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Determination of Familial Inheritance of Human External Ear Pattern Among the Urhobos in Delta State, Nigeria.

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ABSTRACT:

Aim: This study determined the familial inheritance of the external ear pattern among the Urhobos in Delta State, Nigeria.

Materials and Methods: Multistage sampling was employed in this study. Entirety of 11 families were randomly selected from 9 towns. There was stratified sampling such that equal number of male and female subjects were selected. A total of 100 families (100 fathers, 100 mothers and 200 offspring) were examined. The subjects were examined physically and completed a questionnaire regarding gender and ethnicity. The morphological characteristics of the ear were studied in otoscans of persons within each family. The digital images were transferred into a computer by a universal serial bus (USB) cord. Computer assisted analyses of the ear images were done using AutoCAD software (version 2022). Data obtained was analyzed with the Statistical Package for the Social Sciences (SPSS), version 26.0. Ear morphology of the same side was matched between parents and offspring. Measurement of agreement was performed by kappa coefficient and gender association was sought by chi-square test. Value of agreement or association less than 0.05 was considered statistically significant.

Results: The external ear pattern (shape of the ear, shape of the tragus and shape of the helix) are substantially heritable from parents to offspring. A large likelihood ratio with a significant level of agreement ($p<0.05$) is the finding for each trait.

Conclusion: The research established baseline data on the external ear pattern among Urhobo subjects. The study highlights the heritability of the external ear pattern.

KEYWORDS: External, ear, pattern, Urhobo, Delta, Nigeria.

INTRODUCTION

In situations where the dead body is recovered in dismembered or mutilated conditions, the shape, size, and individualistic features of the ears may be useful in identifying the deceased along with other identification characteristics of the human body. [1,2]

The ear is divided into three parts: external, middle and internal ear. The external ear, like the middle ear conducts sound to the internal ear. The external ear consists of the auricle and external acoustic meatus (or ear canal). The auricle (pinna) is a musculocutaneous tissue that is attached to the skull and it captures sound. The auricle is mostly made up of cartilage that is covered with skin. There are two parts of the auricle: medial (inner) and lateral (outer). The medial aspect is attached to the skull and the lateral aspect is concave and has numerous grooves and ridges. The outer rim of the auricle is called the helix, and inferiorly this ends as soft tissue called the lobule of auricle (or earlobe). The helix has three parts: crus, spine, and tail. The crus is the anterosuperior convex arch of the helix, the spine the thick superior part of the helix, while the tail is continuous with the lobule. Parallel to the helix is a convex curvature known as the antihelix, which has two parts: the triangular fossa bound by the crus of the helix and the antihelix; and the crura of the antihelix which is the widening of the antihelix directed posteriorly toward the helix.[3,4]

The center of the auricle has a fossa that is continuous with the external acoustic meatus called the concha of the auricle. This concha is covered with a triangular cartilaginous process called the tragus. The base of the tragus is attached to facial skin, whereas its apex partially covers the entrance to the external acoustic meatus. Opposite to the tragus, there is also a cartilaginous elevation above the lobule called antitragus[3,4].

Researches have been conducted worldwide to show variations in human ears morphologically. These studies have shown that every part of the external ear is morphologically unique and shows reasonable variations in individuals and population groups. These studies have described different types and shapes of the ear, as well as various forms of the helix and tragus. [5,6,7,8,9]

Studies have observed the structure of the ear and formulated the population and community characteristics for anthropological and forensic use [10,11,12,13,14]. These studies have shown that the ear dimensions are variable in individuals and populations. Researchers have shown how the shape of the ear can be predicted for facial reconstruction in forensic examinations.[15,16]

Determination of Familial Inheritance of Human External Ear Pattern Among the Urhobos in Delta State, Nigeria.

Features of the external ear are under multiple genetic controls and are expected to behave in a similar manner in genetically related persons.[17] Neupane *et al*., (2020) considered the degree of similarities of external ear features among generations. [18] Purkait (2016) considered diverse external ear traits among parents and offspring and compared these features. Oval shaped pinnae was the most prevalent trait among parents and offspring.[6] Ordu *et al*., (2014) affirmed the inheritance of the external ear among Nigerians. [19]
This study determined the familial inheritance of the external ear pattern among the Urhobos in Delta State, Nigeria. Scrutiny of published literature divulged want of information on the heritability of the external ear pattern among the Urhobos in Delta State, Nigeria, thus the need for this research. The current study sought new information on the ear variability and characteristics of families in the Urhobo ethnic set. This research added to the anthropological knowledge on morphological variability of the external ear structure for further use in forensic examinations.

MATERIALS AND METHODS

A descriptive cross-sectional study design was employed which involved the use of questionnaire, direct observation and in-depth interviews.
The research involved a total of 400 subjects from the Urhobo ethnic group. The formula for sample size determination is:

$$\mathbf{n} = \frac{\mathbf{z^2 \times p(1-p)}}{\mathbf{e^2}}$$

n = required sample size, **z =** confidence level at 95% (standard value of 1.96), **p =** estimated prevalence in the project area (assumed to be .5), q =1-p, e **=** margin of error at 0.05.

$$\mathbf{n} = \frac{1.96^2 \times .5(1-.5)}{0.05^2} = 384 \text{ approximated to } 400.$$

Multistage sampling was employed in this study. A list of the 9 Urhobo speaking Local Government Areas (Ethiope East, Ethiope West, Okpe, Sapele, Udu, Ughelli North, Ughelli South, Uvwie and Warri South) in Delta State was made. A town was randomly selected in each of the 9 Local Government Areas. Entirety of 11 families were randomly selected from each of the 9 towns (Warri, Sapele, Abraka, Ughelli, Effurun, Oghara, Agbarho, Ekpan, Okparabe). There was stratified sampling such that almost equal number of male and female subjects were selected. A total of 100 families (100 fathers, 100 mothers and 200 offspring) were examined.
All the subjects were normal and healthy. None of them suffered from any auricular (congenital and traumatic) or maxillofacial deformity or had undergone any auricular surgical procedure.
The research subjects met the following criteria:
Age 18 to 65 years.
Parents and grandparents must be Urhobos.
The subjects were examined physically and completed a questionnaire regarding age, gender and ethnicity. The morphological characteristics such as overall shape of the ear, shape of the tragus, and shape of the helix were studied in otoscans of persons within each family. Morphological characteristics of the external ear of the study subjects were evaluated on otoscans in order to develop standards for the unique morphology of the ear in the family subsets.
Otoscans, precisely 3D scans of the external ear were taken, and some peculiar characteristics were noted in the family subsets. The 3D scan images of the outer ear were taken at the same distance in all the subjects. Images of subjects were taken from a distance of 0.5 m. When taking an otoscan, the head of the subject was oriented in the Frankfort horizontal plane and the focal plane of the scanner was parallel to the longitudinal plane of the external ear. The scanner was fixed on a tripod so that it could be elevated to the level of ear of the subject. The images were acquired in daylight. The digital images (figure 1) were transferred into a computer by a universal serial bus (USB) cord. Computer assisted analysis of the ear images were done using AutoCAD software (version 2022).
Overall shape of the ear; shape of the tragus; and shape of the helix were studied. Sex differences were also evaluated in these non-metric characteristics of the ear. The following anthroposcopic/somatoscopic characteristics/features were observed according to a study conducted by Singh and Purkait (2009):
Shape of the ear: Oval, oblique, rectangular, round and triangular (figure 1).
Shape of the helix: concave marginal, normally rolled, flat and wise covering scapha.
Shawpe of the tragus: Double knob, single knob and round.
Ethical clearance was sought from the Research and Ethics Committee of the Delta State University Teaching Hospital, Oghara, Delta State prior to the commencement of this research. Data collection was done between the first day of the month of February and the last day of the month of July in the year 2024.
Data obtained was subjected to Statistical Package for the Social Sciences (SPSS), version 26.0. Results were presented in frequency distribution and cross tabulation. Somatoscopic features of the ears of fathers, mothers and first offspring were categorized. Pinnae morphology of the same side were matched between parents and offspring.

Measurement of agreement was performed by Kappa Coefficient and association by chi-square. Value of agreement or association less than 0.05 was considered statistically significant.

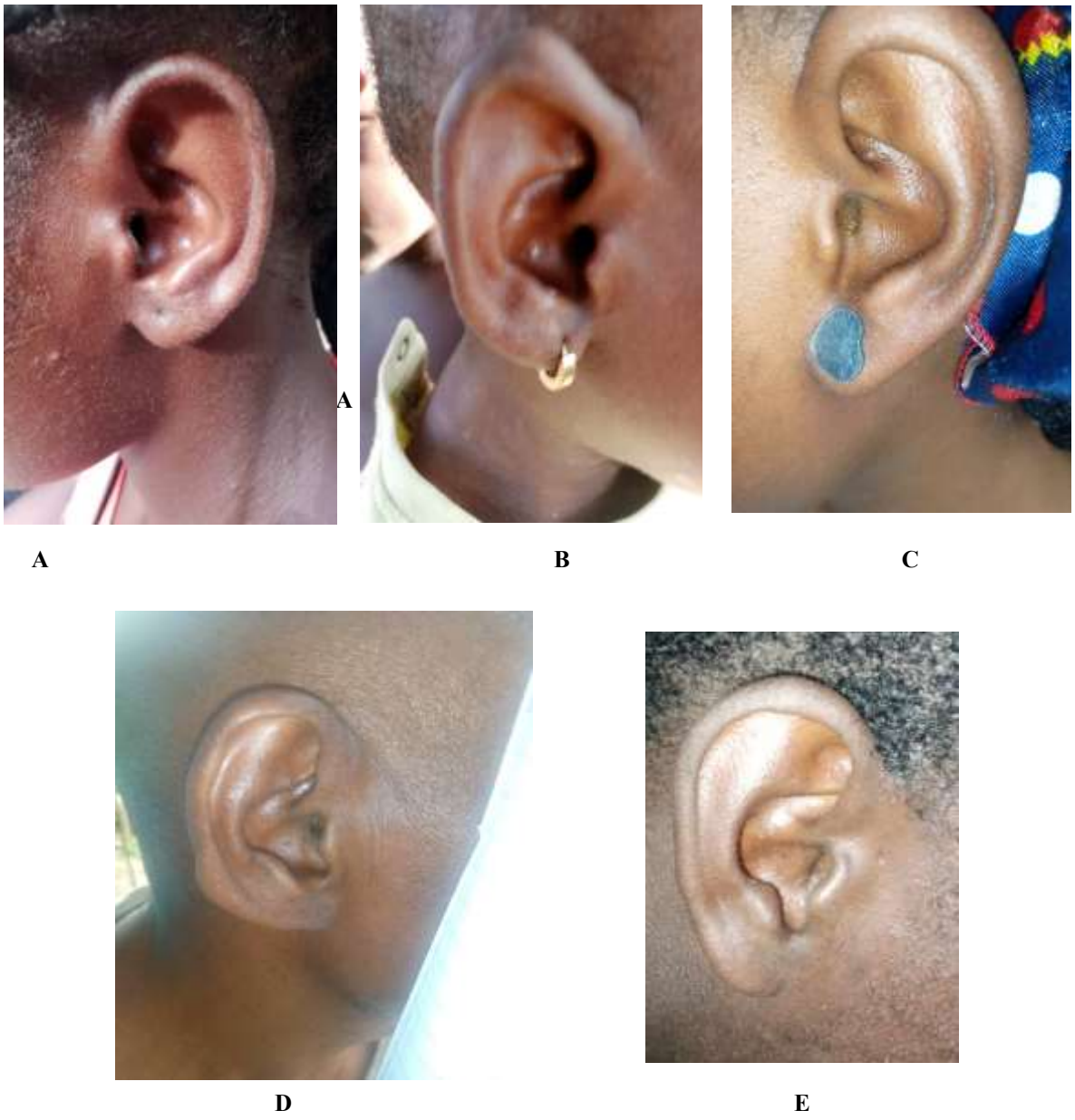

Figure 1: Photographs showing different ear shapes.

A. Round
B. Oblique
C. Oval
D. Rectangular
E. Triangular.

RESULTS

Table 1: Demographic data of the study subjects based on gender.

Gender	Frequency	Percent (%)
Female	200	50.0
Male	200	50.0
Total	400	100.0

Table 1 shows the distribution of the study sample based on gender. Equal number of male and female subjects participated.

Table 2: Shape of the Ear.

Shape of the Ear	Frequency	Percent (%)
Oblique	13	3.3
Oval	297	74.3
Rectangular	18	4.5
Round	58	14.5
Triangular	14	3.5
Total	**400**	**100.0**

Table 2 shows the shape of the ear as observed among the study subjects. Most of the study subjects have oval ears.

Table 3: Shape of the Helix

Shape of the Helix	Frequency	Percent (%)
Concave Marginal	42	10.5
Flat	20	5.0
Normally Rolled	311	77.8
Wide Covering Scapha	27	6.8
Total	**400**	**100.0**

Table 3 illustrates the shape of the helix for the Urhobo subjects scrutinized. The flat helix was rarely seen.

Table 4: Shape of the Tragus

Shape of the Tragus	Frequency	Percent (%)
Double Knob	54	13.5
Round	37	9.3
Single Knob	309	77.3
Total	**400**	**100.0**

Table 4 divulges the shape of the tragus examined. Majority of the tragus have single knob shape.

Table 5: Association of Gender and Shape of the Ear

	Shape of the Ear					
Gender	**Oblique**	**Oval**	**Rectangular**	**Round**	**Triangular**	**P-value**
Female	8	147	8	32	5	
Male	5	150	10	26	9	0.608
Total	**13**	**297**	**18**	**58**	**14**	

Table 5 discloses the association of gender and the shape of the ear**.** Gender variation in the shape of the ear is not significant (p>0.05).

Table 6: Association of Gender and Shape of the Helix

	Shape of the Helix				
Gender	**Concave Marginal**	**Flat**	**Normally Rolled**	**Wide Covering Scapha**	**P-value**
Female	21	8	158	13	
Male	21	12	153	14	0.821
Total	**42**	**20**	**311**	**27**	

Table 6 divulges the association of gender and the shape of the helix**.** Gender variation in the shape of the helix is not significant (p>0.05).

Table 7: Association of Gender and Shape of the Tragus.

	Shape of the Tragus			
Gender	**Double Knob**	**Round**	**Single Knob**	**P-Value**
Female	21	15	164	
Male	33	22	145	0.076
Total	**54**	**37**	**309**	

Table 7 divulges the association of gender and the shape of the tragus**.** Gender variation in the shape of the tragus is not significant (p>0.05).

Table 8: Shape of the Ear Matched Between Father and Daughter.

	Shape of the Ear					X^2	Likelihood Ratio	P-value
Participant	**Oblique (%)**	**Oval (%)**	**Rectangular (%)**	**Round (%)**	**Triangular (%)**			
Father	2 (2)	76 (76)	3 (3)	13 (13)	6 (6)	42.3	26.643	<0.001
Daughter	3 (3)	72 (72)	3 (3)	21 (21)	1 (1)	48		

Table 8 divulges the shape of the ear matched between Father and Daughter. A high likelihood ratio with a highly significant level of agreement (p<0.001) was noted. This means that it is much likely that the shape of the ear is heritable from Father to Daughter.

Table 9: Shape of the Ear Matched Between Father and Son.

	Shape of the Ear					X^2	Likelihood Ratio	P-value
Participant	**Oblique (%)**	**Oval (%)**	**Rectangular (%)**	**Round (%)**	**Triangular (%)**			
Father	2 (2)	76 (76)	3 (3)	13 (13)	6 (6)			
Son	3 (3)	69 (69)	6 (6)	17 (17)	5 (5)	83.426	51.534	<0.001

Table 9 shows the shape of the ear matched between Father and Son. A very high likelihood ratio with a highly significant level of agreement (p<0.001) resulted. This implies that it is much more likely that the shape of the ear is passed from Father to Son.

Table 10: Shape of the Ear Matched Between Mother and Son.

	Shape of the Ear					X^2	Likelihood Ratio	P-value
Participant	**Oblique (%)**	**Oval (%)**	**Rectangular (%)**	**Round (%)**	**Triangular (%)**			
Mother	8 (2)	72 (72)	6 (6)	10 (10)	4 (4)	38.202	30.789	0.001
Son	3 (3)	69 (69)	6 (6)	17 (17)	5 (5)			

Table 10 divulges the shape of the ear matched between Mother and Son. A very huge likelihood ratio with a highly significant level of agreement (p=0.001) emerged. Hence it is very likely that the shape of the ear is passed from Mother to Son.

Table 11: Shape of the Ear Matched Between Mother and Daughter.

	Shape of the Ear					X^2	Likelihood Ratio	P-value
Participant	**Oblique (%)**	**Oval (%)**	**Rectangular (%)**	**Round (%)**	**Triangular (%)**			
Mother	8 (2)	72 (72)	6 (6)	10 (10)	4 (4)	91.1	48.331	<0.001
Daughter	3 (3)	72 (72)	3 (3)	21 (21)	1 (1)	04		

Table 11 divulges the shape of the ear matched between Mother and Daughter. A very large likelihood ratio with a highly significant level of agreement (p<0.001) appeared. Therefore, it is extremely likely that the shape of the ear is passed from Mother to Daughter.

Table 12: Shape of the Helix Matched Between Father and Son.

Participant	Shape of the Helix				X^2	Likelihood Ratio	P-value
	Concave Marginal (%)	Flat (%)	Normally Rolled (%)	Wide Covering Scapha (%)			
Father	8 (8)	9 (9)	75 (75)	8 (8)	68.5	56.308	<0.001
Son	13 (8)	6 (6)	72 (72)	9 (9)	67		

Table 12 discloses the shape of the helix matched between Father and Son. A very high likelihood ratio with a highly significant level of agreement ($p<0.001$) was inferred. Thus, it is likely that the shape of the helix is substantially heritable from Father to Son.

Table 13: Shape of the Helix Matched Between Father and Daughter.

Participant	Shape of the Helix				X^2	Likelihood Ratio	P-value
	Concave Marginal (%)	Flat (%)	Normally Rolled (%)	Wide Covering Scapha (%)			
Father	8 (8)	9 (9)	75 (75)	8 (8)	100.2	65.137	<0.001
Daughter	8 (8)	7 (7)	76 (76)	9 (9)	51		

Table 13 shows the shape of the helix matched between Father and Daughter. A very high likelihood ratio with a highly significant level of agreement ($p<0.001$) was noted. So, it is plausible that the shape of the helix is substantially heritable from Father to Daughter.

Table 14: Shape of the Helix Matched Between Mother and Son.

Participant	Shape of the Helix				X^2	Likelihood Ratio	P-value
	Concave Marginal (%)	Flat (%)	Normally Rolled (%)	Wide Covering Scapha (%)			
Mother	12 (12)	4 (4)	76 (76)	8 (8)	87.874	63.951	<0.001
Son	13 (8)	6 (6)	72 (72)	9 (9)			

Table 14 shows the shape of the helix matched between Mother and Son. A very high likelihood ratio with a highly significant level of agreement ($p<0.001$) was observed. Consequently, it is reasonable that the shape of the helix is substantially heritable from Mother to Son.

Table 15: Shape of the Helix Matched Between Mother and Daughter.

Participant	Shape of the Helix				X^2	Likelihood Ratio	P-value
	Concave Marginal (%)	Flat (%)	Normally Rolled (%)	Wide Covering Scapha (%)			
Mother	12 (12)	4 (4)	76 (76)	8 (8)	87.353	68.773	<0.001
Daughter	8 (8)	7 (7)	76 (76)	9 (9)			

Table 15 shows the shape of the helix matched between Mother and Daughter. A very high likelihood ratio with a highly significant level of agreement ($p<0.001$) was noted. Thus, it is very plausible that the shape of the helix is substantially heritable from Mother to Daughter.

Table 16: Shape of the Tragus Matched Between Father and Son.

Participant	Shape of the Tragus			X^2	Likelihood Ratio	P-value
	Double Knob (%)	Round (%)	Single Knob (%)			
Father	15 (15)	9 (9)	76 (76)	3.807	2.957	0.433
Son	12 (12)	8 (8)	80 (80)			

Table 16 shows the shape of the tragus matched between Father and Son. A likelihood ratio greater than 1 with a non- significant level of agreement ($p=0.433$) was noted. Accordingly, it is not certain that the shape of the tragus is manifestly heritable from Father to Son.

Table 17: Shape of the Tragus Matched Between Father and Daughter.

Participant	Trait			X^2	Likelihood Ratio	P-value
	Double Knob (%)	Round (%)	Single Knob (%)			
Father	15 (15)	9 (9)	76 (76)	16.634	11.244	0.002
Daughter	13 (13)	9 (9)	78 (78)			

Table 17 shows the shape of the tragus matched between Father and Daughter. A large likelihood ratio with a highly significant level of agreement (p=0.002) was logged. Thus, it is unquestionable that the shape of the tragus is noticeably heritable from Father to Daughter.

Table 18: Shape of the Tragus Matched Between Mother and Son.

Participant	Shape of the Tragus			X^2	Likelihood Ratio	P-value
	Double Knob (%)	Round (%)	Single Knob (%)			
Mother	19 (19)	11 (11)	70 (70)	10.723	8.100	0.030
Son	12 (12)	8 (8)	80 (80)			

Table 18 shows the shape of the tragus matched between Mother and Son. A big likelihood ratio with a significant level of agreement (p=0.030) was logged. Thus, it is irrefutable that the shape of the tragus is clearly heritable from Mother to Son.

Table 19: Shape of the Tragus Matched Between Mother and Daughter.

Participant	Shape of the Tragus			X^2	Likelihood Ratio	P-value
	Double Knob (%)	Round (%)	Single Knob (%)			
Mother	19 (19)	11 (11)	70 (70)	18.548	15.290	0.001
Daughter	13 (13)	9 (9)	78 (78)			

Table 19 shows the shape of the tragus matched between Mother and Daughter. A big likelihood ratio with a highly significant level of agreement (p=0.001) was noted. So, it is certain that the shape of the tragus is clearly heritable from Mother to Daughter.

DISCUSSION

This research produced a baseline data on the external ear pattern among the Urhobos of Delta State in Nigeria. The shape of the ear as observed among the study subjects was such that most of the study subjects (297 [74.3%]) have oval ears. Precisely 150 males have oval -type ears while 147 females have oval-type ears. Few subjects have oblique type ears (13 [3.3%]). The Urhobos scrutinized in this research have 58 (14.5%) round ears and 18 (4.5%) rectangular ears. Gender variation in the shape of the ear is not significant (p>0.05). These findings concur with and also differ from the outcomes of the researches of other academicians.

Van der Lugt (2001) scrutinized Dutch males and found them to possess 68.7% of oval-type ears and few rectangular ears (9.1%).[21] The Americans have 65% of oval-type ears in both sexes and few (3%) rectangular ears as reported by Iannarelli (1989).[22] Krishan *et al*., (2019) observed 40–46% of oval-type ears and few (2–9%) rectangular ears. They noted that the males have 22–29% of oblique-type ears.[23] Chattopadhyay and Bhatia (2009) observed that Indian Brahmin males have a high percentage (63.89%) of oblique type ears.[24] Singh and Purkait in their study on the Central Indian population reported 47–52% oval-type ears, 26–30% rectangular type of ears, 26–35% triangular-type ears, and 23–59% round type of ears.[20]

The shape of the helix for the Urhobo subjects scrutinized indicate that the flat helix is rare (20 [5%]). The normally rolled helix is predominant as seen in 311 (77.8) subjects. The concave marginal helix is not common as seen in 42 (10.5%) subjects. The wide covering scapha is the shape of the helix in 27 (6.8%) Urhobos. The outcome of this research is in tandem with that of Farkas (1978) who found 76–79% of normally rolled helix in Americans. However, Krishan *et al*., (2019) saw that half of their subjects (44–51%) possess normally rolled helix.[23] Singh and Purkait (2009) observed 56–60% normally rolled helix in Central Indian subjects.[20]

The outcome of this study (concave marginal helix seen in 42 [10.5%] subjects) differs from the concave marginal helix type found among about 28–48% in the study by Krishan *et al*., (2019).[23] However, the current research is in harmony with the study of Singh and Purkait (2009) who observed concave marginal helix type among 10–11% of their subjects.[20] The North Americans also possess concave marginal helix type uncommonly (25%). The frequency of wide covering scapha was found to be very low in North American males (5.20%) (Farkas, 1978)[25] and Central Indians (6.42%) (Singh and Purkait, 2009)[20]; quite close to the 6.8% observed in the present study.

The shape of the tragus matched between parent and offspring is such that the shape of the tragus is clearly heritable from parent to offspring. Neupane *et al*., (2020) studied different external ear characters among parents and compared with their offspring.They noted that the oval shaped pinnae are the commonest among parents and offspring.Thay also noted that the tragus is the most commonly heritable trait followed by the concha. Their study showed that more than two thirds tragus matched morphologically between parents and offspring.[18]

This current study is also in tandem with that of Purkait (2016) who studied different external ear characters among parents and offspring. Oval shaped pinnae were found to be the commonest among parents and offspring. Tragus was found to be the prevalently matched between parent and offspring. More than two thirds tragus matched morphologically; thus, the tragus is substantially heritable from parent to offspring. [6]

The present study disclosed that the external ear pattern (shape of the ear, shape of the tragus and shape of the helix) are substantially heritable from parents to offspring. This research is in tandem with that of Ordu *et al*., (2014) who affirmed the inheritance of the external ear among Nigerians.[19] The current study reaffirmed the findings of Shihab and Shakir (2023) who did a genetic study of external ear in the Iraq population.[26] An *et al*., (2014) emphasized the genetic predisposition of the external ear pattern.[27] Hays (1943) also affirmed the inheritance of the ears in Rhode Island Reds.[28] Beckman *et al*., (1960) established the heritability of the external ear.[29]

CONCLUSION

The research established baseline data on the external ear pattern among Urhobo subjects. The study highlights the heritability of the external ear pattern. This study affirmed that the external ear pattern is substantially heritable among the Urhobos in Delta State, Nigeria.

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