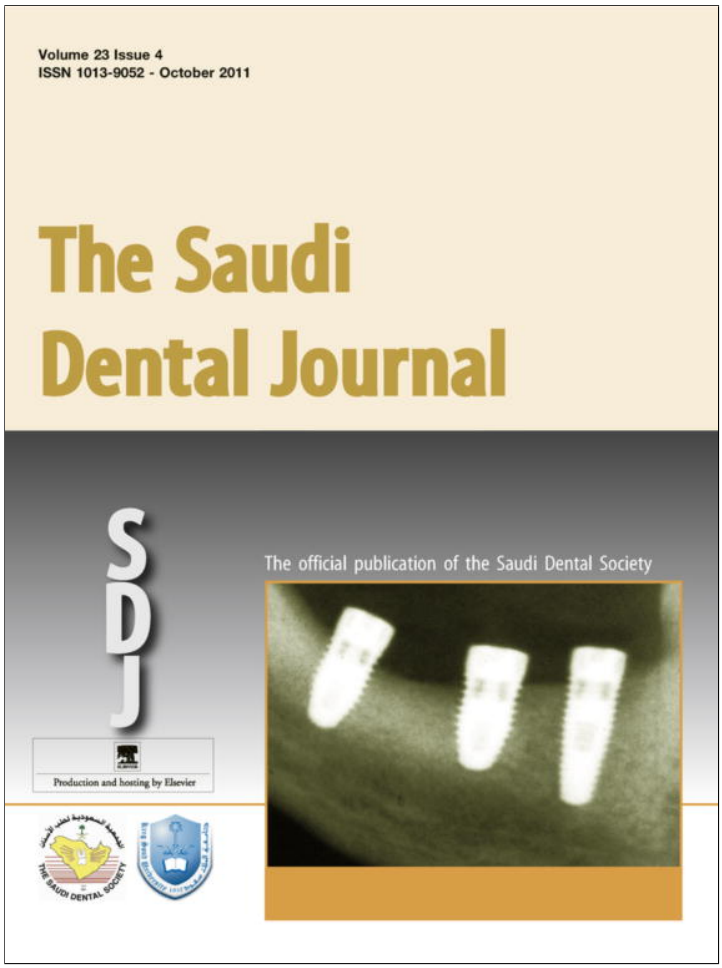

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ORIGINAL ARTICLE

Ethnic differences in dentofacial relationships of Turkish and Saudi young adults with normal occlusions and well-balanced faces

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Saudi;
Ethnicity

Abstract *Objectives:* The aims of the present study were (1) to determine ethnic differences in craniofacial dimensions between Turkish and Saudi populations and (2) to identify possible gender differences between males and females, based on a sample of untreated young adult subjects with normal occlusions and well-balanced faces.

Methods: In total, 163 cephalometric radiographs were traced and evaluated to compare untreated adults of Turkish and Saudi ethnicity. The Turkish group comprised 86 subjects; 45 females and 41 males. The Saudi group comprised 77 subjects; 39 females and 38 males. For statistical evaluation, an independent-samples *t*-test was performed.

Results: The Turkish sample had a more retrognathic maxilla and mandible ($p < 0.001$ for SNA and SNB) and a more vertical direction of facial development ($p < 0.001$), with Turkish males having more retrusive lips ($p < 0.001$). Distinctive ethnic differences were found in craniofacial structures between Turkish and Saudi young adults.

Conclusions: It is appropriate to consider these aesthetic differences when a Turkish or a Saudi patient is being evaluated during routine diagnosis and treatment planning.

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1. Introduction

Cephalometric norms must be considered when establishing harmonious facial aesthetics and an optimal functional occlusion (Bishara et al., 1998). Cephalometric norms for different ethnic and racial groups have been presented in many studies (Basciftci et al., 2004; Ioi et al., 2007). Hence, a patient's culture and ethnic background must be taken into account when determining harmonious facial aesthetics. Therefore, it is important to compare a patient's cephalometric findings with the norms of his or her ethnic group for an accurate diagnostic evaluation, when considering his or her treatment goals and needs.

A number of studies have determined the cephalometric data of the Anatolian Turkish population. Oktay (1991) examined the relationships among ANB, Wits, perpendiculars from points A and B to the Frankfort horizontal plane, and anteroposterior dysplasia indicator measurements in Turkish subjects. Erbay et al. (2002) investigated the horizontal lip position of Anatolian Turkish adults. Basciftci et al. (2003) and Uysal et al. (2009) performed studies on soft tissue measurements of the Turkish population. Basciftci et al. (2004) found significant differences in Turkish cephalometric norms compared to different ethnic groups.

Most investigators have concluded that there are significant differences between ethnic and racial groups, and thus many cephalometric standards have been developed (Hwang et al., 2002; Ioi et al., 2007). Several studies have focused on ethnic differences, including Japanese (Miyajima et al., 1996), African-American (Evanko et al., 1997), Arabic (Hamdan and Rock, 2001), Saudi (Hassan, 2006), and Turkish (Uysal et al., 2009). In addition, the craniofacial patterns of various populations have been examined to identify the skeletal features of a specific ethnic group (Garcia, 1975). All of these studies indicated that normal measurements for one group should not be considered as normal for other races or ethnic groups (Basciftci et al., 2004).

Shalhoub et al. (1987) investigated 48 Saudi adult patients that had normal dental patterns with no severe anteroposterior, vertical or transverse skeletal discrepancies, to establish cephalometric values for the Saudi population. Al-Jasser (2000) evaluated the Steiner norms in Saudi adults of 21 and 27 years in age with normal occlusions. It was concluded that Saudi adults have different craniofacial features compared to Steiner norms. Al-Barakati and Talic (2007) determined the norms of the Saudi population using McNamara analysis.

Turkey is situated in a unique location where populations from different regions are mixed to create a rich gene pool. One might anticipate that the modern Turkish population is composed of genes from Asiatic Turkey, the Balkans, Caucasus, the Middle East, and Iran, as well as ancient Romans, Byzantines, and Arabs (Iscan and Kedici, 2003). It is clear that contemporary Turks are a mixture of these extant and extinct people, and form possibly an ideal representative study population.

The Saudi population is of mixed ethnic origin, comprising descendants of Arabs, Turks, and other groups (Hassan, 2006). Turkey provides trade and transport links among many countries, especially Russia, Saudi Arabia, Germany, Romania, the Ukraine, Jordan, Iraq, and Syria (Dogruel and Leman, 2009). As a result, a large number of ethnic and racial groups live together. Ethnic and racial differences play a major role in diversifying aesthetic preferences (Maganzini et al., 2000). When planning orthodontic treatment, standards must concur with the aesthetic perceptions and norms of the general public (Türkkahraman and Gökalp, 2004). This is very important because facial aesthetics have been found to be an important determinant of self and social perceptions (Albino et al., 1990).

An increasing number of comparative studies between ethnic groups have been published (Hwang et al., 2002; Miyajima et al., 1996). Basciftci et al. (2004) compared Anatolian Turkish norms with the norms of other investigators. In addition, Uysal et al. (2009) compared Turkish norms with the norms of the North American population. Saudi cephalometric norms have been compared with those of North American (Shalhoub et al., 1987), British (Sarhan and Nashashibi, 1988), and Steiner's European-American standards (Al-Jasser, 2000). However, we are aware of no studies comparing Turkish and Saudi cephalometric norms.

The aims of the present study were (1) to determine ethnic differences in craniofacial dimensions between Turkish and Saudi populations and (2) to identify possible gender differences between males and females, based on samples of untreated young adult subjects with normal occlusion and well-balanced faces.

2. Material and methods

At the start of this study, a power analysis established by G*Power Ver. 3.0.10 (Franz Faul, Christian Albrechts-Universität, Kiel, Germany, www.psycho.uni-duesseldorf.de/abteilungen/app/gpower3) software was used to estimate the required sample size for our analysis. We calculated that a sample size of 75 patients would provide more than 80 per cent power to detect significant differences with 0.40 effect size and at $\alpha = 0.05$ significance level.

In this retrospective cross-sectional study, a total of 163 cephalometric radiographs were selected from the archive. Cephalograms were traced and evaluated to compare untreated adults of Turkish and Saudi ethnicity. The Turkish sample group comprised 86 subjects; 45 females with a mean age of 20 years and 10 months (SD 3 years and 1 month) and 41 males with a mean age of 21 years and 6 months (SD 2 years and 7 months). The Saudi sample group comprised 77 subjects; 39 females with a mean age of 20 years and 6 months (SD 3 years and 4 months) and 38 males with a mean age of 22 years and 4 months (SD 2 years and 1 month). The subjects met the following criteria (Basciftci et al., 2004): twenty to 30 years of age, class I occlusion with minor or no crowding, normal growth and development, well-aligned maxillary and mandibular dental arches, all teeth present except third molars, good facial symmetry, determined clinically and radiographically, no significant medical history, no history of trauma, no previous orthodontic or prosthodontic treatment or maxillofacial or plastic surgery.

The lateral cephalometric radiograph of each subject was taken with the same Cephalometer (OP100; Instrumentarium, Tuusula, Finland). All subjects were positioned in the cephalostat with the sagittal plane at a right angle to the path of the X-rays, the Frankfort plane parallel to the horizontal, the teeth in centric occlusion, and the lips lightly closed (Erbay et al., 2002).

Cephalometric radiographs were traced by the same operator (A.Y.) using Dolphin Image Software 9.0 (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). Landmark identification was carried out manually on digital images using a mouse-driven cursor. Landmarks are presented in Table 1 and are shown in Fig. 1.

To determine the errors associated with radiographic measurements, 15 radiographs were selected. Their tracings were repeated four weeks after the first measurement. A Bland and Altman plot was applied to assess repeatability. It was found that the difference between the first and second measurements was insignificant (Table 2).

In total, 24 measurements (13 linear and 11 angular) were traced and recorded as skeletal, dental, and soft tissue

Table 1 Cephalometric measurements and descriptions used in the present study.

Skeletal angular and linear measurements
SNA angle (SNA): inward angle towards the cranium between the NA line and the sella-nasion (SN) plane
SNB angle (SNB): inward angle towards the cranium between the NB line and the SN plane
ANB angle (ANB): angle between the NA and NB lines, obtained by subtracting the SNB from the SNA
SN plane to mandibular plane angle (SN–MP): angle between the SN plane and the mandibular plane (MP)
A point to nasion perpendicular (A to N perp): distance between A point and N perpendicular line measured perpendicular to the N perpendicular line
Pogonion to N perpendicular (Pog to N perp): distance between pogonion and N perpendicular line measured from the perpendicular to the N perpendicular line
Midface length (Co–A): measurement on a line drawn from the condylion to point A
Mandibular length (Co–Gn): measurement on a line drawn between the condylion and gnathion
Upper anterior facial height (N–ANS): distance from the nasion to the anterior nasal spine (ANS)
Lower anterior facial height (ANS–Me): distance from the ANS to the menton
Facial axis angle (Ba–Na/Pt–Gn): the most posterior inferior angle between the Ba–Na and Pt–Gn planes

Dental angular and linear measurements
Maxillary central incisor to mandibular central incisor (U1–L1) (interincisal angle): angle is measured between the extension of the maxillary and mandibular incisor long axis line; the most posterior angle is measured
Maxillary incisor to SN plane (U1–SN): most inferior inward angle formed by the extension of the long axis of the maxillary incisor to the SN plane
Maxillary incisor to NA plane (U1–NA): distance between the tip of the upper incisor and a line from N to point A
Maxillary incisor–NA angle (U1–NA): angle formed by the long axis of the upper incisor to a line from N to point A
Mandibular incisor to NB (L1–NB): distance between the tip of the mandibular incisor and a line from nasion to point B
Mandibular incisor–NB angle (L1–NB): angle formed by the long axis of the mandibular incisor to a line from N to Point B
Mandibular incisor to mandibular plane (L1–MP): angle formed by the intersection of the mandibular incisor axis to mandibular plane
Mandibular incisor to A–Pog plane (L1–APog): distance between the tip of the mandibular incisor and a line from Point A to Pog

Soft tissue angular and linear measurements
H (Holdaway) line: tangent drawn from the tip of the chin to the upper lip
H angle: angle formed between the soft tissue facial plane line and the "H" line
Upper lip to E plane: distance between the upper lip and a line from the tip of the nose to the end of the chin
Lower lip to E plane: distance between the lower lip and a line from the tip of the nose to the end of the chin
Upper lip to S plane: distance between the upper lip and a line from the middle of the Steiner S curve to the chin projection
Lower lip to E plane: distance between the lower lip and a line from the middle of the Steiner S curve to the chin projection

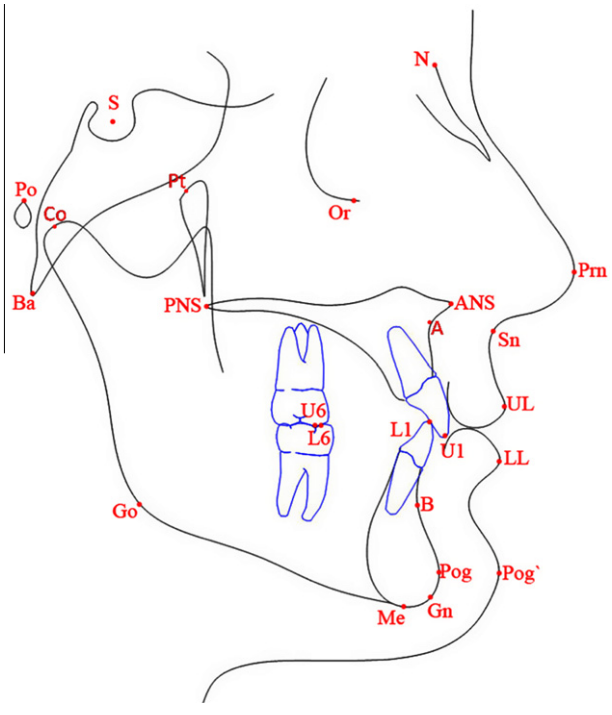

Figure 1 Cephalometric landmarks used in the study.

measurements. Eleven skeletal and eight dental angular and linear measurements were selected for evaluation. In addition, five soft tissue measurements were considered.

All statistical analyses were performed using the Statistical Package for Social Sciences (Windows, version 13.0, SPSS Inc., Chicago, Illinois, USA). The arithmetic mean and standard deviation values were calculated for all cephalometric measurements. The normality test of Shapiro-Wilks and Levene's variance homogeneity test were applied to the data. The data were normally distributed, with homogeneity of variance among the groups; thus, statistical evaluation was performed using parametric tests. To compare the Turkish and Saudi samples and to determine gender differences independent-samples *t*-tests were performed.

3. Results

3.1. Gender differences

3.1.1. Turkish sample

Six skeletal and three dental measurements were shown to have statistically significant differences between genders (Table 3). The SNB angle was greater in males (78.4° ± 2.7) than females 77.3° ± 2.2) ($p = 0.036$). The ANB values were greater in females (2.9° ± 1.6) than males (2.1° ± 1.7) ($p = 0.026$). Measurements of midfacial length (Co–Point A) and mandibular length (Co–Gn), in addition to those of upper and lower anterior facial height, were significantly greater in males than

Table 2 Altman Bland test to assess repeatability. (n = 15).

Measurements	Bias	95% Cl	t-Test	Correlations coefficients
Skeletal measurements				
SNA (°)	−0.03	−0.44 to 0.38	0.980	0.981
SNB (°)	−0.03	−0.47 to 0.41	0.981	0.977
ANB (°)	0.01	−0.19 to 0.21	0.985	0.979
SN–MP (°)	0.05	−0.63 to 0.73	0.984	0.986
Na ⊥ A (mm)	−0.22	−0.68 to 0.24	0.850	0.980
Na ⊥ Pog (mm)	−0.43	−0.94 to 0.08	0.790	0.985
Midface length (Co–A) (mm)	0.95	−0.28 to 2.18	0.598	0.912
Mandibular length (Co–Gn) (mm)	1.28	−1.05 to 3.61	0.675	0.888
Upper anterior facial height (N–ANS) (mm)	0.24	−1.03 to 1.51	0.844	0.830
Lower anterior facial height (ANS–Me) (mm)	0.54	−0.55 to 1.63	0.865	0.976
Facial axis angle (Ba–Na/Pt–Gn) (°)	0.06	−0.40 to 0.52	0.966	0.979
Dental measurements				
Interincisal angle (U1–L1) (°)	0.02	−1.16 to 1.20	0.995	0.973
U1–SN (°)	0.02	−0.94 to 0.98	0.910	0.964
U1–NA (mm)	0.14	−0.29 to 0.57	0.595	0.878
U1–NA (°)	0.38	−0.45 to 1.21	0.854	0.975
L1–NB (mm)	0.32	−0.03 to 0.67	0.688	0.960
L1–NB (°)	−0.59	−1.79 to 0.61	0.677	0.941
L1–APog (mm)	0.23	−0.11 to 0.57	0.762	0.961
L1–MP (°)	−0.42	−1.66 to 0.82	0.880	0.965
Soft tissue measurements				
H angle (°)	0.23	−0.21 to 0.67	0.862	0.979
UL–E (mm)	0.17	−0.04 to 0.37	0.819	0.987
LL–E (mm)	0.13	−0.16 to 0.42	0.733	0.984
UL–S (mm)	0.14	−0.05 to 0.33	0.834	0.984
LL–S (mm)	0.11	−0.15 to 0.37	0.733	0.983

Table 3 Comparison of male and female Turkish variables.

Measurements	Female (n = 45)		Male (n = 41)		Sig.
	Mean	SD	Mean	SD	
Skeletal measurements					
SNA (°)	80.2	2.5	80.5	2.1	0.537
SNB (°)	77.3	2.2	78.4	2.7	0.036*
ANB (°)	2.9	1.6	2.1	1.7	0.026*
SN–MP (°)	32.0	4.0	31.0	4.1	0.318
Na⊥A (mm)	0.0	2.5	−0.9	2.8	0.111
Na⊥Pog (mm)	−3.4	4.8	−2.8	6.1	0.604
Midface length (Co–A) (mm)	86.9	4.3	90.8	4.5	< 0.001***
Mandibular length (Co–Gn) (mm)	116.4	5.5	125.3	5.4	< 0.001***
Upper anterior facial height (N–ANS) (mm)	55.3	3.0	58.1	2.9	< 0.001***
Lower anterior facial height (ANS–Me) (mm)	68.4	4.5	74.6	4.7	< 0.001***
Facial axis angle (Ba–Na/Pt–Gn) (°)	−1.6	3.2	−2.9	3.7	0.089
Dental measurements					
Interincisal angle (U1–L1) (°)	129.3	9.3	134.2	9.4	0.018*
U1–SN (°)	100.6	5.9	101.7	6.0	0.384
U1–NA (mm)	3.9	2.0	3.9	2.3	0.959
U1–NA (°)	20.4	6.2	21.2	5.8	0.537
L1–NB (mm)	5.0	2.0	4.4	2.5	0.059
L1–NB (°)	27.3	5.6	22.4	6.0	< 0.001***
L1–APog (mm)	2.3	1.9	1.5	2.5	0.073
L1–MP (°)	95.2	5.9	89.8	6.9	< 0.001***
Soft tissue measurements					
H angle (°)	12.7	3.6	12.7	3.3	0.966
UL–E (mm)	−5.8	2.5	−6.1	2.2	0.678
LL–E (mm)	−2.6	2.2	−3.4	2.5	0.116
UL–S (mm)	−2.0	2.0	−1.8	1.8	0.617
LL–S (mm)	−0.3	1.9	−0.8	2.3	0.253

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 4 Comparison of male and female Saudi Arabian variables.

Measurements	Female (n = 39)		Male (n = 38)		Sig.
	Mean	SD	Mean	SD	
Skeletal measurements					
SNA (°)	82.5	2.6	83.0	2.4	0.391
SNB (°)	78.5	2.8	80.8	2.9	< 0.001***
ANB (°)	4.1	1.4	2.5	2.4	< 0.001***
SN–MP (°)	34.5	4.6	30.5	4.9	< 0.001***
Na ⊥ A (mm)	2.1	3.2	1.0	2.9	0.119
Na ⊥ Pog (mm)	−2.6	5.3	−0.6	5.8	0.065
Midface length (Co–A) (mm)	82.7	4.2	86.3	5.1	0.001**
Mandibular length (Co–Gn) (mm)	108.4	6.3	118.5	7.5	< 0.001***
Upper anterior facial height (N–ANS) (mm)	50.0	3.6	52.8	3.8	0.001**
Lower anterior facial height (ANS–Me) (mm)	63.5	4.9	68.5	6.6	0.001**
Facial axis angle (Ba–Na/Pt–Gn) (°)	−2.7	3.4	−0.1	3.8	0.002**
Dental measurements					
Interincisal Angle (U1–L1) (°)	121.1	8.7	120.3	7.8	0.397
U1–SN (°)	104.5	6.7	110.2	6.1	< 0.001***
U1–NA (mm)	3.6	2.2	6.0	2.5	< 0.001***
U1–NA (°)	21.9	6.2	27.2	6.0	< 0.001***
L1–NB (mm)	6.0	1.8	6.6	2.1	0.205
L1–NB (°)	30.7	4.9	28.6	5.5	0.093
L1–APog (mm)	3.0	1.9	4.4	2.0	0.003**
L1–MP (°)	96.4	6.9	95.9	5.4	0.718
Soft tissue measurements					
H angle (°)	15.4	2.9	16.3	3.2	0.219
UL–E (mm)	−4.1	1.9	−3.8	2.0	0.356
LL–E (mm)	−1.7	1.6	−0.3	2.4	0.006**
UL–S (mm)	−1.0	1.6	−0.3	1.7	0.114
LL–S (mm)	0.4	1.5	1.8	2.3	0.003**

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

females, as expected. L1–NB (°) and L1–MP (°) measurements were greater in females (27.3° ± 5.6 and 95.2° ± 5.9, respectively) than males (22.4° ± 6.0 and 89.8° ± 6.9, respectively) ($p < 0.001$). Furthermore, the interincisal angle was more obtuse in males (134.2° ± 9.4) than females (129.3° ± 9.3) ($p = 0.018$). Soft tissue measurements showed no significant difference between genders ($p > 0.05$).

3.1.2. Saudi sample

Greater gender differences were found in the Saudi sample (Table 4). The SNB angle was greater in males (80.8° ± 2.9) compared to females (78.5° ± 2.8) ($p < 0.001$). The ANB and SN–MP values were greater in females (4.1° ± 1.4 and 34.5° ± 4.6, respectively) than males (2.5° ± 2.4 and 30.5° ± 4.9) ($p < 0.001$). Measurements of midfacial length (Co–Point A) and mandibular length (Co–Gn), as well as those of upper and lower anterior facial height, were significantly greater in males than females. The upper incisors were more protrusive and procline in males than females ($p < 0.001$). The lower incisors were more protrusive in males than females ($p = 0.003$). The lower lips were more protrusive in males than females.

3.2. Comparison between groups

3.2.1. Comparison between Turkish and Saudi females

The cephalometric values for Turkish and Saudi females are provided in Table 5. Relative to the cranial base, the maxilla (SNA) was found to be more retrognathic in Turkish females (80.2° ± 2.5) than Saudi females (82.5° ± 2.6) ($p < 0.001$). Relative to the Nasion perpendicular, Point A was positioned more posteriorly in the Turkish sample ($p = 0.002$). All linear skeletal measurements were greater in the Turkish sample ($p < 0.001$).

With respect to dental measurements, the lower incisors were retroclined ($p = 0.005$) and retrusive ($p = 0.034$) in the Turkish sample compared to the Saudi sample. The upper lip was more retrusive according to the "S" and "E" planes in Saudi females. Holdaway's "H" angle was smaller in Turkish females ($p = 0.014$).

3.2.2. Comparison between Turkish and Saudi males

The cephalometric values for Turkish and Saudi males are provided in Table 6. The maxilla (SNA) and mandible (SNB) relative to the cranial base were positioned more anteriorly in Saudi males (83.1° ± 2.4 and 80.8° ± 2.9, respectively) than Turkish males (80.5° ± 2.1 and 78.4 ± 2.7, respectively). Relative to the Nasion perpendicular, Point A was positioned more posteriorly in the Turkish sample ($p = 0.006$). All linear skeletal measurements were greater in Turkish males ($p < 0.001$). A statistically significant difference was found for the facial axis angle, which was more acute in the Turkish sample (−2.9° ± 3.7) than the Saudi sample (−0.1° ± 3.8) ($p = 0.002$).

With respect to dental measurements, the upper and lower incisors were retrusive and retroclined in the Turkish sample

Table 5 Comparisons between Turkish and Saudi female subjects ($n = 84$).

Measurements	Turkish ($n = 45$)		Saudi ($n = 39$)		Sig.
	Mean	SD	Mean	SD	
Skeletal measurements					
SNA (°)	80.2	2.5	82.5	2.6	<0.001***
SNB (°)	77.3	2.2	78.5	2.8	0.057
ANB (°)	2.9	1.6	4.1	1.4	0.002**
SN–MP (°)	32.0	4.0	34.5	4.6	0.015*
Na ⊥ A (mm)	0.0	2.5	2.1	3.2	0.002**
Na ⊥ Pog (mm)	−3.4	4.8	−2.6	5.3	0.364
Midface length (Co–A) (mm)	86.9	4.3	82.7	4.2	<0.001***
Mandibular length (Co–Gn) (mm)	116.4	5.5	108.4	6.3	<0.001***
Upper anterior facial height (N–ANS) (mm)	55.3	3.0	50.0	3.6	<0.001***
Lower anterior facial height (ANS–Me) (mm)	68.4	4.5	63.5	4.9	<0.001***
Facial axis angle (Ba–Na/Pt–Gn) (°)	−1.6	3.2	−2.7	3.4	0.135
Dental measurements					
Interincisal angle (U1–L1) (°)	129.3	9.3	121.1	8.7	0.003**
U1–SN (°)	100.6	5.9	104.5	6.7	0.006**
U1–NA (mm)	3.9	2.0	3.6	2.2	0.497
U1–NA (°)	20.4	6.2	21.9	6.2	0.271
L1–NB (mm)	5.0	2.0	6.0	1.8	0.034*
L1–NB (°)	27.3	5.6	30.7	4.9	0.005**
L1–APog (mm)	2.3	1.9	3.0	1.9	0.121
L1–MP (°)	95.2	5.9	96.4	6.9	0.419
Soft tissue measurements					
H angle (°)	12.7	3.6	15.4	2.9	0.014*
UL–E (mm)	−5.8	2.5	−4.1	1.9	0.007**
LL–E (mm)	−2.6	2.2	−1.7	1.6	0.053
UL–S (mm)	−2.0	2.0	−1.0	1.6	0.010*
LL–S (mm)	−0.3	1.9	0.4	1.5	0.07

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

compared to the Saudi sample. The upper and lower lips were more retrusive in the Turkish sample for all soft tissue measurements.

4. Discussion

In the current study, we focused on the comparison of cephalometric values of Turkish and Saudi young adults. All subjects included in this study had balanced facial aesthetics and normal occlusion, as judged by clinicians from the same ethnic group as the subjects. Untreated subjects were selected to avoid the effects of orthodontic treatment on craniofacial structures. The data were separated according to gender to obtain more specific and useful cephalometric normative values; not surprisingly, gender dimorphism was found to be significant.

The human body undergoes dimensional changes throughout life. At 18–20 years of age, the growth curves of several dimensions have reached a plateau. However, many investigations of skull growth have demonstrated continuous dimensional changes up to considerably advanced ages. Forsberg (1979) investigated growth changes in the adult face from 24 to 34 years of age, and found significant changes in soft tissue variables. Similarly, Proffit et al. (2003) showed that significant soft tissues change occurred with time and ageing in adults. For this reason, the two groups in the present study were matched by means of age. The mean chronological age was 21 years and 2 months for the Turkish sample and 21 years and 5 months for the Saudi sample.

Oliver (1982) stated that the instruction to "bring the lips lightly closed" would allow the subject to provide a tactile neuromuscular input to facilitate the positioning of the lips in a repeatable manner. In the present study, all subjects were positioned in the cephalostat with the lips lightly closed. To eliminate inter-examiner variability, a single investigator traced and measured all radiographs. Moreover, landmark identification error was minimized through a repeated check by the same author, and by a test of intra-examiner reliability.

4.1. Skeletal relationships

The measurements showing the positions of the maxilla and mandible relative to the cranial base (SNA, SNB, Na ⊥ A, Na ⊥ Pog) showed the retrusion of both jaws for the Turkish sample. It may be suggested that the relatively smaller dimensions of the maxilla and mandible resulted in a posterior positioning of the jaws in the Turkish sample. The midface and mandibular lengths, in addition to anterior facial heights, were found to be smaller in the Saudi sample compared to the Turkish sample. The results of this study were similar to the findings of Basciftci et al. (2004) for the craniofacial dimension in the Turkish sample. These investigators reported that the unique skeletal measurement that deviated from ideal values was the lower anterior facial height, which was longer in the sample

Table 6 Comparisons between Turkish and Saudi male subjects (n = 79).

Measurements	Turkish (n = 41)		Saudi (n = 38)		Sig.
	Mean	SD	Mean	SD	
Skeletal measurements					
SNA (°)	80.5	2.1	83.0	2.4	<0.001***
SNB (°)	78.4	2.7	80.8	2.9	<0.001***
ANB (°)	2.1	1.7	2.5	2.4	0.474
SN-MP (°)	31.0	4.1	30.5	4.9	0.321
Na ⊥ A (mm)	−0.9	2.8	1.0	2.9	0.006**
Na ⊥ Pog (mm)	−2.8	6.1	−0.6	5.8	0.125
Midface length (Co–A) (mm)	90.8	4.5	86.3	5.1	<0.001***
Mandibular length (Co–Gn) (mm)	125.3	5.4	118.5	7.5	<0.001***
Upper anterior facial height (N–ANS) (mm)	58.1	2.9	52.8	3.8	<0.001***
Lower anterior facial height (ANS–Me) (mm)	74.6	4.7	68.5	6.6	<0.001***
Facial axis angle (Ba–Na/Pt–Gn) (°)	−2.9	3.7	−0.1	3.8	0.002**
Dental measurements					
Interincisal angle (U1–L1) (°)	134.2	9.4	120.3	7.8	<0.001***
U1–SN (°)	101.7	6.0	110.2	6.1	<0.001***
U1–NA (mm)	3.9	2.3	6.0	2.5	<0.001***
U1–NA (°)	21.2	5.8	27.2	6.0	<0.001***
L1–NB (mm)	4.4	2.5	6.6	2.1	<0.001***
L1–NB (°)	22.4	6.0	28.6	5.5	<0.001***
L1–APog (mm)	1.5	2.5	4.4	2.0	<0.001***
L1–MP (°)	89.8	6.9	95.9	5.4	<0.001***
Soft tissue measurements					
H angle (°)	12.7	3.3	16.3	3.2	<0.001***
UL–E (mm)	−6.1	2.2	−3.8	2.0	<0.001***
LL–E (mm)	−3.4	2.5	−0.3	2.4	<0.001***
UL–S (mm)	−1.8	1.8	−0.3	1.7	<0.001***
LL–S (mm)	−0.8	2.3	1.8	2.3	<0.001***

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

of Basciftci et al. (2004). Al-Jasser (2000) showed that Saudi samples have a relatively similar skeletal relationship, while dentally there was a tendency towards bimaxillary protrusion when compared with Steiner norms.

The facial axis angle, which is an indication of the growth direction and position of the chin, was more acute in Turkish males. In addition, all anterior facial height measurements were greater in the Turkish sample. This finding may explain the relative mandibular retrognathism in Turkish individuals, because it is known that increased vertical growth may result in the mandible appearing more retrognathic.

Similarly, Hassan (2006) showed increased vertical growth in a Saudi sample relative to European-American standards. Furthermore, Al-Barakati and Talic (2007) found increased lower facial height and backward rotation mandibular growth. On the other hand, in the present study, lower anterior facial height was higher in the Turkish sample. Thus, the correlation between vertical dimension and mandibular retrusion may be a valid argument for this finding. Furthermore, the more protrusive position of the nasion, or a longer anterior cranial base length, may be a factor for the retrusion of the jaw in the Turkish sample compared to the Saudi sample.

In the present study, statistically significant gender differences were determined in skeletal measurements. Most of the skeletal measurements were found to be greater in males than in females for both groups. Dempsey et al. (1995) discovered that males had larger dimensions than females, overall. Ursi et al. (1993) indicated that there is an approximately 5% gender difference in the size of human skeletal bones, with females being smaller.

4.2. Dental relationships

When the dental measurements of the Turkish and Saudi samples were evaluated, one notable significant difference was the proclination of the lower incisors relative to the mandibular plane in the Saudi sample. Basciftci et al. (2004) reported increased mandibular incisor proclination for the Anatolian Turkish sample. In this study, the lower incisor measurements are in accordance with the results of Basciftci et al. (2004) for females.

Hassan (2006) showed no differences from the European-American standards in dental measurements of the Saudi sample. In contrast, Al-Barakati and Talic (2007) found that the upper and lower incisors were more forward in Saudi males than European-American males. In the current study, obvious dental differences were identified between Turkish and Saudi males for all dental measurements. According to the findings of this study, Turkish males had more retrusive and retroclined incisors compared to Saudi males.

In the present study, Turkish females had more retroclined upper incisors, as well as retrusive and retroclined lower incisors, compared to Saudi females. Similarly, Al-Barakati and Talic (2007) found that the lower incisors were more protruded in Saudi females than European-American females.

In this study, statistically significant gender dimorphism was found in the dental measurements of both groups. In contrast, Basciftci et al. (2004) found no statistically significant gender dimorphism in the dental measurements of Anatolian Turkish adults.

4.3. Soft tissue relationships

When the soft tissue measurements of the Turkish and Saudi males were evaluated, one notable significant difference was the protrusion of the lower and upper lips in the Saudi sample. Turkish adult females have a more retrusive upper lip. Similarly, the comparative study by Hashim and Al-Barakati (2003) showed that the lips of the Saudi sample were more protruded compared to Caucasian Americans.

With respect to soft tissue measurements, the Turkish sample showed no statistically significant differences between genders. These results are in accordance with previous findings on Turkish populations (Erbay et al., 2002; Basciftci et al., 2003). The most obvious difference in the soft tissue of Saudi adults was the position of the lower lip for gender dimorphism. Saudi males showed relatively higher labial protrusion.

5. Conclusions

Distinctive ethnic differences were found in the craniofacial structures between Turkish and Saudi young adults. The results of this study support the view that a single standard of facial aesthetics should not be applied to all racial and ethnic groups. It is appropriate to consider these aesthetic differences when a Turkish or a Saudi patient is being evaluated during routine diagnosis and treatment planning.

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