

Sexual Dimorphism Based on Comparative Study of Anthropometric Measurements of External Ear in Indian Population

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Abstract:

Anthropometric measurements are considered to be a significant part while studying physical anthropology. This branch of physical anthropology involves measurements of the human beings in order to understand the physical variations occurred in humans on the basis of measurements of their morphological and physiological traits. External ear morphometric measurement is also an attribute of such anthropological studies which helps in determining the age, gender but also leads to successful identification of an individual.

In the present study also, some physiognomic characteristics of external ear (shape of external ear and variation in ear lobe) along with the morphometric measurements and normal dimensions of total ear length and width (both right and left external ear) are taken from the population of India (North India) comprises of 100 individuals. The sampling procedure involves measurement from both males and females so as to make a comparison in such parameters which helps in determining the gender differences and thereby creates a data which leads to successful sexual dimorphism.

Key Words: *External ear, anthropometric measurements, physical variations, physiognomic characteristics, sexual dimorphism*

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Introduction

The ear is one of the significant feature of the face whose characteristics if studied cautiously proves to be highly unique. The study of ear is known as earology. The uniqueness owes to its external structure and morphology which aids in determining the age and sex of an individual. The uniqueness lies primarily in the morphological features because of the variation in the distinctive characteristics of ear shape, ear lobe shape, type of ear lobe and ear size. These characteristics are highly specific to a person and remains unchanged throughout the life of an individual except the increase in size of ear lobe during adulthood. In humans the features of external ear solely contributes to the identification of an individual and also in doing the gender differentiation (Brucker *et al*, 2003; Chattopadhyay and Bhatia, 2009).

The study of these characteristics is called Otomorphology which can also be defined as the study of physiognomy of the external ear (Singhal *et al*, 2016).

In humans external ear is primarily composed of auricle/pinna and external acoustic meatus, which has been used as one of the parameter for identification extensively (Murgod *et al*, 2013). This auricle is in the form of a trumpet attached to the lateral side of the skull and is directed downwards or forward to catch the sound easily. This auricle is generally made up of a yellow single elastic sheet of fibro cartilage that possesses various undulations (Singhal *et al*, 2016).

The auricle is further characterized by helix which represent to the edge of the ear or at the outermost rim, which begins to form in middle of ear as raised, considered as helix root. This portion is the posterior free margin of the auricle. Another part of the ear is the thick or raised ridge which is upwardly parallel with the helix in center of ear and hence also considered as the inner elevated margin (Landgren, 61-65; Csillag, 2-4).

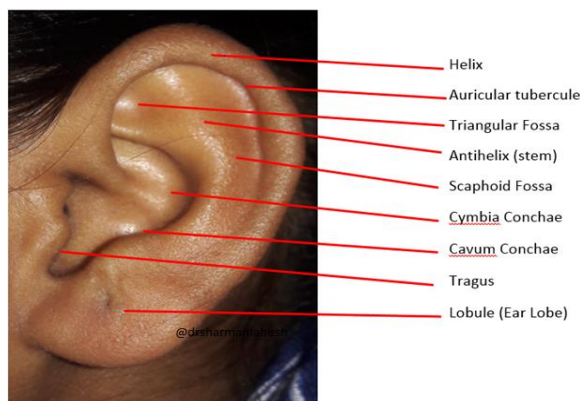


Figure 1 Morphology of External Ear (Original)

The development of ear pinna occurs during fourth to sixth weeks of gestation when the neural crest cells of first and second pharyngeal arches interacts with the surface of the ectoderm lying under these arches. During this time the arches starts developing in the pinna folds and are ready to get shifted on the head at their final position. This pinna or auricle is lined by the skin at its both sides and at its lower portion or at the base it possesses ear lobes or lobules auricular. These are composed of soft, fleshy connective tissues which is covered by the skin and the only part of the ear which is not supported by a cartilage. So, pinna or external ear is collectively composed of cartilaginous framework, connective tissues and muscles which are synthesized from the neural crest cells and head mesoderm respectively and its lateral surface faces slightly forward, irregularly shaped and shows numerous depressions (Kumar and Selvi, 2016; Ordu *et al*, 2014).

It has been studied by Adamson *et al*, (1965) that the growth of the ear occurs to its maximum before 3 years of age i.e. ear has developed up to 85% around this time period and it gets completed and the ear fully develops at the age of 20. After this age only ear lobes or auricle undergoes development due to the gravitational forces and therefore became elongated. The average length of the ear lobes is about 2cm which may vary slightly with the age (Kumar and Selvi, 2016).

These ear lobes show variations in their pattern or arrangement i.e. these may either be directly attached to the lateral side of the head called attached or fused ear lobes or these may be present hanging freely away from the lateral side of the head called as free or detached ear lobes (Ordu *et al*, 2014).

It has been reported by Altman in 1951, that the size and shape of the auricle varies from individual to individual and also in between different races. Also, the studies has been conducted which proves that existence of free ear lobule pattern among individuals is a dominant trait while the occurrence. The detached type is slightly bigger than the attached ear lobe of the attached lobule pattern is recessive trait (Verma *et al*, 2014).

Healthcote *et al*, 1995 in their research presented that the size of the external ear varies according to the ethnic groups and found that the height and width of the ear is greater in males than the females. Similar studies have been conducted on different populations to find the morphological differences in the external

ear of both males and females which provides fruitful results that help in understanding the variations.

As there exists differences in the ear length and breadth because of the variations in the ear dimensions occurred genetically or due to the increment in age the objective of this study is also the same to find out the variations in the external ear parameters of both right and left ear in males and females in order to carried out sexual dimorphism or gender differentiation based on these dimensions. Also, the pattern of ear lobe free or attached in both males and females is studied on the basis of their occurrence so that conclusive findings can be obtained which helps in gender identification among a wide group of individuals or distribution of population.

Materials and Method

Materials- a pair of Vernier Callipers, Pencil, Arm Chair, erasure etc.

Methodology

The study is conducted on Indian population comprises 50 males and 50 females belonging to age group 15-60 years with the use of vernier calliper (least count 0.01mm).

- 1) The subjects are allowed to sit on the chair with their head positioned natural in a way so that the subject is looked straight forward and anthropometric measurements of the external ear (pinna) are taken based on the international standard. The following measurements are taken with the help of vernier calliper.
- a) **Ear length/ height (both right and left ear)** - It is measured as 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. The vernier calliper is placed at the defined points and the measurement is taken in both males and females.

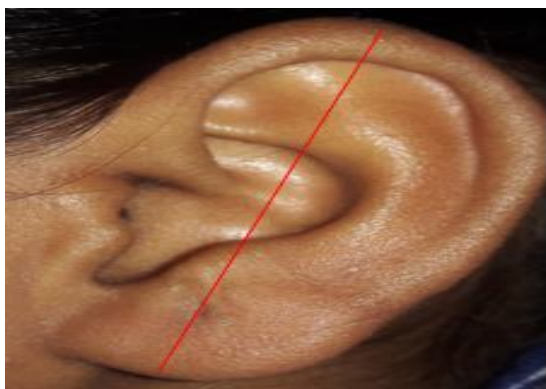


Figure 2- Measurement of Ear Length (Original)

- b) **Ear breadth /width (both right and left ear)** - It is measured as the distance between the most anterior and the most posterior point of pinna. The measurement of the ear breadth is carried out by placing the vernier calliper on the defined points and recording of the reading in both males and females.



Figure 3- Measurement of Ear Breadth (Original)

- 2) The sampling procedure starts with the measurement of ear length first followed by the width and after these morphometric measurements the shape of the external ear along with the pattern of ear lobe free or attached is also observed and noted in both males and female ears.
- 3) The successful completion of the sampling is proceeded by recording the entire measurement data in a tabular form. A separate table for both males and females is prepared comprises the details of both right and left ear measurement.
- 4) The data collected is then studied statistically by determination of the mean and standard deviation for each measurements i.e. length and breadth of both right and left ear in both the genders.
- 5) At the last the data obtained for the occurrence of type of ear lobe pattern is then analysed for determining the maximum percentage of occurrence of both the patterns of ear lobe pattern in both males and females.
- 6) All the data collected and analysed helped in finding the differences in the gender on the basis of variation in measurable and observable parameters.

Results

In the present study conducted on the 100 samples of Indian Population (North India) the results provides valuable data related to the morphology of ear. The results obtained shows that there occurs variation in

the length of both right and left ear in both the genders which is tabularized below.

Table no. 1- Comparison of Length of Right and Left Ear in both Genders

Gender Distribution	Right Ear Length (Mean)	Left Ear Length (Mean)	Standard Deviation of Right Ear Length	Standard Deviation of Left Ear Length
Males	6.55	6.30	0.63	0.56
Females	6.1	5.92	0.47	0.48

In the table first quadrant shows the Mean of the length measurements of Right Ear in males and females i.e. 6.55 (For Males) and 6.1 (For Females), second quadrant shows the Mean of the length measurements of Left Ear in males and females i.e. 6.30 (for males) and 5.92 (for females). In the third quadrant standard deviation of the right ear length for both males and females is shown i.e. 0.63(for males) and 0.47(for females) and in the fourth quadrant also the standard deviation of the left ear length for both males and females is shown as 0.56(for males) and 0.48(for females) is shown.

The same results are shown with the help of a bar graph which shows variations in the length of right and left ear in both males and females.

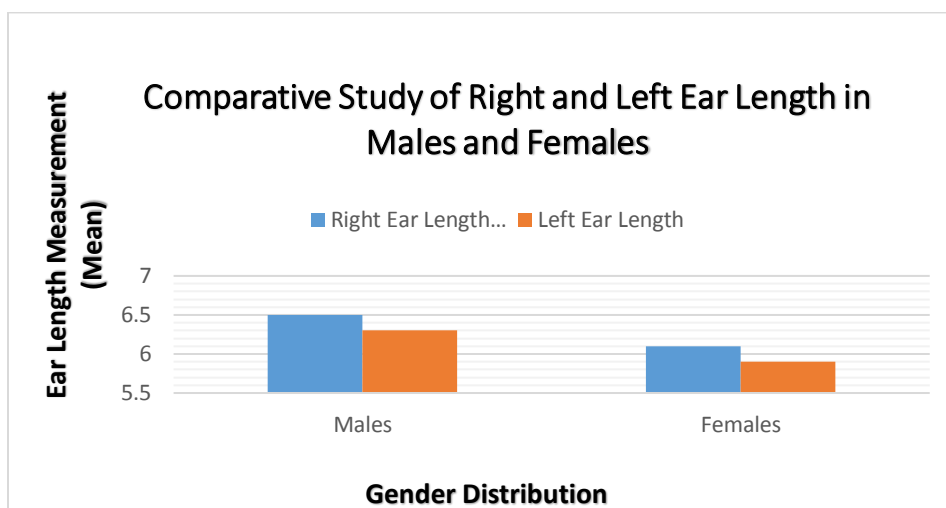


Figure 4- Graphical Representation showing Comparative Study of Right and Left Ear Length in Males and Females

Apart from the variations in length the present study also highlights the variations occurred in the ear breadth (in both right and left ear) in both males and females that have been tabularized below.

Table no. 2- Comparison of Breadth of Right and Left Ear in both Genders

Gender Distribution	Right Ear Breadth (Mean)	Left Ear Breadth (Mean)	Standard Deviation of Right Ear Breadth	Standard Deviation of Left Ear Breadth
Males	3.03	3.03	0.38	0.35
Females	2.81	2.89	0.48	0.36

The table above shows that data in the first quadrant represents the Mean of the breadth measurements of Right Ear in males and females i.e. 3.03(For Males) and 2.81(For Females), while the second quadrant shows the Mean of the breadth measurements of Left Ear in males and females i.e. 3.03 (for males) and 2.89 (for females). In the third quadrant standard deviation of the right ear breadth for both males and females is shown i.e. 0.38 (for males) and 0.48(for females) and in the fourth quadrant also the standard deviation of the left ear breadth for both males and females is shown as 0.35 (for males) and 0.36 (for females) is shown.

The same results are shown with the help of a bar graph which shows slight variations in the breadth of right and left ear in both males and females.

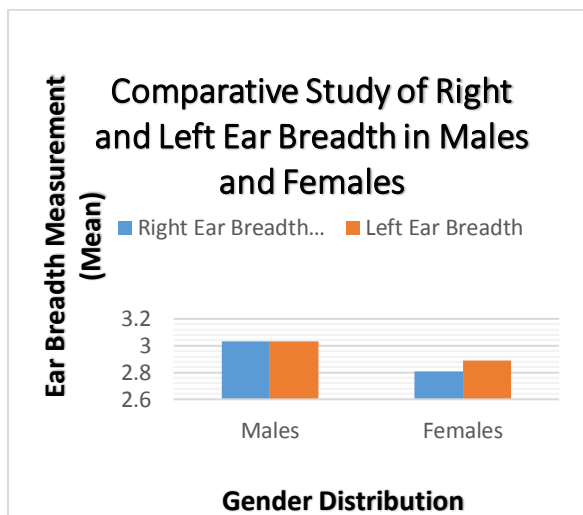


Figure 5- Graphical Representation of Comparative Study of Right and Left Ear Breadth in Males and Females

After finding variations in both the length and breadth of the ear measurements the pattern of ear lobe is studied and on the basis of the data prepared the percentage of occurrence of each free and attached type is determined in both males and females and depicted in the bar graph.

Table no. 3- Comparison of Ear Lobe Pattern in Both Genders

Percentage of Occurrence	Ear Lobe Pattern	
	Free	Attached
Males	33 (66%)	17 (34%)
Females	19 (38%)	31 (62%)

The table shows a comparative study of the type of ear lobe pattern in both males and females based on the maximum percentage of occurrence.

In the table above the first quadrant shows the percentage of occurrence of free ear lobe pattern in males i.e. 66% in females i.e. 38% while the second quadrant shows the percentage of occurrence of attached ear lobe pattern in both genders i.e. 34% in males and 62% in females.

The same results are depicted in bar graph showing that the percentage of occurrence of free ear lobe in males is more as compared to attached ear lobe pattern i.e. 66% of males in the present study are having free

ear lobe and only 34% of them is having attached ear lobe. Similarly, the frequency of females with attached ear lobe in this study is more i.e. 62% in comparison to those having free ear lobe as the rate is very low only 38%.

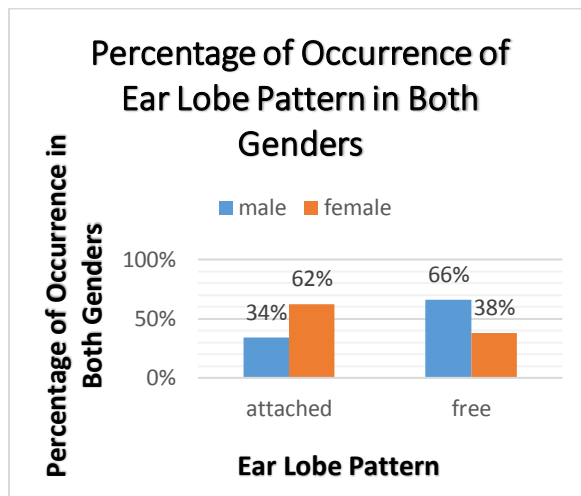


Figure 6- Graphical Representation showing Percentage of Occurrence of Ear Lobe Patterns in Both Genders

Based on the above study it is concluded that in the study the rate of occurrence of free ear lobe pattern is more in males (i.e. 66%) in comparison to females and the pattern of attached ear lobe is more in females (i.e. 62%) than in males.

Discussion

Human ear being a characteristic feature of face, helps in determination of age and sex of an individual based on the various parameters of external ear or pinna. In the present study it is determined that there occurs variations in the ear dimensions both of right and left ear in males and females respectively. The length and breadth of male ear is found to be greater than the female ear. Several studies have shown that there are differences in the ear size in both the genders and these are higher in males in comparison to females.

Healthcote *et al*, 1995 in their research presented that the size of the external ear varies according to the ethnic groups and found that the height and width of the ear is greater in males than the females and therefore in all the parameters men have larger ear then women. They also mentioned that the length and width of the ears increases with the increment of age.

Ferrario *et al*. 1999 worked on the population of Italy comprises individuals with in the age group of adolescence to mid adulthood and found that significant differences occurred in the ear dimensions of males and females. Like in males the width of the

ear males is greater than that of the females and also the mean length of ear in males is significantly higher than those of females.

Ito *et al*, 2001 have studied the morphological changes that have occurred in the adult human ear with the age shows a significant increase in the size in both men and women because the elastic fibers of human auricular cartilage undergoes development.

Brucker *et al*, 2003 in their study found that significant sex related differences occurred in the height or length of the external ear or pinna as this parameter is found to be larger in males than females by 6.5 % while only slight variations occurred in the width or breadth of right and left ears in both the genders. This difference occurs because of the expansion of the ear auricle which starts earlier in males than in males.

According to Shireen and Vrushali, 2005 there occurs differences in the external ear dimensions based on the morphometric measurements of external ear conducted on different population which showed the proof of existence of sexual dimorphism.

Murgod *et al*, 2013 in their study concluded that the external ear parameters shows variations in the length of ear in both males and females and the results of the mean length obtained are higher in males than those of females. They also suggested that the above results provides moderate to good (69–71%) sex assessment accuracy, which is considered as a useful parameter for estimation of sex in Indians.

Kumar and Selvi, 2016 in their study concluded that there occurs differences in the total ear length, width,

length of cartilaginous ear and ear lobe length in Indian males and females and these parameters are higher in males than that of females. These variations in gender might occurs because of the influence of genetic factors which vary with sex.

The results obtained in the present study shows that the external ear parameters vary in both the genders i.e. there occurs differences in the measurements of mean length and breadth of both right and left ear in males and females. The study also reveals that these parameters are larger in males than in females. Apart from these features the occurrence of the pattern of ear lobe also shows variation in both the genders as it is observed that there is high frequency of occurrence of free ear lobe pattern in males i.e. 66% while the frequency of occurrence of attached ear lobe pattern is found to be greater in females i.e. 62%. This shows that majority of males possesses free ear lobe while females are found to have attached ear lobes.

Conclusion

The results of present study shows variations in the measurement of ear dimension with higher mean value of ear parameters in males than the females and also the occurrence of free ear lobe pattern is dominant in males and attached type pattern is dominant in females. These results of variation in the morphometric measurements and the distribution pattern of ear lobe of external ear helps in doing the successful gender identification and differentiation based on sexual dimorphism...

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