



## **Assessment of sagittal lip position and some affecting factors in a sample of Iraqi adults**

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### **Abstract**

This study aimed to determine the sagittal lip position and some of the factors affecting it regarding the gender differences, and their correlations in a sample of Iraqi adults.

Sixty two participants (37 females and 25 males) collected among dental students having CI I skeletal and occlusal relations and full permanent dentition regardless the third molars were chosen for this study. Each person was subjected to clinical examination and digital true lateral cephalometric radiograph. The radiographs were analyzed by using AutoCAD 2007 computer program to measure the sagittal lip position using the soft tissue analyses of Steiner, Burstone, Ricketts, Sushner, Holdaway, and Merrifield. Descriptive statistics were obtained from the measurements of both genders; independent samples t-test was performed to evaluate the gender differences and Pearson's correlation coefficient test was used to find the contributing factors to the sagittal lip position.

Sagittal jaw angles were significantly higher in males than females, while vertical jaw angle was higher in females. Lower incisors showed slight proclination in both genders. The mean values of H-angle and revised H-angle in males were non-significantly higher than that of females, while the mean value of Z-angle was non-significantly higher in females. Upper and lower lips thickness mean values were significantly higher in males. Females had non-significantly more projected nose compared to males. Regarding the sagittal lip position, upper and lower lip measurements were non-significantly higher in males than females in Ricketts, Steiner, Burstone, and Holdaway analyses, but it was significant in Sushner analysis, while Z-angle of Merrifield was non-significantly higher in female sample. Pearson's correlation coefficient test revealed that upper and lower lip thickness was significantly positively correlated with sagittal lip position, while nose projection was significantly negatively correlated.

Sagittal position values of the upper and lower lips in a sample of Iraqi adults are close to the norms of Ricketts, Steiner, Sushner, Burstone, and Holdaway analyses with a slight tendency of upper lip toward retrusion and lower lip toward protrusion with the exception of that when compared with Sushner norms. In addition to the chin position, lips thickness and nose projection are the most important factors that influence the sagittal lip position and compensate for the variations in the jaw bases between genders.

**Key words: Sagittal lip position, soft tissue cephalometry, lips analyses.**

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## Introduction

Angle<sup>(1)</sup> considered the mouth as a most potent factor in making or marring the character of the face, with the form and beauty of the mouth itself depending on the occlusal relation of the teeth. His chief concern was finding or establishing a harmonious relationship between the mouth and other features.

In man, the lower face serves not only in the interest of digestion, speech and respiration, but it also influences to a larger extent the social appearance and psychological well-being of the individual. Appearance, therefore, is one of the primary functions of the face<sup>(2)</sup>.

For a long time, orthodontists have focused on the horizontal lip position as the most important feature in determining beauty. Several lines have been introduced to assess the sagittal position of the upper and lower lips and the esthetic quality of the profile.

Ricketts'<sup>(3)</sup> lip analysis consists of a line (E line) drawn from the tip of the nose to the soft tissue pogonion. Ricketts reported that normally the upper and lower lips lie behind this line a mean distance of 4 mm and 2 mm, respectively.

Holdaway<sup>(4)</sup> described a soft tissue profile analysis using the H line tangent to the upper lip from soft tissue pogonion. He concluded that the angle between the nasion-point B line and H line should be 7° to 8° when the ANB angle was 1° to 3° and the lower lip either on the H line or within 1 mm of it.

In 1983, Holdaway<sup>(5)</sup> re-measured the H angle as the angle formed between the soft tissue facial plane and the H line and stated that clinically, the revised H angle appears far superior to the original H angle. This can be explained by the variability of the chin area, which is not considered by the

ANB angle. This angle measures the prominence of the upper lip in relation to the over-all soft-tissue profile.

Steiner<sup>(6)</sup> attempted to evaluate the soft tissue profile by drawing a line (S1 line) from the middle of the S-shaped curve between the tip of the nose and subnasale to the soft tissue pogonion and stated that the lips should touch the reference line.

Merrifield<sup>(7)</sup> modified Holdaway's H line by drawing a line from soft tissue pogonion to the most procumbent lip (profile line), and measured the angle (Z angle) between this line and the Frankfort horizontal plane; it was 80° in adults.

Burstone's<sup>(8)</sup> B line was drawn from soft tissue subnasale to soft tissue pogonion. Burstone concluded that the upper and lower lips were located anterior to this line a mean distance of 3.5 and 2.2 mm, respectively.

A line (S2 line) drawn from soft tissue nasion to soft tissue pogonion was developed by Sushner<sup>(9)</sup>. He stated that the upper and lower lips were anterior to this line in the black population he analyzed (female, 8.8 mm/6.7 mm; male, 10.3 mm/7.8 mm).

In 1993, Hsu<sup>(10)</sup> found that those analytic reference lines that do not transverse an anatomic landmark of the nose most likely have poor consistency and sensitivity. This finding is consistent with the idea that the nose should be taken into consideration when a line is to be used as a reference for beauty on the lateral facial profile.

Erbay *et al.*<sup>(11)</sup> stated that soft tissue analysis differs according to population because every race has its own nose and chin characteristics. It became obvious that using the soft tissue norms developed for one population would be unsuitable in diagnosis and treatment planning for another group of people. It would be

much more appropriate to evaluate the nose, the chin, and the lips separately and then establish a relationship between them. In other words, orthodontists should establish specific norms for each racial or ethnic group.

In Iraq, many researches had been conducted that studied the lip thickness<sup>(12-14)</sup>, analysis of soft tissues in class I normal occlusion<sup>(15-17)</sup>, comparison of soft tissue parameters between class I and II<sup>(18)</sup> and class I and III<sup>(19)</sup> and evaluation of the lips and incisors in class I and class II and at different ages<sup>(20-23)</sup>.

The aim of the present study was to determine the sagittal lip position and some of the factors affecting it regarding the gender differences, and their correlations in a sample of Iraqi adults.

## Materials and Methods

### The sample

The sample included under and postgraduate students at the College of Dentistry, University of Baghdad. The age ranged between 20-31 years. Out of ninety five students examined, only sixty two subjects (37 females and 25 males) were selected to have sagittal, vertical, and transverse skeletal relationships according to Riedel<sup>(24)</sup> (ANB angle of  $2^{\circ}\pm 2^{\circ}$ , SN-MP angle of  $32^{\circ}\pm 5^{\circ}$ , no crossbite), normal occlusion, full permanent dentition regardless the third molars.

### Method

Each student was examined clinically and subjected to the true digital lateral cephalometric radiograph by using Planmeca ProMax radiograph unit. The individual was positioned within the cephalostat with the sagittal plane of the head vertical, the Frankfort plane horizontal, and the teeth were in centric occlusion. Every lateral cephalometric radiograph was

analyzed by AutoCAD 2007 analyzing software computer program to calculate the linear and angular measurements. Once the picture is imported to the AutoCAD program, it will appear in the master sheet on which the points and planes were determined, and then the angular and linear measurements were obtained. The angles were measured directly as they were not affected by magnifications, while the linear measurements were divided by scale (the ruler in the nasal rod) for each picture to overcome the magnification.

## Cephalometric Landmarks, Planes, and Measurements

### Cephalometric points

1. Point S (Sella): The midpoint of the hypophysial fossa<sup>(25)</sup>.
2. Point N (Nasion): The most anterior point on the nasofrontal suture in the median plane<sup>(25)</sup>.
3. Point A (Subspinale): The deepest midline point on the premaxilla between the Anterior Nasal Spine and Prosthion<sup>(26)</sup>.
4. Point B (Supramentale): The deepest midline point on the mandible between Infradentale and Pogonion<sup>(26)</sup>.
5. Point ANS (Anterior Nasal Spine): It is the tip of the bony anterior nasal spine in the median plane<sup>(25)</sup>.
6. Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose. It marks the dorsal limit of the maxilla<sup>(25)</sup>.
7. Point Is (Incisor superius): The tip of the crown of the most anterior maxillary central incisor<sup>(25)</sup>.
8. Point Ap 1 (Apicale 1): Root apex of the most anterior maxillary central incisor<sup>(25)</sup>.

9. Point Ii (Incisor inferius): The tip of the crown of the most anterior mandibular central incisor <sup>(25)</sup>.
10. Point Ap 1 (Apicale 1): Root apex of the most anterior mandibular central incisor <sup>(25)</sup>.
11. Point Pog (Pogonion): It is the most anterior point on the mandible in the midline <sup>(25)</sup>.
12. Point Me (Menton): The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalograms <sup>(27)</sup>.
13. Point Go (Gonion): A point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and inferior border of the mandible <sup>(27)</sup>.
14. Point Or (Orbitale): The lowest point on the inferior rim of the orbit <sup>(27)</sup>.
15. Point Po (Porion): The most superiorly positioned point of the external auditory meatus <sup>(27)</sup>.
16. The middle point at the labial surface of maxillary central incisor <sup>(28)</sup>.
17. The middle point at the labial surface of mandibular central incisor <sup>(28)</sup>.
18. Point Li (labrale inferius): It is the median point in the lower margin of the lower membranous lip <sup>(29)</sup>.
19. Point Ls (labrale superius): It is the median point in the upper margin of the upper membranous lip <sup>(29)</sup>.
20. Point Sn (subnasale): It is the point where the lower border of the nose meets the outer contour of the upper lip <sup>(29)</sup>.
21. Point Pog' (soft tissue pogonion): It is the most prominent point on the soft tissue contour of the chin <sup>(29)</sup>.
22. Point N' (soft tissue nasion): It is the point of deepest concavity of the soft tissue contour of the root of the nose <sup>(29)</sup>.
23. Point Pn (pronasale): The most prominent point of the nose <sup>(29)</sup>.

### Cephalometric planes

1. Sella-Nasion (SN) plane: It is the sagittal extent of anterior cranial base, formed by a line joining Sella turcica and Nasion <sup>(25)</sup>.
2. N-A line: Formed by a line joining Nasion and point A <sup>(26)</sup>.
3. N-B line: Formed by a line joining Nasion and point B <sup>(26)</sup>.
4. Mandibular plane (MP): Formed by a line joining Gonion and Menton <sup>(25)</sup>.
5. N-Pog: Formed by a line joining Nasion and point Pogonion <sup>(25)</sup>.
6. The Long axis of the upper incisor (U1): A line connecting Is and Ap 1 <sup>(25)</sup>.
7. The Long axis of the lower incisor (L1): A line connecting Ii and Ap 1 <sup>(25)</sup>.
8. Palatal plane (PP): A plane joining between anterior nasal spine and posterior nasal spine <sup>(25)</sup>.
9. Frankfort plane: A line passing through the points Porion and Orbitale <sup>(27)</sup>.
10. S1-line: It extends from the middle of the S-shaped curve between the tip of the nose and subnasale to the soft tissue pogonion <sup>(6)</sup>.
11. E-line: It was drawn from the tip of the nose to the soft tissue pogonion <sup>(3)</sup>.
12. B-line: It was drawn from soft tissue subnasale to soft tissue pogonion <sup>(8)</sup>.
13. S2-line: It was drawn from soft tissue nasion to soft tissue pogonion <sup>(9)</sup>.
14. H-line: A line tangent to the upper lip from soft tissue pogonion <sup>(4)</sup>.
15. Modified H-line (profile line): A line that extends from soft tissue pogonion to the most procumbent lip <sup>(7)</sup>.

### Cephalometric measurements

1. SNA angle: The angle between lines S-N and N-A. It represents the angular sagittal position of the maxilla to the cranial base <sup>(24)</sup>.
2. SNB angle: The angle between lines S-N and N-B. It represents the angular sagittal position of the mandible to the cranial base <sup>(24)</sup>.
3. ANB angle: The angle between lines N-A and N-B. It is the most commonly used measurement for appraising sagittal disharmony of the jaws <sup>(24)</sup>.
4. S-N-Pog: The angle between lines S-N and N-Pog <sup>(26)</sup>.
5. SN plane- Mandibular plane angle (SN-MP): The angle between the S-N plane and the mandibular plane <sup>(25)</sup>.
6. SN plane- Palatal plane angle (SN-PP): The angle between the S-N plane and the palatal plane <sup>(25)</sup>.
7. Maxillary incisor – Palatal plane angle (U1-PP): The angle between long axis of upper incisor and palatal plane, posteriorly <sup>(25)</sup>.
8. Mandibular incisor– Mandibular plane angle (L1-MP): That angle formed by the long axis of the most labial mandibular incisor to the mandibular plane, posteriorly <sup>(24,26)</sup>.
9. Inter-incisal angle (U1-L1): The angle between the long axes of most labial maxillary and mandibular incisors <sup>(25)</sup>.
10. Tissue thickness at upper lip: The distance between the middle point at the labial surface of maxillary central incisor to the labrale superius <sup>(28)</sup>. (Fig. 1)
11. Tissue thickness at lower lip: The distance between the middle point at the labial surface of mandibular central incisor to the labrale inferius <sup>(28)</sup>. (Fig. 1)
12. H-angle: The angle between the H-line and the N-B line <sup>(4)</sup>. (Fig. 1)
13. Revised H-angle: The angle between the H-line and the N'-Pog' line <sup>(5)</sup>. (Fig. 1)
14. Z-angle: The angle between the profile line and the Frankfort horizontal plane <sup>(7)</sup>. (Fig. 1)
15. Nasal projection: The shortest distance between the nasal tip (Pn) and H-line <sup>(5)</sup>. (Fig. 1)
16. The sagittal lip position consisted of measuring the shortest (perpendicular) distance between Ls and Li of the lips and the reference line used (E, S1, S2, B, H lines). The measured distance was denoted as positive when the lip was ahead of the reference line, as negative when the lip was behind the line, and as zero when the lip was on the line <sup>(3,4,6,8,9)</sup>. (Fig. 1)

### Statistical Analysis

All the data of the sample were subjected to computerized statistical analysis using SPSS version 15 (2006) computer program. The statistical analyses included:

#### 1. Descriptive Statistics

- a) Means.
- b) Standard deviations (SD).
- c) Statistical tables.

#### 2. Inferential Statistics

- a) Independent-samples t-test for the comparison between both genders.
- b) Pearson's correlation coefficient test (r) to find the most correlated variables to the sagittal lip position.

In the statistical evaluation, the following levels of significance were used:

Non-significant	NS	P > 0.05
Significant	*	0.05 ≥ P > 0.01
Highly significant	**	0.01 ≥ P > 0.001
Very highly significant	***	P ≤ 0.001

## Results

Descriptive statistics and gender differences (independent samples t-test) were illustrated in table 1, in which the sagittal jaw angles: SNA, SNB, and S-N-Pog were significantly higher in males than females. Both means of SNA and SNB angles were closer to the normal values in females. ANB angle demonstrated a higher mean value in males ( $2.76^{\circ} \pm 1.3^{\circ}$ ) than in females ( $2.38^{\circ} \pm 1.28^{\circ}$ ). S-N plane to mandibular plane angle showed a higher mean value in females ( $32.86^{\circ} \pm 2.77^{\circ}$ ) than that of males ( $30.88^{\circ} \pm 2.68^{\circ}$ ), and again it was closer to the normal range in females. Although the maxillary inclination to the S-N plane was significantly differ between genders, the mean values of this angle were within the normal range.

The mean value of upper incisor inclination to the palatal plane was higher in males ( $113.2^{\circ} \pm 6.85^{\circ}$ ), in contrast to that of lower incisor inclination to the mandibular plane which was higher in females ( $96.27^{\circ} \pm 5.51^{\circ}$ ). Inter-incisal angle had a mean value in males  $126.88^{\circ} \pm 8.55$ , and in females  $128.95^{\circ} \pm 7.12^{\circ}$ . All of the dental measurements were non-significantly differed between genders.

H-angle and revised H-angle had mean values in males of  $12.48^{\circ} \pm 4.04^{\circ}$  and  $16.8^{\circ} \pm 3.75^{\circ}$  respectively, which were non-significantly higher than that of females ( $10.46^{\circ} \pm 4.14^{\circ}$ ,  $15.3^{\circ} \pm 3.57^{\circ}$ ), while the mean value of Z-angle was non-significantly higher in females ( $75.08^{\circ} \pm 5.68^{\circ}$ ) than that of males ( $73.6^{\circ} \pm 4.72^{\circ}$ ).

Upper and lower lips thickness mean values were significantly higher in males. Females had non-significantly more projected nose compared to males as measured from the nasal tip to H-line.

Regarding the sagittal lip position, upper and lower lip measurements

were higher in males than females in Ricketts, Steiner, Burstone, and Holdaway analyses but with non-significant differences. The only significant difference was in Sushner's analysis, in which the lip measurements of males were significantly higher than that of females.

Table 2 presented Pearson's correlation coefficient test for the sagittal lip measurements in different analyses and the other variables used in this study. The most correlated factors were the upper and lower lips thicknesses which were positively correlated with almost all of the upper and lower lips sagittal positions, and the nose projection which showed significant negative correlations with them.

## Discussion

This is the first Iraqi study of its kind that's designed to determine the sagittal lip position in relation to five standardized reference lines, as cephalometric measurements of the face in terms of aesthetics can be difficult and misleading due to the variability of the intra-cranial reference lines. Extra-cranial reference lines have been proposed avoiding the inherent problems associated with possible variations in the intra-cranial lines.

The sample included adults persons as the majority of facial growth is usually complete by 16-17 years of age<sup>(30)</sup>. One of the most important things is to select a sample with class I dental and skeletal relations to minimize the effect of the skeletal and dental discrepancies.

Generally, the lips are affected by the skeletal and dental relations and differed in thickness between genders, so the upper and lower incisor inclination relative to the palatal and

mandibular planes respectively and the lip thickness were taken into consideration.

The nasal projection relative to H-line was also measured to show whether the nasal projection had an effect on the position of the lips as E and S1 lines pass through the nose.

Several researches had been concurred that soft and hard tissue changes were highly correlated. Altemus<sup>(31)</sup> found that facial balance and harmony are often a compromise or a compensation in the relationship among skeletal, dental, and soft tissue components of the face.

In order to determine the factors that affect the sagittal lips position, the objective was to discuss the bases that support the lips, which include the bones and dentition to end up with the lip position.

The results showed that the mean values of the SNA, SNB, and SN-Pog angles were higher in males than females, with very highly significant gender differences (table 1). These findings indicated that the males had a slightly more prognathic maxilla and mandible in comparison with females.

The mean value of SN-MP angle in females was  $32.86^{\circ} \pm 2.77^{\circ}$ , so the decreased mean value in males indicates that males have a tendency toward upward forward rotation of the mandible, and this explains the higher mean values of SNB and SN-Pog angles (table 1). The maxillary plane inclination angle was significantly higher in females, but still within the normal range in both genders<sup>(32)</sup>.

The results showed that the lower incisors were to some extent proclined in both genders and their inclination relative to the mandibular plane was less in males than in females. This is to compensate for the skeletal difference as the mandible is slightly prognathous in males because of the upward mandibular rotation. This finding

comes in agreement with the study of Nahidh *et al.*<sup>(33)</sup> that included larger sample and may explain the slightly decreased inter-incisal angle.

However, the inclination of upper incisors to palatal plane was higher in males than females. Upper, lower incisors inclinations and inter-incisal angle showed non-significant gender differences (table 1).

As shown in table 1, males had thicker upper and lower lips than females with a very high significant gender difference. This may follow the general rule that females are slightly smaller than males in all dimensions<sup>(34)</sup>.

The anteroposterior position of the lips was evaluated with reference to E-line, S1-line, S2-line, H-line and B-line. On reviewing table 1, the projection of upper and lower lips relative to all reference lines used in this study were higher in males than in females with a non-significant difference. This might suggest that in spite of the differences in the jaw bases and lip thickness between genders the non-significant differences in most of the anteroposterior lip position might be due to the compensation from the slightly prominent nose in females and a more prognathic chin in males. The exceptions were in the projection of upper and lower lips relative to S2 line where there were significant gender differences. The significantly thicker lips in males than females might play the major role in such difference.

When comparing with the norms, the Iraqi sample was considered as a whole without gender segregation. Generally, the mean values of Iraqis are very close to that of norms but with a slight tendency of the upper lip toward retrusion and lower lip toward protrusion which may be resulted from the slightly proclined lower incisors. On the other hand, the upper lip was protruded and the lower lip was

retruded for Iraqis compared with the norms developed by Sushner for a black population (table 3). This result was similar to that of Anatolian Turkish adults<sup>(11)</sup>. A protrusive upper lip and a retrusive lower lip in relation to Sushner's S2 line may occur only with a protrusive chin, a retrusive forehead, or both. Since the protrusive chin may not be coordinated with the female sample so the retrusive forehead may be the rational cause for such result in Iraqi adults. These small variations from the norms might be attributed to the great degree of individual variability due to differences in age, sex, or ethnic group.

Regarding the genders, the findings of the present study disagreed with that of Erbay *et al.*<sup>(11)</sup> for Anatolian Turkish adults where the lip projections were higher in females than males in most variables with a non-significant difference.

When the sagittal lip position was evaluated with reference to the H-angle, revised H-angle and Z-angle, the mean values of H and revised H angles were higher in males than females with non-significant differences.

Again the lip thickness and the position of the maxilla, mandible, and the forehead are the major factors for these differences. H-angle for total Iraqi sample was higher than the norms of Holdaway, and the revised H-angle was slightly higher than the upper limit of the norms. This finding may indicate a relative convexity of soft tissue profile or may be related to the upper lip thickness, inclination of upper incisors, the position of points nasion (N) and soft tissue nasion (N'), but being mostly within the standard ranges of different analyses, upper lip effect may be excluded or minimized together with upper incisors inclination, while the impact of point nasion increased and this might indicate that Iraqi sample has more

anteriorly divergent face compared to that of Holdaway and this supports the previous result of protrusive upper lip and a retrusive lower lip in relation to Sushner's S2 line.

The mean value of Z angle was non-significantly higher in females than that of males. This angle depends upon the profile line and Frankfort plane. The latter is subjected to a wide degree of variation as it depends upon two anatomical points namely Porion and Orbitale. Here the effect of greater thickness in males' lips appears more obviously because it affects the profile line in a way that decreasing the Z-angle.

The Z-angle value in this sample ( $74.48^\circ \pm 5.32$ ) illustrated smaller mean value than the norm of Merrifield ( $80^\circ \pm 5$ ), which might also indicate a relative convexity of the soft tissue profile.

Table 1 showed that the nasal projection of females was slightly larger than males with a non-significant gender difference; this can be attributed to the more prognathic maxilla in males which with the higher upper incisor inclination lead to a more forward position of the upper lip adding together with the greater thickness of males' upper lip. All the former causes influence the H line to which the nasal projection is measured.

A correlation test has been done to investigate the correlation of several variables on lip sagittal position (table 2). Upper lip thickness and lower lip thickness were significantly positively correlated with sagittal lip position in almost all of the analyses, while nasal projection to H-line was significantly negatively correlated with them, even though its effect mainly associated with Ricketts' and Steiner's analyses.

## Conclusions



Sagittal position values of the upper and lower lips in Iraqi adults were close to the norms of the Ricketts, Steiner, Sushner, Burstone, and Holdaway analyses with a slight tendency of upper lip toward retrusion and lower lip toward protrusion which may be owing to the proclined lower incisors, with the exception to that when compared with Sushner norms. This should be taken into consideration during planning for orthodontic treatment or orthognathic surgery.

In addition to the chin position, lip thickness and nose projection are the most important factors that influence the sagittal lip position and compensate for the variations in the jaw bases between genders, but since the sample was selected to be sagittally and vertically within the normal range, so the effect of chin position decreased.

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Table 1: Descriptive statistics and gender differences

Variables		Descriptive statistics						Gender difference	
		Total (N=62)		Males (N=25)		Females (N=37)		d.f.=60	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	t-test	p-value
Angular measurements (°)	SNA	81.90	3.87	84.16	3.78	80.38	3.14	4.28	0.000 ***
	SNB	79.35	3.63	81.36	3.56	78.00	3.04	3.99	0.000 ***
	ANB	2.53	1.29	2.76	1.30	2.38	1.28		
	S-N-Pog	80.35	3.3	82.28	3.08	79.05	2.81	4.27	0.000 ***
	SN- MP	32.06	2.89	30.88	2.68	32.86	2.77		
	SN- PP	8.66	3.18	7.56	2.93	9.41	3.17	-2.32	0.024*
	U1-PP	112.10	6.15	113.20	6.85	111.35	5.60	1.16	0.25 (NS)
	L1-MP	96	5.29	95.60	5.04	96.27	5.51	-0.49	0.63 (NS)
	U1-L1	128.11	7.73	126.88	8.55	128.95	7.12	-1.03	0.31 (NS)
	H-angle	11.27	4.19	12.48	4.04	10.46	4.14	1.90	0.06 (NS)
	Revised H-angle	15.90	3.69	16.80	3.75	15.30	3.57	1.59	0.12 (NS)
	Z-angle	74.48	5.32	73.6	4.72	75.08	5.68	-1.08	0.29 (NS)
Linear measurements (mm)	Upper lip thickness	12.47	2.44	14.21	2.46	11.29	1.58	5.72	0.000 ***
	Lower lip thickness	13.36	1.66	14.66	1.43	12.48	1.15	6.62	0.000 ***
	Pn-H line	7.56	3.6	7.08	3.86	7.89	3.44	-0.87	0.39 (NS)
	Ls-S1 line	-1.01	1.70	-0.67	1.86	-1.24	1.56	1.30	0.2 (NS)
	Li-S1 line	0.44	2.01	0.79	1.70	0.20	2.18	1.14	0.26 (NS)
	Ls-E line	-4.84	2.05	-4.63	2.16	-4.98	1.98	0.65	0.52 (NS)
	Li-E line	-1.67	2.24	-1.38	1.87	-1.87	2.47	0.85	0.4 (NS)
	Ls-B line	3.40	1.55	3.83	1.69	3.11	1.40	1.83	0.07 (NS)
	Li-B line	2.85	1.81	3.24	1.52	2.58	1.96	1.42	0.16 (NS)
	Ls-S2 line	9.84	2.49	11.07	2.72	9.01	1.95	3.47	0.000 ***
	Li-S2 line	6.32	2.03	7.11	1.77	5.78	2.04	2.66	0.01 **
Li- H line	0.81	1.39	0.86	1.21	0.78	1.52	0.22	0.82 (NS)	

Table 2: Pearson's correlation coefficient test for the sagittal lip measurements and other variables

Variables		SNA	SNB	S-N-Pog	SN-PP	U1-PP	L1-MP	U1-L1	Pn-H line	Upper lip thickness	Lower lip thickness
Ls-S1 line	r	0.23	0.17	0.13	-0.21	-0.07	0.04	-0.09	-0.97	0.40	0.42
	p	0.07	0.19	0.32	0.10	0.57	0.74	0.47	0.00 ***	0.00 ***	0.00 ***
Li-S1 line	r	0.21	0.12	0.04	-0.14	-0.01	0.15	-0.24	-0.78	0.08	0.29
	p	0.10	0.37	0.75	0.27	0.92	0.24	0.07	0.00 ***	0.55	0.02 *
Ls-E line	r	0.21	0.13	0.09	-0.20	-0.06	0.08	-0.14	-0.99	0.34	0.36
	p	0.10	0.30	0.49	0.12	0.67	0.53	0.28	0.00 ***	0.01 **	0.00 ***
Li-E line	r	0.20	0.10	0.03	-0.13	-0.02	0.17	-0.25	-0.83	0.10	0.28
	p	0.12	0.44	0.85	0.30	0.89	0.19	0.05 *	0.00 ***	0.44	0.03 *
Ls-B line	r	0.21	0.20	0.16	-0.23	-0.06	-0.04	-0.03	-0.89	0.45	0.48
	p	0.10	0.13	0.21	0.08	0.62	0.76	0.83	0.00 ***	0.00 ***	0.00 ***
Li-B line	r	0.20	0.14	0.06	-0.17	0.00	0.11	-0.21	-0.72	0.06	0.29
	p	0.12	0.30	0.64	0.20	1.00	0.40	0.10	0.00 ***	0.62	0.02 *
Ls-S2 line	r	0.34	0.19	0.14	-0.04	-0.06	0.00	-0.13	-0.77	0.65	0.58
	p	0.01 **	0.14	0.27	0.75	0.65	0.98	0.31	0.00 ***	0.00 ***	0.00 ***
Li-S2 line	r	0.31	0.17	0.09	-0.10	-0.01	0.09	-0.24	-0.72	0.26	0.41
	p	0.01 **	0.19	0.49	0.45	0.96	0.50	0.06	0.00 ***	0.04 *	0.00 ***
Li-H line	r	0.06	-0.02	-0.09	-0.02	0.02	0.23	-0.26	-0.43	-0.23	0.07
	p	0.63	0.87	0.49	0.88	0.87	0.07	0.04 *	0.00	0.08	0.61
H-angle	r	0.27	0.12	0.04	0.10	0.01	0.01	-0.14	-0.79	0.42	0.42
	p	0.03 *	0.33	0.74	0.46	0.94	0.92	0.26	0.00 ***	0.00 ***	0.00 ***
Revised H-angle	r	0.24	0.09	0.02	0.11	0.04	0.06	-0.19	-0.79	0.46	0.45
	p	0.06	0.48	0.88	0.40	0.76	0.64	0.14	0.00 ***	0.00 ***	0.00 ***
Z-angle	r	-0.07	0.09	0.14	-0.03	0.11	-0.14	0.09	0.63	-0.19	-0.31
	p	0.58	0.51	0.26	0.83	0.39	0.28	0.48	0.00 ***	0.14	0.02 *

Table 3: The mean values of the sagittal lip position in different studies

Variables	Normal values	Hsu <sup>(8)</sup> (1993)		Erbay <i>et al.</i> <sup>(9)</sup> (2002)		Present study (2012)		
		Taiwan		Turkey		Iraq		
	Total	Male (N=83)	Female (N=27)	Male (N=23)	Female (N=21)	Male (N=25)	Female (N=37)	Total (N=62)
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
H-angle°	7-8	-	-	10.1	10	12.48	10.46	11.27
Revised H-angle°	7-15	-	-	-	-	16.80	15.30	15.90
Z-angle°	80	-	-	67.2	71.2	73.6	75.08	74.48
Ls-S1 line (mm)	0	3.41	1.93	-3.3	-2.7	-0.67	-1.24	-1.01
Li-S1 line (mm)	0	3.46	2.22	-2.7	-2	0.79	0.20	0.44
Ls-E line (mm)	-4	1.39	-0.05	-5.4	-5.2	-4.63	-4.98	-4.84
Li-E line (mm)	-2	2.11	0.95	-4.5	-3.5	-1.38	-1.87	-1.67
Ls-B line (mm)	3.5	6.6	5.1	3.4	3.7	3.83	3.11	3.40
Li-B line (mm)	2.2	5.44	4.19	1.7	2.3	3.24	2.58	2.85
Ls-S2 line (mm)	9.05	12.56	9.66	10.7	9.6	11.07	9.01	9.84
Li-S2 line (mm)	7.25	8.35	7.02	7	5.9	7.11	5.78	6.32
Li- H line (mm)	0-0.5	1.31	1.12	-0.6	-0.2	0.86	0.78	0.81
Pn-H line (mm)	9	-	-	10.1	9.1	7.08	7.89	7.56

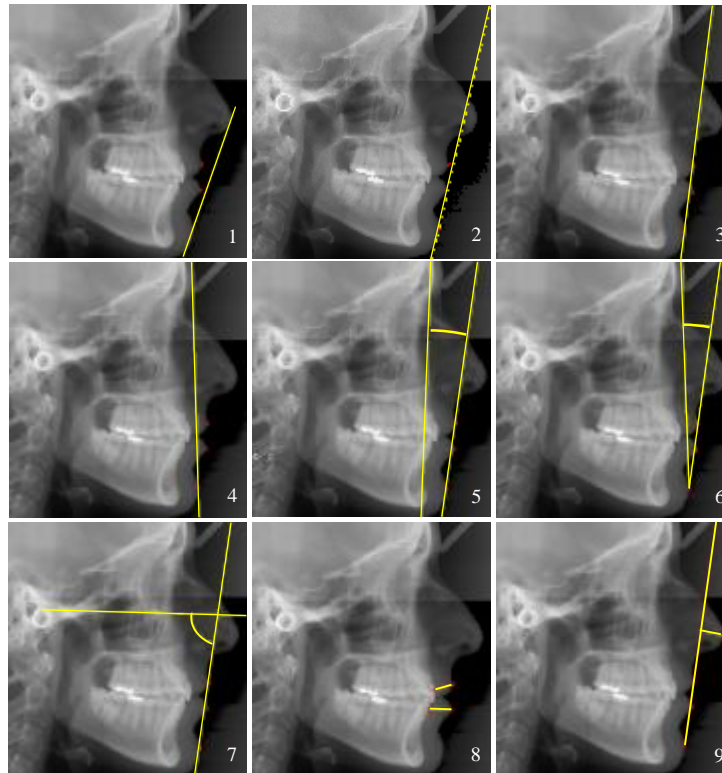


Figure 1: Soft tissue profile analyses and measurements used in the study.  
 1: Ricketts analysis. 2: Steiner analysis. 3: Burstone analysis. 4: Sushner analysis. 5:  
 H-angle of Holdaway. 6: Revised H-angle of Holdaway. 7: Z-angle of Merrifield. 8:  
 Upper and lower lip thickness. 9: Nasal projection.