Morphological changes of the human pinna in relation to age and gender of Urhobos people in Southern Nigeria

D.E.O. Eboh

Department of Human anatomy and Cell Biology, Faculty of Basic Medical Sciences, College of Health Sciences, Delta State University, Abraka, Nigeria

Abstract

Introduction: The knowledge of anthropometry of normal human ear and symmetry is required for the timing of surgical reconstructions, when the contra lateral organ cannot be used as a template and for the design of hearing aid instruments. Ear prints have a potential for personal identification, and reference anthropometric data that consider age and sex related modifications are necessary. Purpose of the study: The purpose of this study was to measure the morphological length and width of the pinna and ear lobe among the Urhobos people of Southern Nigeria (aged 6 to 60 years). **Materials and Methods:** This descriptive cross-sectional study adopted the multistage sampling technique. The study subjects comprised 368 Urhobos individuals (191 males and 177 females). **Results:** Total ear length, Ear width, Lobular length and Lobular width, were measured with digital vernier caliper (in millimeter) and recorded in a proforma. The mean total ear length, ear width, lobular length, and lobular width across the entire cohort for both left and right sides were 56.79 ± 4.26 mm, 30.47 ± 1.99mm, 15.36 ± 1.99mm and 16.12 ± 1.66mm respectively. Pearson's correlations between right and left sides in each of the parameters were positive and highly significant (P = 0.001). The effect of age on the parameters measured as analyzed with two-way factorial ANOVA showed statistical significance (P = 0.001) on both sides. The effect of gender on the parameters measured reached statistical significance only in the cases of lobular length on the right (P = 0.03) and lobular length on the left (P = 0.01); other parameters were not significant (P > 0.05). **Conclusion:** This will be useful in surgery, forensic human identification and product designs.

Key words: Auricle, anthropology, age, gender, growth, morphometry

INTRODUCTION

The pinna or auricle and external auditory meatus form the external ear. The pinna projects from the side of the head to collect sound waves for the external auditory meatus. Its lateral surface is irregularly concave, faces slightly forward and displays numerous eminences and depressions. The cranial surface presents elevations which correspond to the depressions on its lateral surface (Standring, 2008). The pinna possesses a skeleton of resilient yellow elastic cartilage which is thrown into folds that gives its characteristic shape. The lobule is a tag of skin containing soft fibro fatty tissue (Sinnatamby, 2000).

The human pinna is formed between the fourth and sixth weeks of gestation as the neural crest tissues of the first and second branchial arches interact with the underlying surface ectoderm of these arches. During this time, there is the appearance of six auricular hillocks, which are derived from the first and second branchial arches (Van De Water and Staecker, 2006). The cartilaginous framework

Address for correspondence:
Dr. D.E.O. Eboh,
Department of Human anatomy and Cell Biology,
Faculty of Basic Medical Sciences, College of Health Sciences,
Delta State University, Abraka, Nigeria.
E-mail: drebohdennis@yahoo.com

Access this article online	
Quick Response Code:	Website: www.jecajournal.com
	DOI: 10.4103/1596-2393.127964

and connective tissues of the pinna are derived from the neural crest cells of the first and second branchial arches, and the musculature of the pinna is derived head mesoderm (Van De Water and Staecker, 2006). These hillocks develop into the folds of the pinna and gradually shift upwards and backwards to their final position on the head. Streeter (1922) described the essential and precise external movement of the pinna. The two auricular areas nearly meet in the mid-ventral region in a 6 mm embryo; they are gradually moved laterally and dorsally. Streeter opined that the movement of the external ear might be relative rather than real as the external ear is located at the side of the mouth during the development.

The auricle is one of the five primary features of the human face and is particularly influential in determining its appearance (Purkait and Singh, 2007). It is stated in Park (2005) that although an individual's appearance is not defined by the beauty of the ears, a deformed or mal-positioned auricle can detract from one's appearance. Most observers do not view both ears simultaneously and minor asymmetries of detail between the ears are often overlooked. However, gross differences in size or position of the two ears are easily noticed (Park, 2005). Since the morphology of the pinna is highly complex, plastic surgeons require detailed information about its typical dimensions to be able to construct and to determine accurately the position and orientation of the auricular framework (Park, 2005).

The dimensions of the pinna have been found to vary across different ethnic groups (Purkait and Singh, 2007). Anthropometrical studies of the human auricle have been reported in different ethnic groups: Brucker *et al.* (2003) measured the auricle of American individuals and analysed age- and sex-related differences. Gualdi-Russo (1998), Ferrario *et al.* (1999) and Sforza *et al.* (2009) conducted similar studies in Italian populations. Purkait and Singh (2007) investigated the auricle of adult Indian men. Bozkir *et al.* (2006), Kalcioglu *et al.* (2003 and 2006) and Barut and Aktunc (2006) examined the auricles of Turkish people. Wang *et al.* (2011) measured the auricles of Han Chinese population. Azaria *et al.* (2003) surveyed the earlobes of an Israeli population. In Nigeria, Ekanem *et al.* (2010) conducted an anthropometric study of the pinna in Maiduguri metropolis, Northern Nigeria. A thorough search of the literature revealed that similar studies to obtain data for the Urhobo nation in Southern Nigeria are not available.

The data generated in this study will serve as a baseline data to guide surgeons involved in the management of cases of the external ear, including reconstruction and peri-auricular surgery. It will be useful to industries involved in product designs for specific consumer requirements. It will assist the forensic pathologist, the anthropologist, the fingerprint officer, or the facial reconstruction expert in the identification of a living or deceased individual in this part of the world. It may be of pathological relevance, as some diseases can be considered from the appearance of the pinna and may have a bearing on the ultimate cause of death (Frank, 1973; Patel *et al.* 1992; Elliot and Powell, 1996). This study was undertaken to measure the morphological length and width of the pinna and earlobe among the Urhobos of Southern Nigeria.

MATERIALS AND METHODS

This was a descriptive cross-sectional study carried out between February and September, 2011. Three hundred and sixty-eight (368) subjects (191 males and 177 females) aged 6-60 years whose parents and grandparents belong to Urhobo ethnic nation were sampled, using the multistage sampling technique. The subjects who were recruited from primary, secondary schools and the Delta State University, Abraka, included both pupils/students and teachers/lecturers. The research was delimited to the Urhobos in Abraka, a sub-urban university town in Delta state, Southern Nigeria. The subjects were divided into 11 age groups (A-K) with equal intervals [Table 1]: Group A = 6-10 years; group B = 11-15 years; group C = 16-20 years; group D = 21-25 years; group E = 26-30 years; group F = 31-35 years; group G = 36-40 years; group H = 41-45 years; group I = 46-50 years; group J = 51-55 years; group K = 55-60 years. The lower age was chosen because of the assumption that younger children might not cooperate. The upper age was chosen as civil/public servants retire at 60 years. The age grouping was to find out the possibility of significant dimensional differences at intervals of 5 years.

Subjects with history of craniofacial trauma, ear diseases, congenital abnormalities or surgery of the ear were excluded from the study. Prior to data collection, the subjects were informed of the nature and purpose of the study, and only those who gave their consent participated.

Table 1: Age and gender distribution in the current study

Gender	Age (years)											Total
	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	
Females	23	24	30	37	21	11	11	5	6	5	4	177
Males	30	31	28	40	19	11	10	8	6	4	4	191
Total	53	55	58	77	40	22	21	13	12	9	8	368

In the case of a minor, informed consent was obtained from the parent or legal representative of the subject. This is in accordance with World Medical Association Declaration of Helsinki on Ethical Principles for medical Research involving Human Subjects (2008). Accordingly, the study protocol was approved by the local research ethics committee in the College of Health Sciences, Delta state University, Abraka, Nigeria.

Anthropometry involves measurements of the pinna based on international standard (Brucker *et al.* 2003; Ekanem *et al.* 2010; De Carlo *et al.* 1998; McKinney *et al.* 1993) [Figure 1]. Each subject was made to sit in a natural head position in a chair with a backrest and positioned the head so that the subject looked straightforward with the lower borders of the eye sockets in same horizontal plane as the external auditory meatuses (Frankfurt plane). Four parameters were measured on each of the right and left ears: Total ear length, ear width, lobular length and lobular width.

TELwas measured as the distance from the most superior point of the helix (A) to the most inferior point of the earlobe (B). EW was determined by measuring transversely from the otobasionsuperius- in the margin of the helical rim at the point it meets the skin of the temporal part of the head (D) to a point on the posterior part of the helix (C). The LL was taken as the distance from the base of the intertragic notch (E) to the most inferior point of the lobule (B). LW was measured as the horizontal distance of the earlobule at the midpoint of the lobular length (FG). The subjects were asked to sit in a natural head position in a chair with a back rest. All measurements were taken using digital vernier caliper (Mitutoyo, Japan) with an accuracy of 0.01 mm and recorded in millimetre (mm) in a data sheet.

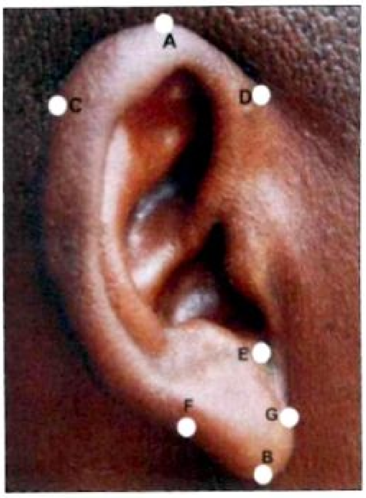

Figure 1: Picture showing ear landmarks and dimensions used in the current study: AB = Total ear length; CD = Ear width; EB = Lobular length; FG = Lobular width

All measurements were taken by one investigator to remove inter-observer error. To improve accuracy, each measurement was taken twice and the average was recorded. In order to assess error of the measurements, 20 subjects were selected randomly and measurement of each parameter taken twice by one investigator on two separate occasions at interval of two weeks. Intra-observer error was assessed as recommended by Dahlberg (1940). Measurement error was found to be non-significant, and hence unlikely to bias the results.

The data obtained were subjected to statistical analysis using descriptive statistics, *t*-test, Pearson's correlation and analysis of variance with the aid of statistical package for social sciences (SPSS) version 16. $P < 0.05$ was considered statistically significant.

RESULTS

Table 2 depicts combined data from both sides in both genders (736). The mean TELacross the entire cohort for both left and right ears was 56.79 mm. The mean EW was 30.47 mm. The mean LL was 15.36 mm. The mean LW was 16.12 mm. Table 2 also shows the descriptive statistics for data when the cohort is broken down into

Table 2: Descriptive statistics of parameters measured across the cohort with respect to gender

Parameters (mm)	Gender	*N*	Minimum	Maximum	Mean	[e]S.D	Variance
[a]TEL	Male	382	45.03	69.80	56.77	4.52	20.46
	Female	354	42.11	69.05	56.80	3.95	15.64
	Combined	736	42.11	69.80	56.79	4.26	18.12
[b]EW	Male	382	20.77	39.35	30.55	2.08	4.32
	Female	354	21.33	38.35	30.40	1.89	3.58
	Combined	736	20.77	39.35	30.47	1.99	3.97
[c]LL	Male	382	9.74	22.74	14.98	1.95	3.81
	Female	354	8.25	23.29	15.77	1.95	3.79
	Combined	736	8.25	23.29	15.36	1.99	3.95
[d]LW	Male	382	9.10	21.90	16.02	1.68	2.82
	Female	354	9.60	21.08	16.22	1.64	2.69
	Combined	736	9.10	21.90	16.12	1.66	2.78

[a]Total ear length; [b]Ear width; [c]Lobular length; [d]Lobular width; [e]Standard deviation.

male and female subgroups. The mean values for TEL, LL and LW were greater in females than males, while mean value for EW was greater in males compared to females.

The results of the descriptive statistics of parameters measured on both sides with respect to gender is shown in Table 3. Apart from the LW that showed higher mean values in females on both sides, the mean values of other parameters are not consistently higher in one gender with respect to side. The data were further broken down to analyse possible relationship between the parameters on both sides. Pearson's correlation was done between right and left sides in each of the parameters measured. It was observed that in all cases the linear relationships were positive and highly significant (P = 0.001). Pearson's r was in the order of 0.96 TEL in males (0.96), TEL in females (0.95), LL in females (0.92), LW in females (0.90), LL in males (0.89), LW in males (0.89), EW in males (0.65) and EW in females (0.63).

The data were also analysed using the t-test for independent samples between genders on both sides. It was observed that females showed statistically significant higher mean values of LL than males (P = 0.001). The differences between genders in other parameters were not significant ($P > 0.05$). When data on the right and left were combined, mean female values were higher than males and the differences were statistically significant in the cases of LL (F = 1.14; t = 7.67; P = 0.001) and LW (F = 0. 68; t = 2.22; P = 0.026). The mean values in other parameters between males and females were nearly identical.

For analysis of age-related changes in ear morphology, the cohort was divided into 11 subgroups [Table 4]. The pattern of age-related changes is different for different parameters. The patterns are almost identical on both sides. The mean TEL increases from 6-10 years to 26-30 years and remain almost at par between 31-35 years and 36-40 years, then increases from 41-45 years to 55-60 years. The mean EW increases from 6-10 years to 41-45 years old and slowed down at 46-50 years then increases from 51-55 years to 56 -60 years old. The mean LL increases from age 6-10 years to 26-30 years, then decreases from 31-35 years to 41-45 years and increases again from 46-55 years to 56-60 years old. The mean LW increases slowly from age group 6-10 years to 55-60 years.

Table 5 depicts P- and F-values from the two-way analyses of variance. The effect of age on the parameters measured as analysed with two-way ANOVA showed statistical significance (P = 0.001) on both sides [Table 5]. Furthermore, the effect of gender on the parameters measured reached statistical significance only in the cases of LL on the right (P = 0.03) and LL on the left (P = 0.01); other parameters were not significant ($P > 0.05$) [Table 5]. The effect of age-gender interaction was not statistically significant [Table 5].

Post hoc tests with Tukey (for means with homogenous variances) for TELR; TELL; EWL; LLR and LLL; and Tamhane tests (for means with non-homogenous variances) were used for EWR; LWR and LWL. They both showed varied patterns. When EWR was considered, there were significant differences ($P < 0.05$) between age group A and groups C, D, F, G and K. There was also a significant difference between age group B and K. For LWR, there were significant differences ($P < 0.05$) between age group A and groups C, D, E, F, G and I. There was also a significant difference ($P < 0.05$) between age group E and D. For LWL, there were significant differences ($P < 0.05$) between age group A and groups E, F and G.

The results of the *post hoc* with Tukey showed different subsets

Table 3: Descriptive statistics of parameters measured on both sides with respect to gender

Parameters (mm)	Side	Gender	*N*	Minimum	Maximum	Mean	[e]S.D	Variance
[a]TEL	right	Male	191	45.03	69.80	56.73	4.52	20.389
		female	177	45.41	69.05	56.86	3.93	15.407
[a]TEL	left	Male	191	45.28	69.28	56.82	4.54	20.633
		female	177	42.11	68.45	56.75	3.99	15.957
[b]EW	right	Male	191	20.77	36.83	30.61	2.09	4.372
		female	177	22.01	36.70	30.43	1.88	3.520
[b]EW	left	Male	191	22.14	39.35	30.49	2.07	4.286
		female	177	21.33	38.35	30.36	1.91	3.657
[c]LL	right	Male	191	9.74	22.01	15.00	1.96	3.837
		female	177	8.25	23.29	15.77	1.95	3.809
[c]LL	left	Male	191	10.09	22.74	14.97	1.95	3.811
		Female	177	9.15	23.21	15.77	1.95	3.797
[d]LW	right	Male	191	10.46	21.90	16.08	1.67	2.800
		Female	177	10.04	21.08	16.28	1.65	2.738
[d]LW	left	Male	191	9.10	21.43	15.97	1.69	2.858
		Female	177	9.60	20.89	16.17	1.63	2.658

[a]Total ear length; [b]Ear width; [c]Lobular length; [d]Lobular width; [e]Standard deviation.

Table 4: Mean of right and left parameters in relation to age in males and females combined

Age group (years)	N	Right ear (Mean±S.D[e])				Left ear (Mean±S.D[e])			
		[a]TEL	[b]EW	[c]LL	[d]LW	[a]TEL	[b]EW	[c]LL	[d]LW
6-10	53	50.69±2.70	29.5±1.35	13.5±1.74	15.39±1.45	50.68±2.62	29.31±1.47	13.47±1.55	15.36±1.60
11-15	55	55.64±3.79	29.7±2.45	14.8±1.76	15.95±2.24	55.43±4.16	29.61±2.66	14.91±1.77	15.63±1.60
16-20	58	56.48±2.94	30.88±1.41	15.27±1.57	16.47±1.80	56.58±3.04	30.69±1.48	15.20±1.46	16.38±1.55
21-25	77	57.91±3.10	30.66±1.95	15.47±1.89	15.81±1.34	57.72±3.09	30.50±1.97	15.46±1.95	15.78±1.32
26-30	40	60.14±2.98	30.75±2.41	16.75±1.94	16.87±1.60	60.16±2.81	31.04±2.37	16.77±2.02	16.65±1.46
31-35	22	57.89±2.32	31.08±1.43	16.34±1.44	16.76±1.27	58.26±2.72	30.87±1.57	16.32±1.30	16.76±1.11
36-40	21	58.49±3.22	31.01±1.27	15.60±1.52	16.64±1.03	58.37±3.06	31.02±1.26	15.44±1.57	16.54±0.83
41-45	13	58.71±2.97	31.65±2.09	15.44±1.45	16.35±0.83	58.77±2.95	31.37±1.75	15.56±1.52	16.38±0.96
46-50	12	59.89±3.37	30.27±3.24	16.49±2.01	16.95±1.18	60.02±3.36	30.87±1.25	16.70±1.99	16.87±1.44
51-55	9	59.41±4.40	31.55±1.45	16.78±2.04	15.96±1.76	60.40±2.95	31.45±1.12	16.90±2.35	15.86±1.42
56-60	8	61.90±2.24	31.65±0.97	17.33±1.75	16.67±1.75	61.81±2.25	31.69±1.00	17.02±1.60	16.72±1.58

[a]Total ear length; [b]Ear width; [c]Lobular length; [d]Lobular width; [e]Standard deviation.

Table 5: F values/P values from the two-way analyses of variance

Measurement	Gender	Age	Gender×Age
Right side			
Total ear length	NS	31.28/0.000	NS
Ear width	NS	3.80/0.000	NS
Lobular length	5.10/0.03	11.69/0.000	NS
Lobular width	NS	3.42/0.000	NS
Left side			
Total ear length	NS	32.06/0.000	NS
Ear width	NS	4.58/0.000	NS
Lobular length	7.29/0.01	12.19/0.000	NS
Lobular width	NS	3.37/0.000	NS

NS - Not significant (P>0.05)

with the different age groups in the different parameters. TELR had five subsets: the means of subgroups B, C, D, E, F, G, H, I, J and k differ significantly ($P < 0.05$) from each other; the means of subgroups A, E, I, J and k are significantly different ($P < 0.05$) from each other; the means of subgroups A, B, E, I and k differ significantly ($P < 0.05$) from each other; the means of subgroups A, B, C and k are significantly different ($P < 0.05$) from each other; the means of subgroups A, B, C, D, F, G and H differ significantly ($P < 0.05$) from each other.

TELL also had five subsets: the means of subgroups B, C, D, E, F, G, H, I, J and k differ significantly from each other; the means of subgroups A, E, H, I, J and k differ significantly from each other; the means of subgroups A, B, E, I, J and k differ significantly from each other; the means of subgroups A, B, C, and k differ significantly from each other; the means of subgroups A, B, C, F and G differ significantly from each other.

EWL had three subsets: the means of subgroups H, J and k differ significantly from each other; the means of subgroups A and k differ significantly from each other; the means of subgroups A and B differ significantly from each other. LLR had four subsets: The means of subgroups C, D, E, F, G, H, I, J and k differ significantly from each other; the means of subgroups A, E, J and k differ significantly from each other; the means of subgroups A, B and k differ significantly from each other; the means of subgroups A, B, C, D and H differ significantly from each other. LLL had four subsets: the means of subgroups B, C, D, E, F, G, H, I, J and k differ significantly from each other; the means of subgroups B, E, I, J and k differ significantly from each other; the means of subgroups A, B and k differ significantly from each other; the means of subgroups A, B and C differ significantly from each other.

DISCUSSION

The understanding of anthropometric dimensions of structures in the face with regards to different ages, ethnic groups and genders is necessary for correct reconstruction of the facial appearance, for surgical and forensic purposes (Azaria *et al.* 2003; Ekanem *et al.* 2010; Sharma *et al.* 2007; Sforza and Ferrario, 2006) as well as for products designs (Liu B-S, 2006). The present study focused on anthropometric measurements of TEL, EW, LL and LW of both sides. In a similar study in Maiduguri, Northern Nigeria (Ekanem *et al.* 2010), the total mean values of TEL, LL and LW when the data were added were lower than in the present study. When the data were grouped in males and females with right and left combined and when the parameters measured on both sides with respect to gender, Ekanem *et al.* (2010) observed mean value of TEL, LL and LW to be lower than the Urhobo, Southern Nigeria.

When the data were broken down to analyse possible relationship between the parameters on both sides, it was observed that in all cases the linear relationships were positive and highly significant ($P = 0.001$). This is similar to the finding of Ekanem *et al.* (2010).

It was observed in this study that females showed statistically significant higher mean values of LL than males ($P = 0.001$)). The reason for this could be factors peculiar to this population. The differences between genders in other parameters were not significant ($P > 0.05$). When data on the right and left were combined, mean female values were higher than males and the difference were statistically significant in the cases of LL ($P = 0.001$) and LW ($P = 0.026$). The mean values in other parameters between males and females were nearly identical. Wang *et al.* (2011) reported that LLs and LW were not significantly different between males and females. Ekanem *et al.* (2010) observed that in all parameters measured, males had higher mean values compared to females. Some other studies have reported that boys and men had larger ears than girls and women (Brucker *et al.* 2003; Gualdi-Russo, 1998; Ferrrio *et al.* 1999; Bozkir *et al.* 2006; Kalcioglu *et al.* 2003; Barut and Aktunc, 2006; Azaria *et al.* 2003; Meijerman *et al.* 2007; Ito *et al.* 2001; Niemitz *et al.* 2007; Sforza *et al.* 2005; Borman *et al.* 1999; Agnihotri and Singh, 2007). Agnihotri and Singh (2007) reported significantly larger ears in Indian boys than in girls at birth and in the first months of life. On the effect of gender on the parameters measured, there was statistical significance only in the cases of LL on the right ($P = 0.03$) and LL on the left ($P = 0.01$); other parameters were not significant ($P > 0.05$). When both sides are compared, the current study observed symmetry in the ear dimensions measured. Bozkir *et al.* (2006) also reported symmetry of ear dimension.

The effect of age on all the parameters measured as analysed with two-way ANOVA showed statistical significance differences ($P = 0.000$) between the age groups on both sides. The pattern of age-related changes is different for the different parameters. The patterns are almost identical on both sides. TEL increases from 6-10 years to 26-30 years and remain almost at par between 31-35 years and 36-40 years, then increases from 41-45 years to 55-60 years. EW increases from 6-10 years to 41-45 years old and slowed down at 46-50 years then increases from 51-55 years to 56 -60 years old. LL increases from age 6-10 years to 26-30 years, then decreases from 31-35 years to 41-45 years and increases again from 46-55 years to 56-60 years old.

Liu (2006) reported that there were no significant differences in pinna length across age groups. Ekanem *et al.* (2010) observed a noticeable increase in the TEL and LL, while the LW decreased with increasing age. Nonetheless, they reported that there were no significant differences in the parameters measured between the different age groups, whether from the right or left ears. Sforza *et al.* (2009) in study on age- and sex-related changes in the normal human ear among Italian Caucasians observed that age significantly influenced all analysed linear distances: right and left EW; right and left ear length, which increased from childhood to old age. Wang *et al.* (2011) in a Northern Chinese study revealed that length of the auricle, width of the auricle, LL and LW increased significantly with age for both males and females. It has been opined that 85% of the growth of the ear occurs before 3 years of age, with the remaining 15% occurring before age 20. Beyond 20 years of age are basically attributable to secondary elongation of the earlobe due to gravitational forces (Adamson *et al.* 1965). In a related study, it was suggested that auricles are among the few organs that continue to develop during the entire adult period of life (Barut and Aktunc, 2006). In a study carried out on age-related morphological changes in adult human auricular elastic cartilage, it was observed that auricular size increased significantly with age in both genders. The authors posited that these changes were associated with changes with the elastic fibers after childhood (Ito *et al* 2001). Bruker *et al.* (2003) noted a statistical significant increment in the earlobe length and suggested that the increase in length could be due to ageing process.

The present study noted gender-age interaction was not significant. Hence the patterns of increment in males and females were almost identical. This is not similar to the findings in previous studies (Sforza *et al.* 2009; Meijerman *et al.* 2007; Ito *et al.* 2001). Variations in auricular morphology among different studies could be attributed to factors like geographic locations, ethnicity or genetics.

CONCLUSION

In the present study, the lobular length has significant higher mean values in females than males. Other parameters do not exhibit significant gender differences. There is high correlation of the respective parameters of the pinna between the right and left sides. There is tremendous effect of age on the dimensions of the human pinna. Only the lobular length exhibits significant gender effect. An anthropometric database in this regard has potential implications for the diagnosis of congenital malformations, syndromes and acquired deformities, in the planning of cosmetic surgery and for the hearing instruments industry.

ACKNOWLEDGEMENTS

Many thanks to my dear students, Mr Benson Onyeije and Miss Mary Nwajei, who participated very actively during the stage of data collection.

REFERENCES

1. Adamson J.E., Hortox C.E., Crawford H.H. (1965). The growth pattern of the external ear. Plast Reconstr Surg 36 (4): 466-70.

2. Agnihotri G., Singh D. (2007). Craniofacial anthropometry in newborns and infants. Iran J Pediatr 17 (4): 332-8.
3. Azaria R., Adler N., Silfen R., Regev D., Hauben D.J. (2003). Morphometry of the adulthuman earlobe: A study of 547 subjects and clinical application. Plast Reconstr Surg 111 (7): 2398-402.
4. Barut C., Aktunc E. (2006). Anthropometric measurements of the external ear in a group of Turkish primary school students. Aesthet Plast Surg 30 (2): 255-9e.
5. Borman H., O¨zgu¨r F., Gu¨rsu G. (1999). Evaluation of soft-tissue morphology of the face in 1050 young adults. Ann Plast Surg 42 (3): 280-8.
6. Bozkir M.G., Karakas P., Yavuz M., Dere F. (2006). Morphometry of the external ear in our adult population. Aesth Plast Surg 30 (1): 81-5.
7. Brucker M.J., Patel J., Sullivan P.K. (2003). A morphometric study of the external ear: Age and sex-related differences. Plast Reconstr Surg 112 (2): 647-52.
8. Dahlberg G. (1940). Statistical method for medical and biological students. Allen and Unwin, London.
9. De Carlo D., Metaxas D., Stone M. (1998). An anthropometric face model using variational techniques. Proceedings of the 25th Annual Conference on Computer Graphics and Interactive Techniques. New York.
10. Ekanem A.U., Garba S.H., Musa T.S., Dare N.D. (2010). Anthropometric study of the pinna (Auricle) among adult Nigerians resident in Maiduguri metropolis. J Med Sci 10 (6): 176-80.
11. Elliott W.J., Powell L.H. (1996). Diagonal earlobe creases and prognosis in patients with suspected coronary artery disease. Am J Med 100 (2): 205-11.
12. Ferrario V.F., Sforza C., Ciusa V., Serrao G., Tartaglia G.M. (1999). Morphometry of the normal human ear: A cross-sectional study from adolescence to mid-adulthood. J Craniofac Genet Dev Biol 19 (4): 226-33.
13. Frank S.T. (1973). Aural sign of coronary artery disease. N Engl J Med 289 (6): 327-8.
14. Gualdi-Russo E. (1998). Longitudinal study of anthropometric changes with aging in an urban Italian population. Homo 49: 241-59.
15. Ito I., Imada M., Ikeda M., Sueno K., Arikuni T., Kida A. (2001). A morphological study of age changes in adult human auricular cartilage with special emphasis on elastic fibers. Laryngoscope 111 (5): 881-6.
16. Kalcioglu M.T., Miman M.C., Toplu Y., Yakinci C., Ozturan O. (2003). Anthropometric growth study of normal human auricle. Int J Pediatr Otorhinolaryngol 67 (11): 1169-77.
17. Kalcioglu M.T., Toplu Y., Ozturan O., Yakinci C. (2006). Anthropometric growth study of auricle of healthy preterm and term newborns. Int J Pediatr Otorhinolaryngol 70 (1): 121-7.
18. Liu B.S. (2006). Incorporating anthropometry into design of ear-related products. Appl Ergon 39 (1): 115-21.
19. McKinney P., Giese S., Placik O. (1993). Management of ear in rhytidectomy. Plast Reconstr Surg 92 (5): 858-66.
20. Meijerman L., van der Lugt C., Maat G.J. (2007). Cross-sectional anthropometric study of the external ear. J Forensic Sci 52 (2): 286-93.
21. Niemitz C., Nibbrig M., Zacher V. (2007). Human ears grow throughout the entire lifetime according to complicated and sexually dimorphic patterns – conclusions from a cross-sectional analysis. Anthropol Anz 65 (4): 391-413.
22. Park S.S. (2005). Facial plastic surgery: The essential guide [Internent] (2005). Available from: http://books.google.com.ng/books?id=mdqIu7jkf-UCandpg=PA33andlpg=PA33anddq=dimensions+of+the+auricleandsource=blandots=WuJQMrkmJZandsig=dnnz9krAP5bQW2ikhHizwEUvpFoandhl=enandsa=Xandei=uA82T5GWPOqq0QWbhZm2Agandved=0CDkQ6AEwAw#v=onepageandq=dimensions%20of%20the%20auricleandf=false. [Last cited on 2012 Feb 11].
23. Patel V., Champ C., Andrews P.S., Gostelow B.E., Gunasekara N.P., Davidson A.R. (1992). Diagonal earlobe creases and atheromatous disease: A postmortem study. J R Coll Physicians Lond 26 (3): 274-7.
24. Purkait R., Singh P. (2007). Anthropometry of the normal human auricle: A study of adult Indian men. Aesthetic Plast Surg 31 (4): 371-9.
25. Sforza C., Dellavia C., Tartaglia G.M., Ferrario V.F. (2005). Morphometry of the ear in Down's syndrome subjects.A three-dimensional computerized assessment. Int J Oral Maxillofac Surg 34 (5): 480-6.
26. Sforza C., Ferrario V.F. (2006). Soft-tissue facial anthropometry in three dimensions: From anatomical landmarks to digital morphology in research, clinics and forensic anthropology. J Anthropol Sci 84: 97-124.
27. Sforza C., Grandi G., Binelli M., Tommasi D.G., Rosati R., Ferrario V.F. (2009). Age- and sex-related changes in the normal human ear. Forensic Sci Int 187 (1): 110.e1-7.
28. Sharma A., Sidhu N.K., Sharma M.K., Kapoor K., Singh B. (2007). Morphometric study of ear lobule in northwest Indian male subjects. Anat Sci Int 82 (2): 98-104.
29. Sinnatamby C.S. (2000). Last's Anatomy, Regional and Applied. 10th ed. Churchill Livingstone: New York. p. 340.
30. Standring S. (2008). Gray Anatomy. 40th ed. Churchill Livingstone: New York. p. 649-52.
31. Streeter G.L. (1922). Development of the auricle in the human embryo. Contrib Embryol 14: 111-38.
32. Van De Water T.R., Staecker H. (2006). Otolaryngology: Basic Science and Clinical Review. Thieme Medical Publishers Inc.: New York. p. 251.
33. Wang B., Dong Y., Zhao Y., Shizhu Bai S., Wu G. (2011). Computed tomography measurement of the auricle in Han population of north China. J Plast Reconstr Aesthetic Surgery 64 (1): 34-40.
34. World Medical Association Declaration of Helsinki. (2008). Ethical Principles for Medical Research Involving Human Subjects [Internet]. Available from: http://www.net/en/30publication/10polocies/b3/index.html. [Last cited on 2011 Nov 05].

How to cite this article: Eboh D. Morphological changes of the human pinna in relation to age and gender of Urhobos people in Southern Nigeria. J Exp Clin Anat 2013;12:68-74.

Source of Support: Nil, **Conflict of Interest:** None declared.