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Study of the Ear Shape and the Lobule Attachement among the Adult Malaysian Population at Shah Alam

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Abstract: Background: Morphological features of human are often used as "Biometrics" traits aimed to establish the identity of individuals which is used by forensic experts and physical anthropologists to identify suspects or victims according to age, gender and race. Objective: Present study aim to determine the racial and sexual variation in the morphometric and biometric characteristics of the external ear and earlobe among Malaysian population in Shah Alam. Methods: The study included 294 adults distributed equally to have 49 participants from each gender and race. The ear length (EL), width (EW), ear shape and lobule attachment were studied to characterize race and gender. Results: The mean EL and EW were 63.4 mm and 29.3mm respectively without significant bilateral variations (P 0.792 and P 0.835 respectively). There is significant intraracial gender variation; EL was biggest among Indian females (68.8 mm) and smallest among Chinese males (60.7 mm). EW was biggest among Indian males (31.2 mm) and smallest among Chinese males (27.1 mm). Ear lobe was attached in both right and left sides in 78 (53.06%) and 61 (41.49%) of the studied males and females respectively. Earlobe was attached in males 28 (57.14%), 31 (63.26%) and 19 (38.77%) of the Malay, Chinese and Indian respectively while, it was attached in females 21 (42.85%), 21 (42.85%), and 19 (38.77%) of the Malay, Chinese and Indian. The oval, round, rectangular and triangular ear shapes are nearly equally distributed among the studied sample. Conclusion: This study demonstrated the crucial role of ear biometrics in race and gender estimation and serve as database for the auricle morphology considering sexual and racial variation among Malaysian population that enable ear prints to be used as identification tool in Malaysia.

Keywords: Malaysian, ear shape, lobule attachment, racial characterization, gender variations.

INTRODUCTION:

The external ear comes in all types and forms of shapes and sizes. This structure helps to give our unique ear appearance especially in the concha and lobe areas. The external ear is a defining feature of the face and thus, ear recognition is receiving acknowledgement as the

new field of interest in the perspective of human authentication. It has been observed that there is a significant variation in geometry and shape of the ear among individuals [1]. Ear is a valuable identification feature used to create a signal portrait, reconstruct appearance, identify persons based on photographs[2]. Also, ears can be used for identification of unknown bodies in cases of mass disasters, burns, drowning and any case where the face is mutilated [3].

Ear biometrics is gaining significant interest and has become the method of identification due to its biological and physiological characteristics that are characterized by having high stability, universality, uniqueness, non-invasiveness and extractability [4]. Ear has been used as a complementary evidence to fingerprints and DNA testing as the courts of law requires presence of at least two types of evidence to accuse a suspect of guilty [5].

Alfred Iannarelli is the one who founded the twelve points of ear biometric measurements and hence named as " Iannarelli's twelve points measurements". The first manual method of ear measurement was used in 1989 by Iannarelli when he randomly examined 10.000 human ears in California. Using ear biometrics as an individual identification has less variation due to ageing compared to face and the ear structure has a high stability of pattern throughout a person's life. Moreover, the appearance of ear is not altered by frontal make-up, spectacles, beard or any accessories [1].

The terms biometrics and biometry have been used earlier in 20th century to identify the field of development of statistical and mathematical methods to analyse biological data and recently biometrics has been used to refer to the technology used for human identification depending on biological traits [3]. Morphometry of the ear is whereby the structure of the ear is used to identify gender and person. Morphometry is the characterization of the ear based on the structures of the ear and earlobe. Ears can be utilized in recognizable proof of obscure people particularly in catastrophes where the confront is seriously distorted. The personality can be set up using strategies depending on the morphology and estimations of ears of the casualty. The ear lobe is more frequently used part of the ear pinna for biometric studies as it can vary from well-formed to attached. Ear lobe attachement is an international standard for identification of disaster victims. In India, ear morphology was used in 2004 to confirm the identity of Veerappan, a sandal wood smuggler who was killed by Special Task Force [2]. Also, the shape and size of the ear are used during facial reconstruction in forensic investigations [6, 7]. It has been recommended to study the ear height and width in conjugation with the lobule of the ear among Malaysians[8].

The purpose of this study is to determine the level of significance of similarily and /or difference between right and left ear biometrics and to determine the racial and sexual characteristics among young adults in Shah Alam population regarding ear and earlobe biometrics and morphometrics.

Materials and Methods

This study included 296 young Malaysian adults; 49 subjects for each gender and race of the three major Malaysian races (Malays, Chinese and Indians) from Shah Alam area with age range of above 18 years old. The participants were confirmed to be Malaysian young adults of pure Malay, Chinese and Indian (are of same race up to the third grandparents) and owns Malaysian Identification Card "MyKad". Subjects were affirmed healthy without any type of congenital syndrome or anomaly as well as have never done any surgical procedure that alter ear measurements. Accessories attached to the ear such as earrings could alter the ear length and affect the ear length; hence, the attachments were needed to be taken off before measurements.

This study was approved by MSU Research Ethics Committee. Consent form was signed by the participants prior taking part in the study. Participants were sit down with the head 90° positioned for measuring the ear length and ear width. Measurements were taken using

stainless steel ruler of 150 mm ± 0.5 mm (Penguin, China). Measurements were standardized into one decimal place. Measurements will be repeated three times in which the average measurements will be used.

Ear length (EL) was measured as the maximum distance of vertical line extending from the top end of superior helix rim to the bottom end of inferior lobule of the ear. Meanwhile, ear width (EW) was measured as the maximum distance between most anterior end of helix rim and the most posterior end of helix rim which cross perpendicularly with the ear length formed [9].

The shapes of the ear were determined oval, round, rectangular and triangular. The oval ear is longer than it is wide, the width being maximal at the middle, having adjusted top and bottom. The rounded ear is nearly as long as wide and includes adjusted top and foot. The rectangular ear is longer than wide, with a rectangular top and bottom part, both ends are nearly as wide as midway down the ear. The triangular ear is longer than wide, with adjusted top that's more extensive than the bottom [10, 11]. Morphological shapes of ears (Oval, Round, Triangular, Rectangular) are shown in figure 1[12].

All the biometrics was recorded in numerical form and tabulated and then analysed using Excel and Statistical Package for the Social Sciences (SPSS). The significance level in all tests was $p < 0.05$.

RESULTS

Ear length (EL) and width (EW) did not show significant bilateral difference among the studied sample of the Malaysian populations. EL mean among the Malaysian populations was 63.4 without significant bilateral variation (p 0.792) as it was 63.6 mm in the right ear and 64.3 in the left ear. EW mean among the Malaysian populations was 29.3without significant bilateral variation (p 0.835) as it was 29.4 mm in the right ear and 29 in the left ear (Table 1).

Ear length (EL) and width (EW) did not show significant sexual variation among the studied sample of the Malaysian populations. EL range in females was 45 – 81 mm and 39 – 82 mm in males without significant gender variation (p 0.480). EW range in females was 18 – 40 mm and 15 – 38 mm in males without significant gender variation (p 0.645). It is noticed also that the EL and EW are larger in females than males (Table 2). Ear length (EL) and width (EW) showed a significant intraracial gender variation among the studied 3 main Malaysian ethnics. Biggest EL was detected in Indian females (68.8 mm) and smallest EL among Chinese males (60.7 mm). Biggest EW was detected in Indian males (31.2 mm) and smallest EW among Chinese males (27.1 mm) (Table 3).

Data showed the earlobe attachment with sexual variation involved shows that males have more attached to the face earlobe (n = 78) compared to females who have more freely hanging lobule from the face (n = 86) with no difference between left and right ear. Ear lobe was attached in both right and left sides in 78 (53.06%) of the studied males and 61 (41.49%) of the studied females (Table 4).

Intra-racial gender characteristics were studied regarding the earlobe attachment to show that 28 (57.14%), 31 (63.26%) and 19 (38.77%) of the Malay, Chinese and Indian males have attached ear lobe respectively. While, 21 (42.85%), 21 (42.85%), and 19 (38.77%) of the Malay, Chinese and Indian females have attached ear lobe respectively. The attachment / not attachment number of participants was 28:21 in Malay males, 31: 18 in Chinese males, 19:30 in Indian males, 21:28 in Malay females, 21: 28 in Chinese males, and 19:30 in Indian females with no difference between right and left ear. (Table 5). By using lobule characterization, it can be stipulated that Chinese male and Malay male have lobules that are attached to the face compared to Indian male. Meanwhile, for freely hanging lobule from the face, females dominate by taking lead in Malay, Chinese and Indians. As a whole, males have

lobules that are attached to the face while females have lobules that are freely hanging from the face.

The right ear was mostly trianglular in shape among Malay males (10/49) and the oval ear shape Malay females (16/49). While the left ear was mostly trianglular (15/49) or oval (15/49) among Malay males and round (19/49) among Malay females. In Chinese adults, the oval ear shape was the commonest among both males and females either in the left or right ear (38/98). In Indian adults, the right ear was mostly rectangular among males (15/49) and the oval among females (15/49) while the left ear was mostly oval among males (15/49) and round among females (20/49). The most common ear shape observed is traiangular among the Malay males (30.6%), rounded among the Malay females (31.6%) and Indian females (34.7%), oval among the Chinese (38.8%) and the Indian Males (28.5%) (table 6).

DISCUSSION

It has been proven that the racial variations has been exist among the the Malaysian races regarding biometrics of the face [13], head[14 & 15] and eye [16]. The current research is planned to determine the morphometric and biometrics characteristics of ear among adult Malaysian population in Shah Alam area. It was found that EL and EW did not show significant bilateral variations. This means that in terms of measurements, the left and right ear of young adults in Shah Alam were generally similar that may be can be explained as karyotype background [17]. Most of the previous studies showed similar results as the bilateral differences were not statistically significant for ear length and ear width [17 - 19]. This bilateral insignificance revealed that intra-person variety was lower than inter-person variety. There can be a few exemptions that caused by diverse population, gender,and sample size and age utilized in several researchs. Paediatrics are routinely having bilateral asymmetry of ear biometrics in comparison to adults. Males are having more asymmetry than females [20]. On studying the morphological age changes in adult human auricular elastic cartilage, it was found that the size of auricle increases significantly with age in both men and women due to the changes in the elastic fibres after reaching adulthood[21].

The results of the present research showed the EL and EW are generally larger in females than males but with non significant gender variation among the studied sample of the Malaysian populations while analysis of the intra-racial gender variations showed a significant variation among the studied 3 main Malaysian ethnics. Another study showed no significant gender differences but with males' mesurements more than females[22]. On the other hand, a previous study under Karl Marx-Leipzig University showed the ear length, breadth and base of auricle are larger in males than in females while the length and breadth of earlobe were larger in females[10]. In fact previous studies have proved the sexual dimorphism existing in auricular linear dimensions between males and females with higher values seen in males compared to females [8, 11, 17, 23].

The racial variations among the studied 3 main Malaysian ethnics in this study, is previously observed with other races. In contrary, White and Negro populations did not have significant difference in width and length of ear[24]. This was contributed to genetic convergence because of living in a similar environment or having intermarriage among variety of races. Another study showed significant difference between races among males [20]. A significant difference in ear height was observed between Turkish and Japanese populations and males within the Turkish population have longer total auricular height and width compared to males of Japaneses populations[25].

Regarding the earlobe attachment in the studied sample, Chinese have attached earlobe more than Malay more than Indians respectively. Males have attached earlobe more than

females. Similar gender variation is proven previously [23] . The attached earlobe was found in more than 50–56% in the subjects from upper reaches of Himachal Pradesh in North India[26].

In the present research, The most common ear shape observed is traiangular among the Malay males (30.6%), rounded among the Malay females (31.6%) and Indian females (34.7%), oval among the Chinese (38.8%) and the Indian Males (28.5%). Not much studies are available for the morphological characteristics of the ear[12, 27-31]. North Indians have oval (40% of males and 44.8% of females respectively), rounded (20% of males and 17–18% of females respectively), and rectangular (2–9%) ear shape [26]. Dutch population had oval ear (68.7%), rectangular (9.1%) and rounded (3%) ear[32]. Americans had oval (65%), rectangular (3%) and rounded (2%) ear[33]. The ear shape distribution among Central Indian population was 47–52% oval, 26–30% rectangular, 26–35% triangular, and 23–59% round [31].

Limitations

The obtained reults are only applicable for Shah Alam young adults in three main races and does not include minorities. Inclusion of more sample size may produce more reliable results to be applicable to whole Malaysian population.

CONCLUSION

Ear length, breadth and base of auricle were found larger in males than in females while the length and breadth of earlobe were larger in females. By using lobule characterization, it can be stipulated that Chinese male and Malay male have lobules that are attached to the face compared to Indian male. Meanwhile, for freely hanging lobule from the face, females dominate by taking lead in Malay, Chinese and Indians. As a whole, males have lobules that are attached to the face while females have lobules that are freely hanging from the face. In terms of shape distribution, the shapes oval, round, rectangular and triangular are nearly equally distributed among young adults in Shah Alam.

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Table 1 : Bilateral ear morphology biometrics (mm) among the Malaysian population.

Ear Biometrics	Right ear (n = 296)		Left ear (n = 296)		T - test			
	Mean	SR	Mean	SR	Mean	SR	p	R*p<0.05
EL	63.6	0.5	64.3	0.5	63.4	0.5	0.307	0.792*
EW	29.4	0.3	29	0.3	29.3	0.3	0.276	0.835*

Measurements are done by mm. SE: Standard Error.

Table 2 : Descriptive Statistics for ear morphology biometrics (mm) among the Malaysian population according to in gender

Ear Biometrics	Female (n = 148)			Male (n = 148)			T - test
	Min	Max	SE	Min	Max	SE	p
EL	45	81	0.7	39	82	0.7	0.480
EW	18	40	0.4	15	38	0.4	0.645

Measurements are done by mm. SE: Standard Error.

Table 3: Intra-racial gender comparison of ear biometrics among the studied sample of the adult Malysian ethnics

	Malay (n = 49)			Chinese (n = 49)			Indian (n = 49)			Anova
	Male	Female	SE	Male	Female	SE	Male	Female	SE	p
EL	62.9	61.7	1.3	60.7	63	1.2	68.7	68.8	0.8	<0.01
EW	28.0	27.9	0.7	27.1	28.5	0.7	31.2	31.1	0.5	<0.01

Measurements are done by mm. SE: Standard Error.

Table 4: Study of the earlobe attachment among the study participants of the adult Malaysian population

A.	B. **Attached (no of cases)**		C. **Non – attached (no of cases)**	
	D. **Right**	E. **Left**	F. **Right**	G. **Left**
H. **Male**	I. 78	J. 78	K. 69	L. 69
M. **Female**	N. 61	O. 61	P. 86	Q. 86

Table 5 : Bilateral study of the Intra-racial gender comparison of earlobe attachment among the studied sample of the adult Malysian ethnics

		Attached						**Non - Attached**					
		Malay (n=98)		**Chinese (n=98)**		**Indian (n=98)**		**Malay (n=98)**		**Chinese (n=98)**		**Indian (n=98)**	
		M (n=49)	**F (n=49)**	**M (n=49)**	**F (n=49)**	**M (n=49)**	**F (n=49)**	**M (n=49)**	**F (n=49)**	**M (n=49)**	**F (n=49)**	**M (n=49)**	**F (n=49)**
Right	n	28	21	31	21	19	19	21	28	18	28	30	30
	%	57.14	42.85	63.26	42.85	38.77	38.77	42.85	57.14	36.37	57.14	61.22	61.22
Left	n	28	21	31	21	19	19	21	28	18	28	30	30
	%	57.14	42.85	63.26	42.85	38.77	38.77	42.85	57.14	36.37	57.14	61.22	61.22

Table 6 : Ear shape based on race and gender in the studied sample of the Malaysian population.

Shape		**Malay (n=98)**		**Chinese (n=98)**		**Indian (n=98)**	
		49 Male (98 ears)	**49 Females (98 ears)**	**49 Male (98 ears)**	**49 Females (98 ears)**	**49 Male (98 ears)**	**49 Females (98 ears)**
Oval	**RIGHT**	10	16	20	18	13	15
	LEFT	15	10	18	20	15	14
	TOTAL	25 (25.5%)	26 (26.5)	**38 (38.8%)**	**38 (38.8%)**	**28 (28.5%)**	29 (29.5%)
Round	**RIGHT**	15	12	13	15	9	14
	LEFT	11	19	15	17	10	20

	TOTAL	26 (26.5)	**31 (31.6%)**	28 (28.5%)	32 (32.6%)	19 (19.4%)	**34 (34.7%)**
Rectangler	**RIGHT**	9	13	5	8	15	6
	LEFT	8	7	5	6	12	8
	TOTAL	17 (17.3%)	20 (20.4%)	10 (10.2%)	14 (14.3%)	27 (27.5%)	14 (14.3%)
Triangular	**RIGHT**	15	8	11	8	12	14
	LEFT	15	13	11	6	12	7
	TOTAL	**30 (30.6%)**	21 (21.4%)	22 (22.4%)	14 (14.3%)	24 (24.5%)	21 (21.4%)

Figure 1: Morphological shapes of ears (a. Oval b. Round c. Triangular d. Rectangular)