

# Linear Morphometric Analysis of Auricular Measurements of a Nigerian Igbo population

*Gabriel Sunday Oladipo* , *Oghenefego Michael Adheke* ,  
*Janet Nneoma Eke*

Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences,  
University of Port Harcourt, Nigeria

**ABSTRACT:** The human ear (auricle) is an important body component in biometric studies and forensic identification. The purpose of this study was to evaluate linear auricular morphometric measurements of a Nigerian Igbo population.

300 participants (142 males to 158 females) of at least 16 years of age were randomly recruited from settlements in the South-Eastern states of Nigeria. The participants were made to sit in a Frankfort horizontal position and auricular measurements such as total ear height (TEH), ear width (EW), lobule height (LH) and lobule width (LW) were obtained using a digital vernier caliper (validated by calibrating to 0.01mm). The ear index (EI) and lobule index (LI) were calculated using the measurements. Data obtained were analyzed using the Statistical Package for the Social Sciences (SPSS version 23.0).

The following mean values were recorded for males: TEH [Right (R) =  $47.01 \pm 6.30$ , Left (L) =  $46.24 \pm 5.85$ ], EW (R =  $25.06 \pm 4.14$ , L =  $24.68 \pm 4.32$ ), LH (R =  $13.92 \pm 2.61$ , L =  $13.99 \pm 2.18$ ), LW (R =  $12.99 \pm 2.30$ , L =  $13.30 \pm 1.94$ ), EI (R =  $53.47 \pm 7.23$ , L =  $53.28 \pm 6.69$ ) and LI (R =  $95.17 \pm 18.12$ , L =  $96.80 \pm 18.56$ ); for females, TEH (R =  $48.25 \pm 6.83$ , L =  $48.25 \pm 6.24$ ), EW (R =  $25.19 \pm 3.93$ , L =  $24.57 \pm 4.21$ ), LH (R =  $14.44 \pm 2.67$ , L =  $14.89 \pm 2.55$ ), LW (R =  $13.37 \pm 2.26$ , L =  $13.78 \pm 2.04$ ), EI (R =  $52.50 \pm 6.85$ , L =  $50.93 \pm 7.05$ ) and LI (R =  $94.60 \pm 19.59$ , L =  $94.30 \pm 16.63$ ). Gender differences were highly significant regarding total ear height, lobular length and width, as well as the ear index of the left auricle.

This study provides a baseline data for auricular morphometrics of adult Nigerian Igbo and could be used as an ergonomic guide towards the creation of hearing aids in the future and to solve possible forensic issues associated with identification of remains.

**KEY WORDS:** Auricle, morphometrics, ergonomic guide, forensic identification, Igbo.



Original article

© by the author, licensee Polish Anthropological Association and University of Lodz, Poland

This article is an open access article distributed under the terms and conditions of the

Creative Commons Attribution license CC-BY-NC-ND 4.0

(<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

Received: 03.05.2023; Revised: 09.06.2023; Accepted: 28.08.2023

## Introduction

Anthropometry often uses a collection of human bodily measurements in order to understand human physical variation as it plays an important role in plastic surgery, prosthetics, personal identification, biometrics and forensic profiling (Purkait and Singh 2007; Ekanem et al. 2010; Depo et al. 2013). The ear, or pinna, is an important but under-studied feature of the face which shape and size conveys information about age and sex (Brucker et al. 2003). The shape, size and orientation of each pinna are as unique as fingerprints although it is possible to make some generalizations (Alexander et al. 2011; Osunwoke et al. 2018).

Currently, anthropometric studies have shown that the morphological variation of the external ear depends on age, sex and race and side (i.e., side-to-side variation) (Meijerman et al. 2007; Purkait and Singh 2007; Murgod et al. 2013). Jung and Jung (2003) surveyed the dimensions and characteristics of Korean ears and found that age, sex, and specific ethnic group were contributing factors of auricular dimensions. Sharma et al (2007) carried out a morphometric study in India where it was observed that North-West Indians have smaller ear lobules compared to Caucasian and Japanese populations but similar to those observed among the Onge tribe of Andhra (India) and Newars of Nepal. A study done by Murgod et al (2013) that assessed ear shape and earlobe metric dimensions of 300 Indian adult subjects concluded that identifying males was about 69% accurate while that of females was 72%. Several Nigerian studies have been conducted on the morphological and morphometric variation of an external ear (Ekanem et al. 2010; Eboh 2013; Taura et al. 2013). The aim

of this study was to examine the accuracy of prediction of age and sex of a selected Nigerian Igbo population using auricular morphometrics for forensic applications.

## Materials and Methods

A cross-sectional, descriptive study design was applied to randomly select Igbo heterogeneous indigenes residing in the South-Eastern states of Nigeria (Abia, Anambra, Ebonyi, Enugu and Imo). Using the Cochran formula, the calculated sample size was 300 adult subjects, comprised of 142 males and 158 females of at least 16 years of age. Study participants showed no past records of ear abnormalities or surgical operations and were selected in line with the Declaration of Helsinki research ethics protocol for human research. Both primary and secondary data were obtained from study participants. Biological profile, such as age and sex, made up the primary data while ear measurements the secondary data.

The participants were made to sit in a Frankfurt horizontal position and with the aid of a digital vernier caliper (validated by calibrating to 0.01mm), the ear measurements obtained from participants included the following:

- i. total ear height (TEH) – The length measured from the most superior part of the ear to the most inferior part of the earlobe.
- ii. ear width (EW) – The length measured from the most anterior to the most posterior parts of the ear.
- iii. lobule height (LH) – The distance between the most inferior point of the earlobe, and the deepest point of the intertragic notch
- iv. lobule width (LW) – The distance between the most anterior and most posterior points of the earlobe

To test the reliability of the instrument, the above measurements were obtained twice and the average score was calculated.

In addition to these parameters, two indices defining the proportion of the ear were also calculated: the ear index (EI) [ear width / ear height x 100] and the lobule index (LI) [lobule height / lobule width x 100].

Statistical Analyses: Raw data obtained from participants were recorded into Mi-

crosoft Excel 2019 version and analyzed using the Statistical Package for the Social Sciences (SPSS version 23.0). Sexual dimorphism was determined using the Independent Sample t-test, while side (left and right) differences were determined using the Paired sample t-test. Differences in auricular dimensions between age categories were determined using Analysis of Variance (ANOVA). Confidence interval was set at 95% and therefore  $P < 0.05$  was considered significant.



Fig. 1. Ear morphometric dimensions. (A) Total ear height (B) Ear width (C) Lobule height (D) Lobule width

### Results

Males had a mean age of 35.34, SD=12.04, while for female subjects, the mean age was 35.21, SD=12.90 (Table 1). The minimum age for males was 16, while the maximum was 62, while for females; it was 16 and 63 respectively (Table 1). There was no significant difference between the mean age of male and female subjects (Table 1).

Gender differences between auricular dimensions are shown in Table 2. Sig-

nificant differences were observed in left ear height, left lobular height, left lobular width and left ear index (Table 2).

Significant differences in symmetry (i.e., side differences) in male Igbo auricular dimensions were only observed in total ear height (Table 3).

Significant differences regarding asymmetry in female Igbo auricular dimensions were observed in ear width, lobular height, lobular width and ear index (Table 4).

Table 1. Descriptive statistics of age of Igbo ethnic group

Sex	Age in years					T-test		
	N	Min	Max	Mean	S.D	t-value	Df	p-value
Male	142	16	62	35.44	12.04	0.09	298	>0.05
Female	158	16	63	35.32	12.90			
Total	300	16	63	35.38	12.48			

Min = Minimum, Max = Maximum, S.D = Standard Deviation, df = degree of freedom

Table 2. Descriptive statistics of the auricular dimensions of the Igbo ethnic group

Auricular Dimensions (mm)	Male [142]			Female [158]		
	Mean (SD)	Min	Max	Mean (SD)	Min	Max
<b>Right Auricle</b>						
Total Ear Height	47.01 (6.30)	24.06	60.84	48.25 (6.83)	24.06	65.14
Ear Width	25.06 (4.14)	11.16	33.22	25.19 (3.93)	13.45	33.51
Lobular Height	13.92 (2.61)	10.03	20.54	14.44 (2.67)	10.19	21.57
Lobular Width	12.99 (2.30)	10.00	22.15	13.37 (2.26)	10.00	20.25
Ear Index	53.47 (7.23)	30.97	70.45	52.50 (6.85)	30.96	69.39
Lobular Index	95.17 (18.12)	55.89	186.26	94.60 (19.59)	53.48	193.44
<b>Left Auricle</b>						
Total Ear Height	46.24 (5.85)	25.67	58.29	48.25 (6.24)	25.67	61.66
Ear Width	24.68 (4.32)	10.21	33.38	24.57 (4.21)	10.12	34.05
Lobular Height	13.99 (2.18)	10.21	21.24	14.89 (2.55)	10.19	21.24
Lobular Width	13.30 (1.94)	10.11	19.75	13.78 (2.04)	10.21	19.26
Ear Index	53.28 (6.69)	32.48	75.12	50.93 (7.05)	29.20	72.06
Lobular Index	96.80 (18.56)	61.29	193.44	94.30 (16.63)	61.80	153.45

SD = Standard Deviation, M.D = Mean Difference, S.E.M = Standard Error of Mean

Table 3. Paired t-test results comparing the right and left auricular dimensions of Igbo males

Auricular Dimensions (mm)	M.D	S.E.M	95% C.I of the Difference		t-value	df	p-value
			Lower	Upper			
Right TEH - Left TEH	0.76	0.27	0.23	1.30	2.84	141	<0.05
Right EW - Left EW	0.38	0.21	-0.04	0.80	1.77	141	>0.05
Right LH - Left LH	-0.07	0.22	-0.51	0.36	-0.34	141	>0.05
Right LW - Left LW	-0.31	0.18	-0.67	0.06	-1.66	141	>0.05
Right EI - Left EI	0.19	0.57	-0.93	1.30	0.33	141	>0.05
Right LI - Left LI	-1.63	1.96	-5.50	2.24	-0.83	141	>0.05

Table 4. Paired T-test comparing the Right and Left auricular dimensions of Igbo females

Auricular Dimensions (mm)	M.D	S.E.M	95% C.I of the Difference		t-value	df	p-value
			Lower	Upper			
Right TEH - Left TEH	0.00	0.27	-0.53	0.53	-0.01	157	>0.05
Right EW - Left EW	0.62	0.21	0.20	1.05	2.91	157	<0.001
Right LH - Left LH	-0.44	0.19	-0.82	-0.07	-2.32	157	<0.05
Right LW - Left LW	-0.40	0.18	-0.75	-0.06	-2.30	157	<0.05
Right EI - Left EI	1.57	0.57	0.45	2.70	2.76	157	<0.05
Right LI - Left LI	0.30	1.86	-3.38	3.98	0.16	157	>0.05

Age related differences were observed in right ear index, left total ear height, and left ear width as well as left ear index (Table 5).

Table 5. Distribution of ear dimensions by age category in Igbo ethnic group along with ANOVA results

Auricular Dimensions (mm)	Age (years)	Descriptive Statistics					ANOVA		
		N	Min	Max	Mean	S.D	df	F-value	p-value
<b>Right Auricle</b>									
Total Ear Height	16 - 25	90	32.15	59.95	48.28	5.73	4	2.17	>0.05
	26 - 35	61	24.06	65.14	46.27	7.87			
	36 - 45	78	24.06	62.84	46.86	6.36			
	46 - 55	52	32.68	61.81	49.47	6.68			
	56 and above	19	39.48	60.84	47.53	5.98			
Ear Width	16 - 25	90	11.16	33.22	25.15	3.93	4	1.30	>0.05
	26 - 35	61	13.45	32.81	24.19	4.73			
	36 - 45	78	13.50	33.51	25.69	4.29			
	46 - 55	52	15.98	30.99	25.42	3.19			
	56 and above	19	19.95	29.51	24.95	2.45			

Auricular Dimensions (mm)	Age (years)	Descriptive Statistics					ANOVA		
		N	Min	Max	Mean	S.D	df	F-value	p-value
Lobular Height	16 - 25	90	10.19	20.85	14.64	2.58	4	1.22	>0.05
	26 - 35	61	10.03	20.54	14.25	2.60			
	36 - 45	78	10.20	21.41	13.82	2.68			
	46 - 55	52	10.19	21.57	14.12	2.95			
	56 and above	19	10.84	18.03	13.66	2.08			
Lobular Width	16 - 25	90	10.11	20.25	13.68	2.40	4	1.64	>0.05
	26 - 35	61	10.11	18.59	13.07	1.76			
	36 - 45	78	10.01	19.75	12.85	2.38			
	46 - 55	52	10.00	22.15	13.12	2.48			
	56 and above	19	10.00	17.15	12.89	2.14			
Ear Index	16 - 25	90	32.56	65.22	52.12	6.29	4	2.46	<0.05
	26 - 35	61	33.11	69.11	52.50	7.59			
	36 - 45	78	30.96	70.45	55.03	7.64			
	46 - 55	52	40.91	66.49	51.83	6.51			
	56 and above	19	41.02	61.68	52.99	6.19			
Lobular Index	16 - 25	90	55.89	186.26	94.97	17.27	4	0.13	>0.05
	26 - 35	61	53.48	120.20	93.57	14.10			
	36 - 45	78	62.33	193.44	94.84	19.19			
	46 - 55	52	65.18	193.44	96.17	26.52			
	56 and above	19	75.95	124.46	95.08	14.30			
<b>Left Auricle</b>									
Total Ear Height	16 - 25	90	32.89	57.25	47.70	5.54	4	2.67	<0.05
	26 - 35	61	25.67	58.29	45.62	7.24			
	36 - 45	78	25.67	61.66	46.86	5.85			
	46 - 55	52	31.43	61.45	49.23	6.10			
	56 and above	19	41.39	56.30	47.37	4.94			
Ear Width	16 - 25	90	11.13	34.05	24.79	4.22	4	2.84	<0.05
	26 - 35	61	10.12	31.27	23.05	5.28			
	36 - 45	78	10.65	33.38	25.31	3.97			
	46 - 55	52	10.12	29.92	25.02	3.44			
	56 and above	19	19.73	28.40	24.98	2.78			
Lobular Height	16 - 25	90	10.21	21.05	14.58	2.34	4	2.40	=0.05
	26 - 35	61	10.19	19.97	13.74	2.29			
	36 - 45	78	10.71	20.36	14.46	2.20			
	46 - 55	52	10.33	21.24	15.11	2.82			
	56 and above	19	10.84	21.24	14.48	2.56			

Auricular Dimensions (mm)	Age (years)	Descriptive Statistics					ANOVA		
		N	Min	Max	Mean	S.D	df	F-value	p-value
Lobular Width	16 - 25	90	10.11	19.75	13.89	2.03	4	1.11	>0.05
	26 - 35	61	10.21	17.00	13.48	1.76			
	36 - 45	78	10.31	18.89	13.28	2.11			
	46 - 55	52	10.35	18.36	13.54	2.08			
	56 and above	19	10.59	18.36	13.27	1.91			
Ear Index	16 - 25	90	29.20	66.06	51.91	6.43	4	3.21	<0.05
	26 - 35	61	30.77	75.12	50.22	8.11			
	36 - 45	78	35.14	72.06	54.11	7.11			
	46 - 55	52	32.20	63.95	51.00	6.20			
	56 and above	19	45.52	61.82	52.90	4.93			
Lobular Index	16 - 25	90	66.74	193.44	97.03	18.71	4	2.08	>0.05
	26 - 35	61	70.81	134.73	99.70	14.96			
	36 - 45	78	61.29	147.86	93.78	19.93			
	46 - 55	52	61.80	127.37	91.33	15.00			
	56 and above	19	73.74	118.45	93.01	13.56			

## Discussion

The racial distributions of ear (auricular) morphological variation and morphometric dimensions have been extensively studied in recent times, providing a relevant knowledge to the fields of biological and forensic anthropology, surgical anatomy and prosthetics. However, certain precautions need to be taken to ensure reliability and reproducibility of anthropometric data. The estimation of age and sex from anthropometric measures of an ear has been studied worldwide across plenty populations (Meijerman et al. 2007; Sforza et al. 2009; Murgod et al. 2013; Eboh 2013; Ahmed and Omer 2015; Sharma 2016). The purpose of this study was to determine the accuracy of prediction of age and sex of selected Nigerian Igbo population using auricular morphometrics for forensic applications.

Studies show that men tend to have larger ears than women, ears increase in

both length and width with increasing age, and overall ear size differs according to ethnic groups. In this study, there was no significant difference between the mean age of males and females. Regarding the sex differences of the right auricle between sexes, males had slightly lower values in total ear height and lobule height compared to females, leading to a slight increase in their ear and lobule indices. In contrast, this study does not support the notion that ear dimensions increased in size with age as they were relatively similar to one another across all age groups. Hence, the morphometric values of right and left auricle of males and females were comparatively very similar. A study done by Kumar and Selvi (2016) showed that the Malaysian female total ear length, width and ear lobe height were not significantly different on both right and left side. They showed that in the Indian population, the morphometry of ear was found to be more pronounced on the right ear in both sexes.



Faakuu et al. (2020) data based on Ghanaian population showed that right ear height was higher compared to the left auricle and similar pattern was observed in this study. In contrast, Barut and Aktunc (2006) had larger ear measurements in the left auricle. This could be influenced by age and geographical differences.

Gender differences were highly significant in the total ear height, lobular height, width, and the ear index of the left auricle of this present study, which could be due to the wide age group in the study population. This is consistent with several other studies which showed similar significant differences in auricular measurements (Alexander et al. 2011; Ahmed and Omer 2015). In a similar study, sexual differences were reported in the total ear height of Americans from

Rhode Island only (Brucker et al. 2003). Furthermore, Taura et al. (2013) showed sexually dimorphic ear length and width on the right side and only in the width on the left side, which corresponds to the findings of our study. In addition, significant side differences were observed only in total ear height of males while side symmetry was observed in all parameters for females except the total ear height and lobular index. Meijerman et al. (2007) argued that these differences might be due to the differences in body maturity levels between sexes.

Studies have reported that the ear-lobe height increases with age (Alexander et al. 2011; Deopa et al. 2013). Age-related differences were observed in right ear index, left total ear height, and left ear width as well as left ear index in this study.

Table 6. Comparison of auricular dimensions (measured in mm) of the present study with related literature

Author(s)	Year	Mean TEH		Mean EW		Mean LH		Mean LW	
Tatlisumak et al.	2015	65.49 (L)	61.33 (L)	33.96 (L)	32.29 (L)	18.37 (L)	17.31 (L)	17.33 (L)	17.08 (L)
		64.47 (R)	60.30 (R)	35.23 (R)	32.97 (R)	18.40 (R)	17.33 (R)	19.22 (R)	18.73 (R)
		(males)	(females)	(males)	(females)	(males)	(females)	(males)	(females)
Elyasi et al.	2020	59.86	60.12	30.71	31.36	N.A		N.A	
		(males)	(females)	(males)	(females)				
Rani et al.	2021	60.40 (L)	57.60 (L)	32.60 (L)	30.50 (L)	16.80 (L)	16.90 (L)	20.10 (L)	18.20 (L)
		61.20 (R)	57.90 (R)	33.20 (R)	30.40 (R)	16.50 (R)	16.70 (R)	18.30 (R)	17.70 (R)
		(males)	(females)	(males)	(females)	(males)	(females)	(males)	(females)
Singh et al.	2022	62.30 (L)	59.10 (L)	32.80 (L)	30.50 (L)	17.70 (L)	17.50 (L)	20.20 (L)	19.80 (L)
		62.90 (R)	59.90 (R)	33.10 (R)	30.40 (R)	17.60 (R)	16.70 (R)	19.00 (R)	18.20 (R)
		(males)	(females)	(males)	(females)	(males)	(females)	(males)	(females)
Present study	2023	46.24 (L)	48.25 (L)	24.68 (L)	24.57 (L)	13.99 (L)	14.89 (L)	13.30 (L)	13.78 (L)
		47.01 (R)	48.25 (R)	25.06 (R)	25.19 (R)	13.92 (R)	14.44 (R)	12.99 (R)	13.37 (R)
		(males)	(females)	(males)	(females)	(males)	(females)	(males)	(females)

L = Left, R = Right, N.A = Not Available

### Conclusions

Overall, this study provides a baseline data for auricular morphometrics of

adult Nigerian Igbos. In both sexes, the total ear height and ear width values were slightly higher on the right sides compared to the left side while the lobule height and lobule width values of



the right side were slightly lower compared to the left side. However, the total ear height and lobular width values in females were much higher than that of the males. The values obtained from this study might play a significant role in forensic identification and surgical operations, as well as serve as ergonomic guide for the production of prosthetics and hearing aids for correction of ear deformities.

### Acknowledgements

Special thanks to the participants that contributed highly to the success of this research.

### Conflicts of interest

All authors declare that there is no form of competing interests.

### Authors' contributions

GSO was the lead researcher, conceived study concept and design, critical revision of the article for important intellectual content, and provision of study materials; OMA performed the data collection, statistical analysis, and wrote the manuscript. JNE performed data collection and compilation, and revised the manuscript. All authors discussed the results and contributed to the final manuscript for publication.

### Corresponding author

Oghenefego Michael Adheke, Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Nigeria; phone number: +234-8032261520, e-mail: mikeadheke@gmail.com

## References

- Ahmed AA, Omer N. 2015. Estimation of sex from the anthropometric ear measurements of a Sudanese population. *Leg Med (Tokyo)* 17:313–319. <https://doi.org/10.1016/j.legalmed.2015.03.002>
- Alexander KS, Stott DJ, Sivakumar B, Kang N. 2011. A morphometric study of the human ear. *J Plast Reconstr Aesthet Surg* 64:41–47. <https://doi.org/10.1016/j.bjps.2010.04.005>
- Barut C, Aktunc E. 2006. Anthropometric measurements of the external ear in a group of Turkish primary school students. *Aesthetic Plast Surg* 30:255e9. <https://doi.org/10.1007/s00266-005-0182-1>
- Brucker MJ, Patel J, Sullivan PK. 2003. A morphometric study of the external ear: age- and sex-related differences. *Plast Reconstr Surg* 112:647e52. <https://doi.org/10.1097/01.PRS.0000070979.20679.1F>
- Deopa D, Thakkar HK, Prakash C, Niranjana R, Barua MP. 2013. Anthropometric measurements of external ear of medical students in Uttarakhand Region. *J Anat Soc India* 62:79–83. [https://doi.org/10.1016/S0003-2778\(13\)80018-4](https://doi.org/10.1016/S0003-2778(13)80018-4)
- Eboh DEO. 2013. Morphological changes of the human pinna in relation to age and gender of Urhobo people in Southern Nigeria. *Journal of Experimental and Clinical Anatomy* 12:68. <https://doi.org/10.4103/1596-2393.127964>
- Ekanem AU, Garba SH, Musa TS, Dare ND. 2010. Anthropometric study of the pinna (auricle) among adult Nigerians resident in Maiduguri metropolis. *J Med Sci* 10:176–80. <https://doi.org/10.3923/jms.2010.176.180>
- Elyasi L, Araban S, Eftekhar Vaghefi SH. 2020. Auricle Morphometry in Iranian Population. *Anatomical Sciences*. 17(2):47–54.
- Faakuu E, Abaidoo CS, Appiah AK, Tetteh J. 2020. Morphological study of the external ear among the Daggabas in the upper

- west region of Ghana. *Scientific African* 8:e00408. <https://doi.org/10.1016/j.sciaf.2020.e00408>
- Jung SH, Jung SH. 2003. Surveying the dimensions and characteristics of Korean ears for the ergonomic design of ear-related products. *Int J Ind Organ* 31:361–73. [https://doi.org/10.1016/S0169-8141\(02\)00237-8](https://doi.org/10.1016/S0169-8141(02)00237-8)
- Kumar BS, Selvi GP. 2016. Morphometry of ear pinna in sex determination. *Int J Anat Res* 4(2):2480–2484. <https://doi.org/10.16965/ijar.2016.244>
- Meijerman L, van der Lugt C, Maat GJ. 2007. Cross-sectional anthropometric study of the external ear. *J Forensic Sci* 52:286–93. <https://doi.org/10.1111/j.1556-4029.2006.00376.x>
- Murgod V, Angadi P, Hallikerimath S, Kale A. 2013. Anthropometric study of the external ear and its applicability in sex identification: assessed in an Indian sample. *Aust J Forensic Sci* 45(4):431–444. <https://doi.org/10.1080/00450618.2013.767374>
- Osunwoke EA, Vidona WB, Atulegwu GC. 2018 Anthropometric study on the anatomical variation of the external ear amongst Port Harcourt students, Nigeria. *Int J Anat Var* 11(4):143–146.
- Purkait R, Singh P. 2007. Anthropometry of the normal human auricle: A study of adult Indian men. *Aesthetic Plast Surg* 31:372–9. <https://doi.org/10.1007/s00266-006-0231-4>
- Rani D, Krishan K, Sahani R, Baryah N, Kanchan T. 2021. Variability in human external ear anthropometry-Anthropological and forensic applications. *La Clinica Terapeutica* 172(6):531–541. <https://doi.org/10.7417/CT.2021.2374>
- Sforza C, Grandi G, Binelli M, Tommasi DG, Rosati R, Ferrario VF. 2009. Age- and sex-related changes in the normal human ear. *Forensic Sci Int* 187:110e7. <https://doi.org/10.1016/j.forsciint.2009.02.019>
- Sharma A, Sidhu NK, Sharma MK, Kapoor K, Singhet B. 2007. Morphometric study of ear lobule in northwest Indian male subjects. *Anat Sci Int* 82:98e104. <https://doi.org/10.1111/j.1447-073X.2007.00166.x>
- Sharma N. 2016. Anthropometric measurement and cross-sectional surveying of ear pinna characteristics in Northern India. *Journal of Experimental and Clinical Anatomy* 15:102–106. <https://doi.org/10.1016/j.sciaf.2020.e00408>
- Singh AB, Gupta P, Singh P. 2022. Anthropometric assessment of human auricle in North Indian population. *Natl J Maxillofac Surg* 3:234–7. [https://doi.org/10.4103/njms.njms\\_347\\_21](https://doi.org/10.4103/njms.njms_347_21)
- Tatlisumak E, Yavuz MS, Kutlu N, Asirdizer M, Yoleri L, Aslan A. 2015. Asymmetry, handedness and auricle morphometry. *Int J Morphol* 33(4):1542–1548.
- Taura MG, Adamu LH, Modibbo MH. 2013. External ear anthropometry among Hausas of Nigeria; the search of sexual dimorphism and correlations. *World Science Research Journals* 1:091–095.