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# PHOTOANALYTIC AURICULAR ASSYMETRY IN SOUTHEAST NIGERIANS

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## ABSTRACT

***Background:*** *Differences between left and right part of the human face especially difference between the paired structures are well known in healthy people.This study was aimed at photoanalytically determining ,total ear width, total ear lenght, total lobe width, total lobular height of right and left ears at different angles.* ***Materials and methods****: 514 subjects (16-30 years) comprising 258 males and 256 females were selected using simple random sampling technique. Total ear length (TEL), Total ear width (TEW), Total lobe width (TLW), Total lobular height.(TLH) at 90º, 45º left and 45º right were measured, analyzed and* ***bilateral assymetry*** *of the measured parameters was investigated.* ***Results****:Both males and females were observed to have higher mean auricular values on the right side than on the left, TLW was also observed to be significant at 90º, 45º left, and 45º right (P<0.05). Two important indices (auricular and lobule) were calculated in both the sexes. In both males and females, the right lobule index was found to be statistically higher (P < 0.05) as compared to left one.* ***Conclusion:*** *Findings from this study show that anatomical variation of the auricle exists amongst south east Nigerians.Results from this study could aid forensic application of ear prints, identification of individuals, facial recognition from security cameras, planning of cosmetic surgery and product design for specific consumer auricular requirements.*

**KEY WORDS:** *Auricle, South east Nigerians, Variations*

## INTRODUCTION

Ear photo-analysis is a valuable additional tool in smart surveillance tasks and forensic image analysis. It employs the use of photogrammetry to obtain angles and distances between facial landmarks as an alternative to direct measurements [1] [2] [3].The ear can easily be captured from a distance, even if the subject is not fully cooperative as perpetrators of some crimes sometimes wear hats in order to cover their faces and avoid looking directly into overhead Surveillance camera so no frontal images of the person is available [4].

The structural difference in the human ear creates unique shapes and morphology similar to the unique finger print of each human being. The external ear is highly variable to the point where even the two ears of a single individual may be notably different [5] [6]. In development, the cells of both ears share the same genes but obviously the ear structure is not under complete genetic control but influenced by enviromental factors as previous studies have shown that the left and right ears of an individual may differ in size and structure [7]

Great diversity exists in both size and shape of the external auricle even in the same ethnic group [8] [9] The relationship between the left and right ear is important for determining the levels of genetic and environmental control of ear structure [10].Studies

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have also noted that variation exist between two sides of the same individual. However gross difference in size or position of two ears is easily noticed.[11]

Cagatay Barut [12] reported that the left ear indices were found to be significantly higher than right ear indices for all the subjects in all 153Turkey primary school children in his cohort.

In a preliminary study conducted by [13]on 350 males and female subjects of Central India,to test the uniqueness of ear pattern, twelve direct measurements taken on the ears were projected in a twelve dimensional feature space. The Euclidean distances were measured between subjects to test uniqueness and none of the ears were found to be identical.

In Nigeria, morphological changes of human pinna in relation to age, sex and ethnicity has been reported [8] [14][9] .Despite the numerous reports on ear anthropometry, very few studies in the sub-saharan Africa including Nigeria has explored the efficiency of photoanalysis and software technology in the assessment of external ear with the aim of individualization and human identification at a large scale. Therefore**,** this study therefore aspires to establish the anatomical variation in the auricular structure of Southeast Nigerians

## MATERIALS AND METHODS

A total of 514 subjects were recruited for the study. Age of subjects ranged from 16-30 years. The subjects were selected using stratified random sampling technique. None of the subjects had previous plastic surgery or trauma on the face. In Ethical approval was obtained from the Ethical Review Committee for Human Experimentation**,** College of Medicine Enugu State University of Science and Technology, Enugu Nigeria (ESUTHP/C-MAC/RA/034/183).

## PROTOCOL OF PROCEDURE

Consent was taken from each participant after explaining the purpose of study in accordance with World Medical Association Declaration of Helinski Ethical Principles for Medical Research Involving Human Subjects 15]

### i Pre-Image Acquisition:

Before photography was taken, Subjects were numbered using self adhesive stickers of known length (45x13mm) at the sides of the facewhich was to calibrate the ImageJ software in order to get the actual measurement from the photographs) and placed on the side of the subjects face Subjects' age, sex and state of origin were recorded along with their identification numbers.

Female subjects were asked to clip back hair using hair clips to prevent it from obscuring the photograph of the ear. The tripod was adjusted so that it was equal with the height of the ear of the subject to ensure the ear was visible within the shots.

### ii Image Acquisition:

- Images were acquired using Nikon D9O digital single lens reflex camera (manufactured by Nikon Corporation Tokyo, Japan) in the same lightening conditions with no illumination changes. Camera settings of 12.3 mega pixel, 600Dpi resolution, fixed local length 90 to150mm, high quality macro lens (which assures maximum depth of field) high aperture setting (f>16) and short exposure time(>125 milli sec) were also kept constant.

Each subject was asked to relax with both hands hanging beside the trunk

Subjects positioned on a line marked 100cm from the camera [15]. Camera was moved to either side in order to have photo taken at $90^0$, $45^0$ angles parallel to the subject to reduce possibility of Image perspective distortion due to poor positioning.

### iii Image Processing

- When photos had been taken they were downloaded into Adobe illustrator version 17.(Adobe systems USA)
- All photos were cropped and sharpened if necessary for a clear picture. They were converted to gray scale (color removed) and contrast increased for the best possible definition. It was necessary for all photographs to be on the same scale for accuracy in measurement.
- Photographs with incorrect lightening or with unnoticed hairs concealing actual auricle dimensions were discarded.
- Image editing software (Image J 1.48 software j (v.j.48 ava 1.6.0 2064 bits written by Wayne Rasband, National institute of mental health, Bethsda ,Mary land, USA) process image option was used to

**A: Process the images**-Sharpen images( optimize brightness), enhance contrast, and size to produce a clear image, subtract background and image calculation

**B**:Furthermore, this program has an analyze option dimension tool used to set scale and create a vertical dimension line that measures vertical distance between any 2 landmarks using y axis.

Thus ear dimension could be easily and accurately calculated while comparing landmarks

### iv. Ear measurements Taken

Various soft issues landmarks were tagged on photograph of the subjects' ear and then measurements were taken in and results were given to 2 decimal places. The present study included the following parameters for the measurements of the right and left external ear.

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**TOTAL EAR LENGHT**
Measurement of the distance between the most superior point of the ear or pinna and the most inferior point of the earlobe **.[16]**
**TOTAL EAR WIDTH:** Measurement of the distance between the most anterior point and the most posterior point of the pinna**.[16]**
**TOTAL LOBULAR LENGTH:** Measurement of the distance between the intertragic notch and the most inferior point of the ear lobule**.[16]**
**TOTAL LOBULAR WIDTH:** Measurement of the distance between the most anterior point and the most posterior point of the ear lobule**.[16]**

**EAR INDEX :**was calculated as
Ear width X 100 [17].
Ear length
**LOBULAR INDEX:** was calculated as
Lobule width x 100
Lobule length

Age of participants was obtained from self-reported date of birth[18].

## STATISTICAL ANALYSIS

Images was analyzed using pro image J analyzer and the data obtained was presented in tables and subjected to statistical analysis by using t-test (independent and sample t-test) for the comparison of measurements taken from right and left ears between both sexes, Pearson correlation was used to establish the relationship between known anthropometric variables (Age, Height and Weight) and ear parameters measured with the aid of statistical package for social Sciences (SPSS) IBM version 20. P< 0.05 was considered statistically significant and the Mean and standard deviation was calculated for all the parameters.

## RESULTS

This study provides valuable data pertaining to the ear morphology and their different parameters in south east Nigerians. There are 514 subjects (males and females) in our cohorts.

**TABLE 1: DISTRIBUTION OF AGE AND SEX IN THE STUDY**

| Sex | Age group (years) | | | | | Total | χ2 | P-value |
|---|---|---|---|---|---|---|---|---|
| | 16-18 | 19-21 | 22-24 | 25-27 | 28-30 | | | |
| Female | 21 | 104 | 83 | 35 | 13 | 256 | 0.2010.995 | |
| Male | 19 | 103 | 86 | 36 | 14 | 258 | | |
| Total | 40 | 207 | 169 | 71 | 27 | 514 | | |

Age and gender of participants in this study are almost pair-matched (P>0.05) and the male/ female ratio is 1:1(Table 1) .Age distribution of participants showed that majority of population belongs to Age group 19-21 while the less frequent age range was from 28- 30 age group.

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**TABLE 2: COMPARISON OF AURICULAR INDICES AT DIFFERENT ANGLES**

Two important indices (AI and LI) were calculated in both sexes.

| Indices | Angle | Side | Male (n=258) | | Female (n=256) | | Combined (n=514) | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean ±SD | P-value | Mean ±SD | P-value | Mean ±SD | P-value |
| **Ear index** | 90° | Left ear | 58.49±6.04 | 0.600 | 58.68±5.76 | 0.717 | 58.58±5.90 | 0.878 |
| | | Right ear | 58.68±6.47 | | 58.55±5.16 | | 58.62±5.85 | |
| | 45° Left | Left ear | 57.68±6.22 | 0.122 | 58.20±5.65 | 0.161 | 57.94±5.94 | 0.850 |
| | | Right ear | 58.22±6.44 | | 57.75±5.86 | | 57.99±6.15 | |
| | 45° Right | Left ear | 58.22±6.31 | 0.684 | 58.09±5.80 | 0.011* | 58.16±6.06 | 0.040* |
| | | Right ear | 58.38±6.55 | | 58.90±5.31 | | 58.64±5.96 | |
| **Lobule index** | 90° | Left ear | 136.05±26.35 | 0.023* | 120.71±22.58 | 0.000* | 128.41±25.69 | 0.001* |
| | | Right ear | 140.04±26.20 | | 129.10±24.23 | | 134.59±25.80 | |
| | 45° Left | Left ear | 134.10±27.10 | 0.011* | 119.76±21.66 | 0.000* | 126.96±25.55 | 0.001* |
| | | Right ear | 138.38±28.60 | | 128.52±20.96 | | 133.47±25.54 | |
| | 45° Right | Left ear | 136.61±27.77 | 0.648 | 121.88±20.93 | 0.001* | 129.27±25.66 | 0.001* |
| | | Right ear | 137.31±27.21 | | 128.56±21.95 | | 132.95±25.10 | |

* P<0.05 (Significant)

Data was analyzed using paired sample/dependent t-test. Table 2 depicts combined data of ear sides in both sexes and descriptive statistics of different auricular indices when the cohort is broken into male and female subgroup. It was observed that there was significant difference in most of the lobule indices of the left and right ears (P<0.05) and that the right lobule indices of both males and females was higher than the left at all angles observed.

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**TABLE 3: DIFFERENT ANTHROPOMETRIC PARAMETERS IN RELATION TO BILATERAL ASSYMETRY**

| Angle | Parameter | Side | Mean ±SD | P-value |
|---|---|---|---|---|
| **90°** | TEL | Left ear | 5.91±0.49 | 0.926 |
| | | Right ear | **5.91±0.50** | |
| | TEW | Left ear | 3.45±0.35 | 0.854 |
| | | Right ear | 3.46±0.36 | |
| | TLH | Left ear | 1.52±0.22 | 0.105 |
| | | Right ear | **1.53±0.22** | |
| | TLW | Left ear | 1.93±0.31 | 0.000* |
| | | Right ear | 2.01±0.34 | |
| **45° Left** | TEL | Left ear | 6.04±0.55 | 0.006* |
| | | Right ear | 6.08±0.57 | |
| | TEW | Left ear | 3.49±0.38 | 0.061 |
| | | Right ear | 3.51±0.41 | |
| | TLH | Left ear | 1.56±0.25 | 0.669 |
| | | Right ear | 1.57±0.25 | |
| | TLW | Left ear | 1.95±0.33 | 0.000* |
| | | Right ear | 2.05±0.33 | |
| **45° Right** | TEL | Left ear | 5.97±0.50 | 0.674 |
| | | Right ear | 5.97±0.52 | |
| | TEW | Left ear | 3.46±0.36 | 0.059 |
| | | Right ear | **3.49±0.37** | |
| | TLH | Left ear | 1.54±0.23 | 0.603 |
| | | Right ear | **1.55±0.22** | |
| | TLW | Left ear | 1.97±0.32 | 0.000* |
| | | Right ear | 2.02±0.31 | |

* P<0.05 was accepted as statistically significant and significant differences of measurements were accepted as assymetry

The comparison of different anthropometric parameters in relation to ear side using paired sample t-test showed that TLW is significant at 90°, 45° left, and 45° right (P<0.05). This implies that the lobule is wider at the right ear than the left ear. The ear height is significant at 45° left (P<0.05). This implies that the ear is longer at the right than the left side (Table 4).

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**TABLE 4: COMPARISON OF ANTHROPOMETRIC PARAMETERS OF THE SAME EAR SIDE AT DIFFERENT ANGLES**

| Parameter | Side | Angle | Mean ±SD | P-value |
|---|---|---|---|---|
| **TEL** | Left ear | 90° | 5.91±0.49 | 0.001* |
| | | 45° Left | 6.04±0.55 | |
| | Right ear | 90° | 5.91±0.50 | 0.001* |
| | | 45° Left | 6.08±0.57 | |
| **TEW** | Left ear | 90° | 3.45±0.35 | 0.012* |
| | | 45° Left | 3.49±0.38 | |
| | Right ear | 90° | 3.46±0.36 | 0.011* |
| | | 45° Left | 3.51±0.41 | |
| **TLH** | Left ear | 90° | 1.52±0.22 | 0.001 |
| | | 45° Left | 1.56±0.25 | |
| | Right ear | 90° | 1.53±0.22 | 0.001* |
| | | 45° Left | 1.57±0.25 | |
| **TLW** | Left ear | 90° | 1.93±0.31 | 0.018* |
| | Right ear | 45° Left | 1.95±0.33 | 0.016* |
| | | 90° | 2.01±0.34 | |
| | | 45° Left | 2.05±0.33 | |
| **TEL** | Left ear | 90° | 5.91±0.49 | 0.001* |
| | | 45° Right | 5.97±0.50 | |
| | Right ear | 90° | 5.91±0.50 | 0.001* |
| | | 45° Right | 5.97±0.52 | |
| **TEW** | Left ear | 90° | 3.45±0.35 | 0.001* |
| | | 45° Right | 3.46±0.36 | |
| | Right ear | 90° | 3.46±0.36 | 0.001* |
| | | 45° Right | 3.49±0.37 | |
| **TLH** | Left ear | 90° | 1.52±0.22 | 0.001* |
| | | 45° Right | 1.54±0.23 | |
| | Right ear | 90° | 1.53±0.22 | 0.001* |
| | | 45° Right | 1.55±0.22 | |
| **TLW** | Left ear | 90° | 1.93±0.31 | 0.001* |
| | | 45° Right | 1.97±0.32 | |
| | Right ear | 90° | 2.01±0.34 | 0.001* |
| | | 45° Right | 2.02±0.31 | |

The comparison of anthropometric parameters of the same ear side at different angles shows that all the measurement at 90° , 45° Left and 45° Right are significant (P<0.05). This implies that the ear is longer and wider at the 45° Left and Right measurement than that of 90° .

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**TABLE 5:REGRESSION EQUATION OF THE RELATIONSHIP BETWEEN THE MEASUREMENTS AT 45⁰ AND 90⁰ ANGLES**

| Parameters | Side | Angle | Constant | Coefficient |
|---|---|---|---|---|
| **TEL** | Left ear | 45⁰ Left | 1.642 | 0.707 |
| | | 45⁰ Right | 0.826 | 0.852 |
| | Right ear | 45⁰ Left | 2.166 | 0.616 |
| | | 45⁰ Right | 1.286 | 0.774 |
| **TEW** | Left ear | 45⁰ Left | 1.308 | 0.615 |
| | | 45⁰ Right | 1.133 | 0.665 |
| | Right ear | 45⁰ Left | 1.417 | 0.580 |
| | | 45⁰ Right | 1.191 | 0.654 |
| **TLH** | Left ear | 45⁰ Left | 0.364 | 0.744 |
| | | 45⁰ Right | 0.233 | 0.837 |
| | Right ear | 45⁰ Left | 0.434 | 0.691 |
| | | 45⁰ Right | 0.309 | 0.783 |
| **TLW** | Left ear | 45⁰ Left | 0.486 | 0.740 |
| | | 45⁰ Right | 0.473 | 0.740 |
| | Right ear | 45⁰ Left | 0.573 | 0.701 |
| | | 45⁰ Right | 0.380 | 0.810 |

## DISCUSSION

It has been noted that the external ear is an infinitely complex structure with great variation between individuals[19]..Several studies on the variations of the external ear have shown that both ears of an individual vary in its dimensions. These structural differences in the human ear create unique shapes and morphology.[12].

In the present study, attempt was made to establish the anatomical variation of the external ear amongst south east Nigerians. Subtle differences between the right and left ear parameters within each gender group was observed, 95% of the measured subjects had different measurement values for the right ear and left ear dimensions this concurs with the reports of [7]who reported that the "differences between the left and right parts of the human face, especially differences between the paired structures, are well known in healthy people" .

In this study,(Table 3)both males and females were observed to have higher mean values on the right side than on the left, This was similar to the findings of [20][16]..Results of the present study also concurs with the report of [21]anthropometric study on the anatomical variation of the external ear amongst Port Harcourt students in Nigeria, he also reported that all parameters were significantly larger on the right side than on the left.

Kearney et al,[22]. in their Australian studies on the variation of the ears suggested that lots of variations exists between the left and right ear of a single individual and that the fleshy parts of the ear are the most variable because they are the features under the least genetic control and are most greatly affected by environmental factors during development .

In our study,(Table 3), Total lobular width (TLW) was also observed to be significant at 90⁰, 45⁰ left, and 45⁰ right ($P<0.05$). Two important indices (auricular and lobule) were calculated in both the sexes,(Table 2) In both males and females, the right lobule index was found to be statistically higher ($P < 0.05$) as compared to left one, this concurs with the findings of [23]. who reported that the right lobule is wider than the left in both males and females and the difference was found to be statistically significant in his cohort.

In this study(Table 4) comparison of auricular anthropometric parameters at different angles shows that all the measurement at 90⁰ , 45⁰ Left and 45⁰ Right are significant ($P<0.05$).This implies that the ear is longer and wider at the 45⁰ Left and Right measurement than that of 90⁰.Regression equation of the relationship between the auricular mean values at varying angles was also deduced (Table 5) to provide photoanthropometric auricular dimensions at 90⁰, 45⁰ left and 45⁰ right of both ears, as a valuable additional identification tool that will give room for proper conversion intervention in a situation where only the side view of pictures of the auricle is gotten at varying angles other than 90⁰. In this regards the use of the generated formula which is specific to the Igbo ethnic group can be a valuable amendment to existing face recognition systems for identifying subject

## AREA FOR FURTHER RESEARCH

This study has shown that ear is a structure variable enough to be considered useful for the purpose of forensic identification, It is hence recommended that further studies should be carried out using larger population, Age range should be

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increased and selection of individual tribes for wider anthropometric coverage in Nigeria and Africa.

## REFERENCES

1. *Douglas TS. (2004). Image processing for craniofaciallandmark identification and measurement: a review of photogrammetry and cephalometry. Comput MedImaging Graph. 28(7):401-9.*
2. *Guyot L, Dubuc M, Richard O, Philip N,Dutour O.(2003) Comparison between direct clinical and digital photogrammetricmeasurements in patients with 22q11 microdeletion. Int J Oral MaxillofacSurg; 32(3):246-52.*
3. *Zhang X, Hans M, Graham G, Kirchner H, Redline S. (2007). Correlations between cephalometric and facial photographic measurements of craniofacial form. American Journal of orthodontics and Dentofacial Orthopedic. ;131: 67–71.*
4. *Anika Pflug (2015)"Ear Recognition Biometric Identification using 2- and 3-Dimensional Images of Human Ears(PhD Thesis) Gjøvik University College*
5. *Feenstra, L. and van der lugt, C.(2000). Ear witness. The journal of laryngology otology,.114;497-500.*
6. *Hoogstrate, A.J, Van Den Heuval, H. And huyben, E.(2001). Ear identification based on surveillance camera images. Science And justice. 41(3):167-1727*
7. *Ferrario, V. F. ,Sforza C, Ciusa V, Serro G, Tartaglia GM.. (1999) 'Morphometry Of The Normal Human Ear: A Cross-Sectional Study From Adolescence To Mid-Adulthood', Journal of Craniofacial Genetics and Developmental Biology, 19(4), pp. 226–233*
8. *Akpa, A.O.C., Ama, A. Ibiam, Chukwuebuka Ugwu, (2013).Anthropometrical Study Of The Pinna Among Southeast Nigerians .Journal Of Experimental Research. 134(1), Pp. 9–23*
9. *Eboh , .D, (2013)Morphological Changes Of The Human Pinna In Relation To Age And Gender Of Urhobo People In Southern Nigeria. Journal of Experimental clinical anatomy: 37(6) : pp 605-16.*
10. *Pechinkina,E.A benfer, R.A.J., vershoubskaya, G.G and kozlov A.I (2000). Genetic and environmental influence on the asymmetry of dermatoglyphic traits. American journal of physical anthropology. 111(4): 531-543*
11. *Park S.S. Facial plastic surgery: The essential guide (2005);[Internent]. Availablefrom: http://books.google.com.nq/...=0 CDkQ6AEwAw#v=onepageandq=dimensions%20of%20th e%20auricleandf=false.*
12. *Barut C, Aktune A. (2006)Anthropometric Measurement of the external ear in a group of Turkish Primary School Students. Aesth Plast Surg;30:225-59.*
13. *Purkait R. (2007).Ear Biometric: An Aid To Personal Identification. Anthropologist Special volume 2 (3): pp215-218.*
14. *Ekanem A, Garba S, Musa S, et al. (2010) Anthropometric study of the Pinna (Auricle) among adult Nigerians resident in Maiduguri metropolis. J of Med Sci.;10:176-80.*
15. *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].*
16. *Singhal J, Sharma N, Jain SK, Budhiraja V, Rastogi R, Garg R, Nafees H(2016;). A Study of Auricle Morphology for Identification in Indians. Annals of International Medical and Dental Research. 2(4):217-247. s*
17. *Nathan, N., K. Latham, J. Cooper, C. Perlyn, I. Gozlan and S.R. Thaller,(2008). Anthropometry of the external ear in children with cleft lip and palate in comparison to age-matched controls. J. Craniofac. Surg., 19: 1391-1395.*
18. *Taura MG, Adamu LH, Modibbo(2013) MH. External ear anthropometry among hausas of Nigeria; the search of sexual dimorphism and correlations. WSRJ;1:91-5.*
19. *P. Kelley, L. Hollier, S. (2003), Otoplasty: evaluation, technique, and review,J. Craniofac. Surg. 14 643e653*
20. *Shireen, S. and Karadkhelkar, V. P. (2015) 'Anthropometric Measurements of Human External Ear.', Journal of Evolution of Medical and Dental Sciences-Jemds, 4(59), pp. 10333–10338. doi: 10.14260/jemds/2015/1489*
21. *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. Dec;11(4):144-147.*
22. *Bree kearney, Maciej Henneberg (2003 )"Variations of the external ear in an australian population for the purposes of identification author: (BSC Thesis)university of Adelaide*
23. *Sangeetha. S, Anisha. B. (2017)Anthropometric measurements of human ear lobule in adult student population. Int J Anat Res;5(2.2):3784-3787. DOI: 10.16965/ijar.2017.175*