Photogrammetric analysis of facial soft tissue profile of Iraqi adults sample with Class I normal occlusion: (A cross sectional study)

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ABSTARCT

Background: The purposes of this study were to determine the photogrammetric soft tissue facial profile measurements for Iraqi adults sample with class I normal occlusion using Standardized photographic techniques and to verify the existence of possible gender differences.

Materials and methods: Eighty Iraqi adult subjects (40 males and 40 females) with an age ranged between 18-25 years having class I normal occlusion were chosen for this study. Each individual was subjected to clinical examination and digital standardized right side photographic records were taken in the natural head position which is mirror position which the patient looking straight into his eyes into the mirror mounted on the stand. The photographs were analyzed using AutoCAD program 2011 to measure the distances and angles used in the Soft Tissue Photogrammetric Analysis. Descriptive statistics was obtained for the measured variables for both genders and independent- samples t-test was performed to evaluate the genders difference.

Results and conclusions: The results indicated that: males had greater facial heights and lengths as well as greater prominences. The mean values of all angular variables were higher in males than females except in the following angular measurements: nasofrontal, mentolabial, angle of the middle facial third; and angle of the head position, with larger male dimensions in all linear measurements of the facial, labial, nasal, and chin areas except Canut's nasal prominence in nasal area. The nasofrontal, vertical nasal, nasal dorsum, cervicomental, middle facial third and facial convexity angles showed statistically significant gender differences, in which the male dimensions were larger than females while the nasolabial, the mentolabial, nasal, the inferior facial third, the head position and total facial convexity angles showed statistically non significant gender differences.

Key words: photogrammetric analysis, soft tissue, class I normal occlusion. (J Bagh Coll Dentistry 2013; 25(2):164-172).

INTRODUCTION

Soft tissues refer to tissues that connect, support or surround other structures and organs of the body not being bones. Soft tissues of the face together with the underlying skeleton define the facial trait of an individual. Facial traits are major features in physical appearance, which is well related to social acceptance, psychological well being and self esteem of an individual [1]; therefore, the analysis of the human face is a science and an art, utilizing both aesthetic and anthropologic tools. The shape of the human face depends on both the structure of the hard tissue (bone) and the soft tissue that covers it. The quantitative assessments of the size and the shape of facial soft tissue are widely used in several medical fields such as orthodontics, clinical genetics, and maxillofacial and plastic surgery for diagnosis, effective treatment planning, and postoperative assessment [2]

The appearance of the face, the most variable part of the human body, is influenced by age, sex, race, and ethnicity. Obtaining measurements of the soft tissues of the face is important in terms of achieving aesthetic criteria.[3] According to Muge *et al.* [4] , orthodontics has generally led the way in quantitative analysis of the soft tissue facial architecture, developing norms and longitudinal data, important equally to maxillofacial surgeons, plastic surgeons and to clinicians in prosthetic dentistry. All medical specialties interested in improving facial appearance need to measure the face to quantify the desired facial changes [5]

It is now apparent that what has been considered beautiful and acceptable as the norm for one culture may be different for another. Furthermore, facial measurements are also an integral part of the evaluation of dimorphism. Therefore, measurements of facial soft tissue have been made to determine the normal reference values in different populations [1]. Facial soft tissue analysis has been conducted using several methods: direct anthropometry, (2D) photogrammetry, and newer three-dimensional (3D) record of methods such as laser surface and, more recently, scanning digital

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3D photogrammetry. Photogrammetry has been introduced as an alternative to direct measurements to obtain distances between facial landmarks using both two- dimensional and three-dimensional methods. Obtaining measurements from photographs is less intrusive to the patient and more cost-effective; it provides a permanent record for the face that can be accessed at a later time [5]
Two-dimensional photogrammetry has been used for evaluating the soft tissues in orthodontic treatment. The method was shown to be sufficiently reproducible since it was simple to achieve in a conventional setting, without the need for special equipment [4].

Nowadays there are many conflicts about the hazard of radiology that is why the present study focused on use of photometry over cephalometry by means of objective methods studying the facial analysis. In addition, the soft tissue assessment gets priority over hard tissue assessment in that a photograph accurately posturizes how a face actually looks, which is superior to a cephalogram which gives only facial outline. Thus it was felt necessary to do photographic analysis.

MATERIALS AND METHODS

The Sample

Out of 200 clinically examined subjects, only 80 subjects (40 females and 40 males fulfilled the inclusion criteria the sample include undergraduate students from the college of dentistry, university of Baghdad. All of them were Iraqis Arabs with an age range between (18-25) years. According to Arnett *et al.,* Kalha*et al.* [6], Usal*et al.* [7], Lalitha and Kumer [8], Kadhom [9]; the following criteria were used in the selection of the total sample:

1. Full permanent dentition regardless the third molars.
2. No history of previous orthodontic treatment.
3. No history of facial trauma or craniofacial disorder, such as cleft palate.
4. Class I occlusion with normal overjet and overbite (2-4 mm).
5. Bilateral Class I buccal segments "molar and canine" [10].
6. Skeletal Class I relationship determined clinically by the two fingers method [11].
7. Minor or no spacing or crowding [12].
8. Class I incisor classification [13].

The method

Each individual was seated on a dental chair and asked information about name, age, origin, history of facial trauma and previous orthodontic treatment.

Clinical Examination

1. Assessment of the anteroposterior skeletal relationships
2. Assessment of the dental relationship
3. Measurement of the Overjet
4. Measurement of the Overbite.

Standardization of the Photograph

Photographic Set-Up:

The photographic setup consisted of a tripod supporting a digital camera with a primary flash and a 100 mm macro lens. The 100 mm macro lens was chosen to avoid facial deformations [15]. The tripod controlled the stability and the correct height of the camera according to the subject's body height, so that adjustment of the tripod height allowed the optical axis of the lens to be maintained in a horizontal position during the recording; this was adapted to each subject's body height**.** The blue background, 0.95 m width and 1.10 m length was made of a piece of cloth [16]. A primary flash was attached to the tripod by a lateral arm, at a distance of 27 cm from the optical axis of the camera and 75 degrees from the upper right angle to avoid the red eye effect on the photographs. Another element of the set-up was a secondary flash placed behind the subject and its function was to light the background and eliminate undesirable shadows from the contours of the facial profile [15].A slave cell allowed synchronization with the main flash [14]

Record-Taking

The camera was used in its manual position; the shutter speed was 1/125 per second, and the opening of the aperture f/2.8 [15]. In a standing position, each subject was asked to relax, with both arms hanging freely beside the trunk. The subject was positioned on a line marked on the floor and a vertical measurement scale divided into millimeters allowed measurements at life size (1:1) was placed behind the subject[14]A plumb line, suspending a 0.5 kg weight hung from the scale, held by a thick black thread to define the vertical plane, true vertical line (TVL), on the photographs and 120 cm in front of the subject, on the opposite side of the scale was a mirror, the center of the camera lens was kept at approximately110 cm away from the

subject, this distance was standardized to obtain sharp image [15]. In order to take records in natural head posture**,** the subjects were positioned on a line marked on the floor and were asked to stand in relaxed position and to look straight into the mirror at the eye level, with teeth occluded and lips relaxed **[5]**. Standardized right side profile records were taken with the patient in the NHP according to Moorrees and Kean [17], Vaizis[18], and Lundström and Lundström[19]. Previously, glasses were removed and operator ensured that subjects' forehead, neck and ears were clearly visible during recording.

Definition of Soft Tissue Landmarks:

A. Facial Landmarks: According to Fernández-Riveiro et al.[15].

1. Point Prn (Pronasale or Nasal tip): The most prominent point of the tip of the nose.
2. Point G' (glabella): The most anterior point of the middle line of the forehead.
3. Point N' (Nasion soft tissue): The point of deepest concavity of the soft tissue contour of the root of the nose
4. Point Sn (subnasale): The point where the lower border of the nose meets the outer contour of the upper lip
5. Point cm (Columella): The most anterior point on the columella of the nose.
6. Point Pog' (soft tissue pogonion): The most prominent point on the soft tissue contour of the chin.
7. Point Li (labiale inferior): the point that indicates the mucocutaneous limit of the lower lip
8. Point Ls (labiale superior): the point that indicates the mucocutaneous limit of the upper lip
9. Point Me'(Menton soft tissue): the most inferior point of the inferior edge of the chin.
10. Point C' (cervical): The intersection of lines tangent to neck and throat.
11. Point tri (trichion): the sagittal midpoint of the forehead that borders the hairline.
12. Point Mn' (mid nasal): A pronounced convexity of the dorsal profile of the nose
13. PointTrg (tragus): The most posterior point of the auricular tragus.
14. Point Sm (supramentale): The point of greatest concavity in the midline of the lower lip between labraleinferius and menton.
15. PointStomion superior (Sts), the most inferior point of the upper lip.
16. PointStomion inferior (Sti), the most superior point of the lower lip.
17. Superior point of the TVL (sTV).
18. Inferior point of the TVL (i TV).

B. Facial planes and lines: According to Fernández-Riveiro*et al.*[15].

1. True Vertical Line (TVL): The line was placed through soft tissue nasion and was perpendicular to the true horizontal line.
2. True horizontal line (THL): The line was placed through soft tissue tragus and was perpendicular to the true vertical line.
3. G'- Sn line: The line between points glabella and subnasale
4. Sn-columella line: The line between points subnasale and the most anterior point on the columella of the nose.
5. Sn- Ls line: The line between points subnasale and the median point in the upper margin of the upper membranous lip.
6. Sn- pog' line: The line between points subnasale and soft tissue pogonion
7. G'-N' line: The line between points glabella and soft tissue nasion.
8. N'-Prn line: The line between points soft tissue nasion and the tip of the nose.
9. N'-Mn line: The line between points soft tissue nasion and mid nasal.
10. Li-Sm line: The line between point labiale inferior and supramentale.
11. Sm-Pog' line: The line between points supramentale and soft tissue pogonion.
12. C-Me' line: The line between points cervical and soft tissue menton.
13. G'-Pog'line: The line between points glabella and soft tissue pogonion.
14. N'-Trag line: The line between points soft tissue nasion and tragus.
15. Trag-Sn line: The line between points tragus and subnasale.
16. Trag-Me' line: The line between points tragus and soft tissue menton.
17. Sn-Sm line (Canut's line): The line between points subnasale and supramentale.
18. G'-Prn line: The line between points glabella and tip of the nose.
19. Prn-Pog' line: The line between points tip of the nose and soft tissue pogonion.

20. N'-Pog' line:The line between points soft tissue nasion and soft tissue pogonion.
21. Mn-Prn line: The line between points mid nasal and the tip of the nose.

Facial Measurements:

A. Angular Measurements: According to Fernández-Riveiro*et al.*[5]; Milosevic *et al.*[2]; Malkoç*et al.*[14].

1. G'–N'–Prn-: The angle between G'-N' line and N'-Prn line.
2. Cm–Sn/N'–Prn: The angle between Cm-Sn line and N'-Prn line
3. N'–Prn/TV (N): The angle between N'-Prn line and true vertical line at soft tissue nasion.
4. N'–Mn–Prn: The angle between N'-Mn line and Mn-Prn line
5. Cm–Sn–Ls: The angle between Cm-Sn line and Sn-Ls line
6. Li–Sm–Pog': The angle between Li-Sm line and Sm-Pog' line
7. C–Me'/G'–Pog': The angle between C-Me' line and G'-Pog'line
8. N'–Trag–Sn: The angle between N'-Trag line and Trag-Sn line
9. Sn–Trag–Me': The angle between Trag-Sn line and Trag-Me' line
10. Sn–Sm/TH: The angle between Sn-Sm line and true horizontal line.
11. G'–Sn–Pog': The angle between G'-Sn line and Sn-Pog' line.
12. G'–Prn–Pog': The angle between G'-Prn line and Prn-Pog'line.

B. Linear Measurements: According to Fernández-Riveiro*et al.*[15].The reference lines were:
1) TV through N. **2)** TH through Trg.

1.Vertical Linear Measurements (parallel to TV line):

1. Upper facial third, **Tri-G'**
2. Middle facial third, **G'-Sn**
3. Lower facial third, **Sn-Me'**
4. Nasal length, **N'-Sn**
5. Length of upper lip, **Sn-Sts**
6. Length of lower lip, **Sti-Sm**
7. Height of chin, **Sm-Me'**
8. Height of nasal tip, **Sn-Prn**

2. Linear horizontal measurements (parallel to TH line):

1. Facial depth, Trg-Sn
2. Nasal prominence, Prn /TV (N)
3. Subnasal depth, Sn /TV (N)
4. Mentolabial depth, Sm /TV (N)
5. Prominence of upper lip, Ls /TV (N)
6. Prominence of lower lip, Li /TV (N)
7. Prominence of chin, Pg /TV (N).

3. Canut's linear measurements (perpendicular to Sn-Sm line).

1. Canut's nasal prominence, **Prn/ Sn-Sm.**
2. Canut's prominence of pogonion, **Pg/Sn-Sm.**

RESULTS

Descriptive Statistics and Gender Differences of Facial Analysis:

The mean values of all measured variables are higher in males than females. Independent sample *t*-test indicated that there is a very highly significant gender difference (fig.1).

Descriptive Statistics and Gender Differences of Nose Analysis

Generally, the mean values of all measured variables are higher in males than females with a very highly significant difference between genders in nasal length, N-Sn; nasal prominence, Prn /TV (N) and Subnasal depth, Sn /TV (N). But there is highly significant difference between genders inheight of nasal tip; Sn-Prn. On the other hand, the Canut's nasal prominence; Prn/Sn-Sm shows non-significant difference between genders (fig.2).

Descriptive Statistics and Gender Differences of the Lip Analysis

The males show higher mean values than females with a very highly significant difference between genders in all measured variables, whereas there is highly significant difference between genders in prominence of upper lip, (fig.3).

Descriptive Statistics and Gender Differences of the Chin Area

The mean values of all measured variables are higher in males than females with a very highly significant difference between genders in the height of chin **Sm-Me**and Canut's prominence of pogonion; **Pg/Sn-Sm.** While there is a highly significant difference regarding the prominence of

chin; **Pg /TV (N).** On the other hand, there is a significant difference between genders in the Mentolabial depth; **Sm/TV(N) (**fig.4)

Descriptive Statistics and Gender Differences of Angular Measurements

The mean values of all measured variables are higher in males than females except for the following angular measurements: **G–N–Prn**, nasofrontal angle; **Li–Sm–Pg**, mentolabial angle; **N–T–Sn**, angle of the medium facial third; and **Sn–Sm/TH**, angle of the head position, so that females are higher than males in these variables. (fig.5)

Descriptive Statistics and Gender Differences of the Facial convexity

The mean values for the measured variables are higher in males than females and according to independent sample t-test there is highly significant difference between genders in **G–Sn–Pg**, angle of facial convexity, while **G–Prn–Pg**, angle of total facial convexity shows non significant difference between genders. (fig.6)

DISCUSSION

One of the primary goals of Orthodontic treatment is to attain and preserve optimal facial attractiveness. Beautiful faces are largely a subconscious, unstructured decision. However, for professional orthodontists, esthetic decision making should involve a conscious, well structured thought process. For this reason, a scientific and quantitative study of craniofacial morphology is pre-eminently important to orthodontists, the general observation in the present study was to search about facts of facial esthetics.

This study was the first study established in Iraq as a photogrammetric study in Natural head position method and this analysis was the first time used; so there was no comparison with other previous Iraqi studies except a little comparison in soft tissue analysis and little researches in the world were compared with this study.

The sample in this study was selected at age between (18-25) years because the individuals maintain the same facial pattern till 25 years [20] and to minimize the effect of any remaining skeletal growth since the majority of facial growth is usually completed by 16-17 years of age [21]. The sexual differences are due to the influence of the sex hormones on the facial contour, which becomes a very evident by adolescence. The male bony structure is bolder, more prominent, with dominance of the forehead, nose, and chin and stronger contour of the mandible [22]. This comes with the general trend of males having greater measurements than females, this is because males have longer growth period than females.[23,24]. The present study evaluated the photogrammetric linear and angular variables that define the soft tissue facial profile of Iraqi Arab adult sample with standardized photogrammetric records taken in NHP. Several authors have also used NHP in their studies Fernández-Riveiro *et al.*[15, 5]; Milosevic *et al.*,[2];Malkoç *et al.*[14].

Photogrammetric Analysis of the Soft Tissue Facial Profile

An understanding of the facial soft tissues and their normal ranges enables a treatment plan to be formulated to normalize the facial traits for a given individual.

Photogrammetric Analysis of Linear Measurements

The findings of Photogrammetric analysis of linear measurements are discussed under the four headings of the facial soft tissue analysis. In each group, comparisons are drawn and analyzed between the male and female samples and in comparison with the other studies. All the linear measurements of young adult males were higher than that of young adult females. This comes in line with Nasir [25] who found out that females have smaller measurements than males in all dimensions. In general, Males have larger faces, with greater facial heights; longer nasal, labial, and chin lengths; larger nasal, labial, and chin prominences; and a greater nasal and facial depth in the tragus point; this comes in line with Fernández- Riveiro *et al.*[15]. The mean values of (upper facial third; **Tri-G**, Middle facial third; **G-Sn**, lower facial third; **Sn-Me**) measured are higher in males than females. Independent sample t-test indicated that there is very highly significant difference between genders of facial analysis; this reflects that the males tend to have greater facial dimensions than females, this comes in agreement with Fernández-Riveiro *et al.* [15], except in the upper facial third; Tri-G, who found statistically non significant gender differences for upper facial third, this may be either due to difference in ethnic factor or difference in sample size.

Photogrammetric Analysis of Angular measurements

The Nasofrontal angle (G – N – Prn): demonstrates very highly significant gender difference with wider angle in females than males, this may indicate a more flattening of females forehead than males ; this may be due to the more posterior position of point **N'** in males than females or due to more anterior position of **prn** point and /or **G'** point in males than females; this comes in agreement with Fernández-Riveiro *et al.*[5] :Milosevic *et al* [2]; Malkoç *et al.* [14] ,who found gender differences in this angle.

Vertical nasal (N- Prn/TV) angle showed statistically significant gender differences; it was wider in males than in females; this may be due to the more anterior position of **Prn** point and this comes in agreement with Fernández-Riveiro *et al.*[5]; Malkoç *et al.*[14] ; this may reflect larger or prominent noses of the Iraqi group.

Nasal dorsum (N – Mn – Prn) angle also showed statistically significant gender differences with wider angles in males than in females. This may be due to the more anterior position of Mn point or may be due to the more posterior position of point N' in males than females and this comes in agreement with Fernández-Riveiro*et al.*[5]; Malkoç *et al.*[14] who found that there was statistically significant gender differences.

Cervicomental angle (**C-Me/G- Pg**) was more acute in females than in males and showed highly significant difference between genders; this may be due to the more prominence of glabella point in males than females.

Angles of the Facial Third: The middle and lower facial thirds were evaluated by the (**N – Trg – Sn)** and **(Sn – Trg – Me)** angles respectively.

The Nasolabial Angle (Cm – Sn – Ls): showed statistically non significant gender differences, but the mean values were higher in males than females (more acute in females) that may be due to a slight more proclination of the upper anterior teeth in females than males as kadhom [9] pointed out.

The Mentolabial angle (Li- Sm- Pg') was wider in females than in males which means a more rounded border of females chin area and more acute in males, but showed statistically non significant gender differences. Generally, the males have forward position of (**point Pg'**) and **(pointLi**) in comparison with females, so this may be the major cause to the more acute angle in males than females; this finding comes in agreement with Fernández-Riveiro *et al.* [5] while disagrees with Milosevic *et al* [2]; Malkoç *et al.*[14]. who found highly significant gender differences in this angle.

The nasal angle (Cm – Sn/N – Prn): showed statistically non significant gender differences, the mean value was higher in males than females (wider in males than females) that may be due to more nasal length, **N-Sn** in males; this comes in agreement with Malkoç *et al.*[14]and disagrees with Fernández-Riveiro*et al.*[5]; Milosevic *et al.*[2], who reported considerable gender differences in this angle; this may be attributed to the ethnic factor or sample size.

Angle of the head position: The lower profile orientation was analyzed by the line **Sn – Sm** with the true horizontal line or angle of the head position **(Sn – Sm/TH)** with slightly larger angle in females than males that may be due to a more posterior position of **Sn** point in females than males, but gender differences were non significant.

The angle of facial convexity (**G–Sn–Pg**) and the angle of total facial convexity (**G–Prn–Pg**) showed that the mean values were higher in males than females; this may indicate that males have less convex soft tissue facial profile than females; this could be related to the larger chin in males that may be due to a more anterior position of soft tissue pogonion resulting in less convex (more concave) facial profile in males than the females and also may be due to the mandibular growth rotation (direction of mandibular growth in males).

Independent sample t-test indicated that there is highly significant difference between genders in **G–Sn–Pg**, angle of facial convexity; this finding disagrees with Fernández-Riveiro *et al.*[5],Milosevic *et al.*[2]; Malkoç *et al.*[14].

On the other hand, **G–Prn–Pg,** angle of total facial convexity showed non significant difference between genders, this comes in agreement with Fernández-Riveiro *et al.*[5]; Milosevic *et al.*[2]; Malkoç *et al.*[14].

Facial depth (**Trg-Sn**) was also shown to be significantly larger in males than in females. Independent sample t-test indicated that there is a very highly significant difference between genders of facial depth; this may be due to a more posterior position of **Trg** point or may be the more anteriorly position of **Sn** point; this comes in agreement with Fernández-Riveiro*et al.*[15], but in the present study the facial depth is greater in comparison with Fernández-Riveiro*et al*[15].This may be due to ethnic factor or may be due to size of the sample.

On analyzing the nose, it was observed that males had greater nasal length **(N-Sn)**, nasal prominence **(Prn/TV**) and Subnasal depth **Sn /TV (N)** than females with statistically very highly significant differences. The height of the nasal tip **(Sn-Prn)** also was the nasal measurement that showed highly significant difference between genders. The Cantu's nasal prominence **Prn/Sn-Sm** was the only nasal measurement that showed non significant gender difference, this result differs from that of Fernández-Riveiro *et al.*[5], who found that **Prn/Sn-Sm** has statistically significant difference between genders; this may be either attributed to difference in ethnic factors or the size of the sample; these may reflect larger noses of the Iraqi group that may reflect the inherent need of the Iraqi subject for wider nasal passages to accommodate the hot climate(for better evaporation and cooling of nasal air passages).

The **Sn** point with regard to the TV in N' **(Sn/TV** through **N')** was more prominent in males; this may be due to a more anterior position of **Sn** point in males than in females; this comes in agreement with Fernández-Riveiro *et al.* [15],in nasal length, prominence and subnasal point with regard to the TV in N' (Sn/TV through N') who found statistically significant differences between genders and disagrees with Fernández-Riveiro *et al.*[15] in height of the nasal tip (Sn-Prn)

The males showed higher mean values than females with a very highly significant difference between genders regarding length of upper and lower lips (**Sn-Sts** and **Sti-Sm**) in addition to prominence of lower lip and there is a highly significant difference between genders in prominence of upper lip, this may indicate that the males have thicker and longer lips than females that may reflect the feminine and masculine characteristic features, this comes in agreement with Fernández-Riveiro *et al* [15].

In this study, all measurements of the analysis in the area of the chin showed gender differences characterized by greater length and greater prominence in males than in females. This comes in agreement with Fernández-Riveiro *et al.*[15] who found that there was a significant difference between genders; this comes with the general trend that the males have larger dimension than females.

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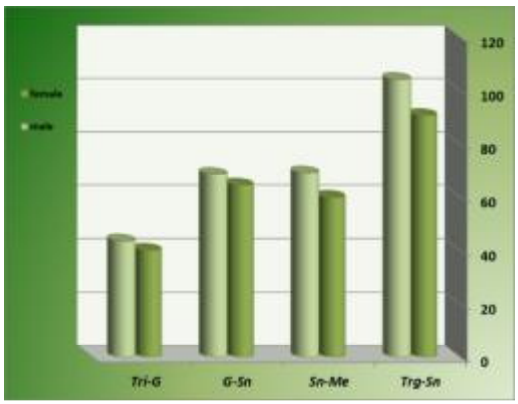

Figure 1: Descriptive statistics and gender differences of facial analysis

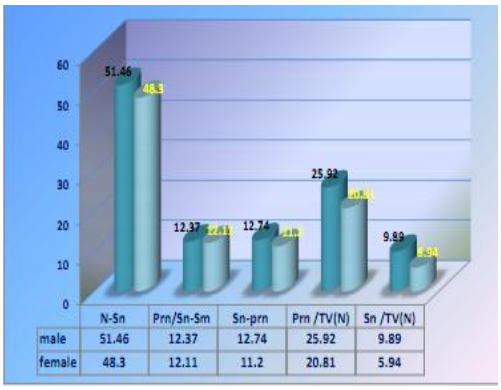

Figure 2: Descriptive statistics and gender differences of nose analysis

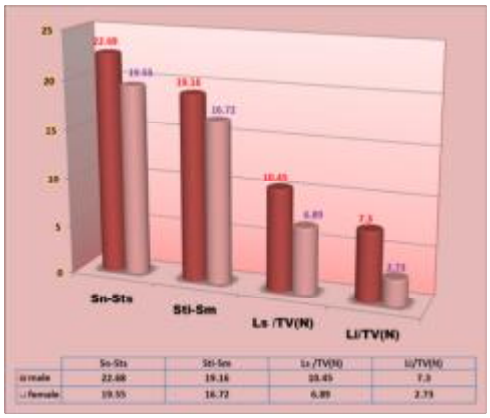

Figure 3: Descriptive statistics and gender differences of the lip analysis

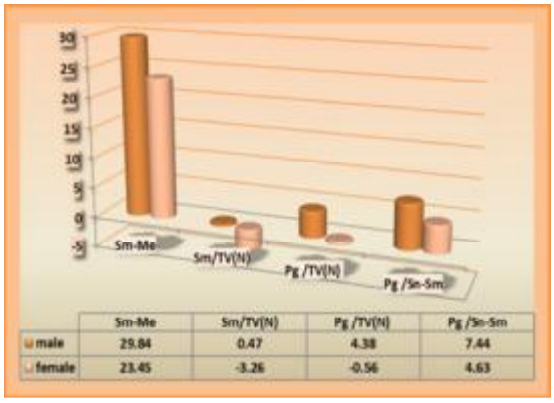

Figure 4: Descriptive statistics and gender differences of the chin area

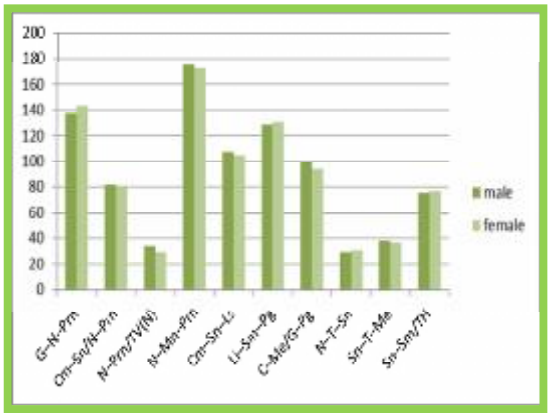

Figure 5: Descriptive statistics and gender differences of angular measurements

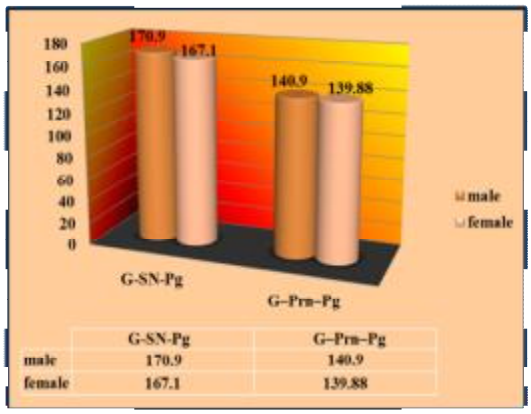

Figure 6: Descriptive statistics and gender differences of the facial convexity