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# Comparative Study of Anatomical Variations of External Ear Among Hausa, Igbo, and Yoruba Ethnic Groups in Kano State, Nigeria

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**Running Title:** Anatomical Variations of External Ear

## ABSTRACT

The task of establishing identity of unknown cases becomes quite difficult for investigating officers especially in cases of mass disaster, burns, drowning etc. where the face is severely disfigured. If the ears are left unharmed, in such cases the identity may be established using metric and morphological features of the victim's ear, as it differs between ethnic groups, sex and geographic location. The present study was aimed at evaluating the morphological variations of the external ear among Hausa, Igbo and Yoruba Ethnic groups in Nigeria. This study comprised a total of 403 subjects that were randomly selected in which 145, 128 and 130 subjects were selected from Hausa, Igbo, and Yoruba ethnic groups respectively. The photographs of the subjects were taken using Sony Hanicam DCR-SX53 camera and transferred to computer and three different observers were used to identify the studied parameters. After the comparison it was observed that the frequencies of the studied morphological parameters were not the same across the three ethnicities. Some parameters were more prevalent in one ethnicity than the others. Significant association between these parameters and ethnicity were obtained in morphological shape of ear, type of antitragus and concha shape. From the findings, it can be concluded that there is existence of variations in some of morphological parameters of the external ear across the three ethnicities studied.

**Keywords**: External ear, variations, Hausa, Igbo, Yoruba, Nigeria

## INTRODUCTION

In forensic investigations, the quest for reliable and innovative methods of identifying individuals is paramount, especially in cases where traditional means such as facial recognition are compromised. Among the structures that show the existence of anatomical variation which is often under-studied is the external ear, a very important facial feature that differs between ethnic groups [1] and can give clue to the bearer's sex and age [2].

The external ear is very important structure of the face. It is among the structures that defines the beauty and the identity of an individual; hence a malformed ear or abnormal ear position affects one's physical appearance. The external ear became an organ of much interest around the beginning of 20th century. German Anatomists studied the ear with the hope that existence of variations might act as a clue to the nature of an individual [4, 5]. Based on their belief, the ear was a gateway to the brain and its physical presentations would reflect the state of the mind, like the mind of a mentally deranged person. This made them to believe that ear structure can be a useful tool in identifying a person or his criminal tendency.

Just as fingerprinting is a generally acceptable tool for human identification due to its uniqueness, the ears have their uniqueness too, which is peculiar to each human [1, 6]. Knowledge of normal ear morphology can help in the ear prosthesis [7] and clinical diagnosis of several developmental abnormalities [8]. Such abnormalities can be detected even during intrauterine life, as ear

morphology is proposed to be marker for ultrasound-based prenatal screening of aneuploidy [9].

The structure of the external ear has been reported to vary with sex [10, 11], ethnicity [12, 1], age and geographic location [2]. This study was aimed at comparing the variations of the morphological parameters of the external ear among the three major ethnic groups in Nigeria namely Hausa, Igbo, and Yoruba.

## MATERIALS AND METHODS

This study was cross-sectional and prospective. A total of 403 participants were randomly selected from each ethnic group, comprising 145 (75 males and 70 female), 128 (66 males and 67 females) and 130 (67 males and 63 females) subjects from Hausa, Igbo and Yoruba ethnic groups respectively. The selection of the sample size was based on the proportion of the population of each ethnic group in Kano state, which was the study area. The subjects are between 10-50 years of age. This age range was selected because of the age dependent changes in the external ear as reports suggested that the external ear has complete adult morphology by 10 years and after 50 years it starts to lose its normal morphology as a result of decreasing elasticity [13]; hence the selected age range is within normal ear morphological range.

The study was conducted in Kano State, Nigeria and the subjects selected for the study were pure indigenes of each ethnic group at least to three generations with no signs of any external ear deformities or history of ear surgery. The ethical approval for the study was obtained from Kano State Ethical Review Committee of the State Ministry of Education. Similarly, the consent of the participants was obtained prior to data capturing.

The external ear photographs of each subject were taken, and the method was as follows: Sony Handycam camera (DCR-SX53) was mounted on a tripod stand and the chair was placed in front of the tripod stand at a constant distance of 75 cm between the chair and the tripod stand and this was the point where the most fitted photographs were obtained. Subjects were asked to sit comfortably on the chair with their ear facing the camera directly and a tag number was affixed beside the ear of each subject for identification. The photographs of the ear were then taken and transferred to a computer for observations. The observations were carried out by three different observers in which six morphological parameters (morphological shape of ear, shape of concha, shape of antitragus, type of lobule attachment, type of crus of helix and Darwin's tubercle) were observed according to the descriptions given in the literature [13, 5].

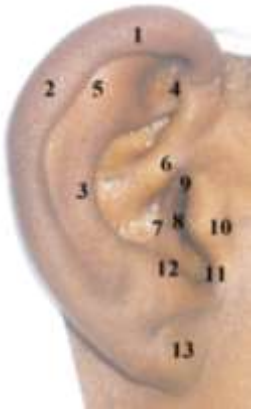


**Figure 1:** Features of the External Ear

1: Helix, 2: Darwin's tubercle. 3:.Antihelix, 4: Triangular fossa, 5: Scapha, 6: Crux of helix, 7: Concha, 8: External auditory meatus, 9: Incisura anterior auris, 10: Tragus, 11: Incisura inter-tragica, 12: Antitragus, 13: Lobule.

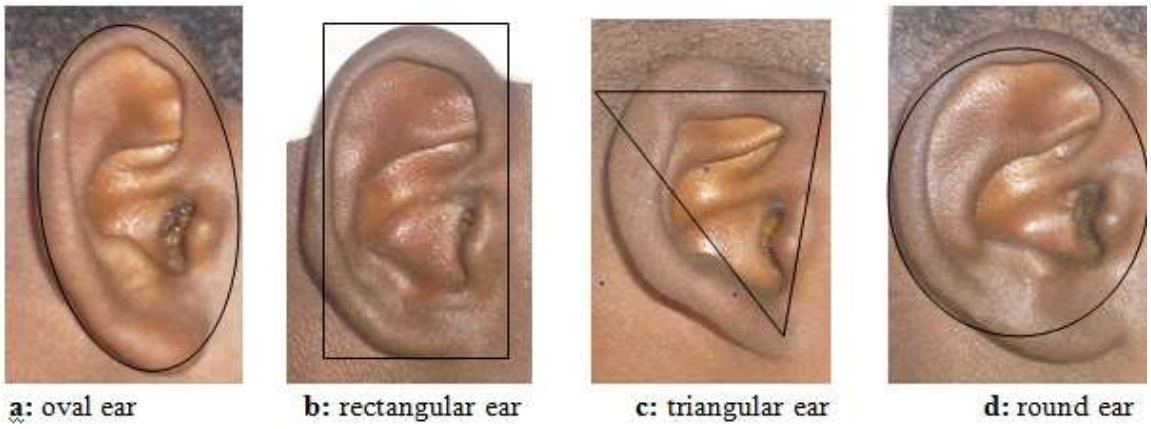


**Figure 2:** Studied Morphological shape of the External Ear

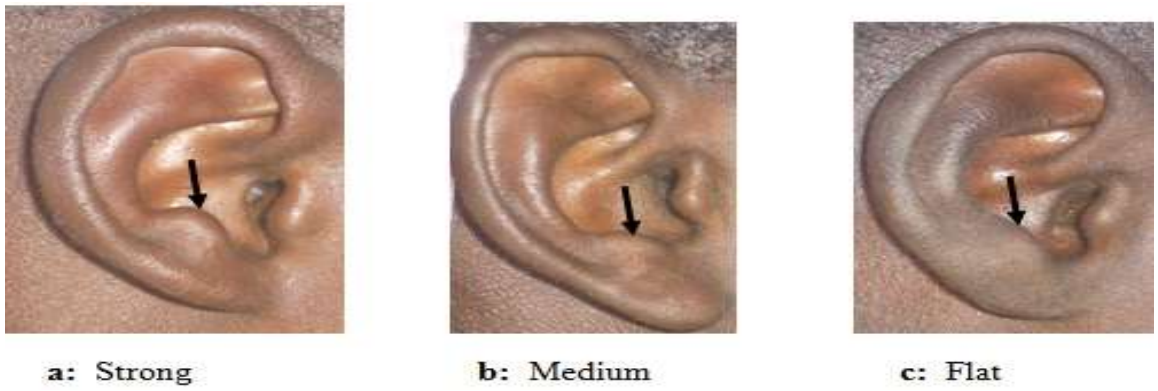


**Figure 3:** Studied antitragus of the External Ear

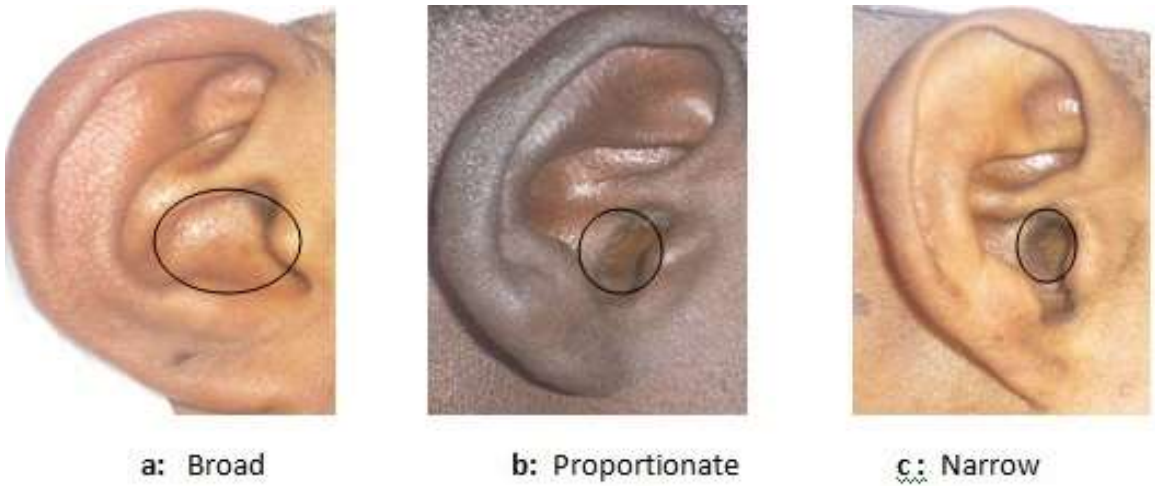


**Figure 4:** Concha of the External Ear

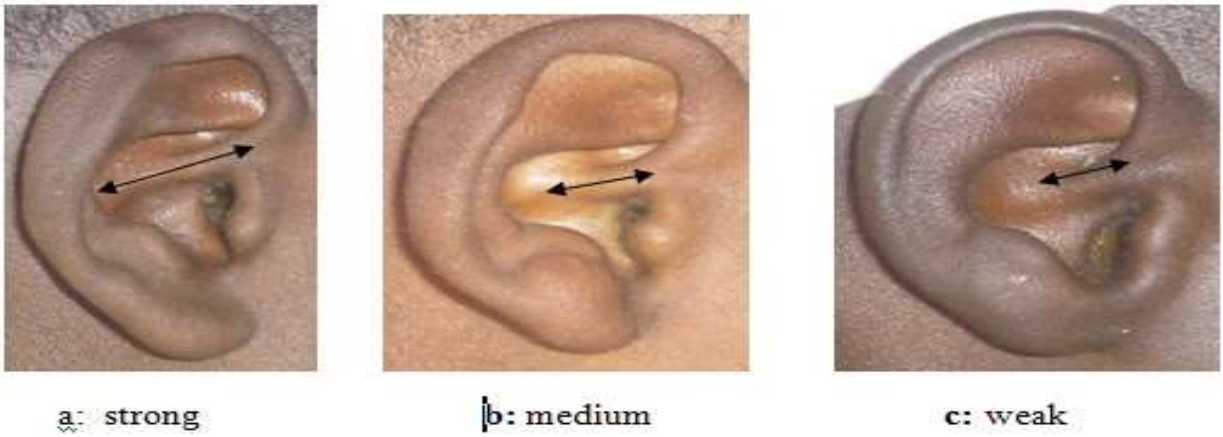


**Figure 5:** Crus of helix of the External Ear

**Statistical Analysis**

The statistical analyses were performed in SPSS version 25. The results were presented as frequencies and percentages; Pearson's Chi-square test was done to determine the association of the ethnicity and the morphological parameters, p values < 0.05 were considered significant.

**RESULTS**

The oval and rectangular shape ear was more common among Yoruba with prevalence of 57 (43.8%) and 9(6.9%) respectively (Table 1), similarly round shape ear was more common among Hausa 60 (41.4%), while triangular ear was more prevalent among Igbos 39 (30.5%). There is significant association between morphological shape of ear and the ethnicity of the subjects ($\chi^2$ = 13.128, p = 0.041). The Strong crus of helix was more common among Hausa and Igbo 67(46.2%) and 49(38.3%) respectively while the weak type was more common among Yoruba ethnic group (Table 2). There was no significant association between crus of helix type and ethnicity of the subjects ($\chi^2$ = 7.951, p = 0.093, df = 4). The prominent type was more common among Yoruba 61 (46.9%) while the medium type of antitragus was more common among Hausa and Igbo 66 (45.5%) and 44 (34.4%) respectively (Table 3). There is significant association between antitragus shape and the ethnicity of the subjects ($\chi^2$ = 17.564, p = 0.002).

The broad concha type was more prevalent among Yoruba 68 (52.3%) while the proportionate shape of concha was more common among Hausa 57 (39.3%) and the narrow type was more common among Igbo Ethnicity 49 (38.3%) (Table 4). There was significant association between Concha shape and the ethnicity of the subjects ($\chi^2$ = 20.923, p = <0.001). In all the ethnicities the absence of Darwin's tubercle was more frequent than its presence (Table 5). No significant association between Darwin's tubercle and the ethnicity of the subjects was observed ($\chi^2$ = 6.136, p = 0.05).

Table 6 compared the type of lobule attachments and the ethnicity. The results indicate that among Yoruba and Igbo the free type was more common than the attached type while the attached type is more frequent in Hausa than free. No significant association between type of lobule attachment and the ethnicity of the subjects ($\chi^2$ = 1.455, p = 0.483).

**Table 1:** Comparison of morphological shape of ear and ethnicity of all Subjects (n = 403)

| | Morphological Shape of Ear | | | | |
|---|---|---|---|---|---|
| | **Oval (%)** | **Rectangular (%)** | **Round (%)** | **Triangular (%)** | **Total (%)** |
| Hausa n = 145 | 54 (37.2) | 5 (3.4) | 60 (41.4) | 26 (17.9) | 145 (100) |
| Igbo n = 128 | 49 (38.3) | 6 (4.7) | 34 (26.6) | 39 (30.5) | 128 (100) |
| Yoruba n =130 | 57 (43.8) | 9 (6.9) | 38 (29.2) | 26 (20) | 130(100) |
| Total | 160 (39.7) | 20 (5) | 132 (32.8) | 91(22.6) | 403 (100) |

$\chi^2$ = 13.128, p = 0.041, df = 6

**Table 2:** Comparison of crus of helix and ethnicity of all Subjects (n = 403)

| | Type of Crus of Helix | | | |
|---|---|---|---|---|
| | **Strong (%)** | **Medium (%)** | **Weak (%)** | **Total (%)** |
| Hausa n = 145 | 67(46.2) | 38 (26.2) | 40 (27.6) | 145 (100) |
| Igbo n = 128 | 49(38.3) | 38 (29.7) | 41 (32) | 128 (100) |
| Yoruba n =130 | 50 (38.5) | 26 (20) | 54 (41.5) | 130 (100) |
| Total | 166 (41.2) | 102 (25.3) | 135 (33.5) | 403 (100) |

$\chi^2 = 7.951$, p = 0.093, df = 4

**Table 3:** Comparison of antitragus shape and ethnicity of all Subjects (n = 403)

| | Type of Antitragus | | | |
|---|---|---|---|---|
| | **Prominent (%)** | **Medium (%)** | **Flat (%)** | **Total (%)** |
| Hausa n = 145 | 36 (24.8) | 66 (45.5) | 43 (29.7) | 145 (100) |
| Igbo n = 128 | 43 (33.6) | 44 (34.4) | 41 (32) | 128 (100) |
| Yoruba n=130 | 61 (46.9) | 34 (26.2) | 35 (26.9) | 130 (100) |
| Total | 140 (34.7) | 144 (35.7) | 119 (29.5) | 403 (100) |

$\chi^2 = 17.564$, p = 0.002, df = 4

**Table 4:** Comparison of concha shape and ethnicity of all Subjects (n = 403)

| | Concha shape | | | |
|---|---|---|---|---|
| | **Broad (%)** | **Proportionate (%)** | **Narrow (%)** | **Total (%)** |
| Hausa n = 145 | 43 (29.7) | 57 (39.3) | 45 (31) | 145 (100) |
| Igbo n = 128 | 40 (31.2) | 39 (30.5) | 49 (38.3) | 128 (100) |
| Yoruba n =130 | 68 (52.3) | 31 (23.8) | 31 (23.8) | 130 (100) |
| Total | 151 (37.5) | 127 (31.5) | 125 (31) | 403 (100) |

$\chi^2 = 20.923$, p = <0.001, df = 4

**Table 5: Comparison of Darwin's tubercle and ethnicity of all Subjects (n = 403)**

| | Darwin's tubercle | | |
|---|---|---|---|
| | **Absent (%)** | **Present (%)** | **Total (%)** |
| Hausa n= 145 | 119 (82.1) | 26 (17.9) | 145 (100) |
| Igbo n = 128 | 91 (71.1) | 37 (28.9) | 128 (100) |
| Yoruba n=130 | 92 (70.8) | 38 (29.2) | 130 (100) |
| Total | 302 (74.9) | 101 (25.1) | 403 (100) |

$\chi^2 = 6.136$, p = 0.05

Table 6: Comparison of type of lobule attachment and ethnicity of all Subjects (n = 403)

| | Type of lobule attachment | | |
|---|---|---|---|
| | **Attached (%)** | **Free (%)** | **Total (%)** |
| Hausa n = 145 | 78 (53.8) | 67 (46.2) | 145 (100) |
| Igbo n = 128 | 60 (46.9) | 68 (53.1) | 128 (100) |
| Yoruba n =130 | 63 (48.5) | 67 (51.5) | 130 (100) |
| Total | 201 (49.9) | 202 (50.1) | 403 (100) |

$\chi^2 = 1.455$, p = 0.483, df = 2

## DISCUSSION

The study determined the broad variations in the external ear parameters among Hausa, Igbo and Yoruba Ethnicities, and also determined the morphological variations because many studies emphasized the used of various morphological parameters of the ear in various settings particularly for individual identification and medico-legal settings [4]. The frequencies of studied parameters were observed to be different in each ethnic group. Some of the parameters were significantly associated with ethnicity of the subjects while others did not. The findings of this study show that morphological shape of ear, antitragus shape and concha shape were significantly associated with the ethnicity of the study subjects.

For comparison of morphological characteristics of the ear with other reports, only few studies are available in the literature [13 - 16]. A study of Port Harcourt population on variability of ear shapes showed that oval ear was more common (58%), followed by round, rectangular and triangular with percentages of 25.5%, 10%, and 6.5% respectively but contrary to the current study where the rectangular type was the least common among all the ethnicities [17]. According to Van der Lugt [18], the Dutch males were found to possess 68.7% of oval-type ears, while Americans have 65% as observed by [19] compared to the subjects of the present study, where 37.2% oval type was seen in Hausa, 38.3% in Igbo and 48.3% in Yoruba ethnic groups. The ethnic variability is important and thus, could be used in identifying a particular ethnic group.

The type of lobule attachment and Darwin's tubercle were similar to findings by Edibamode *et al.* [20] who reported that the free earlobe type was more common in both Igbo (52.33%) and Yoruba (66%) compared to the present study among Igbos (53.1%) and Yorubas (51.5%). The absence of Darwin's tubercle was more common (77.33% for Igbos and 76% for Yoruba) as compared to the present study 71.1% for Igbos and 70.8% for Yorubas. This is in line with another study which reported 66.46% free earlobe and 33.53% attached among the rickshaw drivers of Indian population [21].

The reason behind these morphological variations of the external ear among different ethnicities cannot be unconnected to genetic differences existing among different populations [22]; this is supported by a study conducted by Adhikari *et al.* [23] which showed that variation in the ear morphology of the humans may be associated with a gene called ectodysplasin A receptor (EDAR) gene, which regulates the development of skin appendages. It is then possible that variation in some sequences along this gene among Hausa, Igbos, Yoruba, and other populations could explain the differences observed in their ear morphology.

## CONCLUSION

Findings of this study showed that there exist anatomical variations in the morphology of external ear in the three population groups studied. While some of these variations are significantly associated with ethnicity, others were not.

### Conflict of Interest

It can be declared that no any conflict of interest with respect to the authorship, research, funding and publication of this work.

## REFERENCES


1. Purkait, R. and Singh, P. Anthropometry of the normal human auricle: a study of adult Indian men. *Aesthetic* Plastic Surgery, 2007;31(4): 372-379.
2. Brucker, M. J., Patel, J. and Sullivan, P. K. A morphometric study of the external ear: age- and sex-related differences. Plastic and Reconstructive Surgery, 2003; 112(2): 647-652.
3. Imhofer, R. The significance of the auricle for establishing identity. Archives for Criminology 1906;26: 150-63.
4. Schwalbe, G. On the methodology of static examinations of the ear shapes of the mentally ill and criminals. Archives of Psychiatry and Nervous Diseases; 1875;27: 633-644.
5. Keith, A. The significance of certain features and types of the external ear. Nature, 1901;65(1671): 16-21.
6. McGrath, M. H. and Mukerji, S. Plastic Surgery and the Teenage Patient. Journal of Pediatric and Adolescent Gynecology, 2000;13(3): 105-118
7. Sforza, C., Grandi, G., Binelli, M., Tommasi, D. G., Rosati, R. and Ferrario, V. F. Age- and sex-related changes in the normal human ear. Forensic Science International, 2009;187(1-3), 110.e1-110.e7.
8. Chitkara, U., Lee, L., Oehlert, J. W., Bloch, D. A., Holbrook, R. H., El-Sayed, Y. Y., and Druzin, M. L. Fetal ear length measurement: a useful predictor of aneuploidy? Ultrasound in Obstetrics and Gynecology, 2002;19(2), 131-135.
9. Ekanem, A. U., Garba, S., Musa, T., and Dare, N. Anthropometric study of the pinna (auricle) among adult nigerians resident in Maiduguri Metropolis. Journal of Medical Sciences, 2010;10(6): 176-180.
10. Meijerman, L., Van der Lugt, C. and Maat, G. J. Cross-sectional anthropometric study of the external ear. Journal of Forensic Sciences, 2007;52(2), 286-293.
11. Musa, A., Seney, B. A., Mahinur, U. and Yasemin, A. comparison of some morphometric parameters of the ear on Turkish and African students. Asian Journal of Biomedical and Pharmaceutical, 2017;7(2): 60-69.
12. Purkait, R. External Ear: An analysis of its uniqueness. Egyptian Journal of Forensic Sciences, 2016;6(2): 99-107.
13. Verma, P., Harpreet, K. S., Kanika, G. V., Sharry, G., Madhu, S. and Amit, L. Morphological variations and biometrics of ear: an aid to personal identification. Journal of Clinical and Diagnostic Research, 2016; 10(5): 75-83.
14. Purkait, R., and Singh, P. A test of individuality of human external ear pattern: Its application in the field of personal identification. Forensic Science International, 2008;178(2-3), 112-118.
15. Alexander, K. S., Stott, D. J., Sivakumar, B. and Kang, N. A morphometric study of the human ear. Journal of Plastic, Reconstructive and Aesthetic Surgery, 2011; 64(1): 41-47.
16. Osunwoke, E. A., Vidona, W. B. and Atulegwu, G. C. Anthropometric study on the anatomical variation of the external ear amongst Port Harcourt students, Nigeria. International Journal of Anatomical Variations, 2018;11(4): 144.
17. Van der Lugt, C. Report about the Research on Ears and Earprints. Second International Ear Course. Zutphen (Netherlands)/ Durham (UK): Dutch Police College/National Training Centre NTCSSCI, (1999) Research, Proceedings of the First International Conference on Forensic Human Identification in the Next Millennium 24–26, Oct; London. 1999.
18. Iannarelli, A. Ear Identification, Forensic Identification Series. Paramount Publishing Company, Freemont, California, 1989.
19. Edibamode, E. I., Mordi, K., David, L. K. and Eghoi, A. M. Anthropometry of the external ear among adult Ijaws in Bayelsa State of Nigeria. International Journal of Medicine and Medical Research, 2019; 5(1): 75-83.
20. Verma, K., Bhawana, J. and Kumar, V. Morphological variations of ear for individual identification in forensic cases: a study of an Indian population. Research Journal of. Forensic Science 2014; 2(1): 1-8.
21. Swift, B. and Rutty, G. N. The human ear: it's role in Forensic Practice. Journal of Forensic Sciences, 2003; 48(1): 202-215.
22. Adhikari, K., Reales, G., Smith, A. J. Ruiz-Linares, A. A genome-wide association study identifies multiple loci for variation in human ear morphology. Nature Communications. 2015;6(1):1-10.