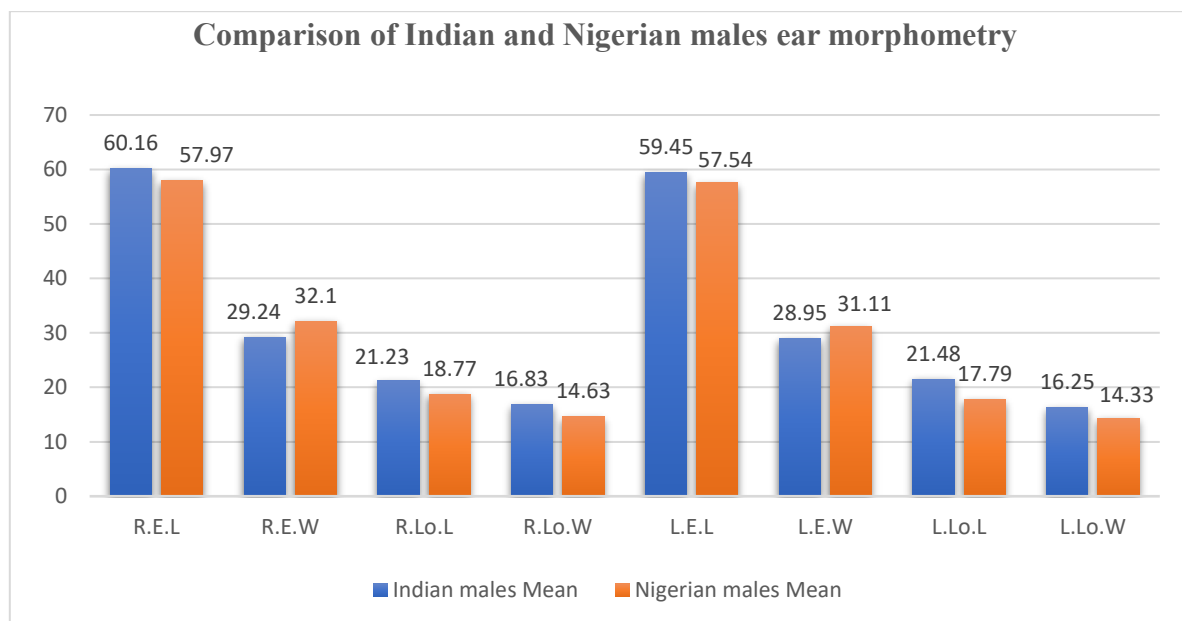


Figure 1: Comparison of Ear Morphometry between Indian and Nigerian subjects

**Table 2: Comparison between Indian and Nigerian males using independent samples t-test (p-value <0.01)**

Parameters	Indian males (Mean ± SD)	Nigerian males (Mean ± SD)	t-value	p-value
R.E.L	60.16 ± 2.92	57.97 ± 4.52	2.41	0.019*
R.E.W	29.24 ± 2.55	32.10 ± 3.09	-4.22	<0.001*
R.Lo.L	21.23 ± 2.48	18.77 ± 3.47	3.42	0.001*
R.Lo.W	16.83 ± 3.07	14.63 ± 3.13	2.98	0.004*
L.E.L	59.45 ± 3.21	57.54 ± 4.65	2.01	0.049*
L.E.W	28.95 ± 2.36	31.11 ± 3.05	-3.33	0.001*
L.Lo.L	21.48 ± 3.36	17.79 ± 2.67	5.08	<0.001*
L.Lo.W	16.25 ± 3.30	14.33 ± 3.11	2.50	0.015*



**Figure 2: Comparison of ear morphometry between males**

**Table 3: Comparison between Indian and Nigerian Females using Mann–Whitney U test. (p-value <0.01)**

Ear Parameters (mm)	Indian females Median	Nigerian females Median	U-value	p-value
R.E.L	56.0	55.3	153.0	0.097
R.E.W	29.6	20.1	219.0	<0.001*
R.Lo.L	21.0	13.2	219.0	<0.001*
R.Lo.W	14.9	10.8	195.5	<0.001*
L.E.L	55.9	54.6	152.0	0.106
L.E.W	28.7	19.9	212.5	<0.001*
L.Lo.L	21.0	13.1	223.0	<0.001*
L.Lo.W	15.1	11.7	180.0	0.005*

**Table 4: Bilateral comparison using Paired Samples t-test (p-value <0.01)**

Parameters	Right (Mean ± SD)	Left (Mean ± SD)	t-value	p-value
E.L	57.71 ± 4.56	57.37 ± 4.36	1.729	0.087
E.W	28.85 ± 4.99	28.22 ± 4.53	2.775	0.006*
L.L	18.94 ± 4.06	18.74 ± 4.05	0.791	0.431
L.W	15.01 ± 3.50	14.72 ± 3.53	1.319	0.190

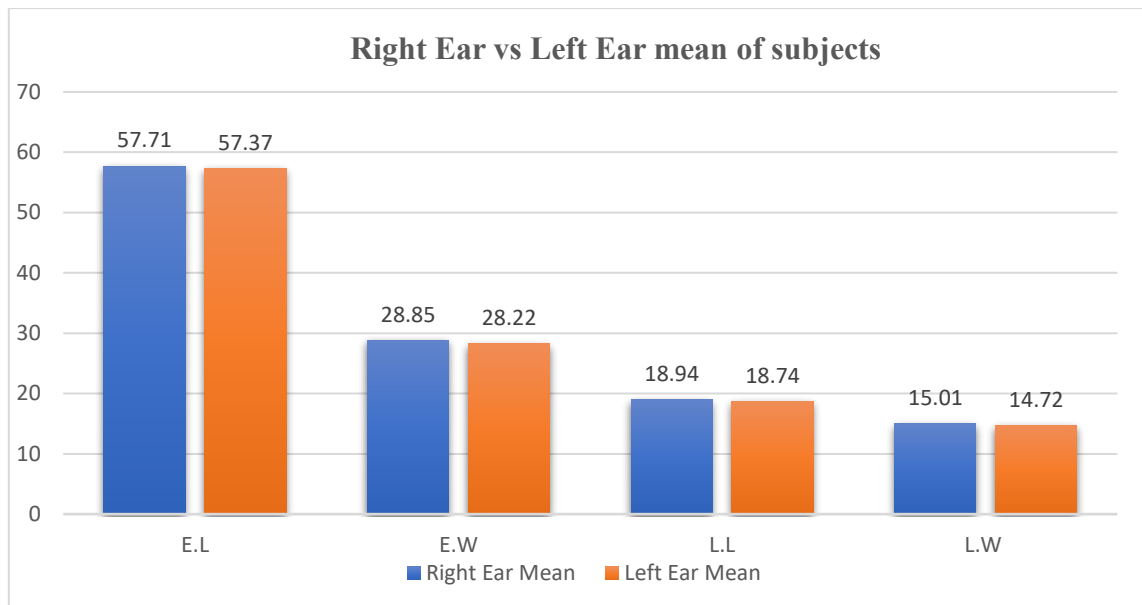


Figure 3: Right ear vs left ear parameters

Table 5: Distribution of lobule type among Indian and Nigerian subjects.

Nationality	Attached (A) %	Not attached (N.A.) %	Total
Indian	6 (12%)	44 (88%)	50
Nigerian	12 (24%)	38 (76%)	50
<b>Total</b>	18 (18%)	82 (82%)	100

### LOBULE ATTACHMENT

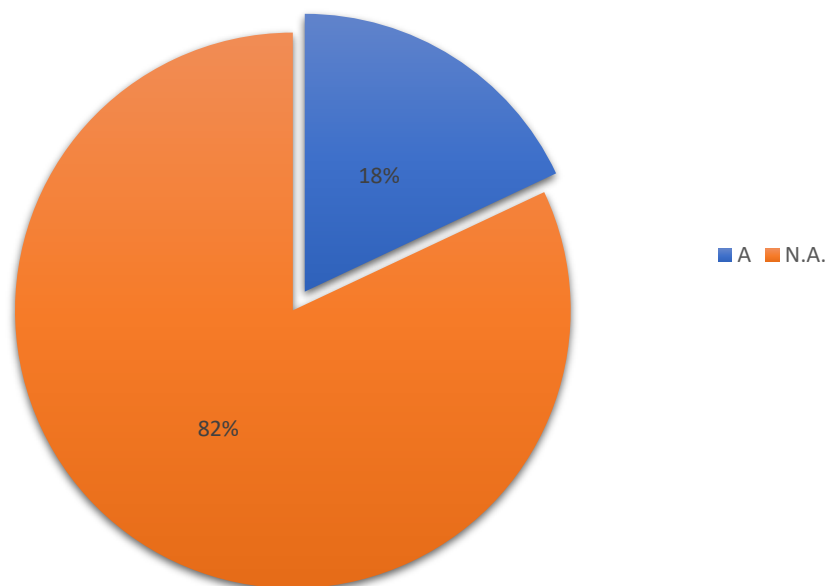
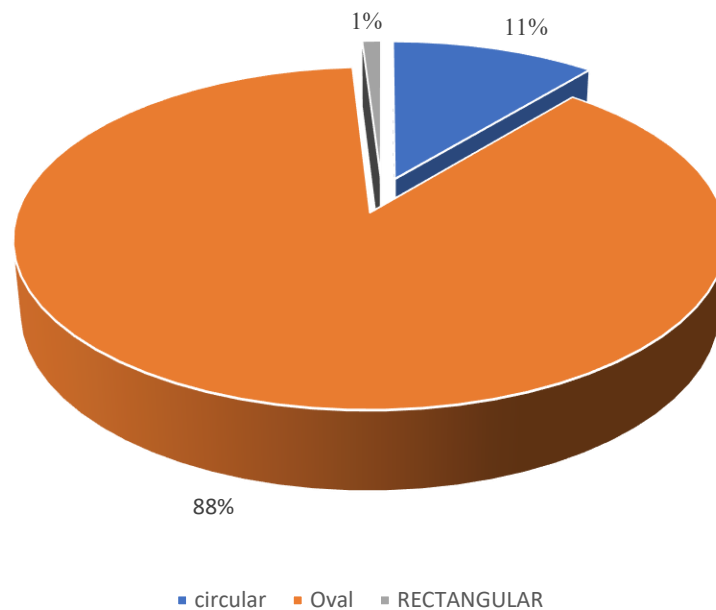


Figure 4: Lobule attachment distribution

Table 8: Distribution of ear shape among Indian and Nigerian subjects

Nationality	Oval n (%)	Non-oval n (%)	Total
Indian	46 (92%)	4 (8%)	50
Nigerian	42 (84%)	8 (16%)	50
<b>Total</b>	88 (88%)	12 (12%)	100

## EAR SHAPE DISTRIBUTION



**Figure 5: Ear shape distribution**

### DISCUSSION

The present study provides a comparative analysis morphometric data on the external ears among Indian and Nigerian students of age 18–30 years which are currently studying at Integral University Lucknow. The study was conducted on 100 subjects, which consisted of 70 males (70%) and 30 females (30%), it mainly focused on parameters like bilateral symmetry, sexual dimorphism, ethnic variation, and the morphological features. The findings provide a population-specific baseline data and which are also broadly consistent with the previous studies conducted.

#### Bilateral Symmetry

The present study demonstrates a very near bilateral symmetry, with the mean right ear length  $57.71 \pm 4.56$  mm and left ear length  $57.37 \pm 4.36$  mm. Similarly, the right ear width ( $28.85 \pm 4.99$  mm) was compared to the measurement of left ear width ( $28.22 \pm 4.53$  mm), which also indicated very minimal asymmetry. Although Oludiran et al.<sup>[8]</sup> found no significant bilateral variation except in the width of the ear. These observations highly suggest that the external ear dimensions are largely symmetrical and had very minor variations that were clinically insignificant.

#### Sexual Dimorphism

This present study confirmed a very clear sexual dimorphism, in which the males showed a significantly higher value among all the measured parameters. The mean right ear length in males was  $59.06 \pm 3.94$  mm as compared to  $54.57 \pm 4.41$  mm in females and the right ear width was  $30.67 \pm 3.16$  mm in males and  $24.59 \pm 5.89$  mm in females. This shows that male subjects had larger ear measurements than the female subjects. These findings go consistently with Eboh et al.<sup>[16]</sup> who reported that males had higher measurements. Deopa et al.<sup>[10]</sup> also found that the male ear length was larger than female subjects. Similar results were given by Alexander et al.<sup>[1]</sup>, Japatti SR et al.<sup>[14]</sup> KumAri A et al.<sup>[13]</sup>

#### Ethnic Variation

The present study showed that the Indian subjects had greater ear parameters than the Nigerian subjects. The mean right ear length in Indian subjects was  $58.96 \pm 3.49$  mm as compared to Nigerians which was  $56.47 \pm 5.16$  mm. Dimensions of the lobule was also found to be significantly different among the Indian and Nigerian subjects. The right lobular length was  $20.96 \pm 2.66$  mm in Indians and in Nigerians it was  $16.92 \pm 4.23$  mm. These findings consistently go with the previous studies in which Oludiran et al.<sup>[8]</sup> reported ear length of Nigerian subjects around 55.6 mm, which is slightly lower than the present measurements of the ears of Indian subjects. Fakorede et al.<sup>[20]</sup> also highlighted the significant variation among Nigerian populations.

#### Ear Width Variation

In the present study the ear width showed minimal variation among subjects. Indians had a mean right ear width of  $29.31 \pm 2.48$  mm, while the Nigerian subjects had  $28.38 \pm 6.62$  mm, with no statistically significant differences. This goes

consistently with the study of Fakorede et al.<sup>[20]</sup>, where the ear width was found to be reported as a non-significant parameter ( $p > 0.05$ ), which is clearly suggesting that the ear width is relatively stable compared to other measurements.

### Lobular Dimensions

The present study demonstrates a significant variation in the lobular dimensions between both the populations. The Indian subjects showed greater right lobular length which was  $20.96 \pm 2.66$  mm as compared to Nigerian subjects which was  $16.92 \pm 4.23$  mm. Similar findings were also reported by Eboh et al.<sup>[16]</sup>, in his study the lobule length was 15.36–16.12 mm. Nigam et al.<sup>[14]</sup>, Deopa et al.<sup>[10]</sup>, Singh A et al.<sup>[6]</sup>, Oludiran et al.<sup>[8]</sup>, Ugochukwu et al.<sup>[7]</sup>, Dauda et al.<sup>[3]</sup> also presented with similar findings.

### Comparison with Existing Literature

The ear dimensions that were observed in the present study fall within the range that was reported in previous studies are shown below.

Study	Bilateral Symmetry	Sexual Dimorphism
Alexander et al. <sup>[1]</sup>	Good bilateral symmetry	Ethnic and sex variation observed
Japatti SR et al. <sup>[12]</sup>	Strong bilateral symmetry	Higher values in males
KumAri A et al. <sup>[13]</sup>	Good bilateral symmetry	Males had significantly larger ears
Present Study	Predominant bilateral symmetry	Males showed significantly larger measurements

**Table 9: Bilateral Symmetry and Sexual Dimorphism**

**Table 10: Comparison of mean ear length and width with the values of the previous studies for Indian Subjects.**

Study	Population	Mean Ear Length (mm)	Mean Ear Width (mm)
Singh P et al. <sup>[15]</sup>	Indian	$58.83 \pm 4.85$	$32.70 \pm 2.95$
Nigam R et al. <sup>[14]</sup>	Indian	$60.55 \pm 0.75$	$32.60 \pm 0.49$
KumAri A et al. <sup>[13]</sup>	Indian	$58.23 \pm 3.57$	$29.69 \pm 2.86$
Present Study	Indian	$58.96 \pm 3.49$	$29.31 \pm 2.48$

**Table 11: Comparison of mean ear length and width with the values of the previous studies for Nigerian Subjects.**

Study	Population	Mean Ear Length (mm)	Mean Ear Width (mm)
Eboh et al. <sup>[16]</sup>	Nigerian	$56.79 \pm 4.26$	$30.47 \pm 1.99$
Taura et al. <sup>[17]</sup>	Nigerian	$60.82 \pm 3.84$	$30.85 \pm 2.50$
Akpa AO et al. <sup>[5]</sup>	Nigerian	$59.75 \pm 0.30$	$31.00 \pm 0.22$
Present Study	Nigerian	$56.47 \pm 5.16$	$28.38 \pm 6.62$

These comparisons show that the present values are consistent with the previously reported mean ear dimensions, they do have slight variations which may have been because of ethnic differences.

### Comparison of Lobular Dimensions

**Table 12: Comparison of mean lobule length and width with the values of the previous studies for Indian subjects.**

Study	Population	Mean Lobule Length (mm)	Mean Lobule Width (mm)
Deopa et al. <sup>[10]</sup>	Indian	$16.75 \pm 0.22$	$19.50 \pm 0.22$
Nigam R et al. <sup>[14]</sup>	Indian	$19.55 \pm 0.41$	$19.65 \pm 0.47$
Singh A et al. <sup>[6]</sup>	Indian	$17.65 \pm 0.30$	$19.55 \pm 0.35$
Present Study	Indian	$20.96 \pm 2.66$	$16.43 \pm 3.07$

**Table 13: Comparison of mean lobule length and width with the values of the previous studies for Nigerian subjects.**

Study	Population	Mean Lobule Length (mm)	Mean Lobule Width (mm)
Oludiran et al. <sup>[8]</sup>	Nigerian	$15.85 \pm 3.45$	$17.20 \pm 4.10$
Ugochukwu et al. <sup>[7]</sup>	Nigerian	$16.51 \pm 3.60$	$18.49 \pm 7.63$
Dauda et al. <sup>[3]</sup>	Nigerian	$14.20 \pm 2.43$	$17.12 \pm 5.04$
Present Study	Nigerian	$16.92 \pm 4.23$	$13.59 \pm 3.35$

The present study values fall within previously reported mean ear measurements and demonstrate clear ethnic variation.

## Ear Shape and Lobule Attachment

Morphologically, the present study found that oval ear shape was predominant in 88% of subjects, and free lobules were present in 82%.

**Table 14: Most common shape found in other studies**

Study	Most common ear shape
Singh P et al. <sup>[15]</sup>	Oval
Krishan et al. <sup>[19]</sup>	Oval
Present Study	Oval

**Table 15: Most common lobule type found in other studies**

Study	Free Lobule (%)
Chattopadhyay et al. <sup>[18]</sup>	~80.70%
Maitreyee M <sup>[11]</sup>	65.4%
Krishan et al. <sup>[19]</sup>	~50%
Present Study	82%

These findings confirm that, the oval ear shape and free or non-attached lobules were the most common morphological traits across both the subjects in previous studies and the present study goes consistent with it.

## CONCLUSION

The study demonstrates that external ear morphometry varies between Indian and Nigerian populations. Ear length and lobular dimensions were higher in Indians, while ear width showed variable differences. Non-attached lobules and oval ear shape were the most common morphological features observed. These findings are important for establishing reference values and understanding population-based differences.

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## ETHICAL CONSIDERATION

The Institute Ethical Committee, Integral Institute of Medical Sciences and Research, gave the ethical clearance and permission to conduct this research. The certificate number is IEC/IIMSR/2025/07.

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