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EFFECT OF AGE AND SEX ON EAR MORPHOMETRY: A STUDY ON BENGALI HINDU POPULATION

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ABSTRACT

The present study aimed to find out the relation of age and sex on ear morphometry. The study was carried out among the Bengali speaking Hindu group. A total of 248 individuals (123 male and 125 female) were selected who were divided into 3 age groups: group 1(n=96; age range: 18-40 years); group 2 (n=118; age range: 41-60 years); and group 3 (n=34; age range: > 60 years). Four measurements, namely ear length and width, lobule length and width of both ears were taken on each individual, following standard techniques.

Bivariate analysis (t-test) revealed significant male female differences for ear length and breadth. One-way ANOVA indicated significant differences in ear morphometric measurements among three age groups. Post-Hoc test showed that ear morphometric measurements were significantly greater in group 3 for male and in group 2 for female participants. Multivariate analyses (two-way ANOVA) did not reveal any statistical interaction within age, sex and ear morphometry. In conclusion, individually, age and sex was statistically associated with ear morphology. But interactive effect of these two parameters on ear morphology was not found.

Keywords: Ear morphometry, Bengali-Hindu

INTRODUCTION

Ear shape and size is influenced by age, sex and ethnic origin (Brucker et al., 2003; Alexander et al., 2011) and it is possible to make some generalization regarding morphometric measurements of ear. For example, men have larger ears than women (Brucker et al., 2003), age related changes in ear morphology do exit (Brucker et al., 2003; Ekanem et al., 2010) and overall ear size differs within and between the ethnic group (Purkait and Singh, 2007; Sharma, 2007).

A number of studies on the age related variation of ear morphometric measurements have been conducted on various ethnic groups such as, Germans (Niemitz et al., 2007) and Turks (Barut and Aktunc,2006). Taura et al. (2013)

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conducted a study to examine the sexual dimorphic character of ear morphometry. In India, cross-sectional studies were undertaken on populations from central (Purkait and Singh,2007), northwest (Sharma et al., 2007) and the north (Deopa et al., 2013). However, the number of studies exclusively focused on, either the age or sex wise, variations of ear morphometry are few and there is lack of work that explores both the effect of age and sex on ear morphometry. Thus, the present study aims to find out the relation of age and sex on ear morphometry.

MATERIALS AND METHODS

Study participants

The present study was carried out among Bengali speaking Hindu population. We selected 315 individuals. Subsequently, participants having torn ear lobe or any deformity on lobe were excluded from the study. Finally, data were collected from 248 individuals, of which 123 comprised males and 125 females. We divided study participants into three age groups, following Azaria et al. (2003), - group 1 (18-40 years); group 2 (41-60 years); and group 3 (above 60 years). Group 1 consisted of 96 individuals, group 2 consisted of 118 and group 3 consisted of 34 individuals. None of the male participants had pierced earlobes in our study.

Study area

Study participants were selected from the urban area of West Bengal, a state located in the eastern part of India. Three districts, namely Kolkata, Hoogle and North 24thParagana from where we selected our participants. Kolkata is the capital of West Bengal. Three municipal wards were randomly selected from the municipal corporation/municipality (urban administration unit) under the district headquarter of each districts. Thus the study participants were selected from total number of six municipal wards of three districts.

Data collection

The present study was conducted during the period from April 2015 to June 2015. Before collecting data, participants were informed about the voluntary nature of their participation and oral consent was taken from them. On each participant, a total of four measurements were taken: ear length and width, lobule length and width. Measurements were taken on both ears. Thus we took eight measurements. The participants were asked to hold their head oriented in Frankfort Horizontal Plane during measurements.All the measurements were taken following De Carlo et al. (1998), McKinney et al. (1993) and Deopa et al. (2013). Ear length was the distance from the most superior projection of the helix to the most inferior projection of the ear lobule. Ear width was the distance between most anterior and most posterior points of the ear. Lobule length was the distance from the base of the tragal notch to the most inferior end of the lobule and lobule widthwas measured as the transverse or horizontal width of the lobule at the midpoint of the lobular height.All the ear measurements were taken during a house-to-house survey by the first author (SS). Martin's sliding calliper was used, which is capable of measuring to the nearest 0.1 mm. Each of the measurements was taken three times and the mean value was calculated and recorded. Age of the participants was obtained by their self-reported data. Age was further cross-checked by their birth certificates or electoral identification cards.

Data analysis

The data were analyzed using SPSS software (version 18.0). We computed descriptive statistics (mean ± SE and 95% confidence interval) of ear mormhometric measurements of each of the sex and age groups. One way ANOVA was done to compare the ear length and breadth of both ears, lobular length and breadth of both ears, among three age groups of both sexes. After that, Tukey post-hoc test was used for each of these comparisons independently to understand the differences between group 1 and group 2, group 2 and group 3, and group 3 and groups 1.

We aimed to understand whether there was an interaction between sex and age groups on ear morphometric measurements. Sex (males/females) and age groups were categorical variables.We applied Kolmogorov-Smirnov test of normality and found that each of the eight ear morphometric measurements were normally distributed for each sex and age group (**Sig.** value of the Kolmogorov-Smirnov test were greater than 0.05).

We then performed two-way ANOVA to understand if there was an interaction between sex and age groups with respect to ear morphometric measurements. We used sex and age groups as the independent variables and each of the eight ear morphometric measurements as dependent variable.A minimum p value of 0.05 was considered as statistically significant for all inferential statistics.

RESULTS

Ear length and ear width of both ears were significantly higher among the male population than their female counterpart. Measurements on lobules of both ears did not differ significantly between two sex groups. Barring the lobular length of right ear, rest of the seven measurements of ear and lobe significantly differed within the three age groups. Moreover, ear length and width, and lobular length and width, irrespective of side, were significantly higher among the age group 3 followed by age groups 2 and 1 (Table -1).

Table 1: Distribution of ear morphometry by sex and age groups

Sex	Ear length (right ear) Mean ± se	Ear length (left ear) Mean ± se	Ear width (right ear) Mean ± se	Ear width (left ear) Mean ± se	Lobular length (right ear) Mean ± se	Lobular length (left ear) Mean ± se	Lobular width (right ear) Mean ± se	Lobular width (left ear) Mean ± se
Male	6.500±0.04	6.490±0.04	3.141±0.03	3.122±0.03	1.491±0.03	1.520±0.03	1.747±0.03	1.743±0.03
Female	6.083±0.03	6.022±0.05	2.892±0.02	2.878±0.03	1.704±0.95	1.516±0.03	1.715±0.03	1.678±0.03
t test	t=6.921, p=0.001	t=6.736, p=0.001	t=5.778, p=0.001	t=5.421, P=0.001	t=-1.186, P=0.237	t=0.076,x P=0.237	t=0.693 P=0.489	t=1.539 P=0.125
Age category								
Group 1	6.084±0.04	5.996±0.04	2.949±0.03	2.920±0.04	1.393±0.14	1.372±0.03	1.592±0.03	1.578±0.03
Group 2	6.349±0.04	6.283±0.03	3.050±0.03	3.033±0.03	1.710±0.27	1.581±0.03	1.807±0.03	1.781±0.03
Group 3	6.682±0.08	6.695±0.08	3.095±0.07	3.090±0.07	1.723±0.13	1.695±0.06	1.816±0.06	1.811±0.06
One way ANOVA	F=28.120 p=0.001	F=37.368 P=0.001	F=4.600 P=0.011	F=4.024 P=0.003	F=1.678 P=0.189	F=15.880 P=0.001	F=13.249 P=0.001	F=14.550 P=0.001

Barring the right ear width, rest of the seven ear morphometric measurements of male participants significantly differed across three age groups. Tukey's post-hoc test revealed that ear length of both ears, ear width of left ear, lobular length and width of both ears were significantly greater in group 3 and 2 compared to group 1. On the other hand, among females, significant differences were found across three age groups with respect to ear length of both ears, lobular length of left ear and lobular width of both ears. Tukey's post-hoc test also indicated that ear length of both ears, ear width of left ear, lobular length and width of both ears were significantly greater in group 2 compared to group 1 (Table-2).

Table 2: Distribution of ear morphometry by the age groups of two different sexes

Male	Ear length (right ear) Mean ± se (95% C.I.)	Ear length (left ear) Mean ± se (95% C.I.)	Ear width (right ear) Mean ± se (95% C.I.)	Ear width (left ear) Mean ± se (95% C.I.)	Lobular length (right ear) Mean ± se (95% C.I.)	Lobular length (left ear) Mean ± se (95% C.I.)	Lobular width (right ear) Mean ± se (95% C.I.)	Lobular width (left ear) Mean ± se (95% C.I.)
Age Group 1	6.209±0.06 (6.083-6.334)	6.137±0.06 (6.014-6.260)	3.076±0.05 (2.978-3.174)	3.057±0.05 (2.955-3.158)	1.357±0.20 (0.946-1.767)	1.354±0.05 (1.254-1.455)	1.650±0.05 (1.550-1.750)	1.626±0.04 (1.534-1.719)
Age Group 2	6.577±0.06 (6.459-6.695)	6.487±0.06 (6.371-6.602)	3.165±0.04 (3.073-3.257)	3.125±0.04 (3.030-3.220)	1.544±0.19 (1.158+1.930)	1.569±0.04 (1.475-1.664)	1.765±0.04 (1.671-1.859)	1.779±0.04 (1.692-1.866)
Age Group 3	6.876±0.08 (6.706-7.046)	6.856±0.08 (6.689-7.023)	3.212±0.06 (3.079-3.345)	3.236±0.07 (3.098-3.374)	1.632±0.28 (1.075-2.189)	1.724±0.06 (1.588-1.860)	1.888±0.06 (1.752-2.024)	1.888±0.06 (1.762-2.014)
One way ANOVA result	F=16.398, p 0.001	F=28.097, p=0.001	F=2.106, p=0.126	F=0.037, p=0.052	F=4.367, p=0.015	F=9.144, p=0.001	F=4.439, p=0.014	F=6.061, p=0.003
Post Hoc test (p value)	Gp1 vs Gp2 (0.001) Gp 2 vsGp 3 (0.036) Gp 3 vsGp 1 (0.001)	Gp1 vs Gp2 (0.001) Gp 2 vsGp 3 (0.007) Gp 3 vsGp 1 (0.001)	NA	Gp1 vs Gp2 (0.389) Gp 2 vsGp 3 (0.341) Gp 3 vsGp 1 (0.043)	Gp1 vs Gp2 (0.042) Gp 2 vsGp 3 (0.833) Gp 3 vsGp 1 (0.036)	Gp1 vs Gp2 (0.005) Gp 2 vsGp 3 (0.353) Gp 3 vsGp 1 (0.001)	Gp1 vs Gp2 (0.066) Gp 2 vsGp 3 (0.632) Gp 3 vsGp 1 (0.022)	Gp1 vs Gp2 (0.020) Gp 2 vsGp 3 (0.631) Gp 3 vsGp 1 (0.007)
Female								
Age Group 1	5.960±0.06 (5.840-6.080)	5.856±0.06 (5.738-5.974)	2.822±0.04 (2.728-2.916)	2.784±0.04 (2.687-2.881)	1.430±0.20 (1.036-1.824)	1.390±0.04 (1.294-1.486)	1.534±0.04 (1.438-1.630)	1.530±0.04 (1.441-1.619)
Age Group 2	6.121±0.05 (6.016-6.226)	6.079±0.05 (5.976-6.182)	2.935±0.04 (2.853-3.017)	2.941±0.04 (2.856-3.026)	1.902±0.17 (1.559-2.244)	1.592±0.04 (1.509-1.676)	1.848±.04 (1.765-1.932)	1.783±0.03 (1.706-1.861)
Age Group 3	6.489±0.14 (6.205-6.773)	6.533±0.14 (6.255-6.812)	2.978±0.11 (2.757-3.199)	2.944±0.11 (2.715-3.174)	1.789±0.47 (0.861-2.717)	1.667±0.11 (1.440-1.893)	1.744±0.11 (1.518-1.970)	1.733±0.10 (1.524-1.943)
One way ANOVA result	F=6.389 p=0.002	F=9.158 p=0.001	F=1.656 p=0.195	F=2.189 p=0.116	F=1.165 p=0.315	F=7.048 p=0.001	F=14.273 p=0.001	F=10.866 p=0.001
Post Hoc test (p value)	Gp1 vs Gp2 (0.048) Gp 2 vsGp 3 (0.098) Gp 3 vsGp 1 (0.007)	Gp1 vs Gp2 (0.011) Gp 2 vsGp 3 (0.046) Gp 3 vsGp 1 (0.001)	NA	NA	NA	Gp1 vs Gp2 (0.001) Gp 2 vsGp 3 (0.996) Gp 3 vsGp 1 (0.232)	Gp1 vs Gp2 (0.001) Gp 2 vsGp 3 (0.727) Gp 3 vsGp 1 (0.286)	Gp1 vs Gp2 (0.001) Gp 2 vsGp 3 (0.682) Gp 3 vsGp 1 (0.480)

Two-Way ANOVA result suggested that there were no statistical interaction within age groups and sex on each of the eight types of ear morphometric measurements (Table-3).

Table-3: Results of two-way ANOVA for the eight morphometric measurements of ear lobe attachments

	Ear length (right ear)		Ear length (left ear)		Ear width (right ear)		Ear width (left ear)		Lobular length (right ear)		Lobular length (left ear)		Lobular width (right ear)		Lobular width (left ear)	
	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.	Type III Sum of Squares	Sig.
Corrected Model	20.851	0.000	22.942	0.000	4.616	0.000	4.943	0.000	10.680	0.378	3.813	0.000	3.833	0.000	3.342	0.000
Intercept	6432.46	0.000	6337.22	0.000	1455.808	0.000	1439.64 9	0.000	410.080	0.000	380.351	0.000	478.767	0.000	470.475	0.000
Sex	5.243	0.000	4.501	0.000	2.274	0.000	2.463	0.000	1.520	0.384	0.051	0.993	0.137	0.283	0.267	0.106
Age category	8.511	0.000	11.199	0.000	0.729	0.042	0.943	0.022	6.147	0.217	3.313	0.000	2.694	0.000	2.513	0.000
Sex* Age category	0.567	0.222	0.216	0.549	0.008	0.967	0.130	0.589	1.089	0.762	0.046	0.826	0.631	0.072	0.209	0.359

DISCUSSION

Results of the present study reveal that significant differences exist between male and female with respect to ear length and ear breadth. All ear morphometric measurements also differed significantly within three age groups. In male participants, ear morphometric measurements were significantly greater in group 3 and 2 as compared to group 1. On the other hand, in females, these measurements were significantly more in group 2 than group 1. There was no statistical interaction within age groups and sex of participants with all the ear morphometric measurements considered here.

Similar results were reported by a study on adult Nigerians (aged 18-65 years) which found that earlobe size did not vary significantly between the male and female (Ekanem et al., 2010:179).This result was similar to Brucker et al. (2003), who also observed that though the ear length was larger in the male, their lobular length and width remained nearly identical to female. One hospital based study on Rhode Island also stated that although ear length was larger in male but their earlobe length and width remain nearly identical to female (Sullivan et al., 2010). In contrast, another study on adult Indian population from Uttarakhand region found that all ear dimensions were significantly larger in males than in females (Deopa et al., 2013).

Our study explored age related changes with all ear dimensions, there were significant increases in the ear length and width, lobular length and width with increasing age. However here we have not considered the sex of our study population.

Maximum ear length and width as well as maximum lobular length and width increased significantly above 60 years of age of males of the present study. Ear circumference increased on average 0.51 mm per year with increase in age. This enlargement is likely associated with age changes in collagen (Tan et al. 1997; Brucker et al., 2003). Furthermore, female participants did not show any specific trend for these measurements. Ear length of right ear and lobular length of left ear increased maximally above 60 years of age, whereas maximum ear length of right ear and lobular width of both ear significantly increased between 41 and 60 years then these decreased with increase in age. Use of ear ring at lobular part might be a reason for large lobular length in female population (Azaria et al., 2003). Unlike present finding, studies found that, irrespective of sex, lobular width decreased significantly with age (Brucker et al., 2003; Sullivan et al., 2010; Ekanem et al., 2010). However, we are not in a position to explain any further the reason for it.

A number of studies have explored anatomical differences in the ear between male and female, as well as changes in ear morphology with age (Azaria et al., 2003; Brucker et al., 2003; Ekanem et al., 2010; Sullivan et al., 2010). Azaria et al. (2003) found that earlobe length was determined by age and sex. Furthermore Sforza et al. (2009) found a significant effect of age on all ear dimensions, with larger values in older individuals. Although present study did not find statistically interactive effect of age, sex and ear dimension.

Ear mormhometry has medico-legal importance. Ear pattern is unique like fingerprint (Hoogstrate et al., 2001; Abbas and Rutty, 2003). Thus, Forensic Ear Identification (FEARID) research project used ear prints for identification purpose (Alberink and Ruifork 2007). Moreover, external ear mormhometry is also associated with the presence of congenital anomaly(Pimple et al., 2013). A case-control study on Down Syndrome patients of north Sudanese population revealed that ear width and length was significantly smaller among them than their reference group (control group) (Sforza et al., 2011). In addition, studies have shown a significant association between coronary artery disease and the presence of diagonal earlobe creases (Evrengül et al., 2004; Edston, 2006; Friedlander and Scully 2012; Shmilovich et al., 2012). However, medico-legal utility of ear morphometry was not within the purview of the present work, but it is very interesting aspect of ear morphometry.

In conclusion, we state that the changes in ear morphology that occur with advancing age. In addition, sex differences in ear morphology,excluding earlobe, were also noticed. Individually, age and sex were statistically associated with ear morphology. But interactive effect of these two parameters on ear morphology was not found.

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