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ORIGINAL ARTICLE

Phenotypic variations of the human ear in the Basrah population

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ABSTRACT:

Introduction: External ears are distinct and do not alter with age. Ear traits may be as reliable as fingerprints in identifying people. An external ear morphological analysis and observation of Basrah population ear features were undertaken to assess how beneficial the ear is for identification.

Aim: This study gathered comprehensive data on the external ear phenotypic variations in the Basrah population.

Methods: A cross-sectional study of 608 patients aged 7–70 years (308 men, 300 women). Abnormal ears were omitted. Photographs and population statistics were randomly collected.

Results: The predominant ear shape among our population is oval, including 38.7% of males and 42.7% of females. Females predominantly exhibit tongue-type earlobes (44.7%), while males are more likely to possess arched lobes (39.6%). In both genders, the attached earlobe is the second most prevalent ear type, behind the free earlobe (41.2% in males and 60.0% in females). The long variety of the tragus is uncommon, while the knob-shaped variant is more prevalent, seen in 46.8% of males and 51.3% of females. The normal rolled helix is common in both genders. Many individuals in our population lack Darwin's tubercle.

Conclusions: External ear forms vary according to heredity. Despite minor gender and country variations, it is useful in forensics, plastic surgery, and anomaly identification.

KEYWORDS: Basrah population, earlobe attachment, ear shapes, external ear, helix, morphology, variation

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INTRODUCTION

The auditory canal's exterior and auricle form the ear's outer portion, an organ in the human body. By the 38th day following conception, the ear has already begun to develop. On the 56th day of gestation, the ear reaches its final position, and by the 70th, its shape is clear. From birth to death, the ear maintains the same shape [1]. The side of the ear that faces forward is slightly irregularly concave and contains many protrusions and depressions that can contact different sides and create a pattern that looks like a print [2]. Although auricle external shape differs between ethnic groups, morphometric data has been valuable for criminal identification, forensics, and medical diagnosis, just as morphological measurements of the face, iris, fingerprints, footprint, and DNA print havebeen. For identification purposes, the ear stands out due to its physical features such as the helix, lobe, scapha, and tragus [3]. In addition to being an essential anthropological trait for researching ethnic heterogeneity and some inherited disorders in an early period of life, aesthetic considerations include size, type, and spatial position on the face. In addition, the external ear measures provide details about age, race, and gender, making them useful for biometrics, forensics, and personal identification [4]. Males consistently outperform females across every demographic in terms of ear morphology [5], which is a hereditary trait [6]. There is a high correlation between underlying genetic determinants and variations in external ear morphology [7], which includes multiple strong candidate genes with known developmental implications. In his manual system of identifying persons, Alphonse Bertillon included the ear as one of eleven anthropometric measurements in the late nineteenth century [8]. Since then, the ear has previously been utilized as a human-identifying tool. Identical twins can be distinguished from one another using fingerprints and ear prints [9]. Since the ear is less affected by facial rejuvenation, aging, and the use of facial disguises like spectacles and mustaches, it outperforms traditional biometric qualities like facial recognition. As previously shown [10], it is also unaffected by variations in facial expressions. Information about the client's or patient's auricular dimensions according to their age, gender, race, and ethnicity is necessary for reconstructive surgeons to make the proper corrections [11]. Industries looking to improve the ergonomics of earpieces, hearing aids, and other ear appliances might also benefit from normative data on auricular dimensions for various populations [12].

AIM

This study gathered comprehensive data on the external ear phenotypic variations in the Basrah population. Using ear landmarks for sex estimation in forensic ethnic community identification, cosmetic surgery, and industrial applications requires a deeper understanding of the subject and the ability to offer reliable results.

METHODS

A cross-sectional study included 608 participants (308 males and 300 females) aged 7 to 70. The study examined people with normal ears and omitted those with apparent abnormalities. After gaining

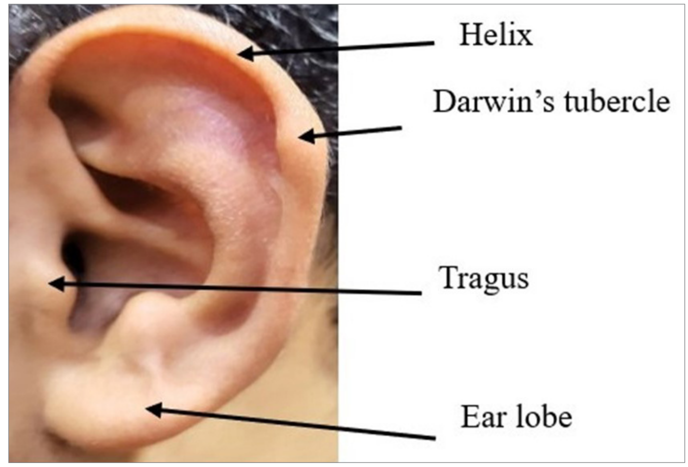

Fig. 1. Morphology and different parts of the ear of a 25-year-old male.

Tab. I. Ear shape in both males and females.

Ear Shape	Male		Female		P-Value (Chi-Squared)
	NO.	%	NO.	%	
Oval	119	38.7	128	42.7	0.125 (5.732)
Rectangular	30	9.7	27	9.0	
Round	90	29.2	64	21.3	
Triangular	69	22.4	81	27.0	
Total	308	100.0	300	100.0	

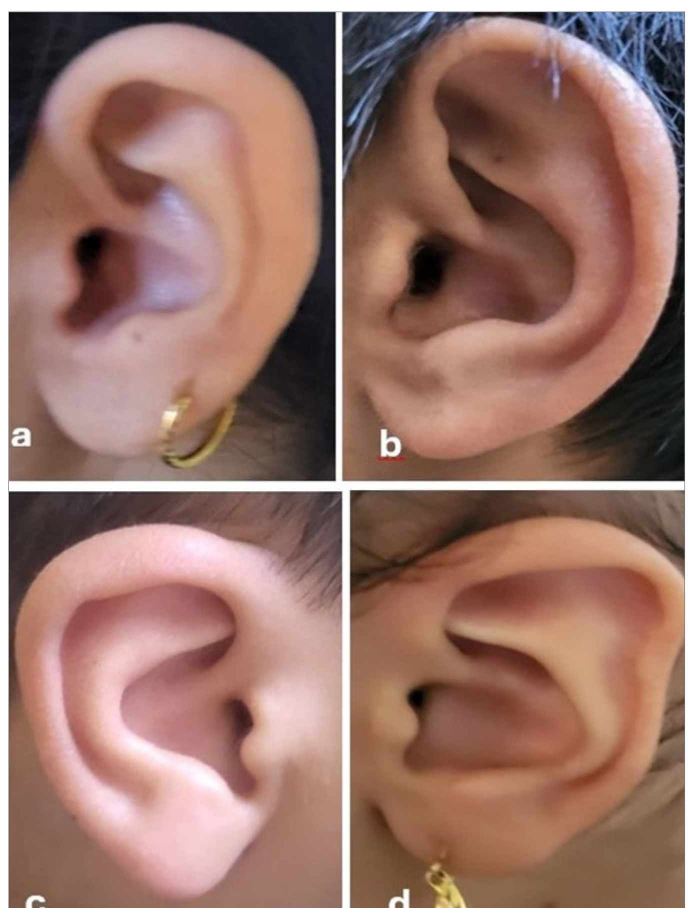

Fig. 2. Ear Shape: (A) 15-year-old female with Oval ear shape; (B) 15-year-old male with Round ear shape; (C) 19-year-old male with Triangular ear shape; (D) 10-year-old girl with Rectangular ear shape.

a written agreement, those were requested to give external ear images. The photos of the subjects were obtained at the same distance (0.5 m) using an Android mobile with a 12-pixel back camera. During photographing, the subject's head was positioned horizontally in the Frankfurt plane, and the camera's focus plane was parallel to the outer ear longitudinal plane. The camera was tripod-mounted and brought to the subject's ear level. The photos were taken in the daytime.

Data were randomly obtained from the Basrah people. The sample size was calculated based on the following equation: Sample size (N) = Z 2 P(1-P)/e2.

According to Singh et al. study, the participants' ears had the physical characteristics shown in (Fig. 1.) [13]:

1. External ear shape;
2. Helix;
3. Tragus;
4. Earlobe shape;
5. Earlobe attachment types;
6. Darwin's tubercles.

Statistical analysis

Chi-square and correspondence analysis were used to evaluate the associations between morphological characteristics with significant values, and Cramer's V test was used to determine their strength. A P-value of ≤ 0.05 was considered statistically significant.

RESULTS

Our study included 608 participants (308 males and 300 females) aged 7 to 70 who had normal ears in the Basrah community. The lack of major differences between genders may be due to ethnic and genetic differences.

Tab. I. shows that oval-shaped ears are more common in the Basrah population in males (38.7%) and females (42.7%), while rectangular ears are the least common. Male ears have a round form (29.2%) more than triangular one (22.4%). Males had a less prominent triangular shape (22.4%) than females (27.0%). In females, the triangular shape is more than round (21.3%). There is no significant statistical difference between the genders in relation to ear shapes as the P = 0.125, as shown in (Fig. 2.).

Tab. II. shows that an earlobe can be arched, tongue, triangular, or square as shown in (Fig. 3.). Males had a higher prevalence of arched earlobes (39.6%), followed by tongue (36.4%), triangular (12.3%), and square (11.7%). Females have a larger predominance of tongue (44.7%), followed by arched shape (30.7%), while triangular and square shapes are equally prevalent (12.3%). There is no significant statistical difference between the genders in relation to earlobe shapes as the P = 0.107.

Tab. III. indicates that the free earlobe is the most prevalent type in both males (41.2%) and females (60.0%). The attached earlobe is more prevalent than the partially attached type in both genders. There is a significant statistical difference between the genders in relation to earlobe attachment as the P <0.001, as shown in (Fig. 4.).

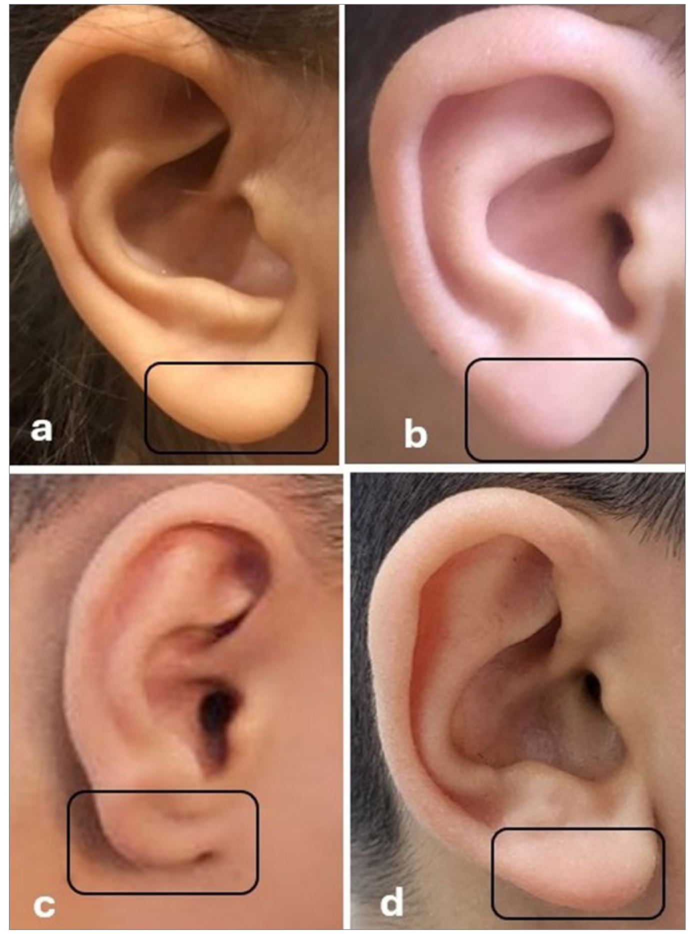

Fig. 3. Shape of the ear lobe: (A) 21-year-old female with Tongue lobe; (B) 19-year-old male with Triangular lobe; (C) 20-year-old male with square lobe; (D) 18-year-old male with Arched lobe.

Tab. II. Earlobe shape in both males and females.

Shape of the earlobes	Male		Female		P-Value (Chi-Squaredd)
	NO.	%	NO.	%	
Arched	122	39.6	92	30.7	0.107 (6.096)
Tongue	112	36.4	134	44.7	
Square	36	11.7	37	12.3	
Triangular	38	12.3	37	12.3	
Total	308	100.0	300	100.0	

Tab. IV. shows the tragus's knob-shaped is more prevalent in both males (46.8%) and females (51.3%), while the long type of tragus is less common in both males and females (19.5% and 14.7%, respectively). There is no significant statistical difference between the genders in relation to earlobe shapes as the P = 0.258, as shown in (Fig. 5.).

Tab. V. demonstrates that the most frequent helix form in both sexes (62.4 and 59.3%, respectively) is normally rolled. The flat shape is less prevalent in both sexes (males 4.2%, females 2.3%); however, females have a higher prevalence of wide-covering scapha (21.3%) than males (13.6%). There is no significant statistical difference

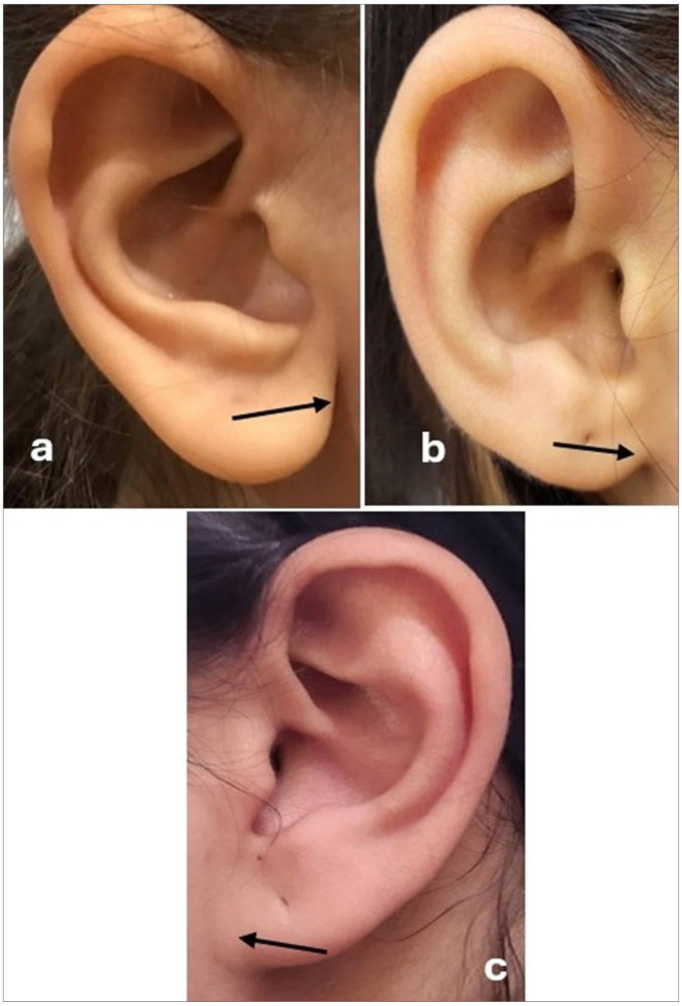

Fig. 4. Earlobe Attachment: (A) Free (21-year-old female); (B) Partially (15-year-old female); (C) Attached (15-year-old female).

Tab. III. Earlobe attachment in both males and females.

Earlobe Attachment type	Male		Female		P-Value (Chi-Squared)
	NO.	%	NO.	%	
Free	127	41.2	180	60.0	<0.0001 (23.604)
Attached	108	35.1	61	20.3	
Partially	73	23.7	59	19.7	
Total	308	100.0	300	100.0	

between the genders in relation to earlobe shapes as the P = 0.053, as shown in (Fig. 6.).

Tab. VI. indicates the absence of Darwin's tubercle range in males (66.5%) and females (62.0%). The enlargement shape is more commonly found in both genders, while the projection kind is less common. There is a significant statistical difference between the genders in relation to earlobe shapes as the P = 0.041 as shown in (Fig. 7.).

DISCUSSION

The findings of our investigation reveal that oval-shaped ears are more common in the Basrah population in both males (38.64%) and females (42.67%), while rectangular ears are the least common.

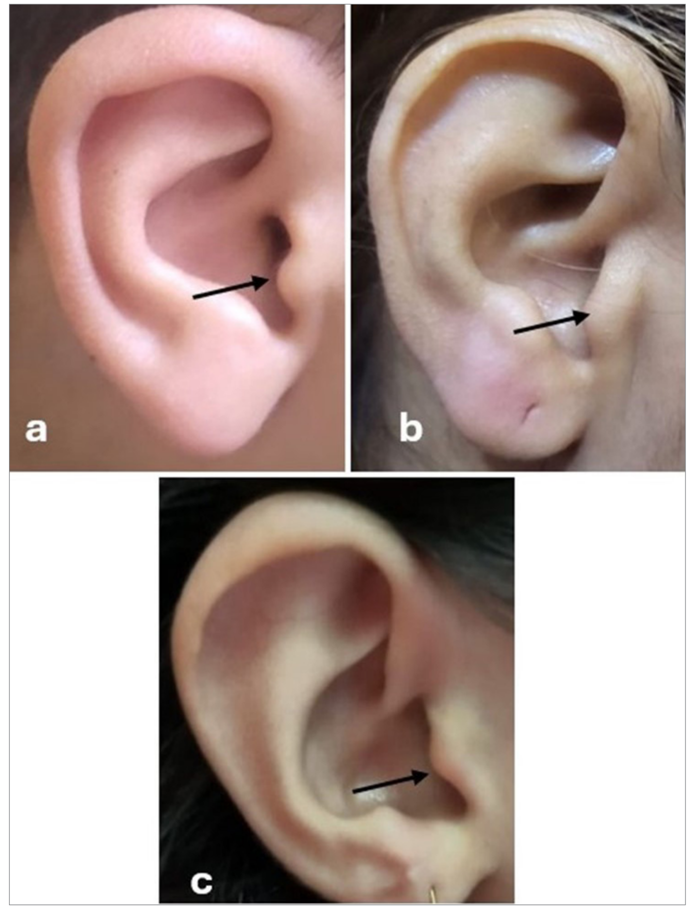

Fig. 5. Ear tragus shape: (A) Round (19-year-old male); (B) Long (29-year-old female); (C) Knob (25-year-old female).

Tab. IV. Ear tragus shape in both males and females.

Ear tragus shape	Male		Female		P-Value (Chi-Squared)
	NO.	%	NO.	%	
Knob	144	46.8	154	51.3	0.258 (2.711)
Long	60	19.5	44	14.7	
Round	104	33.7	102	34.0	
Total	308	100.0	300	100.0	

These findings are consistent with Verma et al., Krishan et al., Sunder et al., Fakorede et al., and Osunwoke et al. [2, 3, 7, 14, 15]. Male ears have a round form (29.22%) more than triangular one (22.40%). Males had a less prominent triangular shape (22.40%) than females (27%), which is consistent with Verma et al., Krishan et al., and Fakorede et al. among Nigerian Hausas [2, 3, 14]. In females, the triangular shape is more than round (21.33%), which agrees with Sunder et al. [7].

The shape of the earlobe differs in the individual showing different features such as arched, tongue, triangular, or square, males had a higher prevalence of arched earlobes (39.61%), followed by tongue (36.36%), triangular (12.34%), and square (11.69%). This is consistent with the findings of Krishan et al. in Himachal Pradesh, North India and Fakorede et al. in the Nigerian population [3, 14]. Females have a larger predominance of tongue (44.67%), followed by arched shape (30.67%), while triangular and square shapes are equally

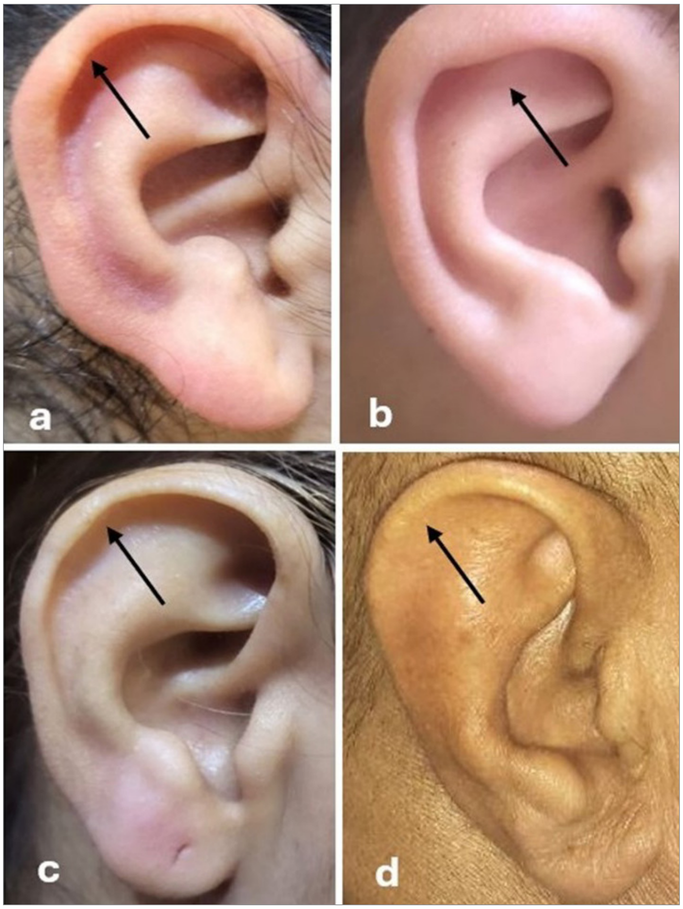

Fig. 6. Ear helix shape: (A) Normally rolled (20-year-old female); (B) Wide covering scapha (19-year-old male); (C) Concave marginal (29-year-old female); (D) Flat (60-year-old male).

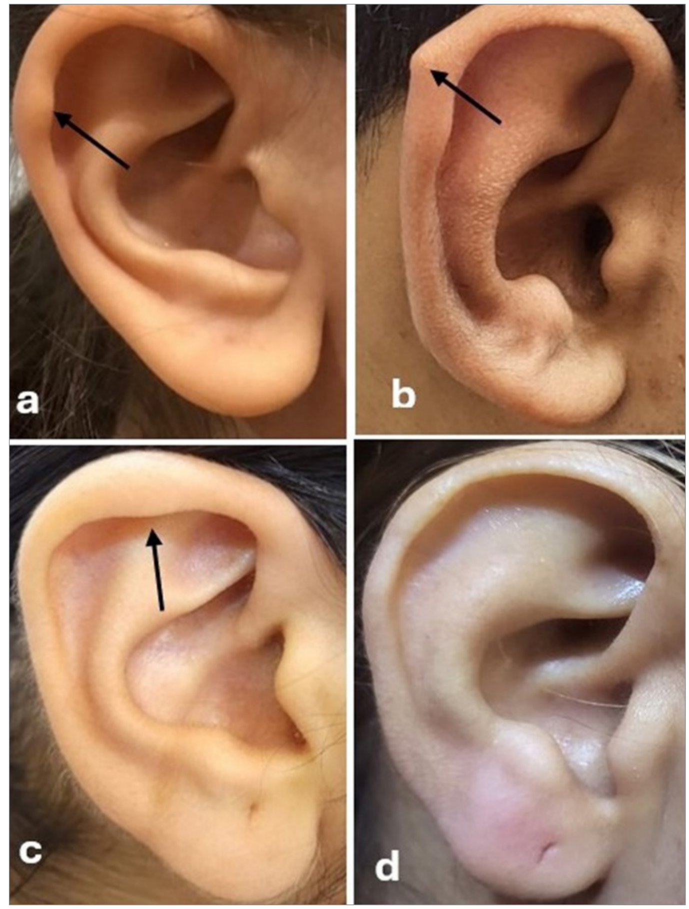

Fig. 7. Forms of "Darwin's tubercle": (A) Projection (21-year-old female); (B) Nodosity (25-year-old male); (C) Enlargement (24-year-old female); (D) Without tubercle (29-year-old female).

Tab. V. Ear helix shape in both males and females.

Ear helix shape	Male		Female		P-Value (Chi-Squared)
	NO.	%	NO.	%	
Concave marginal	61	19.8	51	17.0	0.053 (7.685)
Normally rolled	192	62.4	178	59.3	
Flat	13	4.2	7	2.3	
Wide covering scapha	42	13.6	64	21.4	
Total	308	100.0	300	100.0	

Tab. VI. Frequency of the "Darwin's tubercle" in both males and females.

Darwin's tubercle	Male		Female		P-Value (Chi-Squared)
	NO.	%	NO.	%	
Absent	205	66.5	186	62.0	0.041 (8.267)
Nodosity	35	11.4	30	10.0	
Projection	31	10.1	23	7.7	
Enlargement	37	12.0	61	20.3	
Total	308	100.0	300	100.0	

prevalent (12.33%). When these findings were compared to those from other studies, they differed, potentially due to genetic, ethnic, and geographical factors.

The free earlobe is the most common kind in males (41.23%) and females (60%) and this is documented in Rehman et al. among the population of Punjab, Pakistan [16]. The attached earlobe is more prevalent than the partially attached type, which corresponds to the findings of Fakorede et al. and Kapil et al. in Uttar Pradesh, India [14, 17]. In 1954, Gates observed that the presence of attached earlobes in Africans is a characteristic that can be inherited through a recessive pattern [18], and in 1965, Dutta and Ganguly suggested that ear lobe attachment is a recessive trait [19].

The fact that earlobe attachment is hereditary was recognized by Shaffer et al., and that phenotype is often used as an example of a visible Mendelian trait in textbooks and is still investigated as such in modern primary sources [20]. Due to its continuous phenotypic distribution, earlobe attachment is most likely a polygenic feature, as Wiener 1937 noted [21]. Ebeye et al. found that the variability in genes is present in a wide variety of creatures. Many processes, including natural selection, migration, gene flow, and genetic drift, contribute to the fact that humans possess a wide range of genetic variations. Hereditary traits are a part of human genetics and comprise both dominant and recessive features. While some genes do not follow the Mendelian pattern of inheritance, the vast majority do [22].

The tragus's knob-shaped is more common in both males (46.75%) and females (51.33%), while the long type tragus is less common in both males and females (19.48% and 14.67%, respectively), which is consistent with Krishan et al. in Himachal Pradesh, North India and Fakorede et al. in the Nigerian population [3, 14]. According to a study conducted by Jovevska et al. in 2019, the long form of the tragus is less frequently observed in comparison to the more prevalent knob-shaped variant [23].

The helix has several structures, in the current study the most frequent helix form in both sexes (62.34 and 59.33%, respectively) is normally rolled, which is consistent with Krishan et al. in Himachal Pradesh, North India, Sunder, Neelima in Andhra Pradesh, India, Singh, Purkait in central Indian populations and Fakorede et al. in the Nigerian population [3, 7, 13, 14]. Dharap et al. (1995) also found a predominance of normally rolled helix shapes in the Malaysian population [24]. The flat shape is less prevalent in both sexes (males 4.22%, females 2.33%); however, females have a higher prevalence of wide-covering scapha (21.33%) than males (13.64%), which is consistent with Krishan et al. in North India [4]. In comparison to Singh et al., our findings on the concave marginal shape range in males (19.81%) and females (17%) while in central Indian populations showed a range of 10–11% [13], whereas Farkas 1978 observed a 25% concave marginal shape helix among North Americans [25].

Darwin's tubercle is a crucial structure, found in both males (66.55%) and females (62%).

Although "Darwin's tubercle" is a benign helical structure, the impact of heredity on its expression is uncertain. Additionally, there is conflicting evidence regarding its link with gender and age – Sforza et al. [26]. Our study reveals a different distribution of Darwin's tubercle shapes: the enlargement shape is more commonly found in both genders, while the projection kind is less common, which is consistent with Fakorede et al. in the Nigerian Yoruba population [14].

Other research studies, such as Krishan et al. in North India, and Singh et al. in central Indian communities, indicated that the predominant type is the Nodosity [3, 14], Singh et al., Loh et al. suggested that "Darwin's tubercle" might be specific to each person [13, 27].

Environmental, genetic, and ethnic factors can all contribute to differences in ear appearance among communities, which give the uniqueness of personal identity in particular crimes [28, 29]. The spectrum of differences assists in distinguishing members of geographical areas from one another, where biological evidence gathered at the scene of the crime can be utilized to aid in the investigation [15]. Forensic DNA analysis and variations in ear morphology can be used in certain circumstances where biometric identification methods such as fingerprint or facial recognition are not applicable [14].

A thorough understanding of ear variations aids in the application of plastic procedures and the detection of congenital deformities [2].

The genetic basis has been researched in the most current genome-wide association research by Adhikari et al., which demonstrates that variations in human ear morphology may be connected with the "ectodysplasin A receptor gene". The regulation of the development of skin appendages during embryonic development is an essential role of this gene. Some traits are related to the "T-box protein 15 gene". Understanding related genes can improve the application of genetic tools for familial connection and human identification [30].

CONCLUSIONS

Researchers showed that the Basrah inhabitants exhibited the morphological traits of a typical human external ear. The results showed that the evaluated external ear features vary greatly in shape and appearance among the assessed individuals. The assessed variables' sex categorization accuracy was determined to be inadequate. Therefore, while ear measures may be beneficial in assessing sex, they should not be utilized as the only way of identifying a person.

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