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Evaluation of the Range of Variations Seen in the Anthropometry of the Ear Among Chukwuemeka Odumegwu Ojukwu University Nigeria Students Between the Ages of 16-36 Years

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ABSTRACT

External ear morphology has been used by physical anthropologists and forensic experts in the identification of individuality. A thorough knowledge of ear morphology is important for facial reconstruction and other surgical procedures carried out for ear replacement. In line with this, this study was carried out to determine the range of variations seen in the anthropometry of the ear among Chukwuemeka Odumegwu Ojukwu University (COOO) students between the ages of 16-35 years. Two hundred and eighty-five (285) subjects comprising of one hundred and fifty-one (151) males and one hundred and thirty-four (134) females were selected using convenient sampling technique. The ages of the subjects ranged from 15years to 31 years. The height and width of the external ear of the subjects were measured using sliding vernier caliper (12.5cm with an accuracy of 0.01cm).

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The obtained data were analyzed using SPSS version 20.0. The results of this study showed that mean age of male and female subjects was 24.38 ± 4.28 years and 24.60 ± 4.31 years, respectively. The overall mean age of the subjects was 24.48 ± 4.29 years. The mean height of the right ears of the male and female subjects were 5.59 ± 0.30cm and 5.52 ± 0.27cm respectively. The total mean height of the right ear of all the subjects were 5.55 ± 0.29cm. The mean height of the left ears of the male and female subjects were 5.62 ± 0.30cm 5.52 ± 0.33cm respectively. The total mean height of the left ear of all the subjects was 5.57 ± 0.32cm. The mean width of the right ears of the male and female subjects were 2.65 ± 0.28cm and 2.56 ± 0.25cm respectively. The total mean width of the right ear of all the subjects was 2.61 ± 0.27cm. The mean width of the left ears of the male and female subjects were 2.65 ± 0.29cm and 2.65 ± 0.23cm respectively. The total mean width of the right ear of all the subjects was 2.65 ± 0.26cm. The result of the paired sample t-test showed no significant difference between the right ear height and left ear height of all the subjects ($P>0.05$) but a significant difference between the right ear width and left ear width of all the subjects ($P<0.05$). The result of the paired sample t-test also showed no significant difference between the height of the right ear of male and female subjects at ($p>0.05$). It also showed a significant difference between the width of the right ear of males and females at ($p<0.05$). The result of the paired sample t-test also showed the height of the left ear of males showed a significant difference with the height of the left ear of their female counterparts at ($p<0.05$) but no significant difference between the width of the left ear of male and female subjects at ($p>0.05$). This study has also established the values of the right and left ears of the studied subjects which are vital in aesthetic surgery and individuality.

Keywords: Ear, Anthropometry, Morphology, Measurement, Biometrics, Forensics, Identification, Variation

1. INTRODUCTION

The study of human body measurements, known as anthropometry, is critical in various fields like medicine, forensics, ergonomics, and biometrics. Among the many body parts studied, the ear holds significant importance due to its unique and relatively unchanging structure after adolescence. The ear's dimensions and shape vary widely among individuals and are influenced by factors such as age, gender, and ethnicity. These variations make ear anthropometry valuable for personal identification, as well as for designing products like hearing aids and earphones, and improving biometric systems (Deopa et al., 2013).

This research aims to examine the range of ear anthropometric variations in students between the ages of 16 and 35 at Chukwuemeka Odumegwu Ojukwu University. This age group is of particular interest because it represents a period where many anthropometric features, including ear size, stabilize (Oludiran et al., 2014). The objective is to evaluate differences in ear dimensions within this population and to investigate potential correlations with age and gender, thereby contributing to a broader understanding of anthropometric characteristics specific to the Nigerian population.

The study of ear measurements is crucial due to its practical application across various disciplines. In forensic science, ear dimensions are often used for identification purposes, as the ear tends to retain its shape and size throughout adulthood (Sforza et al., 2009). Ear anthropometry is also increasingly integrated into biometric systems, which rely on physical features for identification. As biometric technologies evolve, ear measurements provide an alternative method of identification, particularly in settings were other methods, such as facial recognition, might be less reliable (Murgod et al., 2013). Additionally, precise ear measurements are essential in the design of medical devices and wearables, such as hearing aids and earphones, to ensure proper fit and comfort.

Previous studies have shown that ear anthropometry is influenced by several biological factors. Gender, for instance, has been found to impact ear dimensions, with males generally having larger ears than females (Zadey et al., 2010). Variations in ear size also differ across populations, with African, European, and Asian groups exhibiting distinct patterns (Deopa et al., 2013). Despite the extensive research on ear measurements globally, data specific to Nigerian populations remain scarce, particularly in the context of university settings. Addressing this gap by gathering population-specific data will improve the accuracy of forensic and biometric applications in Nigeria (Ekanem et al., 2010).In Nigeria, anthropometric studies have primarily focused on overall body measurements, with little attention paid to ear-specific data. Oludiran et al. (2014) examined general body proportions in Nigerian adolescents, but there is a lack of focused research on ear dimensions. This study aims to address that deficiency by providing detailed ear anthropometric data from a Nigerian university population. These findings can serve as a reference for future research and enhance practical applications in the areas of biometrics and ergonomics, especially for designing products that require ear-specific measurements.As biometric systems continue to advance, ear measurements have gained recognition as reliable identifiers, owing to their consistency across different age groups and populations (Rahman et al., 2016). Because of the unique anthropometric traits seen in different ethnic groups, the development of population-specific biometric systems is essential. By focusing on Nigerian students, this study provides essential data that can inform the creation of more accurate biometric systems tailored to African populations, addressing the limitations of systems that rely on data from other regions (Sforza et al., 2009).The relevance of this research extends to ergonomic design as well. Devices such as hearing aids, earphones, and headsets depend on accurate ear measurements to ensure comfort and functionality. Products not designed with population-specific anthropometry can lead to discomfort and decreased performance. Thus, collecting ear data from a Nigerian university population will contribute to the development of ergonomically sound products that are better suited to local users (Murgod et al., 2013).

This study seeks to evaluate the range of ear measurements—such as length, width, and lobe size—among students aged 16 to 35 at Chukwuemeka Odumegwu Ojukwu University. The research will explore how factors like gender and age influence ear anthropometry. By providing this data, the study will fill the gap in the literature concerning ear dimensions in Nigerian populations and serve as a foundation for future investigations in biometrics, forensic science, and product design. Additionally, the research will provide comparative insights into how ear dimensions in Nigerian populations differ from global trends. Studies have shown that ear measurements can vary significantly between African, European, and Asian populations, underscoring the need for region-specific data (Deopa et al., 2013). As existing global data may not be directly applicable to Nigeria, localized research like this is crucial for improving biometric systems and other applications. Ear anthropometry is essential in numerous applications, from forensics and biometrics to ergonomic design. Despite its significance, research on ear dimensions within Nigerian populations is limited. By focusing on students from Chukwuemeka Odumegwu Ojukwu University, this study will provide valuable data on the range of ear variations within this demographic. The results will contribute to a better understanding of Nigerian anthropometry and help improve biometric systems and product designs tailored to the local population.

2. MATERIALS AND METHODS

2.1. Area of Study

This study was carried out in the Department of Anatomy, Faculty of Basic Medical Sciences, Chukwuemeka Odumegwu University, Uli in Ihiala Local Government Area of Anambra State. Chukwuemeka Odumegwu Ojukwu University (COOU) is an Anambra State Government Owned University which was formerly known as Anambra State University. COOU has two campuses, which are Uli Campus and Igbariam Campus.

2.2. Sample Size Determination

The sample size was determined using the formula below:

$n=N/1+N(e)^2$ (Yamane, 1967)

Where n = sample size

N = Finite Population

e = Level of Significance or Limit of Tolerable Error

l = Unity (a constant)

The number of students in Uli campus was used as a yardstick to determine the sample size. It was estimated that the total number of students in Chukwuemeka Odumegwu University, Uli was 3000. According to Uzuagulu (1998), the level of significance used was 0.056.

2.3. Inclusion Criteria

Apparently and asymptomatic healthy subjects meeting the following criteria were recruited: Subjects must have no history of congenital ear abnormalities, craniofacial injury or trauma, infectious ear disease, or prior ear surgery, and female subjects must show no evidence of heavy earring wear.

2.4. Exclusion Criteria

Subjects must have a positive history of congenital ear abnormalities, craniofacial injury or trauma, infectious ear disease, or prior ear surgery, and female subjects must show evidence of heavy earring wear.

2.5. Recruitment of Subjects

In this study, a large representative of the population was targeted. However, as a result of the constraints encountered in convincing the subjects, two hundred and eight-five (285) subjects were selected from the area of the study through convenient sampling. These subjects comprised of one hundred and fifty-one (151) males and one hundred and thirty-four(134) females aged 16years to 33years. The age of the subjects was determined from their reported date of birth. However, the range was preferred because of the convenience in convincing these subjects who were mainly students.

An oral consent was sought from these subjects after appropriate explanation of the research procedures was made to them. Only subjects who gave their consent were included in this study. They were made aware of the option to withdraw from the study anytime without any adverse consequences.

2.6. Method of Measurement

The following measurements were obtained from the subjects who met the criteria.

2.6.1. Measurement of External Ear

Measurements of the external ear were taken by sliding Vernier Caliper (12.5cm With and accuracy of 0.01cm). This was used in the measurement of the Total Ear Height (THE) and Ear Breadth (EB).

2.6.2. Measurement of the Total Ear Height (THE)

Total Ear Height is the distance between the highest point of auricle and the lowest point of ear lobe or the distance between the most superior point of pinna and most inferior point of ear lobe (Neha, 2018). The Total Ear Length was measured as the distance from the caudal most projection of the lobule to the cephalic most projection of the helix (Brucker *et al.,* 2003). The sliding vernier caliper was placed at the defined points, and the measurement was obtained in both male and female subjects.

Figure 1. The Measurement of the Total Ear Height (Sidra and Vrushali, 2015).

2.6.3. Measurement of the Ear Breadth (EB)

Ear Breadth is the distance between the most anterior and the most posterior point of pinna (Neha, 2018). Ear Breadth was measured as the distance between the most anterior and posterior points of the external ear (Brucker *et al.,* 2003). The measurement of the ear breadth was performed by placing the sliding vernier caliper on the defined points and obtained the reading for both male and female subjects.

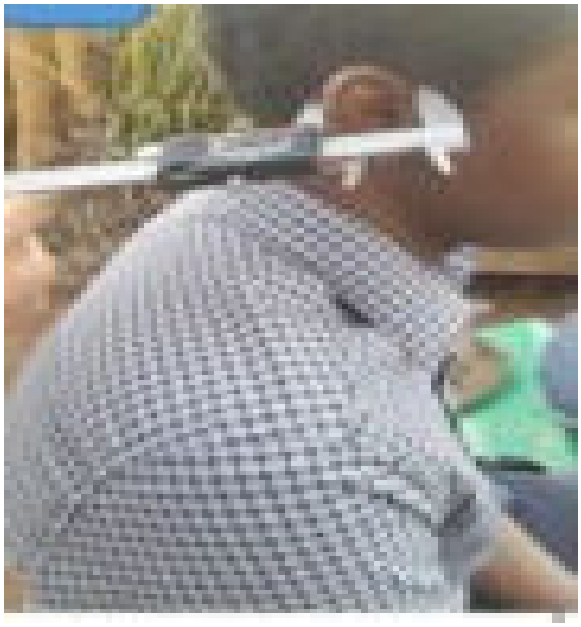

Figure 2. The Measurement of the Ear Breadth (Amir et al., 2018).

All measurements were obtained with the subjects on a chair in a relaxed condition and head placed in Frankfurt position i.e., the inferior borders of orbit and center of external auditory meatus lies in the same horizontal plane (Nidhi, 2018). The muscles of the face were relaxed in order not to alter the size of the ear. All the variables were measured in mm. Ear index was calculated as ear width/total ear height x 100/1 (Nathan *et al.,* 2008). Based on this, the overall shape of the ear was classified (Vinita *et al.,* 2013) as Narrow if the value is ≤600, Medium if >600 but 650 and Wide if ≤650.

In addition, to ensure accuracy, all measurements were performed three (3) times after which the average of the results was taken. While taking reading from the Vernier caliper, error due to parallax was avoided by looking vertically on the divisions of the main scale and subdivisions of the Vernier scale. Again, all measurements were done by one observer to avoid inter-observer's error.

2.7. Method of Data Analysis

All collected data were subjected to statistical analysis using Statistical Package for Social Science (SPSS) version 20.0. The mean and standard deviation of the collected data were calculated. Independent t-test was used to obtain sexual dimorphism. Paired sample t-test was used in this study for the comparison of mean difference between the right and left external ears. The level of significance was fixed at 5% (0.05) and the difference between them was considered significant at $p<0.05$.

2.8. Limitations of the Study

The major constraints encountered by the researcher in the course of this study were: For some individuals, the study seemed funny and strange, making it difficult to obtain their consent. The sight of the Vernier Caliper, particularly its upper and lower jaws, caused fear of potential injury during measurement. As a result, only a few provided consents, leading to delays in the completion of the research.

3. RESULTS AND DISCUSSION

A total of three hundred and ten (310) subjects were studied. These comprised one hundred and fifty-one (151) males and one hundred and thirty-four (134) females. However, on statistical analysis, the following were derived:

Table 1. Age and Sex Distribution of the Subjects.

Age (Years)	Males	Females	Total
16 – 22	49 (17.1%)	51 (17.8%)	100(35%)
23 – 28	68 (23.7%)	57 (19.9%)	125(44%)
29 – 33	34 (11.8.%)	26(9.1%)	60(21%)
Total	151(53%)	134(47%)	285(100%)

From table 1 above, it was discovered that the age of the subjects ranged from 16 years to 33 years. The highest total number of the subjects within the ages 23 years to 28 years with sixty-eight (68) males and fifty-seven (57) females at 23.7% and 19.9% respectively, and the lowest number of subjects was within the ages 29 years to 33 years with thirty-four (20) males and twenty-six (26) females at 11.8% and 9.1% respectively. These were due to the nature of the subjects used in this study which were mainly students.

Table 2. Right and Left Ear Dimensions of Males and Females.

Dimensions	Males(151)	Females(134)	Total (285)	T-Value	P-Value
REH (CM) ± SD	5.59 ± 0.30	5.52 ± 0.27	5.55 ± 0.29	-1.988	0.048*
LEH (CM) ± SD	5.62 ± 0.30	5.52 ± 0.33	5.57 ± 0.32	-2.880	0.004*
REW (CM) ± SD	2.65 ± 0.28	2.56 ± 0.25	2.61 ± 0.27	-2.722	0.007*
LEW (CM) ± SD	2.65 ± 0.29	2.65 ± 0.23	2.65 ± 0.26	-0.326	0.745
Age (Yrs) ± SD	24.38 ± 4.28	24.60 ±4.31	24.48 ± 4.29	0.431	0.667

*= significant at 0.05 level (2-tailed). Data are mean and standard deviation.

From table 2 above, the total mean height of the right ears (REH) for male and female subjects were 5.59 ± 0.30cm and 5.52 ± 0.27cm respectively. The total mean height of the left ears (LEH) for male and female subjects were 5.62 ± 0.30cm and 5.52 ± 0.33cm respectively. The total mean width of the right ears (REW) for male and female subjects were 2.65 ± 0.28cm and 2.56 ± 0.25cm respectively. The total mean width of the left ears (LEW) for male and female subjects were 2.65 ± 0.29cm and 2.65 ± 0.23cm respectively. However, the total REH, LEH, REW and LEW for all the subjects were 5.55 ± 0.29cm, 5.57 ± 0.32cm, 2.61 ± 0.27 and 2.65 ± 0.26cm respectively. The independent sample t-test showed a statistically significant difference between males and female REH, LEH and REW at $p<0.05$. but the test showed no statistical significance between males and females LEW and males and females age of the subjects with P = 0.745 and P = 0.667 respectively.

Table 3. Right and left Ear Dimensions of the Male Subjects at Different Age Groups.

Age Grp (Yrs) / **Dim. (CM)**	**16 – 22 (n=49)**	**22 – 28 (n=68)**	**29 – 35 (n=34)**	**Total (n=151)**	**F – Value**	**P - Value**
RE Height (REH)	5.57 ± 0.25	5.54 ± 0.23	5.70 ± 0.44	5.59 ± 0.30	3.496	0.033*
RE Width (REW)	2.56 ± 0.25	2.56 ±0.25	2.77 ± 0.34	2.65 ± 0.28	5.997	0.003*

LE Height (LEH)	5.61 ± 0.29	5.60 ± 0.22	5.70 ± 0.42	5.56 ± 0.29	1.274	0.283
LE Width (LEW)	2.66 ± 0.24	2.61 ± 0.26	2.72 ± 0.38	2.65 ± 0.29	1.408	0.248
Age	19.94 ± 1.95	24.50 ± 1.48	30.68 ± 1.80	24.41 ± 4.28	391.831	0.000*

*Significant at 0.05 level (2-tailed). Data is mean and standard deviation.

From table 3 above, it was discovered that the height of the right ear of the male subjects varied from 5.54 ± 0.23cm to 5.70 ± 0.44cm. The width of the right ear of the male subjects varied from 2.56 ± 0.25cm to 2.77 ± 0.34cm. The height of the left ear of the male subjects from 5.60 ± 0.22cm to 5.70 ± 0.42cm. The width of the left ear of the male subjects varied from 2.61 ± 0.26cm to 2.72 ± 0.38cm. however, the overall mean REH, REW, LEH and LEW of the male subjects were 5.59 ± 0.30cm, 2.65 ± 0.28cm, 5.65 ± 0.29cm and 2.65 ± 0.29cm respectively. The Analysis of Variance (ANOVA) test showed no statistically significant difference in the height and width of the left ear of the meal subjects at different age groups at P = 0.283, and P = 0.248 respectively. While the ANOVA test showed a significant difference in the right ear (P=0.003) and Age (P=0.000) of the male subjects across the age groups.

Table 4. Right and Left ear Dimensions of the Male Subjects at Different Age Groups.

Age Grp (Yrs) / **Dim. (CM)**	**16 – 22 (n = 51)**	**22 – 28 (n = 57)**	**29 – 35 (n = 26)**	**Total (n = 134)**	**F – Value**	**P - Value**
RE Height (REH)	5.50 ± 0.28	5.54 ± 0.26	5.52 ± 0.26	5.52 ± 0.27	0.236	0.790
RE Width (REH)	2.56 ± 0.25	2.55 ± 0.26	2.58 ± 0.23	2.56 ± 0.23	0.127	0.881
LE Height (LEH)	5.49 ± 0.25	5.51 ± 0.42	5.57 ± 0.26	5.52 ± 0.33	0.430	0.652
LE Width (LEW)	2.65 ± 0.22	2.66 ± 0.24	2.59 ± 0.24	2.65 ± 0.23	0.850	0.430
Age	20.39 ± 1.34	25.26 ± 1.86	31.23 ± 2.20	24.57 ± 4.31	333.926	0.000*

*Significant at 0.05 level.Data are mean and standard deviation.

From Table 4 above, it was observed that the height of the right ear of the female subjects varied from 5.50 ± 0.28 to 5.54 ± 0.26cm. The width of the right ear of the female subjects varied from 2.55 ± 0.26cm to 2.58 ± 0.23cm. The height of the left ear of the female subjects varied from 5.49 ± 0.25cm to 5.57 ± 0.26cm. The width of the left ear of the female subjects varied from 2.59 ± 0.24cm to 2.66 ± 0.24cm. However, the overall mean REH, REW, LEH and LEW of the female subjects were 5.52 ± 0.27cm, 2.56 ± 0.25cm, 5.52 ± 0.33cm and 2.65 ± 0.23cm respectively.

The Analysis of Variance (ANOVA) test showed no statistical significant difference in the height of the right ear, width of the right ear, height of the left ear and width of the left ear of female subjects at different age groups and at (P = 0.790), (P = 0.881), (P = 0.652), and (P = 0.430) respectively. However, the test revealed significant difference in the age groups of female subjects at (P = 0.000).

Table 5: Right and Left Ear Dimensions of all the subjects at Different Age Groups

Age Grp (Yrs) / Dim. (CM)	16 – 22 (n = 100)	22 – 28 (n = 125)	29 – 35 (n = 60)	Total (n = 285)	F – Value	P - Value
RE Height (REH)	5.53 ± 0.27	5.54 ± 0.24	5.62 ± 0.38	5.55 ± 0.29	2.014	0.135
RE Width (REW)	2.56 ± 0.25	2.61 ± 0.26	2.69 ± 0.31	2.61 ± 0.27	4.153	0.017*
LE Height (LEH)	5.55 ± 0.27	5.56 ± 0.33	5.64 ± 0.36	5.57 ± 0.32	1.715	0.182
LE Width (LEW)	2.66 ± 0.23	2.64 ± 0.25	2.66 ± 0.33	2.65 ± 0.26	0.245	0.783
Age	20.17 ± 1.68	24.85 ± 1.70	30.92 ± 1.99	24.48 ± 4.29	707.653	0.000*

*Significant at 0.05 level Data are mean and standard deviation.

From table 5 above, it was deducted that the height of the right ear of all the subjects varied from 5.53 ± 0.27cm to 5.62 ± 0.38cm. The width of the right ear of all the subjects varied from 2.56 ± 0.25cm to 2.69 ± 0.31cm. The height of the left ear of all the subjects varied from 5.55 ± 0.27cm to 5.64 ± 0.36cm. The width of the left ear of all the subjects varied from 2.64 ± 0.25cm to 2.66 ± 0.33cm. However, the overall mean REH, REW, LEH and LEW of all the subjects were 5.55 ± 0.29cm, 2.61 ± 0.27cm, 5.57 ± 0.32cm and 2.65 ± 0.26cm respectively. The Analysis of Variance (ANOVA) test showed no statistically significant difference in the height of the right ear, height of the left ear and width of the left ear of all the subjects at different age groups at P = 0.135, P = 0.182, and P= 0.783 respectively. While the ANOVA test showed a significant difference in the width of the right ear at (P=0.017) and Age at (P=0.000) of all the subjects at different age groups.

Table 6. Relationship between Right and Left Ear Dimensions of the Male Subjects (n=151).

	Paired Sample Test	t-Statistic	Sig
Pair 1	Male REH vs Male LEH	-1.695	0.092

Pair 2	Male REW vs Male LEW	-0.161	0.872
Pair 3	Male REH vs Male REW	113.663	0.000*
Pair 4	Male LEH vs Male LEW	108.342	0.000*

*Significant at 0.05 level (2-tailed) .

In table 6, the paired sample t-test showed that the height of the right ear showed no significantly difference with the height of the left ear of the male subjects at ($p>0.05$). Similarly, in Pair 2, width of the right ear showed no significant difference with the width of the left ear of the male subjects ($p>0.05$). in contrast, pair 3 showed that the right ear height dimension for males was significantly greater than the right ear width dimensions of the male subjects at ($p<0.05$). similarly, in Pair 4 it was observed that the left ear height dimension was significantly greater than the left ear width dimensions of he male subjects at ($p<0.05$).

Table 7. Relationship between Right and Left Ear Dimensions of the female Subjects (n=134).

	Paired Sample Test	**t-Statistic**	**Sig**
Pair 1	Female REH vs Female LEH	0.083	0.930
Pair 2	Female REW vs Female LEW	-3.530	0.001*
Pair 3	Female REH vs Female REW	93.970	0.000*
Pair 4	Female LEH vs Female LEW	83.661	0.000*

*Significant at 0.05 level (2-tailed) .

From table 7 above; the paired sample t-test showed that there was no significant difference between the right ear height and left ear height of the female subjects at ($p>0.05$). A significant difference was observed between the right ear width and left ear width of the female subjects at ($p<0.05$). in Pair 3, the right ear height was significantly greater than the right ear left ear height of the female subjects at ($p<0.05$). Similarly in Pair 4, the left ear height was significantly greater than the left ear width of the female subjects at ($p<0.05$).

Table 8. Relationship between Right and Left Ear Dimension of all the Subject (n=285).

	Paired Sample Test	**t-Statistic**	**Sig**
Pair 1	REH vs LEH	-1.004	0.316
Pair 2	REW vs LEW	-2.528	0.012*
Pair 3	REH vs REW	146.332	0.000*
Pair 4	LEH vs LEW	133.685	0.000*
Pair 5	Male REH vs Female REH	-1.133	0.259
Pair 6	Male REW vs Female REW	-2.062	0.041*
Pair 7	Male LEH vs Female LEH	-2.553	0.012*
Pair 8	Male LEW vs Female Lew	-0.136	0.892

*significant at 0.05 level (2-tailed).

From table 8 above; the paired sample t-test showed no significant difference between the right ear height and left ear height of all the subjects (P>0.05) while there was a significant difference between right ear width and left ear width of all the subjects as shown in Pair 2 at (P<0.05). in Pair 3, the right ear height was significantly greater than their right ear width of all the subjects at (p<0.05). Similarly, in Pair 4, the left ear height was significantly greater than the left ear width of all the subjects at (p<0.05). on the other hand, in Pair 5 the sample t-test showed on significant difference between the height of the right ear of male and female subject at (p>0.05). In pair 6, there was a significant difference between the width of the right ear of males and females at (p<0.05). In Pair 7, the height of the left ear of males showed a significant difference with the height of the left ear of their female counterparts at (p<0.05). but in Pair 8, there was no significant difference between the width of the left ear of male and female subjects at (p>0.05).

The external ear is an important component of the human facial complex. It defines the face and conveys information about the age and sex of an individual (Brucker *et al.,* 2003). The external ear's parameters, shape, and proportion to the face are vital in aesthetic surgery as this information helps guide a plastic surgeon in correcting ear defects. It is important to recognize that there is no standard ear morphology and variations across ethnic groups that have been noted (Purkait and Singh, 2007).

The external ear which is composed of auricle/pinna and external acoustic meatus, has been extensively studied as an identification parameter. The external ear has been described by many authors as having an important role in establishing the identity of criminals and victims of crimes or accidents (Feenstra and Van, 2000; Meijerman *et al.,* 2007; Standing Gray's Anatomy, 1998). The anatomy of the pinna, which differs according to age, sex, race, and ethnic group, has been used by physical anthropologists and forensic experts in identification (Meijerman et al., 2007; Alexander *et al.,* 2010; Asai *et al.,* 1996; Ito *et al.,* 2010; Sforza *et al.,* 2009;Niemitz *et al.,* 2007).

This study is intended to determine the variations of external ear dimensions with many observed similarities as well as differences compared with the result obtained by other authors. The result of this study showed that the total mean height of the right ears of male and female subjects was 5.59 ± 0.30cm and 5.52 ± 0.27cm respectively. Also, that the total mean height of the left ears of male and female subjects was 5.62 ± 0.30cm and 5.52 ± 0.33cm respectively. In addition, that the total mean width of the right ears of male and female subjects was 2.65 ± 0.28cm and 2.56 ± 0.25cm respectively. Also, that the total mean width of the left ears of male and female subjects was shown as 2.65 ± 0.29cm and 2.65 ± 0.23cm respectively. Also, the result of the present study showed that the total REH, LEH, REW and LEW for all the subjects were 5.55 ± 0.29cm, 5.57 ± 0.32cm, 2.61 ± 0.27 and 2.65 ± 0.26cm respectively. The result of the independent sample t-test also showed a statistically significant difference between males and females REH, LEH and REW at <0.05. But the result of the test showed no statistical significance between males and females LEW at P = 0.745.

The above result of the present study on the height of the ear of male and female subjects are like the findings of the study by Ekanem et al., 2010 among adult Nigerians resident in Maiduguri metropolis who reported that their mean ear height as 5.61 ± 0.59cm for the males and 5.60 ± 0.51cm for the females. The result of the height and width of the ears of both male and female subjects in this study is at variance to the findings of Arora and Singh, (2016) conducted at North-Western part of India who reported the length and width of the auricles of both males and females respectively as 61.57 ± 3.55mm and 31.04 ± 2.69mm, 56.74 ± 3.75mm, 29.40 ± 2.50mm. The findings of this study, which also showed slightly higher mean values in right sides is in line with the fingers of Taura *et al.,* (2013) on Hausas Nigeria. This is also slightly like the findings of Vijay *et al.,* (2017) on the external ear of North Indian males and females, who showed that their total ear height and width had higher values in males than females. The observed statistically significant higher values in males than females in this study indicates that sexual dimorphism exits in the measured parameters. This is also in line with the findings of Taura *et al.,* (2013) on Hausas of Nigeria, who observed sexual dimorphism in both sexes.

The variations observed in this study and previous studies could be attributed to age, genetic, racial, and environmental factors. The result of the Analysis of Variance (ANOVA) test showed no statistically significant difference in the height and width of the left ear of the male subjects at different age groups at P = 0.283, and P = 0.248 respectively. On the other hand, the result of the ANOVA test showed a significant difference in the height of the right ea (P=0.033) and width of the right ear (P-0.003) of the male subjects across the age groups.

The result of this study also demonstrated that the overall mean REH, REW, LEH, and LEW of the female subjects were 5.52 ± 0.27cm, 2.56 ± 0.25cm, 5.52 ± 0.33cm and 2.65 ± 0.23 respectively.

The result of the Analysis of Variance (ANOVA) test showed no statistically significant difference in the height of the right ear, width of the right ear, height of the left ear and width of the left ear of female subjects at different age groups and at (P=0.790), (P=0.881), (P=0.652), and (P=0.430) respectively. However, the result of the test revealed significant difference in the age groups of female subjects at (P=0.000).

The result of this study also demonstrated that the overall mean REH, REW, LEH, and LEW of all the subjects were 5.55 ± 0.29cm, 2.61 ± 0.27cm, 5.57 ± 0.32cm and 2.65 ± 0.26cm respectively. The result of the Analysis of Variance (ANOVA) test also showed no statistically significant difference in the height of the right ear, height of the left ear and width of the left ear of all the subjects at different age groups at P = 0.135, P = 0.182 and P = 783 respectively. On the other hand, the result of ANOVA test showed a significant difference in the width of the right ear at (P=0.017) and Age at (P=0.000) of all the subjects at different age groups. The result of the morphometric study of the external ear of medical students at Bharatpur, Chitwan, Nepal by Ruku et al., (2017) revealed using ANOVA that the effect of age on ear height was statistically significant on both right and left sides among all three age groups studied at $p<0.05$ which is in comparison with the findings of this study.

The result of the comparative study on ear parameters of Turkish and African students by Musa *et al.,* (2017) which showed that the left and right ear width of Turkish male individuals were significantly higher than their female counterparts ($p<0.05$) and that the left ear height of African male individuals were found significantly higher than African individuals ($p<0.05$) is slightly in conformity with the statistical significant difference observed the height and width of the right and left ears of both genders in this study. The result of the study by Durgawale and Jadhav (2015) on Western Maharashtrian population which showed that ear length and width were higher in males when compared with the female subjects, that all parameters statistically were significantly larger on right side in both males and female and that all measurements were found higher in males than in females on both sides, total ear length and ear width were found to be significantly greater, is slightly at variance to the findings of this study using paired sample t-test.

4. CONCLUSION

This study has demonstrated significant variations in external ear dimensions across sexes, with males generally showing larger measurements than females. The results align with previous studies that suggest sexual dimorphism in ear morphology, though differences exist across ethnicities and geographical regions. While right ear dimensions were slightly larger than left in most cases, some findings, such as the lack of statistical significance in left ear width between males and females, diverged from previous research. The observed variations may be attributed to factors like age, genetics, and environment, highlighting the complexity of ear morphology. Furthermore, the study's findings provide useful insights for aesthetic surgery and forensic identification, reinforcing the importance of understanding ear morphology in different populations. Overall, these findings contribute to the broader body of knowledge on human anatomy, particularly the significance of the external ear as an identification marker.A study on the anthropometry of the ear among Chukwuemeka Odumegwu Ojukwu University (COOU) students revealed significant variations in ear shape, size, and morphological features. The study measured ear length, width, circumference, and morphological features in 285 students (152 males, 134 females) aged 16-35 years.

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