Original article:

Anthropometric Measurement of External Ear and Correlation with Age in North Regional People of Bangladesh

Asadujjaman[1], Md. Harum Or Rashid[2], Sohel Rana[3]

Abstract

Objective: The purpose of this study was to build an external ear anthropometric database in North regional people of Bangladesh. This study also aimed to show the morphological variations between male and female as well as changes in ear anthropometry with age. ***Materials and Methods:*** Ear dimensions of 313 people (150 male and 163 female), aged between 18-75 years, were measured pursuant to standard anthropometric measurement procedure. A total of five external ear dimensions- ear length, ear breadth, base of the auricle, lobe length and lobe breadth was measured. Pearson correlation coefficient was used to determine the relationship among various ear measurements, and linear regression analysis was used to estimate ear dimensions from the age of the people. ***Result:*** All ear dimensions were found larger in male than in women. The result also revealed that, dimensions of ear parameters increase proportionally with the increase of age, except male left-lobe breadth and female lobe breadth in both sides. ***Conclusion:*** Of course, this study of human ear morphology will serve as a quantitative database and play an enormous importance of anatomy and human factors engineering point of view.

Keywords: External Ear; Anthropometry; Morphometry

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Introduction

Anthropometry means human body measurement,[1] which plays an important role in product design, forensic investigation, and human factors engineering. The measurement of human body varies within a nation and between nations, even within a family.[2-3] Abeysekera and Shahnavaz[4] noted that, a product designed for 90% male American would fit about 90% of Germans, 80% of Frenchmen, 65% of Italians, 45% of Japanese, 20% of Thais, and only 10% of Vietnamese. On the other hand, in India,[5] a study showed that North East Indian has lower ear length than other Indians and Indian subcontinent people.

Age of human being can be predicted from anthropometry.[6] Similarly, body measurements can be also be predicted from age.[7] Ear anthropometry is a vital feature for face detection, identifying age and gender in forensic investigation. Numerous researches have been conducted on ear dimensions in Indian,[5,8-10] Korean,[11] Japanese,[12] African[13] population. However, no research on ear morphology is done for North regional people in Bangladesh. As a result, there has a lack regarding ear dimension data in the adult population of this region.

The aim of this study was to provide information about ear morphology in adult Bangladeshi population, i.e. statistical mean, variance, maximum and minimum values of ear length, ear breadth, base of the Auricle, lobe length and lobe breadth for both genders and its variation associated with the age. This research also developed linear regression equations to estimate ear dimensions from age.

Materials and Methods

A total of healthy 150 male and 163 female Bangladeshis lives in northern part aged between 18 to 75 years were participated in this study. Before taking the data, the purpose of this study was explained clearly to each of

1. Md. Asadujjaman, Assistant Professor, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh.
2. Md. Harum Or Rashid, Undergraduate Student, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh.
3. Sohel Rana, Undergraduate Student, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh.

Correspondence to: Md. Asadujjaman, Assistant Professor, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh, E-mail: asadujjaman@ruet.ac.bd

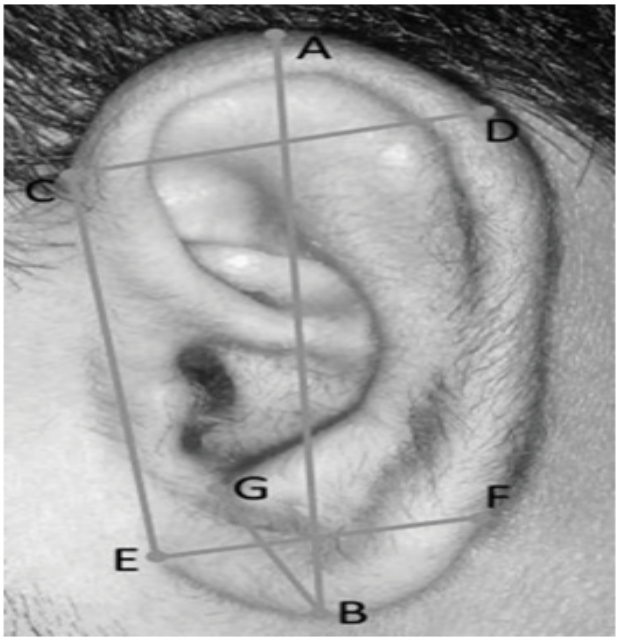

Figure 1: Anatomical landmark of the external ear. Ear length = A to B, Ear breadth = C to D, Base of the auricle = C to E, Lobe length = B to G, Lobe width = E to F

the participants. Five ear dimensions- ear length (EL), ear breadth (EB), base of auricle (BA), lobe length (LL) and lobe breadth (LB) for both ears were taken from each subject. Figure 1 shows the anatomical landmark of the external ear. All the measurements were taken using a digital slide calipers and were recorded in millimeters. To minimize the error of measurement, all measurements were taken twice from each subject and therefore the average was used for each dimension. After collecting the numerical data, the result was prepared in terms of mean, variance, maximum and minimum value, coefficient of correlation, and coefficient of determination, and linear regression models using Microsoft Excel 2016.

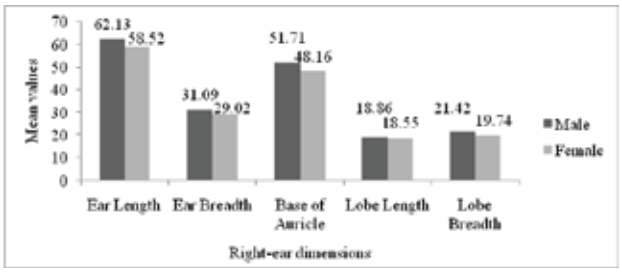

Figure 2: Comparison of right-ear dimensions according to sex

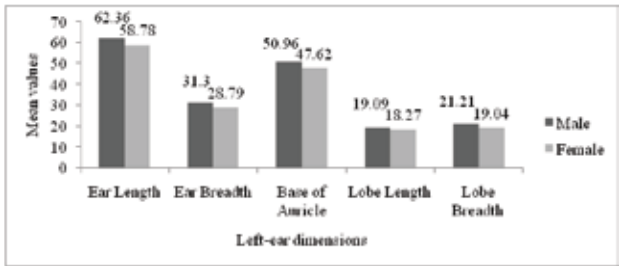

Figure 3: Comparison of left-ear dimensions according to sex

Ethics approval and consent to participate

Participants who have given their earnest consent and permission have taken into account for body measurement. As the data has been collected anonymously; therefore, there was no need to take prior ethical approval. They were fully aware what they were measured.

Result and Discussion

Descriptive statistics and comparison of the result for both right and left sides and both genders of all subjects who participated in this study are shown in Table 1. According to sex differences, in case of both sides, the mean of ear length, ear breadth, base of the auricle, lobe length, and lobe breadth in men were higher than in women. This is also proved by past researches.[5,10,14] It was also seen that, in both sexes, ear dimensions for both right and left sides were almost same. Figure 2 and Figure 3 also exhibits the comparison of ear morphology in both sexes based on right and left side respectively.

Table 1. Descriptive statistics of the measured ear variables (measurements in mm)

Parameter	Sides	Male				Female			
		Mean	Max	Min	SD	Mean	Max	Min	SD
Ear Length	Right	62.13	74.29	49.02	4.24	58.52	68.64	44.34	4.00
	Left	62.36	74.3	49.3	4.28	58.78	70.21	48.33	4.08
Ear Breadth	Right	31.09	36.89	16.76	2.75	29.02	36.28	19.09	2.47
	Left	31.30	51.80	23.32	3.15	28.79	35.8	19.23	2.62
Base of Auricle	Right	51.71	63.28	37.31	4.25	48.16	58.31	34.88	3.70
	Left	50.96	64.31	15.86	5.78	47.62	57.25	33.65	3.80
Lobe Length	Right	18.86	24.64	10.94	2.70	18.55	24.65	11.87	2.20
	Left	19.09	27.26	11.51	3.00	18.27	28.29	11.80	2.51
Lobe Breadth	Right	21.42	28.15	14.35	2.86	19.74	26.31	12.00	2.94
	Left	21.21	27.14	14.47	2.69	19.04	24.82	11.12	2.55

Table 2 exhibits the correlation among different ear dimensions of male on both sides. In case of both right and left sides there exists a positive correlation between ear measurements. In male adults, coefficient of correlation varied from +0.17 to +0.66 for the right ear and from +0.12 to +0.60 for the left ear. In male, high correlation exists between EL and BA (+0.66 for male right-ear and +0.51 for male left-ear), and between EL and LL (+0.53 for right-ear and +0.60 for left-ear).

Table 2: Correlation matrix of male-ear dimension

		Male Right-Ear							Male Left-Ear				
		EL	**EB**	**BA**	**LL**	**LB**			**EL**	**EB**	**BA**	**LL**	**LB**
Male Right-Ear	EL	1					Male Left-Ear	EL	1				
	EB	0.45	1					EB	0.32	1			
	BA	0.66	0.33	1				BA	0.51	0.12	1		
	LL	0.53	0.26	0.26	1			LL	0.60	0.22	0.27	1	
	LB	0.36	0.25	0.17	0.43	1		LB	0.45	0.26	0.22	0.36	1

In female, positive coefficient of correlation was also exists between ear measurements, on both sides (Table 3). It was seen that, in women coefficient of correlation varied from +0.05 to +0.66 for the right ear and from +0.05 to +0.68 for the left ear. High correlation exists between EL and BA (+0.66 for female right-ear and +0.68 for female left-ear), and between EL and LL (+0.56 for female right-ear and +0.51for female left-ear).

Table 3: Correlation matrix of female-ear dimension

		Female Right-Ear							Female Left-Ear				
		EL	EB	BA	LL	LB			EL	EB	BA	LL	LB
Female Right-Ear	EL	1					Female Left-Ear	EL	1				
	EB	0.27	1					EB	0.16	1			
	BA	0.66	0.05	1				BA	0.68	0.05	1		
	LL	0.56	0.14	0.50	1			LL	0.51	0.38	0.38	1	
	LB	0.08	0.17	0.13	0.33	1		LB	0.11	0.29	0.09	0.38	1

Table 4 represents linear regression equations to estimate an ear anthropometry form age for both sexes. It was seen that, for male, estimation of right-ear length was statistically significant (p<0.01) in both sexes. In case of ear breadth and lube breadth, for both sides, both sexes the equations were not statistically significant (p>0.05). In all cases, base of the auricle was statistically significant (p<0.01). Lube length estimation form age was statistically significant only for male right-side (p<0.05) and left-side (p<0.01); but not for female (p>0.05). An equation statistically significant means we can estimate the parameter from the age, but in case of not significant we can't estimate it. Therefore, we can only estimate male right and left-lobe length, ear-length and base of the auricle in both sexes in both sides from the age of the human being.

Table 4 also represents the coefficient of correlation (R), coefficient of determination (R^2), standard error of estimation (SEE) and p-value. The value of the coefficient of correlation varies from 0.01 to 0.33 in male ear dimensions and 0.07 to 0.35 in female ear dimensions. For male ear dimensions the value of the coefficient of determination varies from 0.00 to 0.11 and for female 0.01 to 0.12. A lower value of coefficient of determination means a lower variation of the response data around the mean, whereas a zero value means no variability and we can't predict the dependent variable from the independent variable. Therefore, we can't predict male left-lube breadth from the age as the value of R^2 is zero.

It is known that, practically perfect estimation is not possible for regression analysis. Therefore, SEE is needed to determine the variation from estimation. A lower value of SEE means higher reliability in estimation, whereas a zero value of SEE means a perfect estimation with no variation. The value of SEE was varied from 2.67 mm to 5.63 mm for male

Table 4. Linear regression equations for the estimation of ear measurements (in cm) from age

Side	Male					Female				
	Equation	*R*	R^2	SSE	*p*-value	Equation	*R*	R^2	SSE	*p*-value
Right	EL = 58.76 + 0.09 (age)	0.25	0.06	4.12	0.002*	EL = 54.82 + 0.10 (age)	0.35	0.12	3.77	0.000*
Left	EL = 59.44 + 0.08 (age)	0.21	0.04	4.19	0.009*	EL = 55.41 + 0.09 (age)	0.31	0.10	3.89	0.000*
Right	EB = 29.77 + 0.03 (age)	0.15	0.02	2.73	0.068***	EB = 28.54 + 0.01 (age)	0.07	0.01	2.47	0.360***
Left	EB = 30.07 + 0.03 (age)	0.12	0.01	3.14	0.140***	EB = 28.26 + 0.01 (age)	0.08	0.01	2.62	0.335***
Right	BA = 47.18 + 0.12 (age)	0.33	0.11	4.03	0.000*	BA = 45.53 + 0.07 (age)	0.27	0.07	3.58	0.001*
Left	BA = 46.54 + 0.11 (age)	0.24	0.06	5.63	0.003*	BA = 45.33 + 0.06 (age)	0.22	0.05	3.71	0.004*
Right	LL = 17.45 +0.04 (age)	0.16	0.03	2.67	0.048**	LL = 17.89 + 0.02 (age)	0.11	0.01	2.20	0.157***
Left	LL = 16.62 + 0.06 (age)	0.26	0.07	2.90	0.002*	LL = 17.71 + 0.02 (age)	0.08	0.01	2.51	0.287***
Right	LB = 21.02 +0.01 (age)	0.04	0.00	2.87	0.596***	LB = 20.72 - 0.03 (age)	0.12	0.02	2.92	0.113***
Left	LB = 21.33 - 0.003 (age)	0.01	0.00	2.70	0.869***	LB = 19.65 - 0.02 (age)	0.09	0.01	2.55	0.255***

*Significant (< 0.01)

**Significant (< 0.05)

***Not significant (> 0.05)

and 2.20 mm to 3.89 mm for female. Therefore, the values of SEE were lower for the regression models. The result revealed that, dimensions of ear length, base of the auricle, lobe length, and lobe breadth have increased positively with the increase of age in both genders. In contrast, with the increase of age dimension of lobe breadth has decreased except male right-lobe breadth. These findings were somewhat contradictory with past researches. Sharma[15] showed that, with the increase of age dimensions of EL, EB, LL and LB increases. In contrast, Eboh[16] showed that, after 30 to 35 years, dimensions of EL, EB, LL and LB may decrease and after 50 to 55 years old these dimensions may increase again. On the other hand, Ekanem et al.[17] also showed that, EL, LL and LB dimensions fluctuate with age.

Conclusions

In this paper, a detailed information regarding to ear measurements in healthy North regional Bangladeshis was provided. Data collected in this research could use as a quantitative database of auricular morphology considering age and sex variation. In summary, this study contributes to provide a baseline databank of ear morphology for anthropologists and forensic researchers. In future, further study is needed in the South region to compare the results of our present study and to generalize the findings to the whole Bangladeshi population.

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Conflict of Interest

None declared.

Author Contribution:

Data gathering and idea owner of this study: Md. Asadujjaman, Md. Harum Or Rashid, Sohel Rana
Study design: Md. Asadujjaman
Data gathering: Md. Harum Or Rashid, Sohel Rana
Writing and submitting manuscript: Md. Asadujjaman, Md. Harum Or Rashid, Sohel Rana
Editing and approval of the final draft: Md. Asadujjaman

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