Facial Anthropometry in an Arab Population

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Objective: To measure the inter-alar width of the nose, the maxillary inter-canine distance and mouth width of an Arab sample and evaluate the ethnic variations.

Design: A prospective study.

Setting: College of Medicine and Medical Sciences, Arabian Gulf University, Bahrain.

Method: One hundred sixty-eight young adult Arab subjects (51 males and 117 females), from five countries of the Gulf Cooperation Council (GCC), were selected randomly from undergraduate medical students during the academic year 2009/2010. Mouth, nose and teeth dimensions were measured using Vernier caliper; for each subject, three measurements were taken and the average was recorded.

Result: The mean inter-alar width of the nose was 35.06 mm (37.14 mm in males and 33.21 mm in females). The mean maxillary inter-canine distance was 37.96 mm (39.66 mm in males and 36.38 mm in females). The mean mouth width was 50.66 mm (52.85 mm in males and 48.63 mm in females). The maxillary inter-canine distance was 75% of mouth width; therefore, the mouth width is a reliable predictor of the maxillary inter-canine distance and vice versa in the Arab population. Comparison between nationals from different GCC countries showed that Bahraini males had significantly wider mouths than Saudi Arabian males (P=0.034).

Conclusion: GCC Arab males had significantly wider noses, broader maxillary arches and wider mouths than females (P<0.001). Anterior maxillary arches were found to be wide in males and females, which seems to be an ethnic characteristic in Arabs of this region.

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Measurements of the inter-alar width of the nose, the distance between the tips of the upper canine teeth and mouth width are important for making appropriate prosthetic teeth, in aesthetic medicine, anthropology and forensic medicine. The principle behind forensic facial reconstruction depends on the shape and proportions of facial bone. The technique of facial approximation is often used to identify skeletal remains[1,2]. This technique consists of building people's faces from their skulls. Mouth width is usually predicted by the measurement of the maxillary inter-canine distance, pupil width and medial iris width or by using the canine's bony landmarks[2].

During prenatal development, the medial nasal process, a subdivision of the fronto-nasal process from the first branchial arch, determines the nose size as well as the position of the maxillary canines[3]. This nasal/alveolar relationship continues during post-natal development[4]. In the face, the two maxillary canines determine the position of the other maxillary teeth as well as the shape of the upper lip. The upper lip tends to protrude if the canines are close together and to sink inwards if the canines are excessively separated from each other[5]. The size and shape of the maxillary anterior teeth are important in achieving pleasing dental and facial esthetics[6]. Patients receiving their first dentures often expect to appear similar to their natural teeth. One of the most important aspects of the complete denture prosthodontics is the selection of appropriately sized maxillary anterior denture and the width of the nose can be used as a reliable guide for selection of the maxillary anterior teeth width[7].

Studies on mouth width, inter-alar width of the nose, and the maxillary inter-canine distance and their relationships have been reported for several populations including Malays, Brazilians, Caucasians, Nigerians and Chinese[5,7-9].

There is a paucity of such studies in the Arab population. The aims of this study are to establish a baseline data for the mouth width, the inter-alar width of the nose and the distance between the tips of the maxillary canines in an Arab population and to explore the significant correlation between the three facial measurements in the population studied.

METHOD

One hundred sixty-eight Arab students (51 males and 117 females) were selected randomly from the College of Medicine and Medical Sciences (CMMS), Arabian Gulf University (AGU) in Bahrain during the academic year 2009/2010.

Each student signed a consent form permitting the anthropometric measurements of the nose, mouth and teeth. A female investigator did the measurements for females, while a male investigator (the first author) did all the measurements for males. Mouth, nose, and teeth dimensions were measured with a caliper gauge having a Vernier scale accuracy of 0.05 mm, see figure 1. Three readings were taken for each facial measurement and the average was recorded.
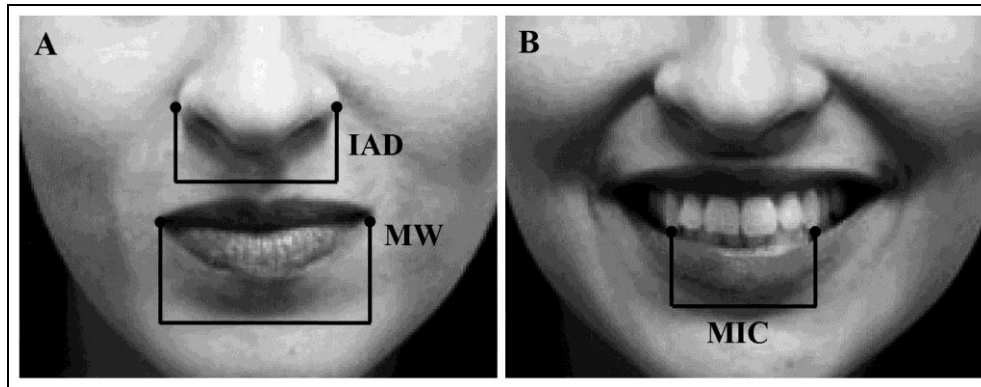
Figure 1: Facial Measurements Used in the Present Study (IAD = Inter-alar Distance, MW = Mouth Width and MIC = Maxillary Inter-canine Width)

To measure the mouth width, each subject was asked to look straight in front and adopt a relaxed, neutral facial expression to prevent any distortion of the lips or the angles of the mouth. The tips of the Vernier calipers were placed on the lateral-most aspects of the angle of the mouth on each side (chelion to chelion). The inter-alar width of the nose was measured by placing the side of the Vernier calipers in light contact with the skin of the lateral-most aspects of the alae nasi. The maxillary inter-canine distance was measured between the tips of the maxillary canines. Students with previous orthodontic treatment, periodontal disease and facial deformities or previous surgery of the face were excluded from the study.

Data were analyzed using the statistical package SPSS (version 13). The independent-samples t-test was used to ascertain significance of differences between males and females in the means of the inter-alar width of the nose, the maxillary inter-canine distance and the mouth width. P-value of <0.05 was considered to be statistically significant. Pearson's linear correlation coefficient was used to measure the degree of linear relationships between the three facial measurements for each subject.

RESULT

One hundred sixty-eight Arab students were included in this study, 51 were males and 117 were females. Sixty-four students (17 males, 47 females) were from Bahrain, 53 students (10 males, 43 females) were from Saudi Arabia, 38 students (20 males, 18 females) were from Kuwait, 7 students (2 males, 5 females) were from Oman, 2 students (both females) were from the United Arab Emirates and 4 students (2 males, 2 females) were Arabs from non-GCC countries. In AGU, 95% of students are GCC nationals and 5% are Arabs (non-GCC nationals) residing in one of the GCC countries. The majority of medical students (70%) in AGU are females. The mean age of male students was 19.98 years (±1.53) with a range 18-24 years, while the mean age of female students was 19.57 years (±0.86) with a range 18-23 years. The difference between the ages of males and females was statistically not significant.

Table 1 shows the mean values for inter-alar width of the nose (IAW), maxillary inter-canine distance (ICD) and mouth width (MW). The mean inter-alar width of the nose was 35.06 mm (37.14 mm in males and 33.21 mm in females), the mean maxillary inter-canine distance was 37.96 mm (39.66 mm in males and 36.38 mm in females) and the mean mouth width was 50.66 mm (52.85 mm in males and 48.63 mm in females). The differences of these three facial measurements between males and females were statistically significant (P<0.001). This was confirmed using the Student's t-test, IAW (t=7.52), ICD (t=7.93) and MW (t=7.63).

Table 1 also shows that in the Arab population the maxillary inter-canine distance was 75% of mouth width (or mouth width was 133% of maxillary inter-canine distance). The ICD/IAW ratio was 1.083 for all subjects (n=168), 1.068 for male subjects (n=51) and 1.095 for female subjects (n=117).

Table 1: The Mean, Standard Deviation and Range of the Inter-alar Width of the Nose, the Maxillary Inter-canine Distance and the Mouth Width

	Males (n=51)		Females (n=117)		Total (n=168)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Inter-alar Width of the Nose	37.14* ± 3.4	30 - 45	33.21 ± 2.4	27 - 39	35.06 ± 3.7	27 - 45
Maxillary Intercanine Distance	39.66* ± 2.4	33 - 45	36.38 ± 2.5	28 - 43	37.96 ± 2.8	28 - 43
Mouth Width	52.85* ± 3.3	47 - 60	48.63 ± 3.4	41 - 57	50.66 ± 3.6	41 - 60

*$p<0.001$

Table 2 shows the mean values for the three facial measurements only in subjects from Bahrain, Saudi Arabia and Kuwait because of greater number of subjects (155 students out of 168). In each of these three nationalities, male subjects had higher values than female subjects for all the three facial features studied but these differences were not statistically significant. In addition, Bahraini males had significantly wider mouths than Saudi Arabian males (P=0.034). However, none of the other facial measurements showed a statistically significant difference when compared between Bahrainis, Saudi Arabians and Kuwaitis, see table 2.

Table 2: The Mean and Standard Deviation of the Inter-alar Width of the Nose, the Maxillary Inter-canine Distance and the Mouth Width

Measurement	Nationality	Male		Female		Total	
		No.	Mean ± SD	No.	Mean ± SD	No.	Mean ±SD
Inter-alar Width of the Nose	Bahrain	17	39.69 ± 3.1	47	33.26 ± 2.26	64	34.97 ± 3.79
	KSA	10	36.25 ± 2.11	43	33.29 ± 2.34	53	33.85 ± 2.56
	Kuwait	20	35.45 ± 3.24	18	32.42 ± 2.74	38	34.01 ± 3.35
Maxillary Inter-canine Distance	Bahrain	17	40.41 ± 2.33	47	36.48 ± 2.90	64	37.53 ± 3.25
	KSA	10	39.67 ± 2.80	43	36.45 ± 2.27	53	37.06 ± 2.67
	Kuwait	20	38.78 ± 2.31	18	35.99 ± 2.33	38	37.46 ± 2.69
Mouth Width	Bahrain	17	53.59* ± 2.64	47	49.37 ± 3.56	64	50.50 ± 3.81
	KSA	10	52.62 ± 3.87	43	48.13 ± 3.35	53	48.97 ± 3.85
	Kuwait	20	52.53 ± 3.60	18	47.72 ± 3.58	38	50.25 ± 4.30

KSA = Kingdom of Saudi Arabia, No = Number; *$p=0.034$

A weak but significant correlation was seen between inter-alar width of the nose and maxillary inter-canine distance (r=0.466, P<0.001), between inter-alar width of the nose and mouth width (r=0.489, P<0.001) and between the maxillary inter-canine distance and mouth width (r=0.440, P<0.001).

Table 3 shows the mean values for facial measurements in different populations. Anthropometric studies of facial measurements show wide variation between different ethnic groups.

Table 3: Means of the Inter-alar Width of the Nose, Maxillary Inter-canine Distance and Mouth Width (Chelion to Chelion) in Different Populations[2,5,7,9-12]

Author and Year	Population	No. of Subjects	Inter-alar Width of the Nose (mean)		Maxillary Inter-Canine Distance (mean)		Mouth Width (chelion to chelion) (mean)	
			Males (mm)	Females (mm)	Males (mm)	Females (mm)	Males (mm)	Females (mm)
Keng (1986)	Chinese	118	39.60	36.41	35.60	34.96	-	-
Dharap et al. (1997)	Malays	266	39.80	36.20	36.70	36.20	-	-
Farkas et al. (2005)	North American Whites	-	34.70	31.40	-	-	-	-
Farkas et al. (2005)	Portuguese	-	36.60	31.90	-	-	-	-
Farkas et al. (2005)	Thai	300	40.80	40.20	-	-	-	-
Farkas et al. (2005)	Angolan	210	46.30	40.80	-	-	-	-
Gomes et al. (2009)	Brazilian	81	43.19	38.79	38.01	37.05	-	-
Stephan, Henneberg (2003)	Central/South East Asian	32	-	-	-	-	54.21	51.22
Stephan, Henneberg (2003)	European	64	-	-	-	-	55.01	51.41
Arslan et al. (2008)	Turks	173	37.00	32.70	-	-	50.02	47.30
Patnaik, Goel (2010)	North Indian	250	-	-	-	-	46.83	43.88
Dharap et al. (Present Study)	Arabs (Middle East)	168	37.14	33.21	39.66	36.38	52.86	48.63

DISCUSSION

Anthropometric studies of facial measurements show wide variation between different ethnic groups[11]. For example, Arab males in our study had the widest maxillary inter-canine distance amongst the populations compared. Paulino et al reported high correlations between the distance between tips of the canines and the arch length, both for the upper and lower arches and for males and females, r=0.925, indicating a linear relationship[13]. They concluded that the distance between the tips of the canines could be used in predicting arch length of artificial teeth for preparing dentures or for cosmetic procedures. Arab males have the widest anterior maxillary arches; Brazilian males show slightly wide arches and Chinese males had the narrowest ones[7,9,14]. Brazilian females have the widest anterior maxillary arches, female Arabs have arches only slightly narrower than those seen in Brazilians and the Chinese have the narrowest arches. In general, the Arab population (males and females) have wide anterior maxillary arches. A buccal location of the maxillary canines could explain the reason for this variation. A wider anterior maxillary arch could be an ethnic characteristic for Arabs.

In general, males are known to have a wider inter-alar width of the nose than females. In our study, males were seen to have a significantly wider inter-alar width of the nose than females (P<0.001). This is similar to the findings of Arslan et al in the Turkish population and in other ethnic populations[10]. The mean values for inter-alar width of the nose are highest in both male and female Angolans and the lowest in North American whites (males and females); the Arabs are somewhere in-between[15]. This wide variation in the inter-alar width of the nose in different populations may be due to the different methods used or due to genuine ethnic differences.

Farkas et al have suggested that in hot and moist climates the nasal aperture becomes much wider, present in all African and Asian ethnic groups in both genders, than in those who live in cold places[11]. However, the Arabs in the Arabian Gulf region, though living in a hot desert climate, have smaller dimension of the inter-alar width of the nose than seen in other Asian populations, such as, Thailand, Malaysia or China[5]. Inter-alar width of the nose in Arabs are similar to those in Turks and are slightly larger than that in European and North American whites who live in colder climates suggesting that Arabs are ethnically closer to Turks, Europeans and North American white populations rather than to other Asian populations[10,15].

In dentofacial anomalies correction, the surgeon must understand the possible effects of maxillomandibular manipulation on structures that play a significant role in the overall aesthetic balance of the face, such as, the nose. Widening of nasal ala is often associated with maxillary advancement. This effect would be ideal in a patient with narrow nostrils but not in someone who already has a wide nasal base[16]. Since they have narrow inter-alar width of the nose, the Arabs have the advantage that even if there is a need for maxillary advancement, the overall aesthetic balance of the face would be retained postoperatively.

The widest mouth dimensions are the Europeans and the narrowest are the North American Indians, in both genders[2,12]. Arab females and Turkish females show similar values for mouth width but Arab males have a mouth width similar to Central/Southeast Asian populations[10,11].

In North American Caucasians, the mouth width is 1.5 times the inter-alar width of the nose[15]. In the Arab population in our study, the mouth width was found to be 1.44 times the inter-alar width of the nose, which is similar to that in North American Caucasians and indicates an ethnic similarity between these two populations[15]. Arslan et al stated that the proportions between mouth width and inter-alar width of the nose depend on the facial type[10]. In adult Turkish females, this value is lower in the euryprosopic group and higher for other face types and among adult Turkish males; the relative mouth width is higher for all face types[10].

Comparison of the three facial measurements between subjects from three different GCC countries show that Bahraini males have significantly wider mouths than Saudi Arabian males (P=0.034). This indicates that though the Arab populations of the different GCC countries appear to be a homogeneous group, significant differences in some facial dimensions exist.

Stephan and Henneberg have reported that the maxillary inter-canine distance measured between the tips of the maxillary canines was 75.8% (range 74.7%-76.9%) of the mouth width and this ratio between maxillary inter-canine distance and mouth width was constant in Europeans as well as Central/Southeast Asians[2]. They concluded that the distance between the tips of the maxillary canines was correlated well with the mouth width.

In our study, the maxillary inter-canine distance was 75% of the mouth width, which confirms the conclusions of Stephan and Henneberg[2]. Thus, in the Arab population, mouth width seems to be a reliable predictor of maxillary inter-canine distance. Though the position of the maxillary canine teeth provides the most accurate predictor of the position of the corners of the mouth, the medial borders of the iris could be used instead when these teeth are absent[1].

In Chinese, the mean inter-alar width of the nose was greater than the mean maxillary inter-canine distance by 4.00 mm in males and by 1.45 mm in females[9]. In the Arab subjects studied, the mean maxillary inter-canine distance was seen to be greater than the mean inter-alar width of the nose by 2.52 mm in males and by 3.17 mm in females. This is contrary to what was seen in the Chinese and it is probably because the nose is much wider in the Chinese population.

In our study, we found that when the inter-alar width of the nose was multiplied by a factor of 1.08 it could approximate the maxillary inter-canine distance measured between the tips of the canines. However, to estimate the maxillary inter-canine distance, the inter-alar width of the nose had to be multiplied by a factor of 0.91 in Brazilian subjects, by a factor of 1.03 in North American whites and by a factor of 1.56 in Saudi Arabian subjects[7,14,17]. Therefore, our findings in Arab subjects are similar to those of Hoffman et al[14]. The marked difference between the findings in the Saudi Arabian population and the Arab population in our study could be due to the difference in the methods used or could indicate that Arab nationals of GCC countries are not an ethnically homogeneous group[17].

Gomes et al and Hoffman et al found that inter-alar width of the nose is a reliable guide for the selection of suitable maxillary anterior teeth when constructing dentures[7,14]. However, studies among Malays, Chinese, Croatians and in four ethnic groups of Brazilians showed a weak correlation between inter-alar width of the nose and maxillary inter-canine distance and concluded that the use of inter-alar width of the nose for the selection of artificial denture teeth is generally inaccurate[5,9,18,19]. Our findings in Arab subjects showed a weak correlation between inter-alar width of the nose and maxillary inter-canine distance (r=0.334 in males and r=0.208 in females), which is similar to reports in Chinese, Malay, Croatian and Brazilian populations. Thus, inter-alar width of the nose cannot be used reliably to select maxillary anterior teeth for constructing dentures in the Arab population.

Our study has certain limitations. Since the study was conducted on students, the age group studied was narrow, 18-24 years. Future studies including wider age group from the Arab population are recommended. We had a small number of subjects from each GCC country especially from Oman and United Arab Emirates. There is a need to involve larger numbers of subjects from each of the six GCC countries.

CONCLUSION

The present study establishes a preliminary baseline value for mouth width, inter-alar width of the nose and maxillary inter-canine distance in young adult Arab students. Statistically significant differences exist for some facial anthropometric features within Arab nationals of different GCC countries. Arabs in GCC countries seem to be ethnically closer to Turks, Europeans and North American white populations. To complement this preliminary study's validity and reliability, we plan a future study with larger cohort samples including various ages of Arab groups in the Middle East region.

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