

ORIGINAL ARTICLE

Sex Determination by Morphometry of Eyes*Senthil Kumar B*

*Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College & Hospital,
Vinayaka Mission's Research Foundation (Deemed to be University), Salem- 636308 (TamilNadu)
India.*

Abstract:

Background: Facial anthropometrics are affected by various factors such as age, sex, ethnicity, socioeconomic status, environment and region. The anthropometric analysis of face is essential for craniofacial plastic and reconstructive surgeries. *Aim & Objectives:* The purpose of this study was to create a baseline data in determining the sex of the people from India and Malaysia depending on morphometry of eyes. *Material and Methods:* A total of 100 Malaysians and 100 South Indians were enrolled for the study. Various morphometric measurements of eyes were taken using Digital Vernier caliper. The data were analyzed by independent t test for comparison of sides and one way ANOVA to find out the significance among the sex and populations. *Results:* The height of upper and lower eye lid were higher in females as compared to that of males whereas depth of eyes and interpupillary distance were higher in males than in females and thus sexual dimorphism exists. Fissure height and biocular width were more in Indian males when compared to Indian females. Fissure height and interocular width were more in Malaysian female when compared to other groups. Indian males and females differed significantly in upper and lower eye lids height from Malaysian males and females. All eye morphometric parameters except interpupillary distance were increased in Malaysians when compared to Indians thus ethnic variations also exist. *Conclusion:* The facial aesthesia is highly contributed by eye appearance and symmetry, facial rejuvenation by a plastic surgeon requires morphometric data of eye.

Keywords: Morphometry, Indian, Malaysian, Facial Aesthetics, Eyes

Introduction:

Anatomical dimensions of facial structures are considered to be useful for plastic surgeons undertaking repair and reconstruction of facial deformities and to maintain proportions of facial structures [1, 2]. The physical appearance of an individual is associated with various factors such as social- psychological well-being, and the self-esteem of an individual which is strongly dependent on facial appearance. An attractive pleasing face depends on many factors such as culture, personality, ethnic background and age [3]. To plan the surgical corrections of craniofacial structures the knowledge of craniofacial norms of the patient's ethnic groups are very much essential [4, 5]. Surgeons must consider the specific facial structures of the patients when planning for reconstructive surgery [6]. Aesthetic correction from surgical treatments depends on proportions of anatomic structures present. The anthropometric methods were used in practice to quantify the craniofacial structures for distinguishing various races/ethnic groups [4]. Anthropometry uses direct measurements to analyze the size of the soft tissues in the face [6]. Obtaining measurements of the soft tissues of the face is important in terms of achieving aesthetic criteria [7]. A number of studies have investigated facial profiles by measuring the

angles and separation of the soft tissues using cephalographs, two-dimensional photogrammetry or direct measurements [8-10].

Facial aesthetics play an important role in self-identification, self-image, self-presentation, and interpersonal confidence. Furthermore, they affect social behavior. Therefore, in most cultures, the face is regarded as the most salient characteristic of one's identity [11]. The present study is a part of a research work on morphometry of facial structures. To create a baseline data's in determining the sex of the people from India and Malaysia depending on morphometry of the eyes.

- Primary Objective – To compare the morphometric data of eyes between the male and female for sexual dimorphism.
- Secondary Objective – To compare the morphometric data of eyes in between two groups of populations for ethnic variations.

Material and Methods:

This cross-sectional study was approved by Institutional Ethics Committee of Vinayaka Mission's Kirupananda Variyar Medical College & Hospital, Salem (VMKVMC/IEC/18/02). A total of 100 Malaysians (50 males and 50 females) and 100 South Indians (50 males and 50 females) of age group ranging between 20 to 40 years were enrolled for the study and an informed consent was taken from each one of them. This cross sectional study was carried out in VMKV Medical College & Hospital, Salem. In each population sampling was done by random sampling methods. Volunteers with any anomalies on face were excluded from the study. Various morphometric measurements of eyes such as height of an eye lid was measured between palpebrale superioris to orbitale superius (Fig 1), interocular width was measured between 2 endocanthion, biocular

breadth was measured between 2 ectocanthion, ocular width was taken between endocanthion to ectocanthion, fissure height was the distance between two palpebralia, interpupillary distance was measured between 2 pupilaria, depth of an eye was the distance between glabella to ectocanthion (Fig 2), were measured using digital caliper [12].

Statistical analysis:

Data were tabulated and analyzed by independent "t" test for comparison in between Malaysian and Indian male and female and also for side comparison. One way ANOVA was done to find out the significance among the Malaysian and Indian sex and *post hoc* pair wise comparison among the groups. The statistical analysis was done using the online graph pad calculator and statpages. $P < 0.05$ was considered as statistically significant.

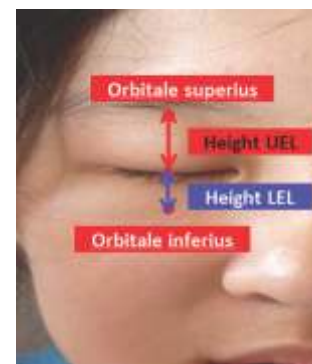


Fig. 1: Morphometry of Eye Lids
UEL - Upper Eye Lid, LEL – Lower Eye Lid

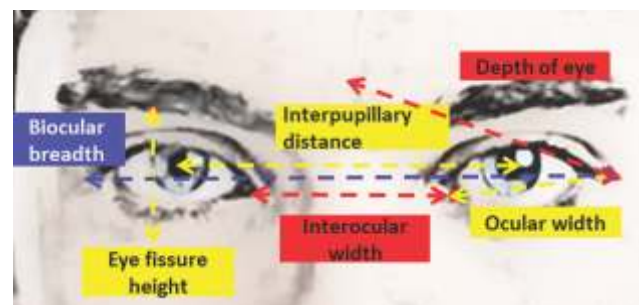


Fig. 2: Morphometry of Eyes

Results:

The morphometric data was collected and analyzed by one way ANOVA to find out the significance among the population and *post hoc* pair wise to compare between the sexes. The height of upper and lower eye lid were higher in Malaysian females as compared to that of Malaysian males. The height of upper eye lids was found to be more in Indian males and females

followed by Malaysian males and females (Table 1). The height of lower eye lids was found to be more in Indian males followed by Indian females and vice versa in Malaysian population (Table 1). When compared to the population the upper eyelid height was found to be highly statistically significant (Table 1).

Table 1: Morphometry of Eyelids in Both Populations

Population	Sex	Height of upper eyelid Mean ± SD (cm)		Height of lower eyelid Mean ± SD (cm)		
		Side	L	R	L	R
Malaysian	Male		0.41±0.28	0.40±2.82	0.25±0.14	0.23±0.14
	Female		0.54±0.21**	0.55±0.14 [#]	0.36±1.34 [#]	0.37±1.34***
Indian	Male		1.4±0.35	1.3±0.28	1.21±0.14	1.3±0.20
	Female		1.2±0.42**	1.1±0.57*	1.18±0.49 [#]	1.2±0.57***
P value	(ANOVA)		0.001***	0.01*	0.001***	0.001***

Values are expressed as Mean ± SD, n = 100 in each population with 50 males & 50 females, # - non significant, * - significant, P value *P<0.05, **P< 0.01, ***P<0.001. Statistical analysis – Independent t test (Gender Comparison) & One Way ANOVA (Population Comparison)

Table 2: Morphometry of Ocular and Pupillary Distance in Both Populations

Population	Sex	Bi-ocular breadth Mean ± SD (cm)	Interocular width Mean ± SD (cm)	Interpupillary distance Mean ± SD (cm)
Malaysian	Male	10.6±1.2	3.44±0.42	6.11±0.85
	Female	10.1 ±1.34 [#]	3.69 ±1.41 [#]	5.46 ± 1.06 *
Indian	Male	9.5 ± 0.84	3.49 ± 1.13	6.24 ± 0.35
	Female	8.8 ± 0.77 *	3.27 ± 0.78 [#]	6.12± 0.07 [#]
P Value	(ANOVA)	0.001***	0.22 [#]	0.001***

Values are expressed as Mean ± SD, n = 100 in each population with 50 males & 50 females, # - non significant, * - significant, P value *P<0.05, **P< 0.01, ***P<0.001. Statistical analysis – Independent t test (Gender Comparison) & One Way ANOVA (Population Comparison)

The interpupillary distance (Table 2) and depth of eye (Table 3) were higher in males than in females and thus sexual dimorphism exists. Biocular width (Table 2) and fissure height (Table 3) were more in Indian males when compared to Indian females. Interocular width (Table 2) and eye fissure height (Table 3) were more in Indian male when compared to other groups.

All eye morphometric parameters except interpupillary distance (Table 2) were found to be more in Malaysians when compared to Indians thus ethnic variations also exist.

The measurement were compared among Indian and Malaysian population using Post HOC pairwise comparison to find out the significant difference of male and females among the population group and compare it (Table 4 and 5).

Table 3: Morphometry of Depth and Fissure of Eyes in Both Populations

Population	Sex	Depth of eyes Mean ± SD (cm)		Ocular width Mean ± SD (cm)		Eye fissure height Mean ± SD (cm)	
		L	R	L	R	L	R
Malaysian	Male	6.12±1.20	6.6±1.20	3.84±0.71	3.9±0.49	1.2±0.70	1.2±0.71
	Female	5.4±0.42**	5.7±0.70**	3.5±0.28**	3.4±0.28**	1.3±0.35 [#]	1.4±0.35 [#]
Indian	Male	5.9±0.42	5.9±0.49	3.32±0.35	3.3±0.35	1.6±0.14	1.7±0.21
	Female	5.4±1.41**	5.2±1.41**	3.03±0.92**	3.05±0.92 [#]	0.99±0.07**	0.97±0.21**
P value	(ANOVA)	0.002**	0.001**	0.001**	0.001**	0.001**	0.001**

Values are expressed as Mean ± SD, n = 100 in each population with 50 males & 50 females, # - non significant, * - significant, P value *P<0.05, **P< 0.01, ***P<0.001. Statistical analysis – Independent t test (Gender Comparison) & One Way ANOVA (Population Comparison)

Table 4: Post HOC Pair wise Comparison of Morphometry of Eyes among Malaysian and Indian Population

	Bi-ocular breadth	Interocular width	Interpupillary distance
Malaysian M vs Malaysian F	NS	NS	S
Malaysian M vs Indian M	S	NS	NS
Malaysian M vs Indian F	S	NS	NS
Malaysian F vs Indian M	S	NS	S
Malaysian F vs Indian F	S	NS	S
Indian M vs Indian F	S	NS	NS

M – Male, F – Female, vs – versus, n = 100 in each population with 50 males & 50 females, NS - non significant, S - significant, P value *P<0.05, **P< 0.01, ***P<0.001, Statistical analysis – Post HOC Pairwise Comparison

Table 5: Post HOC Pair wise Comparison of Morphometry of Eyes among the sides and Population

	Depth of eyes		Ocular width		Eye fissure height		Height of upper eye lid		Height of lower eye lid	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Malaysian M vs Malaysian F	S	S	S	S	NS	NS	NS	NS	NS	NS
Malaysian M vs Indian M	NS	S	S	S	S	S	S	S	S	S
Malaysian M vs Indian F	S	S	S	S	S	S	S	NS	S	S
Malaysian F vs Indian M	S	NS	NS	NS	S	S	S	S	S	S
Malaysian F vs Indian F	NS	S	S	S	S	S	S	NS	S	S
Indian M vs Indian F	S	S	NS	NS	S	S	S	NS	NS	NS

*M – Male, F – Female, vs – versus, n = 100 in each population with 50 males & 50 females, NS - non significant, S - significant, P value *P<0.05, **P< 0.01, ***P<0.001 Statistical analysis – Post HOC Pairwise Comparison*

Discussion:

Various landmark data were used to determine the differences between male and female facial structures. Racial and ethnic differences in the facial traits of American and European Caucasian, Afro-American, Malaysian Indian, Arabians and Chinese have been reported by several authors [8, 13-15]. In the present study, all the parameters were higher in the Indian males when compared to Indian females, whereas in case of Malaysians except eyelid height, eye fissure height and interocular distance were found to be more in male than in females. In a study done by Karaca *et al.*, when compared with both sexes, a significant difference was found in all measurements except the upper eye-fissure width [16], but in the present study the eye fissure height of Indian population showed significant difference whereas, Malaysian population showed no significant difference. Twenty-three anthropometric measurements related with facial soft tissue were compared with those reported by Farkas *et al.* [8]

for American–Caucasian adults, Ngeow *et al.* [13] for Malaysian Indian people. The mean result of biocular width of Turkish adults (96.51 mm in female, 99.74 mm in male) is longer than Malaysian Indian (89.4 mm in female, 92.1 mm in male) and American–Caucasian (87.6 mm in female, 90.7 mm in male) [16]. In case of the present study the biocular width of Malaysians (106 mm in male, 101mm in female) was found to be longer than Indians (95 mm in male, 88 mm in female) (Table 2). In addition another notable finding is that the eye fissure (ocular) width (left) was longer in Turkish adults than from American–Caucasian and Malaysian Indian people [16]. In the present study the ocular width was found to be more in Malaysian male when compared to Indian male (Table 3).

As no studies on only morphometry of eyes were done, this study will serve as a wider reference in future for anthropologist for sex determination and surgeons for constructive plastic surgery.

Conclusion:

This study has the forensic significance of personal identification, racial and sex dimorphic criteria for identification.

Same standards cannot be used on each population for identification of sex and cosmetic surgery as ethnic variation exists. The morphometry of eye can be used as an effective additional tool along with other observations in constructing the face of an individual for forensic investigations. The facial aesthesis is highly contributed by eye appearance and symmetry, facial rejuvenation by a plastic

surgeon requires morphometric data of eye. The morphometry of eyes data also required for surgical correction of ptosis, eye lens preparations, eye tracking glasses and spectacles manufacturing, eye tracking medical research in combination with conventional research methods or other biometric sensors for diagnosing various diseases such as Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Obsessive Compulsive Disorder (OCD), Schizophrenia, Parkinson's and Alzheimer's disease.

References

- Zahra H, Hamidreza MS, Azam AR, Narjes D. Anthropometric measurements of the lips in 18-25-year-old men of Sistani and Baluch Descent. *Bull Env Pharmacol Life Sci* 2014; 3(12): 139-42.
- Uzun A, Akbas H and Bilgic S. The average values of the nasal anthropometric measurements in 108 young Turkish males. *Auris Nasus Larynx* 2006; 33(1): 31-5.
- Fernandez P, Smyth E and Suárez D. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod* 2003; 25(4): 393-9.
- Choe KS, Sclafani AP, Litner JA, Yu PG. The Korean American woman's face: anthropometric measurements and quantitative analysis of facial aesthetics. *Arch Facial Plast Surg* 2004; 6(4): 244-52.
- Sforza CH, Grandi G and Binelli M. Age and sex related changes in three dimensional lip morphology. *Forensic Sci Int* 2010; 200(1-3): 182.
- Arslan S, Genc C, Odabas B, Kama JD. Comparison of facial proportions and anthropometric norms among Turkish young adults with different face types. *Aesthetic Plast Surg* 2008; 32(2): 234-42.
- De Menes M, Rosati R, Baga I, Mapelli A, Sforza C. Three dimensional analysis of labial morphology: effect of sex and age. *Int J Oral Maxillofac Surg* 2011; 40(2): 856-61.
- Farkas LG, Katic MJ, Forrest CR, Alt KW, Bagic I, Baltadjiev G, et al. International anthropometric study of facial morphology in various ethnic groups/races. *J Craniofac Surg* 2005; 16(4): 615-46.
- Taskinalp O, Erdem N. Some vertical proportions of the face in Turkish adults. *Balkan Med J* 2009; 26(1):49-52.
- Porter JP, Olson KL. Anthropometric facial analysis of the African American woman. *Aesth Plast Surg* 2001; 3(3): 191-7.
- Bazmi BA, Zahir S. A cross-sectional study of soft tissue facial morphometry in children of West Bengal. *Contemp Clin Dent* 2013; 4(1):42-7.
- Indera P Singh, Bhasin MK. A manual of biological anthropology. 2nd Ed. Delhi: Kamla Raj enterprises; 1995: 232-57.
- Ngeow WC and Aljunid ST. Craniofacial anthropometric norms of Malaysian Indians. *Indian J Dent Res* 2009; 20(3): 313-9.
- Ofodile FA, Bokhari F, Ellis C. The black American nose. *Ann Plast Surg* 1993; 31(3): 209-18.
- Sforza C, Laino A, D'Alessio R, Dellavia C, Grandi G, Ferrario VF. Three-dimensional facial morphometry of attractive children and normal children in the deciduous and early mixed dentition. *Angle Orthod* 2007; 77 (6):1025-33.
- Karaca Ö, Gülcen B, Ku MA, Elmalı F, Ku . Morphometric facial analysis of Turkish adults. *Balikesir Saglik Bil Derg* 2012; 5(1): 7-11.

***Author for Correspondence:** Dr. B. Senthil Kumar, Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Vinayaka Mission's Research Foundation (Deemed to be University) Salem – 636308, Tamil Nadu, Email: skdrchinu88@gmail.com Cell: 9894398677