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SEX DETERMINATION USING ANTHROPHOMETRIC MEASUREMENTS OF THE HUMAN EXTERNAL EAR IN CHENNAI POPULATION

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INTRODUCTION: The human external ear, including the auricle (pinna) and the external auditory canal, is valuable in forensics. External ear: Its unique parameters can be used for identification through ear measurements. These features make the external ear useful for identifying individuals and collecting forensic evidence.

OBJECTIVE: This current study, objective is to find out that with the help of the ruler (in cm) is possible to differentiate the person by measuring their outer ear's parameter variations, also to determine their sex with the these measurements.

METHODOLOGY: The present study consists of 100 participant of 50 male and 50 female. The external ear measured using the ruler in cm. The sample universe for this study is Chennai population age group of 20-25 years. For statistical analysis SPSS software were used.

RESULT: According to the current study, there is a significant variation of parameters among both the sexes of participant. Additionally as expected, the uniqueness in the variations of parameters from each participant.

CONCLUSION: The study has successfully demonstrated that the variations in outer ear parameters offer a reliable and effective additional method of individual identification. In future and with reference to the articles these findings in this field suggests that ear biometrics could be integrated into existing security systems to enhance identification processes, confirming the potential of outer ear measurements as a valuable tool in the field of forensic science and personal security technologies.

KEYWORDS: Ear measurements, Anthropometric measurements, Ear evidence

INTRODUCTION: The human ear is a complex and fascinating organ essential for hearing and balance. It can be divided into three main parts: the outer, the middle, and the inner. Each sections plays a crucial role in processing sound and maintaining equilibrium. Measurements of the outer ear provide valuable evidence in various fields, including anthropology, forensic science, and medicine. These measurements can reveal differences in ear shape and size across populations, and aid in diagnosing certain medical conditions. In forensic investigations, detailed measurements of the outer ear can be used to identify individuals. The unique contours and dimensions of the person ears, much like fingerprints, can be critical in solving crimes or identifying bodies.

In the study, (Vijay Laxmi) the mean values of various measurements of the right and left ears were determined to provide information about sex-related dimensions of the ear and the symmetry between the left and right sides. The study was conducted using 100 samples from the medical college in Amritsar, comprising 50 males and 50 females aged between 18 and 25 years. All ear parameters were measured using a standard digital vernier caliper.

This study aimed to establish a precise and reproducible protocol for identifying anthropometric features and measuring biometric parameters of the ear. Fourteen subjects were recruited from the students of the Faculty of Biology, University of Bucharest, aged between 20 and 25. Anthropometric measurements were conducted using the photogrammetry method, an indirect measurement approach. Statistical analysis was performed using SPSS V19.0. It was concluded that among the linear dimensions measured at the ear, the lobular width and the intertragic distance showed the greatest variability. Conversely, the physiognomic length and the morphological length of the ear were the least variable dimensional parameters. The linear dimensions of the left ear were found to be slightly larger than those of the right ear. (PETRESCU, 2018)

METHODOLOGY & PROCEDURE

In this chapter, discussed about the entire research procedure includes the aim, objectives, materials required for the research, sampling technique and other details related to this current study.

AIM:

The main of the study is to differentiate between the sexes with the help of the anthropometric measurements of the external ear of the human and also for the personal identification.

PROBLEM STATEMENT:

Even though there are other methods to identify and individualize the person, this will be used as a corroborative evidence if, other methods is unable to attain at the scene of the crime. To aid in the field of bio metrics as ear measurements will contribute more to the face structure recognition. Here in this locality there's only limited study based on this topic.

OBJECVTIVE:

This current study, objective is to find out that with the help of the ruler (in cm) is possible to differentiate the person by measuring their outer ear's parameter variations, also to determine their sex with the these measurements.

PURPOSE OF THE STUDY:

Main purpose of this study is to establish the ear as the one of the evidence and as the identification tool for individualizing the person.

SAMPLE UNIVERSE:

The participant of the current study was the people, who live in the Chennai.

SAMPLE SIZE:

Total of 100 participant data was used in this current study, in that which consists of 50 males and 50 females of the 20-25 of age groups.

SAMPLING METHOD:

This current study uses the simple and random sampling technique.

MATERIALS REQUIRED:

15cm Ruler (which is used to measure the parameters of the both the ears of the participants), Hand gloves.

PROCEDURE:

The present study is consists of 100 participant of the age group between 20-25 of years, which consists of 50 females and 50 males. So, the sample we'll obtain will be 200, 100 from left ear and 100 from right ear. The participant is explained about the procedure and the purpose of the study. With the concerned of the participant the parameter of the ear is measured.

- Hand gloves were worn throughout the procedure.
- The participant is seated in a comfortable position of their choosing.
- The participant is instructed to relax.
- For female participants, earrings are removed prior to the procedure.
- Total ear length is measured by placing the ruler from the topmost point of the upper auricle to the lowest point of the lobe.
- Total ear width is measured by placing the ruler from the edge of the tragus to the helix.
- Lobular length is measured by placing the ruler from below the antitragus part to the lowest part of the lobe.
- The width of the lobe is measured horizontally by placing the ruler on the lobular part.

For each the participant the measurement is rechecked for the accuracy of the data, the following parameters of external ear were taken with reference (Vijay Laxmi, 2017)

1. Total ear length: Uppermost point of pinna to the lowest point of lobule.
2. Ear width: From root of the ear to maximum convexity of the helix
3. Ear index: Ear width/ ear length x 100
4. Lobular length: From the most caudal attachment of the ear to the head to the caudal extension of the ear lobe free margin.
5. Lobule width: From the most caudal attachment of the ear lobule to the head and to the outer most maximum transverse width of the ear lobule.
6. Lobule index: Lobular width/ lobule length x 100

EXCLUSION CRITERIA:

- The participants born with ear deformities.
- Those with piercings covering the entire ear.
- Participants with accidental or burn scars on the ear.
- Male participants, who wear ear studs.

ANALYSIS:

This current study uses the SPSS for the statistical analysis part. The correlation of bivariate is used to analyse the obtained parameters.

DATA ANALYSIS

CORRELATION OF THE BOTH THE SEXES

Table 1:

	Mean	Std. Deviation	N
EIL	48.811206392194070	5.205075708769344	100
LIL	156.975141434932480	28.877841292181056	100
EIR	49.360951496290156	4.304852256357949	100
LIR	154.008689324091850	28.909300424269635	100

Table 1 shows the descriptive statistic of the Ear index and the lobular index of the both the sexes.

Table 2:

		EIL	LIL	EIR	LIR
	Pearson Correlation	1	.425**	.716**	.337**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	100	100	100	100
	Pearson Correlation	.425**	1	.210*	.668**
	Sig. (2-tailed)	<.001		.036	<.001
	N	100	100	100	100
	Pearson Correlation	.716**	.210*	1	.218*
	Sig. (2-tailed)	<.001	.036		.029
	N	100	100	100	100
	Pearson Correlation	.337**	.668**	.218*	1
	Sig. (2-tailed)	<.001	<.001	.029	
	N	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2 shows the correlation of between the Ear index and Lobular index of the both sides of the ear of male and female. The correlation between the Ear index and lobular index is significant at the level of 0.05.

Table 3:

	Mean	Std. Deviation	N
TELL	6.036	.4414	100
TELR	6.059	.4102	100

Table 3 shows the descriptive statistics of the Total ear length of the both the sides.

Table 4:

		TELL	TELR
	Pearson Correlation	1	.929**
	Sig. (2-tailed)		<.001
	N	100	100
	Pearson Correlation	.929**	1
	Sig. (2-tailed)	<.001	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 shows the correlation between the Total ear length of both the side of ear of the both the sexes. Correlation of the Total ear length of the both side is significant at level of <0.001.hence, it is highly significant.

Table 5:

	Mean	Std. Deviation	N
TEWL	2.937	.3017	100
TEWR	2.984	.2612	100

Table 5 shows the descriptive statistics of the Total ear width of the both sides of the ear.

Table 6:

		TEWL	TEWR
	Pearson Correlation	1	.764**
	Sig. (2-tailed)		<.001
	N	100	100
	Pearson Correlation	.764**	1

Sig. (2-tailed)	<.001	
N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6 shows the correlation of the Total width of the both sides of the ear of both the sexes. The correlation of the total width of the both sides of the ear is highly significant at the level of <0.001.

Table 7:

	Mean	Std. Deviation	N
LLL	1.388	.2350	100
LLR	1.349	.2181	100

Table 7 shows the descriptive statistics of the Lobular length of the both sides of the ear.

Table 8:

	LLL	LLR
Pearson Correlation	1	.792**
Sig. (2-tailed)		<.001
N	100	100
Pearson Correlation	.792**	1
Sig. (2-tailed)	<.001	
N	100	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8 shows the correlation of the between the Lobular length of both sides of the ear of both the sexes. The p value of the both sides is <0.001. hence, it is highly significant.

Table 9:

	Mean	Std. Deviation	N
LWL	2.124	.2179	100
LWR	2.034	.2764	100

Table 9 shows the descriptive statistics of the both sides of the ear.

Table 10:

		LWL	LWR
	Pearson Correlation	1	.590**
	Sig. (2-tailed)		<.001
	N	100	100
	Pearson Correlation	.590**	1
	Sig. (2-tailed)	<.001	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10 shows the correlation between the Lobular width of the both sides of the ear of both the sexes. The p value of the width of Left and right is <0.001. hence, it is highly significant.

CORRELATION OF FEMALE

Table 11:

	Mean	Std. Deviation	N
EILF	49.709949141971170	4.800893163365202	50
LILF	157.500154446516750	27.270023128720247	50
EIRF	50.030688194843854	4.100182515683065	50
LIRF	147.896877958642680	25.755152113636115	50

Table 11 shows the descriptive statistics of the Ear index and the Lobular

Index of the both sides of the ear.

Table 12:

		EILF	LILF	EIRF	LIRF
	Pearson Correlation	1	.278	.699**	.286*
	Sig. (2-tailed)		.050	<.001	.044
	N	50	50	50	50
	Pearson Correlation	.278	1	.134	.602**
	Sig. (2-tailed)	.050		.354	<.001
	N	50	50	50	50
EIRF	Pearson Correlation	.699**	.134	1	.200
	Sig. (2-tailed)	<.001	.354		.164
	N	50	50	50	50
LIRF	Pearson Correlation	.286*	.602**	.200	1
	Sig. (2-tailed)	.044	<.001	.164	
	N	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 12 shows the correlation between the Ear index and the lobular index of the both sides of the ear. The p value of correlation is significant at the level of 0.05.

Table 13:

	Mean	Std. Deviation	N
TELLF	5.834	.3685	50
TELRF	5.882	.3474	50

Table 13 shows the descriptive statistics of the female participant total ear length of both sides.

Table 14:

		TELLF	TELRF
	Pearson Correlation	1	.864**
	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.864**	1
	Sig. (2-tailed)	<.001	
	N	50	50

Table 14 shows the correlation between the left and right ear's total length of the female participants. The p value of correlation is <0.001.So, it is highly significant.

Table 15:

	Mean	Std. Deviation	N
TEWLF	2.892	.2562	50
TEWRF	2.936	.2202	50

Table 15 shows the descriptive statistics of the female participant's ear width of left and the right.

Table 16:

		TEWLF	TEWRF
TEWLF	Pearson Correlation	1	.736**
	Sig. (2-tailed)		<.001
	N	50	50
TEWRF	Pearson Correlation	.736**	1
	Sig. (2-tailed)	<.001	
	N	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 16 shows the correlation value of the ear width is at <0.001. So, it is highly significant.

Table 17:

	Mean	Std. Deviation	N
LLLF	1.372	.2031	50
LLRF	1.354	.1982	50

Table 17 shows the descriptive statistics of the lobular length of the female participant ear.

Table 18:

		LLLF	LLRF
	Pearson Correlation	1	.743**
	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.743**	1
	Sig. (2-tailed)	<.001	
	N	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 18 Shows the p value is <0.001. So, it is highly significant.

Table 19:

	Mean	Std. Deviation	N
LWLF	2.118	.2210	50
LWRF	1.972	.2843	50

Table 19 shows the descriptive statistics of lobular width of both sides of ear of the female participant.

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Table 20:

		LWLF	LWRF
	Pearson Correlation	1	.518**
	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.518**	1
	Sig. (2-tailed)	<.001	
	N	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 20 shows that the p value is <0.001. So, it is highly significant.

CORRELATION OF MALE

Table 21:

	Mean	Std. Deviation	N
EILM	47.912463642417010	5.481014475039562	50
LILM	156.450128423348270	30.670208996680888	50
EIRM	48.691214797736420	4.440135778823949	50
LIRM	160.120500689540960	30.805687413843850	50

Table 21 shows the descriptive statistics of the male participant ear index and lobular index.

Table 22:

		EILM	LILM	EIRM	LIRM
EILM	Pearson Correlation	1	.546**	.716**	.464**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	50	50	50	50
LILM	Pearson Correlation	.546**	1	.273	.753**
	Sig. (2-tailed)	<.001		.055	<.001
	N	50	50	50	50
EIRM	Pearson Correlation	.716**	.273	1	.307*
	Sig. (2-tailed)	<.001	.055		.030
	N	50	50	50	50
LIRM	Pearson Correlation	.464**	.753**	.307*	1
	Sig. (2-tailed)	<.001	<.001	.030	
	N	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 22 Shows the correlation of the ear index and lobular index of the male participant.

Table 23:

	Mean	Std. Deviation	N
TELLM	6.238	.4179	50
TELRM	6.236	.3942	50

Table 23 shows the descriptive statistics of the male participant total ear length.

Table 24:

		TELLM	TELRM
	Pearson Correlation	1	.948**
	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.948**	1
	Sig. (2-tailed)	<.001	

N	50	50

**. Correlation is significant at the 0.01 level (2tailed).

Table 24 shows the correlation of the total ear length of left and right of male participant. The value shows that it is highly significant.

Table 25:

	Mean	Std. Deviation	N
TEWLM	2.982	.3379	50
TEWRM	3.032	.2910	50

Table 25 shows descriptive statistics of total ear width of male participants.

Table 26:

	TEWLM	TEWRM
Pearson Correlation	1	.770**
Sig. (2-tailed)		<.001
N	50	50
Pearson Correlation	.770**	1
Sig. (2-tailed)	<.001	
N	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 26 shows the correlation of the ear width of male participant. The p value is <0.001 it is highly significant.

Table 27:

	Mean	Std. Deviation	N
LLLM	1.404	.2642	50
LLRM	1.344	.2383	50

Table 27 shows the descriptive statistics of the lobular length of the male participant.

Table 28:

	LLLM	LLRM
Pearson Correlation	1	.830**

	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.830**	1
	Sig. (2-tailed)	<.001	
	N	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Table 28 shows the correlation of lobular length of male participant. The value of p is <0.001. So, it is highly significant.

Table 29:

	Mean	Std. Deviation	N
LWLM	2.130	.2169	50
LWRM	2.096	.2563	50

Table 29 shows the descriptive statistics of the lobular width of the male participant.

Table 30:

		LWLM	LWRM
	Pearson Correlation	1	.692**
	Sig. (2-tailed)		<.001
	N	50	50
	Pearson Correlation	.692**	1
	Sig. (2-tailed)	<.001	
	N	50	50

**. Correlation is significant at the 0.01level (2tailed).

Table 30 shows the correlation of the lobular width of the male participant ear. Which, is at <0.001, it is highly significant.

RESULT & DISCUSSION

According to the current study, there is a significant variation of parameters among both the sexes of participant. Additionally, as expected, the uniqueness in the variations of parameters from each participant.

DISCUSSION

The range of the TEL on the right side was found to be 5.1-6.5 cm in females and 5.3-7.2 cm in males. The same when compared to the left side was found to be 5.2-6.5 cm in females and 5.5-7.1 cm in males. It was observed that left side of the ear is greater compared to the right side of the ear. Also observed that left side ear of male is greater than to females. The range of the TEW on the right side was found to be 2.5-3.4 cm in females and 2.1-3.7 cm in males. The same when compared to the left side was found to be 2.1-3.4 cm in females and 2-3.7 cm in males. It was observed that the width of the right side of male was greater compared to the females. The LH in males varied from 0.9-2.1 cm on the left side and 0.9-1.9 cm on the right side of the ear. In, females it ranges from 0.9-2 cm on left side and 0.9-2.2 cm on the right side of the ear. It was observed that the lobular length of female ear is greater compared to the males. The LW in males ranges from 1.6-2.7 cm on the left side and 1.1-2.5 cm on the right side of the ear. In, females it ranges from 1.7-2.9 cm on the left side and 1.6-3 cm on the right side of the ear. It was observed that the lobule width of the female was greater than to males

The research discourse (Verma Kapil, 2014) emphasizes a pivotal aspect often side lined in existing literature: the need for a thorough examination of ear position variations. Despite its fundamental importance in identification protocols, studies on this subject remain notably scarce. This scarcity underscores a critical gap in our understanding of the intricate nuances of ear morphology and its implications for forensic science. By expanding the focus to include detailed analyses of ear positioning, the efficacy and accuracy of identification procedures can be significantly bolstered. Such an endeavour holds profound implications for forensic anthropology, where the ability to precisely discern individual traits can be the difference between a successful identification and an inconclusive outcome. Moreover, a comprehensive exploration of ear position variability not only enhances the scientific rigor of forensic investigations but also underscores the interdisciplinary nature of modern forensic science. Collaborative efforts between researchers, practitioners, and technologists are imperative in advancing our understanding of ear morphology and its forensic applications. Therefore, it is evident that a concerted effort to gather robust data on ear position, alongside other morphological features, is indispensable in refining identification methodologies.

Through meticulous research and collaboration, a path toward more reliable and scientifically sound forensic practices can be forged, ultimately serving the cause of justice and truth.

In another study, (B. Senthil Kumar, 2016) They suggest that the exploration of ear lobule morphometry is seen as a significant avenue for forensic investigation, particularly in the discernment of age and sex, thus contributing crucial insights to forensic medicine and criminology. Initially, the focus of study on ear lobule parameters was primarily on surgical interventions for congenital deformities and reconstructions. However, the utility of ear lobules in individual identification, particularly through photographic or ear print analysis, has been recognized by the evolving field of otomorphology. Notably, the dynamic nature of this anatomical feature and its potential as a forensic marker are underscored by age-dependent changes in lobule morphology. The distinct dimensional variations revealed between Malaysian and Indian populations, with Malaysians exhibiting longer ear dimensions, suggest the influence of genetic and environmental factors on ear morphology, thus warranting further investigation. Moving forward, the scope of findings is aimed to be extended through research endeavors exploring correlations between ear dimensions, height, and various facial/cranial anthropometric parameters. Such investigations are seen as holding promise for enhancing forensic methodologies, particularly in the realm of bite mark analysis, thereby advancing understanding of human variation and aiding in forensic investigations.

The findings outlined of this (Livia PETRESCU, 2018) serve as preliminary indications, given the limitation imposed by the relatively small sample size utilized in the study. Despite this constraint, the study lays down foundational markers for future research endeavors aimed at comprehensively exploring the anthropological dimensions of the external ear within the Romanian populace. It is recognized that the number of subjects included in the current investigation may not suffice to establish statistical significance. However, these initial insights provide a valuable starting point for broader anthropological inquiries into the intricate morphological and dimensional nuances of the ear structure among individuals of the descent.

LIMITATION OF THE STUDY

- If participants make any facial expressions while measuring the parameters, the placement of the ruler may shift, affecting the accuracy of the data.
- This research was conducted with a small sample size of 100 participants.
- The study does not include a broader range of age category.
- For more accurate measurements, imaging technology could be utilized.

CONCLUSION

According to the study, it was determined that the majority of them had ears that were predominantly oval in shape. This conclusion was drawn after examining the each participant directly. The lobule part of the female was greater compared to the male due to the cultural fact of wearing the ear rings also the cause of the gravitational force of attracting the ear downwards. The Total length of ear was greater in male compared to the females. Understanding the different dimensions of the external ear across various ages and sexes is crucial for accurate reconstruction, forensic analysis, and precise determination of the auricular framework's position and orientation. In conclusion, the study has successfully demonstrated that the variations in outer ear parameters offer a reliable and effective additional method of individual identification. In future and with reference to the articles these findings in this field suggests that ear biometrics could be integrated into existing security systems to enhance identification processes, confirming the potential of outer ear measurements as a valuable tool in the field of forensic science and personal security technologies.