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## **Anthropometric Study of the Pinna (Auricle) among Adult Nigerians Resident in Maiduguri Metropolis**

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The ear is an important and under-recognized defining feature of the face whose shape conveys information about age and sex that is clearly difficult to characterize. This study was designed to generate anthropometric, normative cross-sectional data on the adult ear auricle in Nigerians. It was also aimed at showing the morphological and aesthetic differences between males and females; as well as changes in ear morphology with age. A total of 217 adult Nigerians (aged 18-65 years) who met the inclusion criteria were enrolled into the study. Standardized measurements of the ear pinna (total ear height, lobular height and lobular width) were undertaken. The data were analyzed using SPSS version 10.0. The mean total ear height and mean lobular height across the cohort were 5.60 and 1.11 cm, respectively, while the average lobular width measured 1.35 cm. The results indicates that the mean total ear height and mean lobular height were higher in the males than in the females while the females had a higher mean lobular width of 1.37 cm than the mean lobular width of 1.33 cm in males. There were increases in earlobe height and lobular height but a decrease in lobular width with advancing age. This study has shown that age related changes in ear morphology do exist in Nigerians and the changes were with respect to sex from adolescence to the age groups of 41-45 years. But further study to relate the results of our present study to the height of individual and some facial/cranial anthropometric parameters is going on.

**Key words:** Anthropometry, pinna, total ear height, lobular height, lobular width, Nigeria

## INTRODUCTION

Anthropometry in physical anthropology refers to the measurement of living human individuals for the purposes of understanding human physical variation and plays an important role in plastic surgery, prosthetics, industrial design, clothing design, ergonomics and architecture, where statistical data about the distribution of body dimensions in the population are used to optimize products. As products are designed for specific types of consumers, an important design requirement is selection and efficient utilization of the most appropriate anthropometric database. Anthropometry data provides a valuable source of information to ergonomists and designers who attempt to consider a range of body sizes and abilities in the design of occupational environments and products. An anthropometric measurement is simply a construction of an observation or recording of an attribute, which can be affected by the measurer's characteristics, methods used in measurement and the measurement environment (Liu *et al.*, 2010; Feathers *et al.*, 2004; Wickens *et al.*, 2004).

The human ear is divided into external, middle and internal parts. The pinna and the external acoustic meatus, form the external ear. The lateral surface of the pinna is irregularly concave, faces slightly forward and displays numerous eminences and depressions. These structures do not merely act as trumpet; they are the first of series of stimulus modifiers in the auditory apparatus (Williams *et al.*, 1987). It is also a defining feature of the face and its subtle structures convey signs of age and gender that are unmistakable, though not easily defined (Brucker *et al.*, 2003).

The anatomy of the external ear has been detailed by many authors and in many texts (Brent, 1990; Farkas, 1990; Farkas *et al.*, 1992; Bozkir *et al.*, 2006; Fok *et al.*, 2004). A study carried out in India observed that North-West Indians have smaller ear lobules when compared to Caucasian and Japanese populations but similar to those found among the Onge tribe of Andhra (India) and Newars of Nepal (Sharma *et al.*, 2007).

Anthropometric studies had also been carried out on the external ear of children with cleft lip/palate and Down syndrome (Nathan *et al.*, 2008; Sforza *et al.*, 2005). The existence of abnormality of the external ear as an early diagnostic feature for existence of an abnormality of the urinary tract, due to concomitant development of the external ear and urinary tract during embryogenesis has been documented (Perrin *et al.*, 1999). Lettieri *et al.* (1993) carried out a research work on fetal ear length and chromosomal abnormalities. They concluded that aneuploid fetuses could be identified sonographically

considering the fetal ear length. Ejiwunmi *et al.* (1984) published their work on comparative study between Negro and Caucasian neonates and documented shorter ears in the Negro neonates compared to his Caucasian counterpart.

This present study is a preliminary report of an on-going cross-sectional study that is intended to describe the anatomic height of the ear, lobular height and width amongst adult Nigerians (aged 18 to 65 years). From these data, it is envisaged that anatomical and morphological differences and changes of the ear in relation to age and sex in our environment would be established. With the appropriate normative data, it is also hoped that better and objective reference material would be provided for the aesthetic plastic surgeon, particularly those engaged in ear rejuvenation in the country.

## MATERIALS AND METHODS

**Subjects:** This study was carried out on 217 adult volunteers with no evidence of congenital ear anomalies or previous ear surgeries, the volunteers were randomly selected from the Maiduguri Metropolis, Nigeria for this study. The study was conducted in March 2008 and the study cohort consisted of 77 females and 140 males, aged 18 to 65 years. Age and sex were recorded against each volunteer. Informed consent was obtained from each volunteer before measurements.

**Anthropometric measurements:** Standardized measurements of the ear pinna were taken according to the landmark points defined by De Carlo *et al.* (1998) and the methodology was adopted from McKimney *et al.* (1993) and Brucker *et al.* (2003). The parameters measured were Total Ear Height (THE), Lobular Height (LH) and Lobular Width (LW).

Total ear height was measured as the distance from the most inferior projection of the ear lobule to the most superior projection of the helix. The LH was taken as the distance from the most inferior end of the lobule to the base of the tragal notch. The LW was measured as the transverse or horizontal width of the lobule at the midpoint of the lobular height.

All the measurements were taken by a single investigator using standard vernier calipers (Tresna, Japan) capable of measuring to the nearest 0.1 mm and a tape rule. For each volunteer the measurements were carried out thrice to ascertain accuracy. Secondly all the measurements were carried out by the same investigator in order to minimize bias and error of identification of the parts of the ear pinna involved in the measurements.

The numerical data were analyzed using a statistical package for social Sciences Version (SPSS) 10.0. The student T-test with a two tail distribution was applied to analyze the data between male and female participants. Analysis of age and sex related variations were performed using analysis of variance and Pearson’s correlation test for linear relationship.

**RESULTS**

The combined results from both the right and left ears (434) across the cohort are shown in Table 1. The total mean and standard deviation of ear height was 5.60±0.56 cm. The mean lobular height was 1.11±0.27 cm giving a lobular height to total ear height ratio of 19.8%. The average lobular width in all ears was 1.35±0.25 cm. The average height of the pinna, obtained by subtracting the lobular height from the total ear height was about 4.50 cm.

Also shown in Table 1 are the results from the data separated into male and female subgroups to analyze changes in ear morphology in relation to sex. The average lobular width and the average total ear height between the males and females were almost identical. Statistical analysis of the data obtained revealed an average lobular width of 1.37±0.24 and 1.33±0.25 cm in females and males respectively while the average heights of the ear lobule were 1.13±0.28 and 1.06±0.26 cm in males and females respectively. Mean ear height was 5.61±0.59 cm for the males and 5.60±0.51 cm for the females while the height of the pinna was 4.54 cm in females and 4.48 cm in males, longer in females by approximately 1.32%.

In all parameters taken the males had longer maximum distances when compared to those from females. Furthermore, the total ear height in the female ranged

between 4.06 to 7.02 cm while in the male the figures were 3.75 to 7.17 cm. The lobular height in women measured between 0.30 to 1.60 cm but in men 0.40 to 1.80 cm. Lastly, the minimum and maximum distances of the width of the lobule were 0.50 to 2.20 and 0.50 to 1.80 cm in male and female, respectively.

The data were further broken down to analyze possible differences in the anatomy of the right and left ears. It was observed that in all cases the linear relationship between the right and left ear parameters were positive and highly significant ( $p < 0.01$ ) and even between different ear parameters, as depicted in Table 2. The least linear relationship was between the left lobular height and the left total ear height at  $r = 0.34$ ; while the highest correlation was  $r = 0.89$  between the left lobular height and right lobular height.

For analysis of age-related variations in the ear morphology, the cohort was divided into nine subgroups, separately for right and left ears (Table 3). The subgroups were arbitrarily selected based on overall age distribution within the cohort (Brucker *et al.*, 2003). There were no significant differences in the lobular height, total ear height and the lobular width between the age groups, whether from the right or left ears. On the right ear there was a gradual increase in the total ear height from a mean of 5.48±0.41 cm in the age group 15-20 years to a mean of 5.89±0.82 cm in the age group 51-55. A similar pattern was obtained for the left total ear height and the right and left lobular height. In all cases there were noticeable drop in the ear distances from the 41-45 age group.

The right ear lobule increased in height from an average of 1.06±0.30 cm in the 15-20 age groups to 1.23±0.28 cm in age group 51-55 years, while the left lobular width decreased from 1.36±0.24 cm in the age group 15-20 years to 1.30±0.14 cm in the 56-60 year group.

**Table 1: The Mean Total Ear Height (THE), Mean Lobular Height (LH) and Mean Lobular Width (LW) across the sample population with respect to Sex**

Sex	N	Statistical measure	THE (cm)	LH (cm)	LW (cm)
Male	140	Range	3.75-7.17	0.40-1.80	0.5-2.20
		Mean	5.61±0.59	1.13±0.28	1.33±0.25
Female	77	Range	4.06-7.02	0.30-1.67	0.50-1.80
		Mean	5.60±0.51	1.06±0.26	1.37±0.24
Combined	217	Range	3.75-7.17	0.30-1.80	0.50-2.20
		Mean	5.60±0.56	1.11±0.27	1.35±0.25

**Table 2: Mean±SD, pearson correlation between the right and left THE, LH, and LW from adult Nigerians**

Parameter	Sex	Right	Left	Range	R
THE (cm)	F (77)	5.61±0.49	5.58±0.52	4.06-7.02	0.80**
	M (140)	5.60±0.53	5.62±0.64	3.75-7.17	
	Combined (217)	5.60±0.52	5.60±0.60		
LH (cm)	F (77)	1.07±0.27	1.05±0.24	0.30-1.60	0.89**
	M (140)	1.13±0.29	1.12±0.27	0.41-1.80	
	Combined (217)	1.11±0.28	1.12±0.26		
LW (cm)	F (77)	1.38±0.25	1.36±0.22	0.50-1.80	0.86**
	M (140)	1.31±0.26	1.33±0.23	0.50-2.20	
	Combined (217)	1.33±0.25	1.34±0.23		

THE: Total ear height, LH: Lobular height and LW: Lobular width. \*\*Correlation is highly significant at the 0.01 level ( $p < 0.01$ ; 2-tailed)

Table 3: The Mean±SD of right and left THE, LH and LW in relation to age in male and female Nigerians

Age group	N	Right ear			Left ear		
		THE	LH	LW	THE	LH	LW
15-20	27	5.48±0.41	1.06±0.30	1.33±0.30	5.36±0.47	1.04±0.29	1.36±0.24
21-25	93	5.56±0.53	1.05±0.29	1.31±0.26	5.55±0.54	1.06±0.28	1.32±0.25
26-30	37	5.60±0.50	1.14±0.23	1.35±0.27	5.64±0.50	1.09±0.20	1.32±0.23
31-35	23	5.62±0.63	1.19±0.30	1.36±0.20	5.83±1.02	1.17±0.27	1.37±0.19
36-40	17	5.82±0.45	1.22±0.27	1.37±0.16	5.78±0.51	1.18±0.25	1.37±0.16
41-45	10	5.74±0.53	1.22±0.28	1.32±0.29	5.59±0.55	1.14±0.31	1.30±0.17
46-50	04	5.88±0.60	1.25±0.13	1.48±0.33	5.78±0.62	1.20±0.22	1.53±0.33
51-55	04	5.89±0.82	1.23±0.28	1.30±0.29	5.79±0.73	1.13±0.27	1.33±0.21
56-60	02	5.88±0.48	1.15±0.27	1.30±0.14	5.88±0.48	1.15±0.27	1.30±0.14
Total	217	5.60±0.52	1.11±0.28	1.33±0.25	5.60±0.60	1.09±0.26	1.34±0.23

THE: Total ear height, LH: Lobular height and LW: Lobular width. No significant difference between the age groups (p>0.05)

The lobular width got to a peak at age 46-50 years before a decline in mean values.

In analyzing age related changes in ear morphology based on sex it was observed that the height of the pinna reached statistical differences only at age groups 15-20; 21-25; 26-30; 31-35; 36-40; 41-45 but no statistical difference at age group 46-50 and 51-55 years (Table 3).

### DISCUSSION

The ear is an important and under-recognized defining feature of the face whose shape conveys information about age and sex that is clearly difficult to characterize (Brucker *et al.*, 2003). In the present study attempt was made to document the basic aesthetic proportions of the ear pinna.

Extensive discussions of the normal ear morphology as it relates to the rhytidectomy patient had been carried out using cross-sectional study (McKinney *et al.*, 1993). Their study addressed specifically the treatment of the ear and earlobe in aesthetic surgery. McKinney *et al.* (1993) obtained data from 100 normal volunteers and found a mean ear height of 6.50 cm and a mean lobular height of 1.80 cm, with no significant correlation between the earlobe height and aging. Brucker *et al.* (2003) on their morphometric study of the external ear, age and sex related differences, obtained a mean total ear height of 6.30 cm; an average lobular height of 1.88 cm and an average lobular width of 1.96 cm. The results from these two groups of workers correlated well, but are very disparate from the present study on Nigerians. This could be interpreted to be associated with the sample populations which were from different social and ethnic/racial backgrounds.

Similar to the findings of Coward *et al.* (2000) differences between dimensions of the left and right ears were observed, but these differences were of a small magnitude.

Analyzing the data with regard to sex of the volunteers, it was observed that earlobe size did not vary

significantly between the men and women. This was similar to findings of Brucker *et al.* (2003), who also observed that though the total ear height was larger in the men, their lobular height and width remained nearly identical to women.

When, the data were analyzed for age related changes there were noticeable increases in the total ear height, lobular height while the lobular width decreased with increasing age. Brucker *et al.* (2003) observed consistent and statistically significant increment in the earlobe height for both sexes and explained that the increase in the earlobe height with age was not due to weight effects of earrings, since a majority of their women and none of the men had pierced earlobes in their cohort. They suggested instead that the lengthening of the earlobe was more likely to be a result of the aging process. Ito *et al.* (2001) on the morphological study of age changes in adult human auricular elastic cartilage reported that auricular size increased significantly with age in both men and women and that these structural changes were associated with changes with the elastic fibers after adulthood.

In conclusion, it is believed that the data obtained in the present study would serve some very useful purposes in ear morphology and for anthropometric considerations for Nigerians. But further study to relate the results of our present study to the height of individual and some facial/cranial anthropometric parameters is going on

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