A comprehensive assessment of the nasal profile among Iraqi adults with different skeletal classes: A retrospective study

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ARTICLE INFO

Keywords:
Nasal profile
Iraqi adults
Cephalometric

ABSTRACT

Aim: This study was performed to investigate differences in the nasal profile of Iraqi adults with different skeletal class groups.

Materials and methods: Cephalometric radiographs of 90 subjects of Iraqi origin, with the age range of 18–25 years. The collected radiographs were divided into three groups (n = 30) according to the skeletal discrepancies. Different lines and angles were measured and analyzed to determine the size, shape, and position of the nose relative to other facial structures from lateral cephalometric radiograph of each subject.

Results: A number of statistically significant changes were found between cephalometric measurements that reflected differences between the three skeletal class groups. Significant male-female differences were found in the measurements of nasolabial angle and the horizontal distances relating the nose to the incisal edge of the most prominent maxillary central incisor and to the chin. The angular measurements of the nasal tip projection angle, nasomental angle and nasofacial angle were also considerably varied among the three skeletal class groups alongside the vertical distances relating the nose to the upper lip, the incisal edge of the most prominent maxillary central incisor and to the chin.

Conclusion: This study adds valuable information about the impact of the size, shape of nose and its relative position to other craniofacial structures on the nasal profile in patients of Iraqi origin with different skeletal classes. Therefore, the results of the present study are useful guidance for cosmetic surgeons and orthodontists during diagnosis and planning for cosmetic rhinoplasty and orthodontic treatment in Iraqi adults.

1. Introduction

Improvement of the facial aesthetics is the major goal of orthodontic treatment. A great number of studies have recently reported that many factors are associated with facial aesthetics, such as eyes, nose and facial symmetry.^{1,2} As the nose is the central feature of the human face, it has an important influence on the facial aesthetics. The variation in the form, shape and size of the nose have great impacts on the facial profile aesthetics.^{3,4} Thus, orthodontists should carefully align the anterior teeth to prevent the relative prominence of the nose if the teeth are retruded.

Various methods have been used to assess the nasal profile, such as direct clinical examination,⁵ standardized full-facial photographs,⁶ cephalometrics,⁷ stereophotogrammetry,⁸ fabrication of nasolabial casts,⁹ three-dimensional imaging,¹⁰ and computer-morphometric analysis.¹¹ Among the above methods, cephalometrics is the most commonly used as it is simple, economic, and rapid technique with minimal exposure to radiation.

A plethora of studies about the face and nose have been done in various countries, and significant differences were reported in facial and nasal measurements of various ethnics/races with different skeletal and dental patterns. All these differences have greatly contributed to our knowledge of diversity in facial and nasal size, shape, and proportions.^{12–21} However, none of these studies have investigated yet the nasal profile of Iraqi population. In view of this fact, this study was conducted to describe the nose, and to investigate its relation to other craniofacial structures and how it impacts upon the facial profile aesthetics among young, Iraqi adults who skeletally were characterized by class I, class II, and class III, performing in depth analysis of nasal profile measurements for each class. Additionally, the recorded findings were compared with the measurements of other racial/ethnic groups. Therefore, the study could provide reference materials for cosmetic nasal surgeons and orthodontists and it will probably engage in their diagnosis and treatment plan to alter the facial profile of patients of Iraqi origin who are aware of their appearance.

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<https://doi.org/10.1016/j.jobcr.2020.04.003>

Received 27 August 2019; Accepted 9 April 2020

Available online 17 April 2020

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2. Materials and methods

This retrospective study was conducted using lateral cephalometric radiographs of 90 subjects who were classified skeletally based on the subject's ANB angle (the angle formed by A point, nasion, and B point, which describes the anteroposterior relationship of the mandible to the maxilla) into three distinct groups ($n = 30$): Skeletal class I ($0^\circ < \text{ANB} \leq 4^\circ$), skeletal class II ($\text{ANB} > 4^\circ$), and skeletal class III ($\text{ANB} \leq 0^\circ$). In order to make the sample size of each group balance, 15 men and 15 women were included in each study group. The investigated radiographs were selected from the records of College of Dentistry, University of Baghdad - as such, it was judged that ethical approval was not required.

The inclusion criteria were as follows:

- All the subjects were of Iraqi origin
- Chronological age ranging from 18 to 25 years
- None of the subjects had any previous history of facial trauma, congenital defect, orthodontic treatment or any orthognathic or plastic surgery in the face.

The size, shape, and position of the nose relative to other craniofacial structures were obtained from standardized lateral cephalometric radiographs. The latter were taken for each subject using the same digital cephalometric machine (planmeca ProMax) by the same operator with the same cephalometric setup, with subjects positioned in the natural head position, and the teeth occluded in the maximum intercuspation with relaxed lips in order to maintain the standardization of radiographs.

All radiographs were scanned and digitized on a computer using AutoCAD 2018 software. All measurements were performed by one author in order to eliminate inter-examiner variability. The cephalometric landmarks, reference planes, and the subsequent angular and linear measurements given in Tables (1 and 2) and Figures (1 and 2), were marked and defined in this study as described in a study done by Begg and Harkness in 1995,²¹ which established normal values for the nasal form and its relationship to other craniofacial structures among young Caucasian adults.

2.1. Statistical analysis

Statistical analysis was performed with the SPSS software package (version 24; SPSS Inc., New York, NY, USA). All grouped data were tested for normality using the Kolmogorov-smirnov test. The data that normally distributed statistical test was performed using parametric methods two-way analysis of variance (ANOVA) and the data not normally distributed we used the non-parametric test (Kruskal-Wallis, test was used for comparison within groups and Mann Whitney U test

between the groups). A probability value (p value) less than 0.05 is considered statistically significant.

2.2. Error determination

Measurements error for the cephalometric analysis was reassessed in 10 randomly selected patients, whose cephalometric radiographs were redigitized and remeasured by the same investigator one month later to help eliminate memory bias. Then, methodological errors in identification and measurements were assessed using Dahlberg's formula²²:

$$D = \sqrt{\sum_{i=1}^N \frac{d_i^2}{2N}}$$

Where d_i is the difference between the first and second occasions and N is the sample size which was remeasured. The error difference in linear cephalometric measurements ranged from 0. to 0. mm and for angular measurements from 0. To 0. degrees (Table 3). Error was considered negligible.

3. Results

A comprehensive nasal profile analysis was carried out on the three skeletal class groups (class I, class II, and class III), and descriptive statistics (mean and standard deviation; SD) for all linear and angular measurements are presented in Table 4. On analyzing the nasal profile, it was observed that the mean values of 9 linear measurements for men were greater than those measured for women in skeletal class I and II groups. On the contrary, 7 measurements in skeletal class III group (nasal height, nasal length, nasal depth, PRN-STPg horizontal, and all the vertical linear measurements recorded to determine the relative position of the nose to other craniofacial structures) had higher values in women than in men.

3.1. Nasal size

No significant differences were observed in the measurements of the nasal height (STN-Sn), the nasal length (STN-PRN), and the nasal depth (PRN-VP) among the three skeletal class groups (class I, class II, and class III), or between the gender in each group.

3.2. Nasal shape

Significant male-female differences ($P = 0.19$) were found in the nasolabial angle (Cm-Sn-Ls), while the measurements of both nasofrontal angle (STG-STN-DNP) and supratip break angle (STP-DNP) did

Table 1
Cephalometric landmarks and reference planes taken from (Begg and Harkness,1995).

Landmark	Abbreviation	Definition
Columella point	Cm	The most anterior point on the columella of the nose
Incision superius	Is	The incisal edge of the most prominent maxillary central incisor
Labrale superius	Ls	The most anterior point on the upper lip
Nasion	N	The most anterior point of the nasofrontal suture in the midsagittal plane
Pronasale	PRN	The most anterior point on the nose
Sella	S	Midpoint of the sella turcica of the sphenoid bone
Point A	A	Most posterior point in the concavity between anterior nasal spine and the dental alveolus
Point B	B	Most posterior point on the concavity along the anterior surface of the symphysis
Soft tissue glabella	STG	The most prominent point in the midsagittal plane of the forehead
Soft tissue nasion	STN	The point of greatest concavity in the soft tissue profile between glabella and pronasale
Soft tissue pogonion	STPg	The most anterior point on the soft tissue chin
Subnasale	Sn	The point at which the nasal septum merges with the upper cutaneous lip in the midsagittal plane
Supratip plane	STP	The tangent to supratip of the nose
Vertical plane	VP	The perpendicular to the horizontal plane through soft tissue nasion
Dorsal nose plane	DNP	It is constructed by laying a straight edge on the upper aspect of the nose
Horizontal reference plane	HP	It is constructed by drawing a line through soft tissue nasion parallel to the line through nasion 7° up from the sella-nasion line.

Table 2
Angular and linear measurements.

Measurements	Definition
SNA (°)	SN to NA angle
SNB (°)	SN to NB angle
ANB (°)	NA to NB angle
Nasal size measurements:	
STN-Sn (mm)	Nasal height
STN-PRN (mm)	Nasal length
PRN-VP (mm)	Nasal depth
Nasal shape:	
STG-STN-DNP (°)	Nasofrontal angle, the angle formed by the line from glabella through soft tissue nasion and the dorsal nose plane.
STP-DNP (°)	Supratip break angle, measured from the dorsal nose plane to the supratip plane
Cm-Sn-Ls (°)	Nasolabial angle.
Nasal position relative to other craniofacial structures	
Angular measurements:	
HP-DNP (°)	Nasal projection angle, the internal angle between the horizontal plane and the dorsal nose plane.
STG-STPg-DNP (°)	Nasofacial angle, the internal angle between the STG-STPg line and the dorsal nose plane.
DNP-PRN-SPg (°)	Nasomental angle, the internal angle formed by the dorsal nose plane and the line from pronasale to soft tissue pogonion.
Linear measurements:	
PRN-Ls horizontal (mm)	Horizontal distance between PRN and Ls parallel to HP.
PRN-Is horizontal (mm)	Horizontal distance between PRN and Is parallel to HP.
PRN-STPg horizontal (mm)	Horizontal distance between PRN and STPg parallel to HP.
PRN-Ls vertical (mm)	Vertical distance between PRN and Ls measured parallel to VP.
PRN-Is vertical (mm)	Vertical distance between PRN and STPg measured parallel to VP.
PRN-STPg vertical (mm)	vertical distance between PRN and STPg parallel to VP.

Fig. 1. Cephalometric landmarks and reference planes (taken from Begg and Harkness, 1995).

not exhibit any significant differences between the gender ($P = 0.121$, and $P = 0.331$, respectively). Moreover, no statistically significant differences were shown among the three skeletal class groups for the three aforementioned angles.

3.3. Nasal position

On the basis of the angular measurements used for determination the nasal position in relation to other craniofacial structures, there were no significant male-female differences in the nasal tip projection angle (HP-DNP), nasofacial angle (STG-STPg-DNP), and nasomental angle (DNP-PRN-STPg). However, significant differences were observed in

Fig. 2. Horizontal and vertical linear measurements (taken from Begg and Harkness, 1995). Tip of nose relative to subnasale, labrale superius, incision superius, and soft tissue pogonion. Horizontal distance from subnasale and soft tissue pogonion to the vertical reference plane. HP', horizontal plane through pronasale parallel to HP; VP', vertical plane through pronasale parallel to VP.

the nasal tip projection angle and nasomental angle of subjects with skeletal class III in comparison with their corresponding measurements of subjects with skeletal class I and skeletal class II, respectively. The latter two skeletal class groups did not significantly differ for these two angles. The measurement of nasofacial angle considerably differed

Table 3
Error of the method in measuring cephalometric variables used in the study.

Measurements	First occasion (n = 10)		Second occasion (n = 10)		Dahlberg's value
	mean	SD*	mean	SD*	
STN-Sn (mm)	51.40	3.28	51.02	3.02	0.66
STN-PRN (mm)	45.69	2.44	45.46	2.57	0.32
PRN-VP (mm)	24.04	3.58	24.00	3.39	0.21
STG-STN-DNP (°)	133.20	10.93	133.00	10.58	0.83
STP-DNP (°)	6.30	3.26	6.30	3.49	0.22
Cm-Sn-Ls (°)	96.40	10.76	96.80	10.64	1.09
HP-DNP (°)	127.50	6.78	128.10	7.14	0.83
STG-STPg-DNP (°)	38.30	5.88	38.60	6.23	0.59
DNP-PRN-STPg (°)	121.10	6.87	121.50	7.26	0.63
PRN-LS horizontal (mm)	12.35	3.08	12.50	3.11	0.40
PRN-Is horizontal (mm)	24.13	5.33	23.85	5.24	0.66
PRN-STPg horizontal (mm)	23.95	3.44	23.69	3.45	0.42
PRN-LS vertical (mm)	24.54	2.81	24.80	2.68	0.78
PRN-Is vertical (mm)	62.53	5.99	62.33	6.01	0.24
PRN-STPg vertical (mm)	62.53	5.99	62.65	5.97	0.81
SNA (°)	83.90	3.87	83.90	3.87	–
SNB (°)	79.20	4.13	79.20	4.13	–
ANB (°)	4.70	2.26	4.70	2.26	–

*SD: Standard deviation.

between subjects with skeletal class II and those of skeletal class III. Moreover, no significant differences were found between skeletal class I group and the other two skeletal class groups for the same angle.

With regards to the linear measurements that were recorded to determine the nasal position in relation to other craniofacial structures, no significant differences were observed among the three skeletal class groups/gender in the horizontal distances relating the most anterior point of the nose (pronasale; PRN) to the upper lip (PRN-LS horizontal), the incisal edge of the most prominent maxillary central incisor (PRN-Is horizontal), and the chin (PRN-STPg horizontal).

Conversely, significant differences were found between subjects with skeletal class II and those with skeletal class I and class III in the vertical distances relating the nose to the upper lip ($P = 0.034$ and $P = 0.040$, respectively), the incisal edge of the most prominent

maxillary central incisor ($P = 0.037$ and $P = 0.002$, respectively). No significant differences were observed between skeletal class I and III groups for the aforementioned vertical distances. Additionally, the vertical distance between the tip of nose and the soft tissue of the chin significantly differed between skeletal class II and class III groups ($P = 0.024$). The latter two groups did not show any statistically significant differences with skeletal class I group. Moreover, there were significant differences in the vertical distances from the pronasale to the incisal edge of the most prominent maxillary central incisor ($P = 0.002$) and to the chin ($P = 0.039$) for males of skeletal class I and II groups when compared to the females of the same group, as reflected by larger vertical distances (PRN-Is vertical and PRN-STPg vertical, respectively), but there were no significant male-female differences in the vertical distance relating the nose to the upper lip ($P = 0.134$) in both skeletal class I and II groups. All the aforementioned vertical distances were larger for females than males in skeletal class III group.

4. Discussion

There have been many studies on the nasal profile of various ethnic/racial groups in the literature, but the current study was the first study evaluating the nasal profile of Iraqi population with different skeletal discrepancies (Class I, II, and III).

On comparing the results of this study with the results that are available in the literature, it was found that the mean for the nasal height of Iraqi population for men with skeletal Class I (56.32 mm) was close to those of Turkish men in two studies (56.92 mm),¹⁵ and (55.15 mm).¹⁸ In addition, the mean of Iraqi nasal height for men was close to Caucasian men; 58.10 mm;²¹ New Zealand men; 58.10 mm,¹⁸ Han nationality men; 57.80 mm,⁹ but it was greater than those of Chinese men; 53.50 mm,²⁰ Afro-Indian men; 54.7 mm,¹⁴ Afro-caucasian men; 53.6 mm,¹⁴ Caucasian (men, 53.00 mm),³ African (men, 49.3),¹⁴ Japanese (men 47.7 mm),¹⁹ Negroe (men, 52.4 mm)¹³ and was shorter than Saudi men; 62.60 mm.¹⁸ In addition, the mean for the nasal height of Iraqi population for women with skeletal Class I (51.85 mm) was similar to those of Chinese women; 51.70 mm,¹⁶ Korean American women; 51.8 mm;¹⁷ however, it was greater than Caucasian women; 48.90 mm,³ Negroe women; 49.3 mm,¹³ North American white women; 50.6 mm and shorter than Caucasian women; 53.66,²¹ New Zealand women; 53.66 mm, and Saudi women; 60.38 mm.¹⁸

Additionally, the means for nasal length in this study for men in

Table 4
Descriptive statistics of the three skeletal groups.

Measurements	Skeletal class I group				Skeletal class II group				Skeletal class III group			
	Male (N = 15)		Female (N = 15)		Male (N = 15)		Female (N = 15)		Male (N = 15)		Female (N = 15)	
	mean	SD*	mean	SD*	mean	SD*	mean	SD*	mean	SD*	mean	SD*
SNA (°)	82.80	3.56	83.73	3.45	83.73	2.73	83.33	4.56	80.3	5.13	80.46	4.94
SNB (°)	80.06	3.34	80.53	3.24	76.73	2.65	76.26	4.94	81.80	5.26	81.80	4.52
STN-Sn (mm)	56.32	5.70	51.85	3.11	52.94	4.01	50.96	5.17	54.50	3.55	58.51	2.49
STN-PRN (mm)	50.72	4.58	45.73	2.82	46.50	8.79	44.80	5.17	46.98	8.26	51.31	2.24
PRN-VP (mm)	25.93	4.12	24.12	3.52	26.44	2.70	23.84	3.86	22.20	4.60	25.62	1.27
STG-STN-DNP (°)	133.26	14.54	135.33	11.34	129.26	11.88	136.26	9.08	130.20	8.80	131.80	7.36
Cm-Sn-Ls (°)	97.93	9.75	101.73	12.15	91.2	14.95	98.80	13.1	95.33	10.75	101.93	9.81
HP-DNP (°)	128.13	8.01	127.20	5.518	128.80	5.29	127.2	5.37	121.73	8.63	124.53	6.32
STG-STPg-DNP (°)	38.8	7.3	37.4	6.18	42.6	6.11	38.73	5.65	34.40	7.52	34.2	5.54
DNP-PRN-STPg (°)	121.73	8.2	121.80	7.35	116.86	7.50	120.60	6.97	129.93	10.61	129.53	5.92
PRN-LS horizontal (mm)	15.04	3.98	13.729	2.95	13.06	3.83	10.57	1.9	14.26	2.16	14.38	6.39
PRN-Is horizontal (mm)	30.58	6.36	23.61	6.63	25.91	5.26	19.89	2.60	28.8	3.06	28.68	10.66
PRN-STPg horizontal (mm)	26.30	5.44	20.89	8.39	31.82	4.56	25.36	6.36	22.34	7.46	23.15	14.08
PRN-LS vertical (mm)	25.34	3.51	24.98	2.90	25.64	2.97	24.59	3.75	25.09	2.68	28.56	1.19
PRN-Is vertical (mm)	34.16	3.08	30.48	11.57	37.26	3.14	36.1	5.23	33.04	3.36	37.38	1.62
PRN-STPg vertical (mm)	64.48	4.08	60.26	4.78	67.20	5.54	61.78	8.52	67.63	8.56	73.73	3.02

*SD: Standard deviation.

skeletal class I group (50.72 mm) was comparable to those of Caucasian men; 51.45 mm,²¹ New Zealand men 51.45 mm,¹⁸ but it was smaller than those of British men; 54 mm,²³ and Saudi men; 58.60 mm.¹⁸ moreover, the values of nasal length for women of skeletal class I group (45.73 mm) in this study were close to Neo Zealand women; 46.18 mm,¹⁸ but were smaller than those of Caucasian women; 49.10 mm,²¹ and Saudi women; 53.00 mm.¹⁸ Smaller values were also recorded for the nasal depth of Iraqi men (25.93 mm) in comparison with those corresponding values of Caucasian men 29.03 mm,²¹ while there were similarity between the values of the nasal depth for Iraqi women with those corresponding values of Caucasian women 24.61 mm,²¹ Neo Zealand women; 24.61 mm.¹⁸

With regards to the angular measurements, the means for nasofacial angle recorded in this study for skeletal Class I group (men, 38.8°; women, 37.4°) agreed with the findings of Begg and Harkness (men, 38.37°; women, 38.04°),²¹ and the ideal ranges (from 30° to 40°) suggested by O'Ryan and Schendel,²⁴ and Powell and Humphreys.²⁵ In addition, the values of nasolabial angle in Iraqi population, regardless of the gender or the skeletal class group in the present study, were smaller than those corresponding values found by Begg and Harkness²¹ (males, 110.06°; females 112.15°), and those suggested by Powell and Humphreys²⁵ as the ideal range values 115°–130° for nasolabial angle.

A comparison between the values of nasofrontal angle of various racial/ethnic groups with those corresponding values of class I skeletal class group (men; 133.26°, women; 135.33°) in the present study reflected that there were a similarity with those of Chinese (men; 134.50°, women, 135.60°),²⁰ Caucasian (men; 133.29°, women, 135.13°),²¹ Saudi population (men; 134.67°, women; 137.33°),¹⁸ New Zealand population (men; 133.92°, women; 135.13°)¹⁸ and Negrose (men; 135.60°, women, 131.9°).²⁵

With regards to the vertical distances relating the tip of the nose to the upper lip, the incisal edge of the most prominent maxillary, or the chin, it was observed in the present study smaller values recorded for class I skeletal group for Iraqi men (25.34 mm, 34.16 mm, 64.48 mm, respectively) and Iraqi women (24.98 mm, 30.48 mm, 60.26 mm, respectively) in comparison with Caucasian (men; 31.44 mm, 42.30 mm, 72.19 mm, respectively) and Caucasian (women; 27.80 mm, 37.24 mm, 64.56 mm, respectively),²¹ Saudi (men; 23.40 mm, 34.30 mm, 72.27 mm, respectively) and Saudi (women; 25.38 mm, 33.78 mm, 64.92 mm, respectively),¹⁸ and New Zealand (men; 31.44 mm, 42.30 mm, 72.19 mm, respectively) and New Zealand (women; 27.80 mm, 37.77 mm, 64.56 mm, respectively).¹⁸ This means that Iraqi population have a decrease in the lower anterior facial height in comparison with Caucasian, Saudi and New Zealand populations. Similar patterns for the horizontal distances were also recorded for Iraqi populations comparing with Caucasian,²¹ Saudi and New Zealand populations.¹⁸

5. Conclusion

Based on the assessment of the nasal profile data produced in this study, remarkable differences have been identified between Iraqi population and other racial/ethnic groups. Therefore, this study established standards for the size, shape and the relative position of nose for Iraqi population with different skeletal classes. Thus, these findings should be considered carefully during diagnosis and plan for

orthodontic treatment and rhinoplasty in Iraqi adults to achieve satisfactory results.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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