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Correlations between Lateral Cephalometric and Facial Attractiveness of Egyptian Adolescents

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Abstract:

Purpose: *The aim of this study was to find correlations between lateral cephalometric measurements and photographic measurements of facial attractiveness in a group of Egyptian adolescents.*

Materials and methods: *Sixty adolescent laypersons judges (30 males – 30 females) participated in the evaluation of the pre-treatment photographs of 60 adolescent subjects (30 females – 30 males) for facial attractiveness. For each sample, the photographic rankings were correlated with the values of 19 skeletal, dental and soft tissue parameters measured from lateral cephalograms*

Results: Female samples group: *From the 19 cephalometric measurements; ANB, wits appraisal, MMA, lower incisor / mandibular plane angle, profile angle, E-line to lower lip, lower lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness.* ***Male samples group:*** *ANB, facial angle, upper incisor / palatine plane angle, Z-angle, Upper lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness.*

Conclusion:

1. *Convex profile was found to be more attractive than concave profile.*
2. *Short upper lip was found to be more attractive than long upper lip*
3. *Retruded lower lip was found to be more attractive than protruded lip*
4. *Short faces were found to be more attractive than long faces in females.*
5. *Thin upper lip was found to be more attractive in males.*

Facial attractiveness is very important in interhuman communication. Attractiveness means social power, success and has a positive influence in all areas of civilized society. Ancient Egyptians (5000 BC) were probably among the first to deal with harmonious (attractive) proportions of the face and body.

I. Introduction

A person's ability to recognize a beautiful face is innate, but translating this into defined treatment goals is problematic. Traditionally, various authors have tried to relate the importance of soft-tissue esthetics with orthodontic diagnosis and treatment planning. In more recent years, it was suggested that certain cephalometric standards relating teeth to cranial or facial bones could ensure good facial form if adhered to in the treatment goals.

Orthodontists used to rely on esthetic judgments from facial photographs. Correlation between estimates of facial attractiveness made from clinical photographs and measurements from lateral cephalograms could be investigated for more understanding of beauty assessment.

II. Materials And Methods

Sample included pre-treatment photographs and cephalometric radiographs of 60 adolescent subjects (30 females – 30 males) with an age range between 15 to 18 years old. They were randomly collected from the files of outpatients' clinic of faculty of Oral and Dental Medicine-Cairo University.

Subjects of each gender were randomly divided according to their antero-posterior skeletal classification (Class I, Class II and Class III) into 3 equal groups. **(Figure 1)**

The profiles, frontal relaxed and frontal maximum smiling photographs were collected for each subject considered together as the triplet of facial attractiveness assessment **(Figure 2, 3)**

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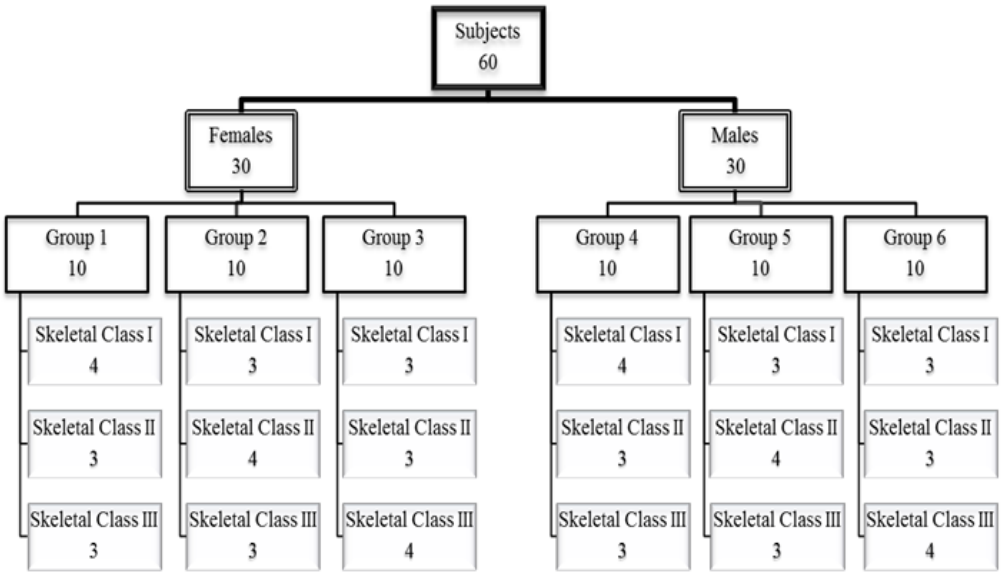

Figure (1): A schematic diagram showing sample grouping

Figure (2): Representative triplet for female: profile, frontal relaxed and frontal maximum smiling photographs

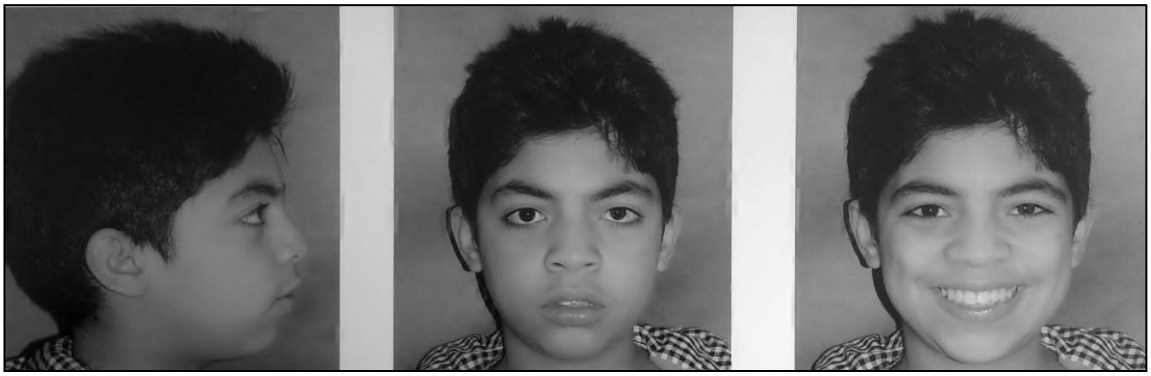

Figure (3): Representative triplet for male: profile, frontal relaxed and frontal maximum smiling photographs

Sixty adolescent laypersons judges (30 males, 30 females) participated in the evaluation of the images. Seven male and 5 female judges had been excluded from the analysis because of inaccurate data in attractiveness charts. The images were presented in grey scale. Each set of images inspected for 15 seconds. At least 15 minutes interval between examined groups was allowed. Rating of facial attractiveness was performed on a 5-points attractiveness scale with values from 1 (very unattractive) to 5 (very attractive).

19 skeletal, dental and soft tissue parameters were measured and recorded for each cephalometric radiograph.

Skeletal measurements

a. Angular measurements

1. **SNA angle**: the angle formed by the intersection of the line nasion-A with the SN line. **(Figure 6)**
2. **SNB angle**: the angle formed by the intersection of the line nasion-A with the SN line. **(Figure 6)**
3. **ANB angle**: the included angle between Point A, nasion, and Point B. **(Figure 6)**
4. **Facial plane angle**: the acute angle formed by the intersection of the line nasion-pogonion with the Frankfort horizontal line. **(Figure 6)**
5. **Maxillary-Mandibular plane angle**: the acute angle formed by the intersection of the line gonion-menton with the maxillary plane. **(Figure 6)**

b. Linear measurements

1. **Wits appraisal**: the distance between the intersection of a perpendicular line to occlusal plane from Point A and the intersection of a perpendicular line to the occlusal plane from Point B. **(Figure 7)**
2. **Face Height ratio**: the ratio of posterior facial height (S-Go) to anterior facial height (N-Me). **(Figure 7)**

1. Dental measurements

1. **Upper incisor to palatine plane angle**: the angle formed by the intersection of the long axis of the upper central incisor and the palatine plane. **(Figure 8)**
2. **Lower incisor to mandibular plane angle**: the angle formed by the intersection of the long axis of the lower central incisor and mandibular plane from gonion to menton. **(Figure 8)**

3. Soft Tissue measurements

a. Angular measurements

1. **Profile angle**: the included angle between glabella (defined as the most anterior point on the soft tissue of the forehead), soft-tissue subnasale, and soft-tissue pogonion (defined as the most anterior point on the soft-tissue surface of the chin). **(Figure 9)**
2. **Nasolabial angle**: the included angle between lower nose tip, soft-tissue subnasale, and the vermilion border of the upper lip. **(Figure 9)**
3. **Z-angle**: the inferior angle formed by the intersection between the Frankfort horizontal line and the line from soft-tissue pogonion to the anterior-most point on the lower lip. **(Figure 9)**

b. Linear measurements

1. **E-line to upper lip**: the distance from the anterior- most point on the upper lip to the line from the nose tip to soft tissue pogonion measured parallel to the Frankfort plane. **(Figure 10)**
2. **E-line to lower lip**: the distance from the anterior- most point on the lower lip to the line from the nose tip to soft-tissue pogonion measured parallel to the Frankfort plane. **(Figure 10)**
3. **Upper lip thickness**: thickness at the most prominent point on the vermillion border of the upper lip parallel to Frankfort horizontal plane. **(Figure 10)**
4. **Lower lip thickness**: thickness at the most prominent point on the vermillion border of the lower lip parallel to Frankfort horizontal plane. **(Figure 10)**
5. **Upper lip length**: vertical distance between subnasale and stomion (the median point of the oral embrasure when the lips are closed. **(Figure 10)**
6. **Lower lip length**: vertical distance between stomion and mentolabial sulcus. **(Figure 10)**
7. **Interlabial gap**: vertical distance between the most inferior point on the upper lip and the most superior point on the lower lip when lips are in rest. **(Figure 10)**

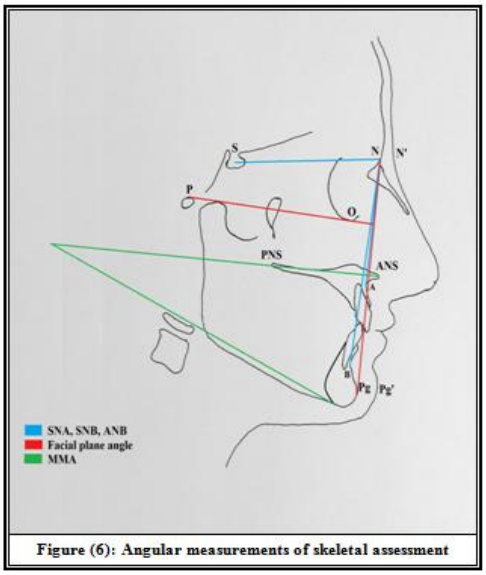

Figure (6): Angular measurements of skeletal assessment

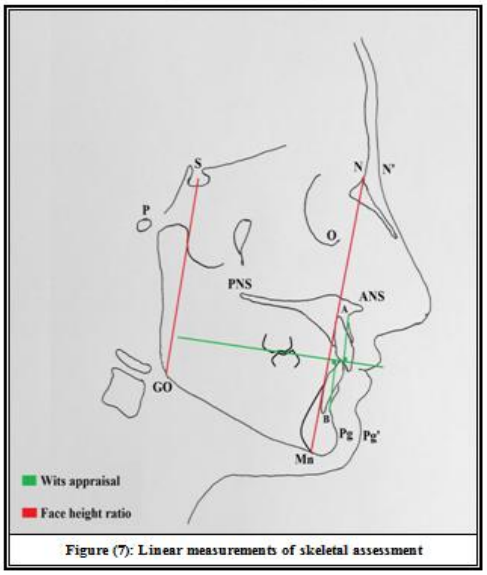

Figure (7): Linear measurements of skeletal assessment

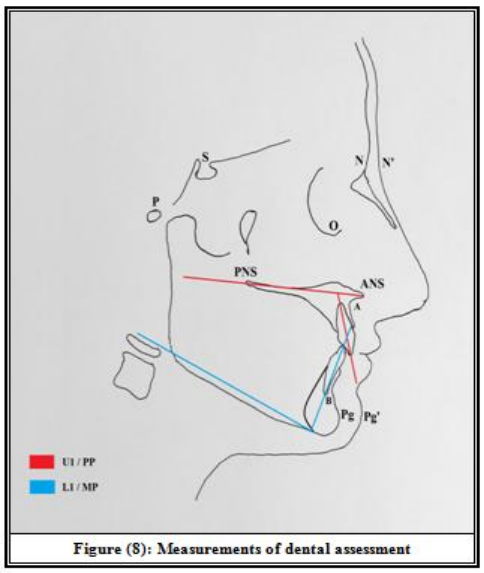

Figure (8): Measurements of dental assessment

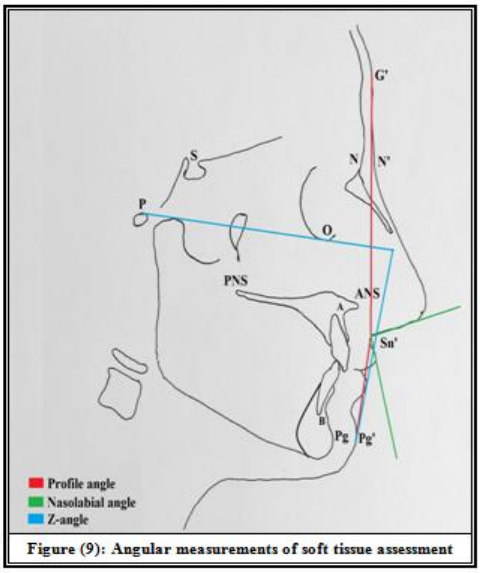

Figure (9): Angular measurements of soft tissue assessment

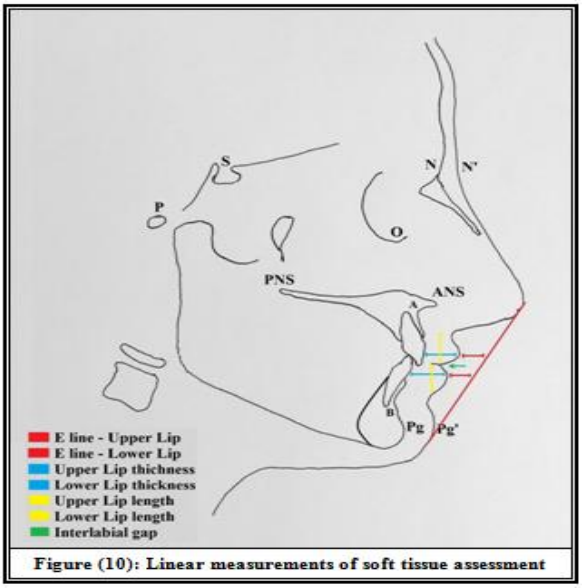

Figure (10): Linear measurements of soft tissue assessment

III. Statistical analysis

Data were examined for normality using Kolmogorov-Smimov test. Spearman rho (r_s) was used to correlate between Attractiveness Ranks of the patients and their scores for each of 19 cephalometric measures.

A power analysis of the data was designed to have adequate power to apply a 2-sided statistical test of the research hypothesis (Null hypothesis). The alpha level was 0.05 (5%), the β level was 0.20 (20%) i.e. power = 80%. After calculation, a minimum of 30 patients per each gender was required.

Intra- and inter-observer reliability (agreement) was measured using Cronbach's alpha reliability coefficient and Intra-Class correlation coefficient (ICC). Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient to1.0, the higher the reliability is. Cronbach's alpha values larger than 0.6; indicated very good agreement.

The median value of photo attractiveness scores for each patient photographs have been used in correlation for 23 male and 25 female observers to simplify the analysis.

IV. Results

Table (2): Mean and standard deviation (SD) of cephalometric measurements for females sample group and best available norms.

	Measurements	Females sample		Males sample		Best available norms	
		Mean	SD	Mean	SD	Mean	SD
Skeletal	SNA (°)	81.71	4.02	81.23	4.06	83.00	2.00
	SNB (°)	77.29	3.30	78.60	4.26	80.00	2.00
	ANB (°)	4.42	2.81	2.53	4.20	3.00	2.00
	Facial plane angle (°)	87.58	2.50	88.60	4.18	89.50	3.00
	Maxillary-Mandibular plane angle (°)	29.25	5.04	30.37	5.44	25.00	3.00
	Wits appraisal (mm)	.54	4.50	-2.93	5.06	-0.80	3.00
	Face Height ratio (FHR) (%)	59.95	4.15	60.87	4.90	67.00	0.00
Dental	Upper incisor / palatine plane angle (°)	115.63	10.43	114.73	6.86	112.00	5.00
	Lower incisor / mandibular plane angle (°)	96.04	8.88	90.90	12.01	98.00	6.00
Soft tissue	Profile angle (°)	161.96	5.99	162.50	6.51	165.00	6.00
	Nasolabial angle (°)	103.79	12.08	105.00	11.43	102.00	8.00
	Z-angle (°)	65.88	6.87	67.63	7.54	74.00	0.00
	E-line to upper lip (mm)	-1.54	2.41	-1.40	4.06	-1.00	3.00
	E-line to lower lip (mm)	1.71	3.10	1.80	2.87	1.00	2.00
	Upper lip thickness (mm)	12.75	2.21	14.30	2.65	15.00	3.00
	Lower lip thickness (mm)	15.38	2.95	15.87	2.89	16.00	3.00
	Upper lip length (mm)	19.63	1.93	20.47	3.62	23.00	3.00
	Lower lip length (mm)	15.58	2.10	16.30	2.56	19.00	3.00
	Interlabial gap (mm)	2.40	2.48	1.70	1.37	0.00	0.00

Correlation between cephalometric measurements and photo attractiveness of females sample judged by Egyptian adolescent observers.

- From the 19 cephalometric measurements; ANB, wits appraisal, MMA, lower incisor / mandibular plane angle, profile angle, E-line to lower lip, lower lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness.

Correlation between cephalometric measurements and photo attractiveness of males sample judged by Egyptian adolescent observers.

- From the 19 cephalometric measurements; ANB, facial angle, upper incisor / palatine plane angle, Z-angle, Upper lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness.

Table 9: Results of Spearman's correlation coefficient (r_s) for the correlation between cephalometric findings in females, males sample group and photo attractiveness judged by Egyptian adolescent observers.

Measurements		Females sample group Attractiveness		Males sample group Attractiveness	
		r	p-value	r	p-value
Skeletal	SNA (°)	0.235	0.108 NS	0.097	0.53 NS
	SNB (°)	0.056	0.706 NS	-0.261	0.088 NS
	ANB (°)	0.286	0.049*	0.460	0.002*
	Facial angle (°)	0.005	0.973 NS	-0.325	0.031*
	Maxillary-Mandibular plane angle (°)	-0.607	≤0.001*	0.147	0.341 NS
	Wits appraisal (mm)	0.307	0.034*	0.097	0.532 NS
	Face Height ratio (FHR) (%)	0.237	0.104 NS	-0.054	0.726 NS
Dental	Upper incisor / palatine plane angle (°)	-0.128	0.388 NS	-0.368	0.014*
	Lower incisor / mandibular plane angle (°)	0.294	0.043*	0.076	0.625 NS
Soft tissue	Profile angle (°)	-0.354	0.014*	-0.140	0.365 NS
	Nasolabial angle (NLA) (°)	0.0	0.998 NS	0.263	0.085 NS
	Z-angle (°)	0.104	0.480 NS	-0.314	0.038*
	E-line to upper lip (mm)	-0.213	0.145 NS	0.260	0.088 NS
	E-line to lower lip (mm)	-0.464	0.001*	-0.118	0.444 NS
	Upper lip thickness (mm)	-0.188	0.201 NS	-0.339	0.025*
	Lower lip thickness (mm)	-0.383	0.007*	-0.284	0.062 NS
	Upper lip length (mm)	-0.314	0.03*	-0.321	0.034*
	Lower lip length (mm)	-0.062	0.674 NS	-0.277	0.069 NS
	Interlabial gap (mm)	-0.252	0.084 NS	-0.167	0.280 NS

V. Discussion

Facial esthetic is fundamental for communication and interaction with the environment. Esthetic improvement is the most frequently reported objective for seeking orthodontic treatment according to **Birkeland et al (1999)** and **Trulsson et al (2002)**. In recent years, orthodontists have also come to rely heavily on esthetic judgments from semi standardized facial photographs. These photographs have now become a component of the orthodontist's routine records set for diagnosis, treatment planning, and outcome analysis.

The clinical ability to alter dentofacial form requires an understanding of facial aesthetics. This is vital for any clinician involved in treatment that will alter a patient's dentofacial appearance, whether through orthodontics, facial growth modification, corrective jaw surgery or aesthetic dentistry. An analysis of the concordance between estimates of facial attractiveness made from lateral cephalograms and those made from clinical photographs is therefore in order. Similar studies were performed by **Hee et al (2009)** and **Macías-Gago et al (2012)** concerning close ideas.

In contemporary orthodontic practice, greater emphasis on appearance and facial attractiveness has evolved as a part of overall treatment goal settings. Although the people's perceptions of attractiveness could be widely varied with regard to age, gender, and demographic origin, this study aimed to summarize the general preference for facial attractiveness of Egyptian adolescents regarding photos and correlate it with the objective cephalometric measurements.

In this study 3 photographs were collected for each subject one profile, one frontal relaxed and one frontal maximum smiling photographs. These photographs were just used for measurement of facial attractiveness by judges. Many studies since **Merrifield (1966), Holdaway (1983)** and **Shafiee et al (2008)** recommended these photographs for characterization of patients' appearance and attractiveness evaluation. These photos were categorized into 6 different groups.

The number of subjects included in this study (60 subjects) was considered average based on review of previous literature. Smaller sample size was seen in other studies like **Matoula and Pancherz (2006)** and **Jain et al (2010).** On the other hand, larger sample size was seen in other studies like **Hee et al (2009)**.

Subjects in this study ranged from 15 to 18 years old, similar age groups were recommended by **Hee et al (2009)** and **Luka et al (2010)** who focused on adolescent subjects. On the other hand **Egle et al (2005)** encompassed a wider age range between 11 to 31 years. **York and Holtzman (1999)** made their study on an older age group between 65 and 75 years. **Bashour (2006)** conducted his study on a younger age group between 4 to 9 years**.** The adolescent age was selected in this study matching with a peak treatment request by that age.

Regarding judges; previous studies like **Howells and Shaw (1985)**, **Newton and Minhas (2005)**, **Kiekens et al (2007)** founded differences in the evaluation of facial aesthetics, depending on panel composition, with regard to age, gender, and demographic origin. Also differences in judging facial attractiveness between orthodontists and non-orthodontists have been found by **Knight and Keith (2005)**, **Maple et al (2005)**. On the other hand **Jen et al (2005)** and **Eugene et al (2008)** asked 3 different groups of judges consisted of laypersons in conjunction with orthodontist and dental students to rank the attractiveness of their sample. They found that all groups of judges demonstrated similar trends in ranking the profiles.

In the present study, it was found logic to choose judges to match the subjects on the basis of age, gender, and demographic origin. Sixty laypersons (30 males, 30 females) were asked to rank the attractiveness of each sample. Five female judges and seven male judges were excluded because of inaccurate attractiveness ranking charts. The images were presented in grey scale so as to minimize the impact of ethnicity or skin tone as recommended by **Swami et al (2008).** Each set of pictures was shown for 15 seconds as recommended by **Kiekens et al (2005).** Every judge was allowed to rest at least 15 minutes between groups to prevent eye fatigue.

In this study; the phrase "attractive" or "attractiveness" was the people's perceptions of attractiveness. While there were several studies concerned with measurements of attractiveness that might be considered more objective, such as facial symmetry **Langlois et al (1994), Grammar and Thornhill (1994)**, **Kowner (1996).** This study was concerned with the more subjective perception of attractiveness.

Most of the attractiveness scales in literature ranged from 1 to some value; however **Stevens et al (1990)** used a scale ranged from -4 to +4. The numeric ranges used in literature also varied. Most of the measurements used a five-point scale **Lerner and Lerner (1977), Frieze et al (1991), Biddle and Hammermesh (1998)** and **Macías-Gago et al (2012).** Others used a seven-point scale **Horai et al (1974), Bogaert and Fischer (1995)**. On the other hand some other scales included as many as 100 points **Kenealy et al (1988)**. However **Alwin (1997)** recognized that adding scale points up to eleven increased reliability, but after eleven the increase in number of points might confuse the respondent. Ranking method used in this study was a scale with 5 points from 1 (the least attractive) to 5 (the most attractive).

Lateral cephalograms, are routinely used in orthodontics for diagnosis. Although quantification of facial esthetics is certainly not the main use of cephalograms in orthodontics, many cephalometric measurements have been proposed as reliable indices of facial attractiveness. From the early work of **Downs (1948)** to the more recent work of **Arnett et al (1999)** almost every proposed cephalometric analysis contained some measures of facial attractiveness. So it seemed reasonable to correlate between the ''objective'' angular and linear measurements of x-ray cephalometry and the ''subjective'' ranking of facial photographs for attractiveness. The cephalometric variables chosen for this study included 19 widely used quantitative cephalometric measures. The best available norms were taken from the cephalometric chart used in orthodontic department Cairo university hospital according to **Soliman (1988)** and **Abd-Elmageed (1989).**

Results of this study showed that the correlation between the photo attractiveness ranks of the male judges and female judges was very strong. The decision to pool the results of male and female judges was based on this finding. Also it was found that the female attractiveness is more correlated with cephalometric measurements than the male attractiveness. Eight cephalometric measurements from the total 19 measurements conducted in this study were correlated with the female attractiveness. On the other hand 6 cephalometric measurements were correlated with the male attractiveness.

It was found that from the 19 cephalometric measurements; twelve variables showed correlation with photo attractiveness. ANB, facial angle, MMA, wits appraisal, upper incisor / palatine plane angle, lower incisor / mandibular plane angle, profile angle, Z-angle, E-line to lower lip, Upper lip thickness, lower lip thickness and upper lip length were the variables showed correlation with photo attractiveness.

When analyzing the antero-posterior relation between maxilla and mandible in males and females sample group. It was found that there was a positive correlation between the ANB angle and facial attractiveness in males and females. That's could suggest that the general preference of the Egyptian adolescents in males and females is toward skeletal Class II. **Matoula et al (2006)** also found that attractive females had a higher ANB angle. On the other hand **Macías-Gago et al (2012)** found that attractive females tended to a Class II, while males tended to a Class III. It was also found that increasing the Wits appraisal increased the facial attractiveness in females. This was in agreement with **Matoula et al (2006).**

It was also found that there was a negative correlation between facial plane angle and facial attractiveness in males sample group. Suggesting that males with skeletal class II and retruded chin are

considered more attractive. This is in agreement with **Shingo et al (2009)** in his investigations on Japanese population. Also **Naini et al (2012)** stated that retruded chin is more tolerated by clinicians and laypeople than protruded chin. However, **Foster (1973)** found that males straight profile were considered attractive. Also **Czarnecki et al (1993)** reported that straight profiles with a prominent chin are more suited to males than females. But if the age of the current study sample was considered, it could be found that previous studies like **Peck and Peck (1995)**, **Nguyen and Turley (1998)** stated that more convex faces have a younger appearance than more concave faces.

A negative correlation was also found between profile angle and facial attractiveness in females sample group. This could mean that skeletal class II with prominent maxilla relative to the mandible and convex profile was a feature of female facial attractiveness. A lot of previous studies recommended these features for females' attractiveness **Bashour (2006), Matoula et al (2006), Sforza et al. (2007)** and **Macías-Gago et al (2012).**

When analyzing face height ratios, no significant correlation between face height and attractiveness of males was found. On the other hand in females sample group a negative correlation between facial attractiveness and the Maxillary-Mandibular angle (MMA) was recorded. So regarding females' attractiveness, it was observed that short faces could be considered more attractive than longer faces. This was in agreement with the study of **Johnston et al (2005)**. Also **Lundström et al (1987)** found that a horizontal growth pattern corresponded to a higher facial attractiveness. **Michiels and Sather (1994)** showed that a diminished inferior face height was more acceptable when it came to judging facial attractiveness. **Padrós (2000), Johnston et al (2005)** advocated that treatment that increases face height should be avoided. On the other hand **Matoula and Pancherz (2006)** did not find differences between attractive and unattractive females with regard to face height.

The position of the lips could be determined by maxillomandibular protrusion or retrusion, by dental protrusion or retrusion and/or by lip thickness. Although protrusive lips recently considered more attractive **- Kiekens et al., (2006), Scott et al., (2006), McNamara et al (2008) -**, in this study it was found that reduced lower lip thickness in females is a feature of attractiveness. This was in agreement with the study of **Takahiro et al (2011)** among Japanese. Also **Abbassy et al (2012)** in their comparison between Egyptian and Japanese females, they found that Japanese subjects had a significantly protruded lip positions compared to Egyptians.

A significant negative correlation between distance between lower lip and E-line and female attractiveness was found in agreement with the study of **Matoula and Pancherz (2006)**. Other factors which could explain this finding could be the bigger nose and chin for non-attractive females **Foster (1973), Czarnecki et al (1993).**

Another factor influencing the lip position is the dental protrusion or retrusion. **Luka et al (2010)** recognized in their study that the bimaxillary alveolar protrusive profile was preferred among the female profile. This was in agreement with the results of this study, as it was found that there was a positive correlation between females' facial attractiveness and the lower incisor to mandibular plane angle. On the other hand in males sample group it was found that there was negative correlation between facial attractiveness and the upper incisor to palatine plane angle. This could postulate that the retrusive position of upper lip in males was a feature of attractiveness. This was in agreement with the study of **Hideki et al (2008)** on Japanese and Korean.

Many of previous studies have probed the relationship between the lips position and attractiveness **Mayumi et al (2009)**, **Takahiro et al (2011), Hockley et al (2012).** But they didn't reveal the relation between lip length and attractiveness. In this study it was found that short upper lip in males and females was a feature of attractiveness.

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