OPEN ACCESS

Scholars International Journal of Anatomy and Physiology
Abbreviated Key Title: Sch Int J Anat Physiol
ISSN 2616-8618 (Print) |ISSN 2617-345X (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Anthropometric Study of the Normal Pinna in Males and Females Among Students of the University of Abuja

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DOI: https://doi.org/10.36348/sijap.2026.v09i04.001 | **Received:** 21.05.2026 | **Accepted:** 10.07.2026 | **Published:** 17.07.2026

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Abstract

The external ear is a defining feature of the face and sometimes has variations. This study was designed to obtain information about the dimensions, morphological, and aesthetic differences of the pinna amongst Nigerians who are students of the University of Abuja. For the photographic aspect of the study, 99 volunteers met the inclusion criteria. Results showed the following: for the lateral view, the detached lobule was 5.9% greater in females than in males, while the attached lobule was larger in males compared to females by 5.9%. An everted helix was not found in the entire population. For the posterior view, the lateral displacement of the pinna was greater in males compared to females by 17.2%. No hairy pinna was observed in the entire population. For the morphometric aspect of the study, 185 volunteers met the inclusion criteria. The mean total ear height and mean lobular height across the cohort were 5.72cm and 1.58cm, respectively, while the average lobular width measured 2.05cm. The average height of the pinna was 4.14cm. The mean total ear height was higher in males compared to females, while the mean values for lobular height and width were both slightly higher in females compared to males. The study establishes normative data for incidence in structural positioning of the ear pinna between male and female sexes, while making clear that hairy pinna and congenital abnormality of the ear are not common occurrences among Nigerians.

Keywords: Pinna, Morphology, Anthropometry, Lobular, Congenital.

INTRODUCTION

Anthropometry in physical anthropology refers to the measurement of body parts of living humans for the purpose of understanding physical variation among populations. It plays a crucial role in fields such as plastic surgery, prosthetics, industrial design, ergonomics, and architecture, where statistical data on body dimensions are used to optimize product design. Since products are often tailored to specific user groups, selecting and effectively utilizing an appropriate anthropometric database is a key design requirement. Anthropometric data thus serve as a valuable resource for ergonomists and designers aiming to accommodate a wide range of body sizes and abilities (Ese et al., 2024; Mansoura University Study, 2025). However, anthropometric measurements are subject to variability due to factors such as the measurer's skill, measurement techniques, and environmental conditions.

Like other parts of the human body, the external ear exhibits considerable variation. In adults, facial features are relatively stable and well-defined, whereas in infants, rapid growth—especially in the first year—leads to noticeable morphological changes that complicate identification. The ear is among the last components of the auricle to fully develop (Elvan et al., 2026). Structurally, the human ear is divided into external, middle, and internal parts. The external ear consists of the pinna and the external acoustic meatus. The lateral surface of the pinna is irregularly concave, faces slightly forward, and contains multiple elevations and depressions. These structures serve not merely as sound collectors but as important modifiers of auditory stimuli.

Beyond its functional role, the ear is a defining facial feature that contributes to overall facial harmony and aesthetics. Its subtle characteristics can convey information about an individual's sex, age, and ethnic

background, although these distinctions are not always easily quantified. In forensic science and plastic surgery, detailed knowledge of ear morphology is valuable for personal identification, facial reconstruction, and paternity assessment (Chhikara & Saini, 2023).

While much emphasis has traditionally been placed on primary and secondary sexual characteristics for distinguishing between males and females, less attention has been given to other anatomical features such as the external ear (pinna), which may also exhibit sexual dimorphism. Consequently, there is limited data on variations in ear morphology with respect to gender, ethnicity, and age, particularly in developing countries (Johnbull *et al.,* 2024).

This study is therefore designed to generate anthropometric and normative cross-sectional data on the adult ear auricle among students at the University of Abuja. Specifically, it aims to identify and analyze morphological and aesthetic differences between male and female ear auricles within this population.

Ear lobules are of particular interest in otomorphology, as they can reflect age-related changes and contribute to individual identification through ear prints. This has important applications in forensic medicine and criminology. Additionally, plastic surgeons rely on knowledge of ear morphology for facial rejuvenation procedures, ensuring that reconstructed features are appropriate for a patient's sex and age, as well as in paternity determination (Prasetyo & Putri, 2022; Taura *et al.,* 2015).

Abnormalities in ear size, shape, and position are also associated with various genetic and developmental disorders. For example, individuals with Down syndrome often exhibit reduced ear length and width, protruding lobules, and increased asymmetry. Conversely, wider ears may be observed in conditions such as Apert and Crouzon syndromes, while low-set ears are characteristic of Noonan syndrome and chromosomal abnormalities such as trisomy 13 and 18. These variations may even be detected prenatally, with ear measurements being explored as markers in ultrasound screening for chromosomal abnormalities (Baldrich *et al.,* 2026).

Knowledge of normal ear dimensions, symmetry, and positioning is essential not only for clinical diagnosis but also for planning reconstructive surgeries—especially when a reference from the opposite ear is unavailable—and for designing hearing aids and other assistive devices. Furthermore, ear prints hold potential for personal identification, highlighting the need for comprehensive anthropometric databases that account for age, sex, and ethnic variations (Ese *et al.,* 2024; Chhikara & Saini, 2023).

This study will be conducted among male and female undergraduate students across various departments of the University of Abuja, located in Abuja, Nigeria. Participants will be selected based on the presence of apparently normal ear pinnas. However, given that the study population primarily consists of young adults aged 14 to 26 years, significant age-related variation in ear morphology may not be fully appreciable within this cohort.

MATERIALS AND METHODS

This study was conducted among undergraduate students of the University of Abuja, located in Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja, Nigeria. Abuja lies north of the confluence of the Niger River and Benue River, approximately at latitude 9°12′ N and longitude 7°11′ E.

A total of 185 subjects were randomly selected from various departments of the university, comprising 82 females and 103 males aged between 16 and 33 years. Participants with a history of craniofacial trauma, ear disease, congenital anomalies, or previous ear surgery were excluded from the study.

All participants were adequately informed about the study procedures, including its purpose, benefits, and potential risks. Informed consent was obtained prior to data collection, and ethical approval was obtained from the University od Abuja Research Ethics Committee. Information such as age, sex, and relevant medical history was collected using a structured questionnaire administered both verbally and in written form.

Anthropometric measurements of the ear pinna were obtained following standardized anatomical landmarks as described by De Carlo *et al.,* (1998), Prasetyo and Putri (2022), and recently Lin (2025), and by methodologies adapted from McKinney *et al.,* (1993) and Brucker *et al.,* (2003). The parameters measured included:

- **Total Ear Height (TEH):** Distance from the most inferior point of the ear lobule to the most superior point of the helix.
- **Lobular Height (LH):** Distance from the inferior end of the lobule to the base of the tragal notch.
- **Lobular Width (LW):** Horizontal width of the lobule measured at the midpoint of the lobular height.

All measurements were taken by a single investigator using a standard digital vernier calliper with a precision of 0.1 mm to minimize inter-observer variability and measurement error.

In addition to anthropometric measurements, photographs of 99 ear pinnae were captured using a 4.2-

megapixel digital camera. Images were taken in standardized lateral and posterior views. These images were visually analyzed for morphological variations using the following criteria:

- **Lateral view:** free or attached lobule, everted or non-everted helix
- **Posterior view:** lateral displacement and cranial displacement
- **Other features:** presence of hair on the pinna and congenital abnormalities

Morphological variations were expressed as percentage frequency using the formula:

$$\text{Percentage frequency} = \frac{n}{N} \times 100$$

Where: n = number of individuals exhibiting a particular attribute N = total number of individuals assessed

Gender differences in morphological traits were determined by calculating the percentage difference between males and females.

Statistical analysis of quantitative data (pinna dimensions) was performed using mean and range values with Epi Info™ version 7.0.8.3 software. The student's t-test (two-tailed) was used to compare measurements between male and female subjects. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

RESULTS

Table 1: Percentage Variation in the Structure of the Male Auricle from Lateral Aspect.

VARIABLES	N	N	Frequency (%)
Detached Lobule	52	39	75
Attached Lobule	52	13	25
Everted Helix	52	0	0.00

Table 2: Percentage Variation in the Structure of the Female Auricle from the Lateral Aspect.

VARIABLES	N	N	Frequency (%)
Detached Lobule	47	38	80.9
Attached Lobule	47	9	19.1
Everted Helix	47	0	0.00

Table 3: Percentage Variation in the Structure of the Male Auricle from the Posterior Aspect.

VARIABLES	N	N	Frequency (%)
Lateral Displacement	52	20	38.5
Cranial Displacement	52	32	61.5

Table 4: Percentage Variation in the Structure of the Female Auricle from the Posterior Aspect.

VARIABLES	N	N	Frequency (%)
Lateral Displacement	47	10	21.3
Cranial Displacement	47	37	78.7

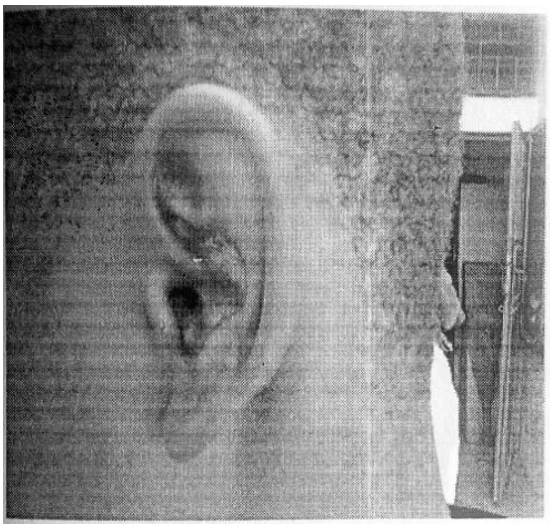

Fig. 1: Detached Lobule

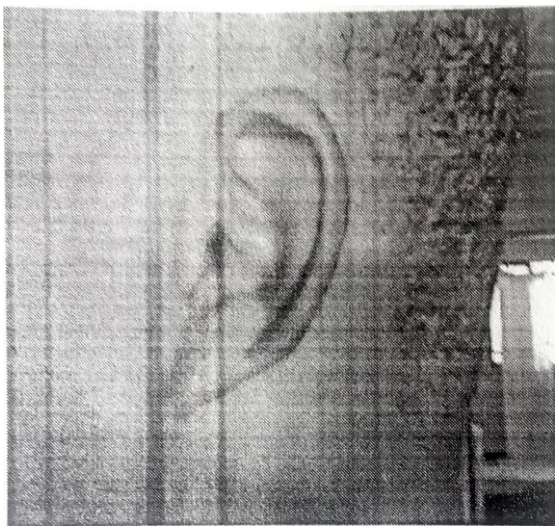

Fig. 2: Attached Lobule

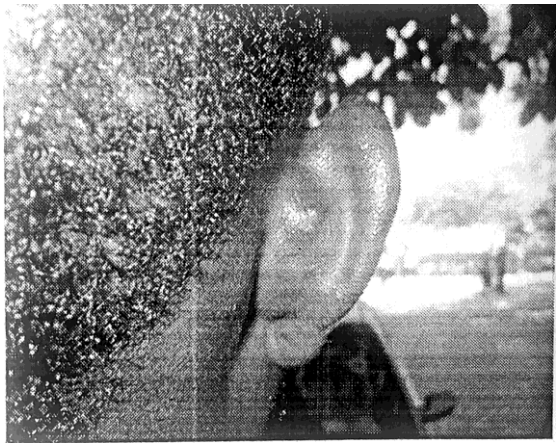

Fig. 3: Laterally Displaced Pinna

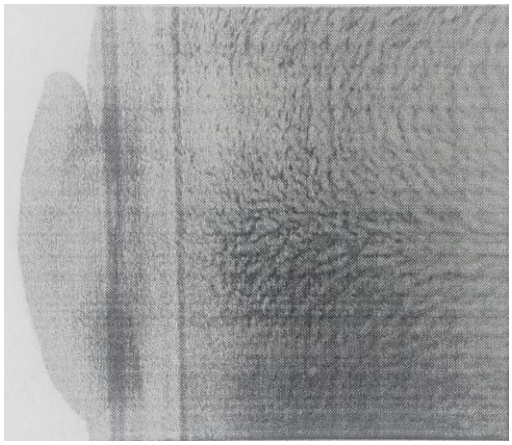

Fig. 4: Cranially Displaced Pinna

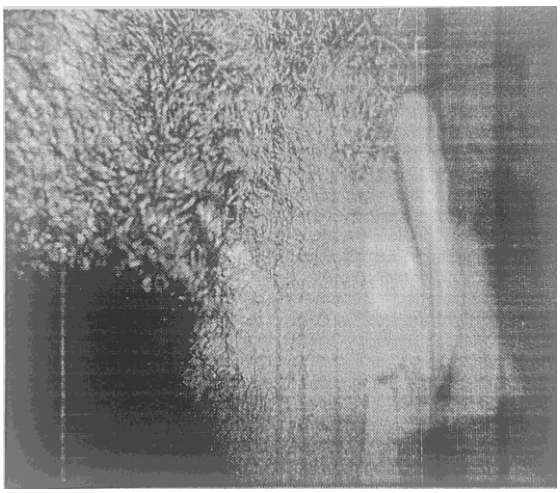

Fig. 5: Cranially Displaced Pinna

Table 5: Average Pinna Dimensions for Males and Females in Different Age Groups.

SEX	AGE GROUP	FREQUENCY	TEH	LH	LW
MALE	< 18	1	5.44	1.93	1.53
	18-20	20	5.71	1.53	2.01
	21-23	47	5.78	1.54	1.99
	24-26	29	5.85	1.53	2.08
	>26	6	5.91	1.43	2.03
	Total	103	5.79	1.53	2.02
FEMALE	< 18	2	5.93	2.01	2.34
	18-20	33	5.60	1.66	2.05
	21-23	35	5.62	1.56	2.13
	24-26	11	5.71	1.66	2.12
	< 26	1	6.25	1.69	2.01
	Total	82	5.64	1.63	2.10
COMBINED		185	5.72	1.58	2.05

TEH: Total Ear Height, LH: Lobular Height, LW: Lobular Width. Correlation for all is significant at the 0.05 level ($p < 0.05$; 2-tailed) except for Lobular Width (LW) ($P > 0.05$; 2-tailed). Sex difference in Lobular Width is therefore statistically insignificant and thus occurred only by chance.

Combined data of all 99 ears are depicted in tables 1 to 4. They show the total variation of each attribute as related to gender. Tables 1 to 4 list the entire attribute when the cohort is tabulated into male and female groups. As expected, based on the incidence of detached lobule, attached lobule, and everted helix, hairy pinna, and the presence of abnormality of the auricle, percentage differences were noted in the positioning of the ear auricle and anatomic structure. For the lateral surface, the determined percentage frequency for subjects with detached lobule was 5.9% greater in

females than males (Tables 1, 2 & Fig. 1). While the percentage frequency of attached lobule was similarly larger in males compared to females by 5.9% (Tables 1, 2 & Fig. 2). However, no everted helix, hairy pinna or abnormality of the auricle were noted between both sexes. For the posterior surface, the incidence of lateral displacement was greater in females than in males by 17.2% (Tables 3, 4, and Fig. 3). Similarly, cranial displacement was greater in females than in males by 17.2% (Tables 3, 4 & Fig. 4). The percentage difference in frequency of attached and detached ear lobules and likewise lateral and cranial displacement of the pinna were found to be highly insignificant at 0.05 level ($p>0.05$). The differences in the distribution of these attributes thus occurred by chance. Therefore, it can be said that for lateral and posterior surfaces, each attribute as related to both male and female subjects was approximately evenly distributed. No congenital abnormality of the ear, everted helix, or hairy pinna was noted among the subjects.

The combined results of all 185 ears measured are shown in Table 5. The combined mean of total ear height was 5.72cm, the mean lobular height was 1.58cm, giving a lobular height to total ear height ratio of 27.6%. The average lobular width in the entire ear was 2.05cm. The average height of the pinna, obtained by subtracting the lobular height from the total ear height, was about 4.14cm. Also shown in the table are the results from the data separated into male and female subgroups to analyze for changes in ear morphology in relation to sex. The average lobular width and the average total ear height between males and females were almost identical. Statistical analysis of the data revealed an average lobular width of 2.02cm and 2.10cm in males and females, respectively, while the average height of the ear lobule was 1.53cm and 1.63cm in males and females, respectively. Mean total ear height was 5.79cm for males and 5.64cm for females, while the height of the pinna was 4.01cm in females and 4.26 cm in males, longer in males by approximately 5.87%.

In all parameters taken, the males had longer maximum distances when compared to those of the females. Furthermore, the total ear height in the females ranged from 4.71 to 6.42cm, while in the males, the figures ranged from 4.76cm to 6.94cm. The lobular height in women measured between 0.98cm and 2.53cm, but in men 0.90cm and 2.54cm. Lately, the minimum and maximum distances of the width of the lobule were 1.42cm to 2.59cm and 1.30cm to 3.07cm in females and males, respectively.

DISCUSSION

A comprehensive understanding of the dimensions and spatial relationships of facial structures across different age groups, sexes, and ethnic populations is essential for accurate facial reconstruction in both surgical and forensic contexts (Angelakopoulos *et al.,* 2023; Lin *et al.,* 2024). The external ear (auricle) is an important yet often under-recognized component of facial morphology. Its shape and dimensions provide valuable information regarding age and sex, although these features are often difficult to quantify precisely (Sowmya *et al.,* 2023).

Over the past decade, ear morphometry has been widely studied across different populations using both direct anthropometry and image-based techniques. Despite variations in ear size and position among different ethnic groups, most studies agree that the auricle continues to grow even after skeletal maturity (Cho *et al.,* 2025; Biwasaka *et al.,* 2024). This continuous growth pattern has important implications in age estimation and reconstructive procedures.

In the present study, an attempt was made to establish baseline aesthetic proportions of the pinna and to classify its morphological variations based on anatomical positioning and associated features such as hairy pinna, everted helix, and congenital abnormalities. The findings align with earlier and recent studies that emphasize the importance of detailed auricular classification in anthropological and clinical practice (Angelakopoulos *et al.,* 2023).

Previous work by Patrick K. Sullivan and colleagues reported mean values of 6.80 cm, 1.88 cm, and 1.96 cm for total ear height, lobular height, and lobular width, respectively, among a United States population, with males exhibiting approximately 4.6% larger dimensions than females. Similarly, studies by Itoh and Ikeda in 2001, and more recently by Söylemez E, Tokgöz Yılmaz S. (2025) demonstrated consistently larger auricular dimensions in males across most age groups. These findings are consistent with more recent studies confirming sexual dimorphism in ear morphology (Cho *et al.,* 2025; Sowmya *et al.,* 2023).

In comparison, studies conducted in Nigerian populations, such as that by A. U. Ekanem, reported lower mean values (5.60 cm, 1.11 cm, and 1.35 cm for total ear height, lobular height, and lobular width, respectively) compared to Caucasian populations. The present study, conducted among Nigerian youths aged 16–33 years, also demonstrated larger mean values in males compared to females. These findings are consistent with previous Nigerian studies and recent African anthropometric research, suggesting that sexual dimorphism in auricular dimensions is a universal pattern, although absolute values vary across populations (Okeke *et al.,* 2024).

The observed differences between Caucasian and Nigerian populations may be attributed to genetic, environmental, and ethnic variations. Additionally, the relatively young age range of participants in this study may explain slight disparities in measurements, as

auricular growth may still be ongoing within this age group.

Analysis of lobular dimensions revealed no significant differences between males and females, which corroborates earlier findings by Brucker and is supported by recent studies indicating that while total ear height tends to be greater in males, lobular dimensions often show minimal sexual variation (Sowmya *et al.,* 2023).

Morphological analysis of the auricle indicated that features such as detached lobules and cranial displacement were more commonly observed in females. This observation aligns with classical anatomical descriptions and is supported by recent morphometric studies highlighting sex-related differences in ear positioning and morphology (Lin *et al.,* 2024).

Furthermore, no congenital abnormalities of the auricle were observed among the study population. This contrasts with earlier findings by Perrin, who reported a relatively high prevalence of auricular abnormalities in children and their association with urinary tract malformations. The absence of such abnormalities in the present study suggests a low prevalence within the sampled population, consistent with previous Nigerian studies (Okeke *et al.,* 2024). However, this finding should be interpreted with caution due to the limited sample size and age range.

Finally, this study provides a structured classification of auricular morphology based on standard anatomical terminology. From the lateral view, ears were categorized into attached lobule, detached lobule, and everted helix, while posterior assessment included lateral and cranial displacement. This classification enhances the understanding of ear morphology and may be useful in clinical evaluation, forensic identification, and reconstructive surgery.

CONCLUSION

This study provides baseline anthropometric data on ear morphology among Nigerians, which may serve as a useful reference in reconstructive surgery, forensic identification, and anthropological research. The findings highlight the relative rarity of features such as hairy pinna, everted helix, and congenital auricular abnormalities, underscoring their potential forensic value. Observed variations in ear morphology may also have genetic implications, including possible relevance in paternity assessment. However, further studies incorporating a wider age range and examining relationships with body height, craniofacial parameters, and genetic factors are recommended to enhance the applicability and generalizability of these findings.

ACKNOWLEDGEMENT

The authors acknowledge the students of University of Abuja who made themselves available as participants in this study

Declaration of Conflict of Interest: The authors declare no conflict of interest in this study. There was no grant or external funding received.

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