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ANGULAR AND LINEAR PARAMETERS OF THE FACIAL PROFILES IN 12-YEAR OLD CHILDREN WITH NORMOGNATHIC OCCLUSION

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Abstract

An aesthetically pleasing and balanced face is one of the objectives of orthodontic treatment. An understanding of the soft tissues and their normal ranges enables a treatment plan to be formulated to normalize the facial traits for a given individual. The aim of this study was to evaluate the variables defining the soft tissue facial profile of an Armenian sample, by means of angular and linear measurements. Additionally, gender differences were tested. The soft tissue facial profiles of 67 children from Yerevan city schools (35 males and 32 females) between 11.5 and 12.5 years of age with a dental Class I occlusal relationship and harmonious soft tissue profile were studied by means of standardized photographs taken in the natural head position (NHP). To compare males and females, a Student's t-test was used. The greatest variability was found for nasofrontal and mentolabial angles. Only one of the angles showed gender differences: angle of the inferior facial third - (sn - trg - gn, P = 0.045), and one of the linear measurements - lower face height (**sn - gn**, P = 0.019). In treatment planning one should take into consideration that soft tissue parameters in this age (12 years) are almost similar in both groups, except the lower face height. Additional studies will be useful for further definitions of other age groups mean values.

Keywords: soft tissue profile, angular measurements, linear measurements, photogrammetric analysis, orthodontic treatment planning.

Introduction

The relevant literature has demonstrated that skeletal, dental and facial profile differences exist when subjects from distinct ethnic groups are compared [*Basciftci F. et al., 2004; Scavone H. et al., 2006; Nakahara C., Nakahara R., 2007*]. Thus, each group should be evaluated differently, considering their racial characteristics, in order to produce better diagnoses and treatment planning [*Mandall N. et al., 2000; Saglam S., Gazilerli Ü., 2001; Magnani M. et al., 2004*]. The improvement of facial aesthetics has been one of the main objectives of orthodontic treatment [*Baig M., 2004; Ioi H. et al., 2005; Chew M. et al., 2007*]. Social acceptance, psychological well-being, and the self-esteem of an individual are related to physical appearance. It has been established that self-esteem is strongly dependent on facial appearance [*Hershon L., Giddon D., 1980; Varela M., García-Camba J., 1995*]. Appearance, therefore, is one of the primary functions of the face. However, the definition of an attractive and pleasing face is subjective with many factors involved (culture, personality, ethnic background, age) [*Saglam S., Gazilerli Ü., 2001*]. On the other hand, several medical specialities (orthognathic and plastic surgery, orthodontics, dental prosthetics) have the ability to change facial features. Hence, there is a need for clinicians working in the maxillofacial area to know the aesthetic standards of a face that guide the aesthetic soft tissue treatment goals in their patients. It is well known that races, ethnic groups, age, sex, etc. influence average facial traits [*Mandall N. et al., 2000*]. In orthodontics, different authors have included soft

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tissue parameters in cephalometric analysis [*Burstone C., 1958; Subtelny J., 1959; Lines P. et al., 1978; Holdaway R., 1983*]. Various soft tissue facial analyses based on photogrammetry have also been described [*Stoner M., 1955; Peck H., Peck S., 1970; Arnett G., Bergman R., 1993a; 1993b*]. Other photographic methods to quantify facial aesthetics have also been used [*Peerlings R. et al., 1995*]. After standardization of teleradiographic techniques [*Broadbent B., 1931*], the analysis of the soft tissue facial profile was relegated in favour of dentoskeletal relationships that, since then, have predetermined the objectives in diagnosis and orthodontic treatment planning. However, it was observed that not all parts of the soft tissue profile directly follow the underlying dentoskeletal profile [*Subtelny J., 1959*]. In 1955, M. Stoner started to use analysis of the soft tissues of the face on photographic records [*Stoner M., 1955*]. G. Arnett and R. Bergman defined the frontal and lateral analysis from photographic records taken in the natural head position (NHP) [*Arnett G., Bergman R., 1993a; 1993b*]. They used, among others, the nasolabial angle and the angle of the contour of the maxillary and mandibular sulcus. They also described the facial profile in Class I (165–175 degrees), Class II (<165 degrees), and Class III profiles (>175 degrees) according to the angle of the facial convexity (**g–sn–pg**).

In the present cross-sectional study, the aim was to quantify average parameters that define the soft tissue facial profile of a sample of Armenian children aged 12. Angular and linear measurements were defined in a standardized photogrammetric technique to analyze the profile.

Materials and Methods

The population of this study embraced pupils of 7 secondary schools of Yerevan city (Nos. 6, 17, 34, 49, 60, 119, and 120). The age ranged 11.5–12.5 years. This age group was chosen as the most optimal age for passing entire orthodontic treatment. A sample of 67 individuals was obtained: 35 males and 32 females. A brief questionnaire was completed for all individuals that included name, age, origin, previous orthodontic treatment, and maxillomandibular relationship (only Class I by Angle classification). Subjects with craniofacial anomalies were excluded from the study. Soft tissue landmarks, angular and linear measurements are presented in Figures 1-3. Nikon Coolpix P4 digital camera was used in its manual position; the shutter speed was 1/45 per second and the opening of diaphragm f/3.8, focal length 10 *mm* and ISO Speed–ISO-50. Pictures were taken in JPEG format and processed with the Microsoft Office Picture Manager software, then uncolored and printed with HP 1020 LaserJet on A4 size paper. After landmark identification and tracing on the printed photographic images, all measurements were done. All the manual procedures were undertaken by 2 operators, who were previously trained to make landmark identification and tracing in the same way before.

The subject was positioned on a line marked on the floor, and framed alongside a vertically adjustable 2-*cm* ruler segment. The ruler allowed measurements at life size (1:1). The height of the camera was at the same time adapted to the subject's body height. In order to take the records in NHP, the subjects were asked to walk a few steps, stand at rest facing the camera and near the ruler. The lips should also be relaxed, adopting the position they normally show during the day. Previously, glasses had been removed and the operator ensured that the patient's forehead and ears were clearly visible during the recording (Figure 4).

Statistical analysis: BioStat (version 2007 Professional Build 3.8.0, AnalystSoft Company) was used for all statistical analyses. To compare males and females Student's *t*-test was used (Table 1). Table 2 presents descriptive statistics of the variables.

Results

Student's *t*-test was applied to all variables to determine the influence of gender in measurements (Table 1). Only one of the angles showed gender-related differences: (**sn-trg-gn**, P = 0.045) - angle of the inferior facial third, and one of the linear measurements - lower face height (**sn - gn**, P=0.019).

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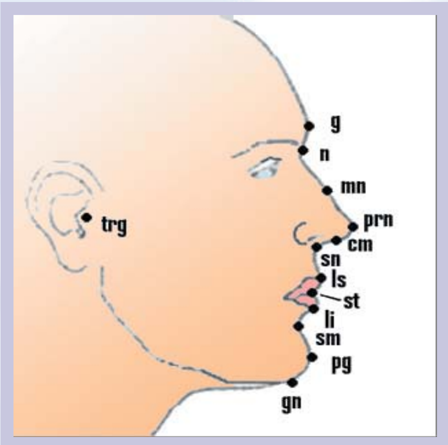


Figure 1. *Soft tissue landmarks used in photogrammetric analysis of the facial profile. g-glabella; n- nasion; mn- mid. nasale; prn- pronasale; cm- columella; sn- subnasale; ls- labiale superior; li- labiale inferior; st- stomion; sm- supramentale; pg- pogonion; gn- gnation; trg- tragion*

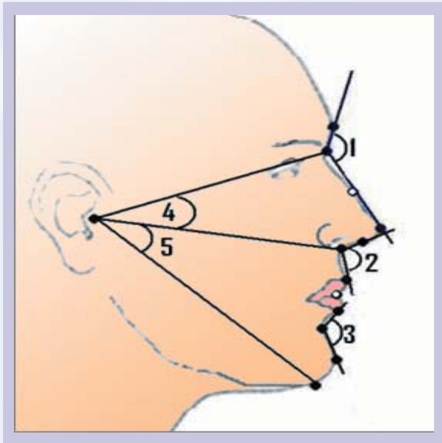
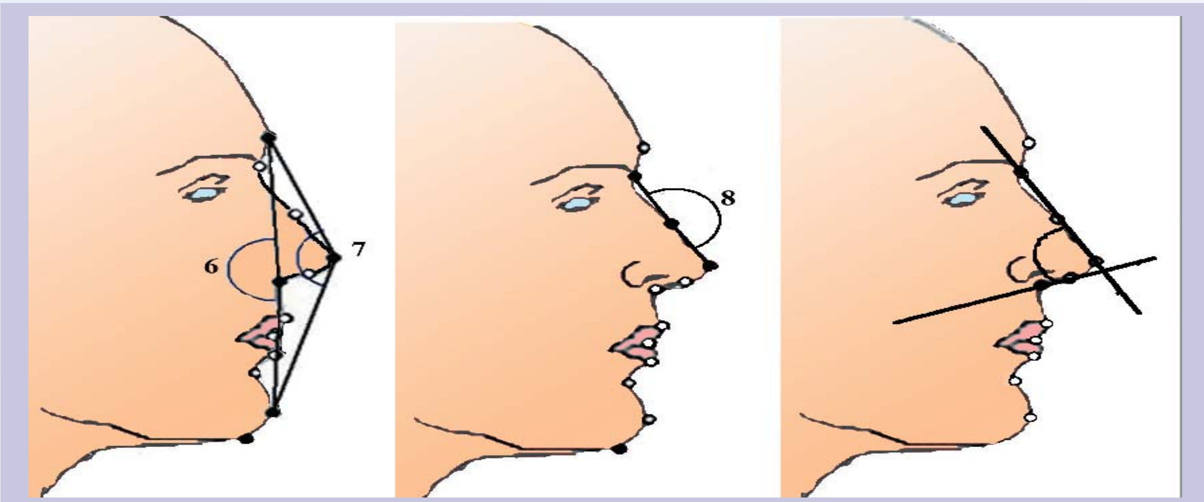
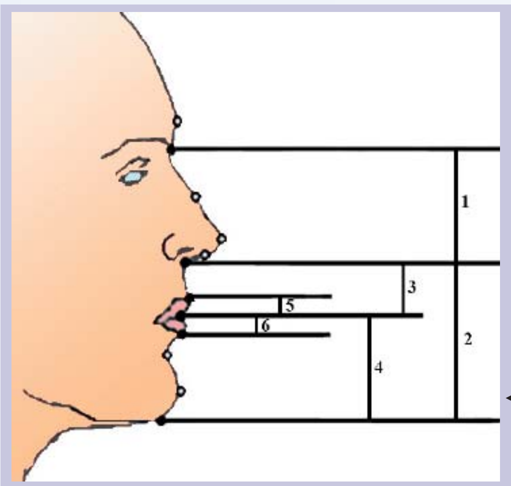


Figure 2a. *Angular measurements used in this investigation: 1- nasofrontal angle; 2 - nasolabial angle; 3 - mentolabial angle; 4 - angle of the medium facial third; 5 - angle of the inferior facial third.*



▲ **Figure 2b.**

Angular measurements used in this investigation: 6 - angle of facial convexity; 7 - angle of total facial convexity; 8 - external angle of the nasal dorsum; 9 - nasal angle.



◀ **Figure 3.** *Linear measurements used in this investigation: 1 -mid-face height; 2. lower face height; 3.upper lip height; 4. mandibular height; 5. upper lip vermilion; 6. lower lip vermilion.*

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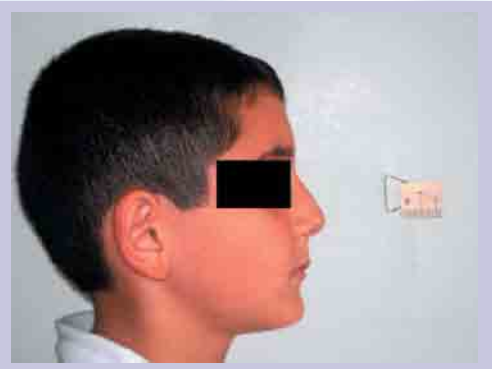

Figure 4. *Image sample.*

Table 2 presents the means, standard deviations, and standard errors for males and females angular and linear measurements. A wider angle of the inferior facial third was found in males (34.6 ± 3 degrees) than in females (33.8 ± 3 degrees). Other measurements such as lower face height were also wider in males (64.3 ± 5.4 *mm*) than in females (61.3 ± 4.6 *mm*). The rest of the measured angles and distances did not present any significant gender-related differences.

Discussion

It was the purpose of this investigation to obtain average parameters, which define the soft tissue facial profile of the investigated population. When comparing the present results with those of other studies, the characteristics of the method and the sample used should be borne in mind.

In this investigation, standardized photogrammetric records taken in NHP were analysed using angular and linear measurements. The records were obtained from a sample of 67 (35 males; 32 females) children from Yerevan, Armenia.

Many authors [*Arnett G., Bergman R., 1993a; 1993b; Yuen S., Hiranaka D., 2007*] also used NHP in their studies. The selected sample was 12-year old, and the race was Armenian. Excluding facial deformities, all the subjects that fulfilled the requirements participated in the study. The difference in the number of males and females in the sample was due to distribution of pupils at their schools. This lack of proportion in male/female distribution is a bias that should be kept in mind. The means, standard deviations (SD), standard errors (SE) and ranges of the confidence interval for the variables are provided in Table 2.

Table 1.

Application of Student's *t*-test in relation to gender

Variable	$P < 0.05$*	limit of confidence interval (95%)	
		Inferior	Superior
g-n-prn	0.211	-1.043	4.643
cm-sn-ls	0.686	-6.509	4.309
li-sm-pg	0.150	-1.378	8.778
sn-cm/n-prm	0.437	-1.755	4.015
n-mn-prn	1.000	-4.12	4.12
n-trg-sn	0.669	-1.525	0.9851
sn-trg-gn	0.045*	0.03166	3.028
g-sn-pg	0.861	-2.079	2.479
g-prn-pg	0.451	-1.308	2.908
n-sn	0.547	-3.182	1.702
sn-gn	0.019*	0.4953	5.385
sn-st	0.203	-0.4431	2.043
st-gn	0.447	-1.112	2.492
ls-st	0.120	-1.291	0.1527
st-li	0.868	-0.7779	0.9199

*Differences statistically significant, $p < 0.05$

The nasofrontal angle (**gn - prn**) did not show statistically significant sexual differences (P =0.2) (males = 153.8± 6 degrees, females = 152 ± 6 degrees). B. Epker in a study of Caucasians undertaken on frontal and lateral facial views, observed no sexual differences in this angle (130 degrees) [*Epker B., 1992*]. The external angle of the nasal dorsum (**n–mn–prn**) did not show sexual differences (P = 1.000) in males and females (Table 2). P. Lines and co-authors provided a mean range of 60–80 degrees for the angle of the intersection of the nasal dorsum and a tangent to columella [*Lines P. et al., 1978*]. In that study, facial profile silhouettes were selected by several groups of 'judges'. The origin

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Table 2.

Average values of measurements in males and females

Variables	**Descriptive statistics of the variables**							
	Gender	N	Mean	SD	SE	Median	Min.	Max.
g-n-prn	male	35	153.8	5.982	1.011	154	140	167
cm-sn-ls	female	32	152	5.637	0.9966	152	142	161.5
	male	35	114.5	8.158	1.379	115	100	131
li-sm-pg	female	32	115.6	14.76	2.61	114.8	84.5	177.5
	male	35	138.9	11.03	1.864	139	114	155
sn-cm/n-prn	female	32	135.2	9.652	1.706	134.5	118	158
	male	35	90.44	6.216	1.051	90	80	106
n-mn-prn	female	32	89.31	5.547	0.9806	89.5	76	105
	male	35	175.3	8.317	1.406	175	161	198
n-trg-sn	female	32	175.3	8.563	1.514	174.2	157.5	199
	male	35	28.29	2.633	0.445	29	23	34.5
sn-trg-gn*	female	32	28.56	2.498	0.4415	28	24	35.5
	male	35	34.61	3.029	0.5121	34	27.5	41
g-sn-pg	female	32	33.08	3.109	0.5495	33	28	42.5
	male	35	163.2	5.021	0.8487	164	152	172.5
g-prn-pg	female	32	163	4.244	0.7503	163.5	154	172
	male	35	140	4.518	0.7637	140	130	148
n-sn	female	32	139.2	4.083	0.7217	139	133	146
	male	35	52.77	5.052	0.854	52.5	42.9	62.9
sn-gn*	female	32	53.51	4.94	0.8733	52.65	42.9	66.3
	male	35	64.27	5.373	0.9081	63	55.2	78.2
sn-st	female	32	61.33	4.567	0.8073	60.8	49.6	74.4
	male	35	20.44	3.105	0.5249	20.8	14.3	28.9
st-gn	female	32	19.64	1.734	0.3066	19.5	16.8	22.4
	male	35	43.31	3.784	0.6396	43.4	37.2	53.3
ls-st	female	32	42.62	3.581	0.633	42	36.4	56.4
	male	35	8.815	1.408	0.238	9.1	4.7	11.2
st-li	female	32	9.384	1.55	0.274	9.1	6.5	13
	male	35	8.26	1.893	0.32	7.8	4.2	11.7
	female	32	8.189	1.55	0.274	7.8	4.8	11.2

*Differences statistically significant, $p < 0.05$.

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of the silhouettes was not mentioned. The relationship between the nasal base (columella) and the upper lip, analyzed by the nasolabial angle, is one of the facial profile parameters with broader clinical uncertainty. In the present sample this angle showed large variability, males =114.5 ±8.2 degrees (SE =1.38), females = 115.6± 14.8 degrees (SE= 2.61). S. Yuen and D. Hiranaka in a study of Asian adolescents on standardized photographic records reported an angle of 102.7 ± 11 degrees for males and 101.6 ± 11 degrees for females [*Yuen S., Hiranaka D., 2007*]. The other measurement that should be evaluated with caution because of its large variability (SD 9.7-11degrees) is the mentolabial angle (**li–sm–pg,** males =138.9 ± 11 degrees, females = 135.2 ± 9.7 degrees). P. Lines and co-authors found in the silhouettes a mentolabial angle of 120–130 degrees [*Lines P. et al., 1978*]. C. Burstone used an angle called the "total facial contour", which was defined as the intersection of the upper facial (**g–sn**) and anterior lower facial (**sn–pg**) components [*Burstone C., 1958*]. From a sample of lateral and frontal photographs of 40 young adult Caucasians with acceptable or pleasing faces, the mean value was 11.3 ± 4 degrees. G. Arnett and R. Bergman presented a clinical facial analysis based on previous studies and their surgical experience [*Arnett G., Bergman R., 1993a; 1993b*]. For the facial examination the angle **g–sn–pg** was used to assess the convexity/concavity of the profile. According to the authors, a Class I profile presented an angle range of 165–175 degrees. S. Yuen and D. Hiranaka reported from their Asian adolescent sample on photographic records a **g–sn–pg** angle of 162 ± 5 degrees in females and 161 ± 6 degrees in males [*Yuen S., Hiranaka D., 2007*]. The **g–prn–pg** angle was 135 ± 4 degrees in males and 135 ± 3 degrees in females. No gender differences were found. In the present investigation, the facial convexity and total facial convexity angles obtained were similar, **g–sn–pg:** 163.2 ± 5 degrees in males and 163 ± 4.2 degrees in females; the **g–prn–pg** angle: 140 ± 5 degrees in males and 139.2 ± 4 degrees in females. H. Peck and S. Peck used a profilometric analysis based on standardized cephalograms and photographs to assess the soft tissue facial profile [*Peck H., Peck S., 1970*]. They analyzed the vertical height by means of angles such as the total vertical (**n–trg–pg**), the nasal (**n–trg–prn**), the maxillary (**prn–trg–ls**), and the mandibular (**ls–trg–pg**) angles. In this investigation, by angular measurements, the middle and inferior facial thirds were evaluated by the **n–trg–sn** and **sn–trg–gn** angles. The inferior third was larger (males: 34.6 ± 3 degrees; females: 33.8 ± 3 degrees) than the middle third (males: 28.3±2.6 degrees; females: 28.6 ± 2.5 degrees). B. Epker also reported in Caucasian subjects that the linear lower face height was larger (38%) than the upper (32%) in relation to total face height [*Epker B., 1992*]. In a study of Caucasians, L. Farkas obtained the following data for vertical distances: lower face height: 72 *mm* (± 6.0) for males, 66 *mm* (± 4.5) for females; upper lip vermilion: 8.9 *mm* (±1.5) for males, 8.4 *mm* (± 1.3) for females; lower lip vermilion: 10.4 *mm* (± 1.9) for males, 9.7 *mm* (± 1.6) for females [*Farkas L., 1981*]. In our investigation, the same parameters were as follows: lower face height: 64.3 *mm* (± 5.4) for males, 61.3 *mm* (± 4.6) for females; upper lip vermilion: 8.8 *mm* (±1.4) for males, 9.4 *mm* (± 1.6) for females; lower lip vermilion: 8.3 *mm* (± 2.0) for males, 8.2 *mm* (± 1.6), appropriately.

Conclusion

Analysis of the soft tissue facial profile and its comparison with standard soft tissue facial profile measurements are necessary in all medical specialties that can change facial traits. There were established average parameters for 12 years old children. Mean values obtained from this sample can be used for comparison with records of subjects with the same characteristics and following the same photogrammetric technique. The measurements displayed almost no significant gender differences for the angular and linear parameters at 12 years. The results showed gender differences in 2 measurements: one angular - angle of the inferior facial third and one linear - lower face height. The lack of proportion in gender distribution is a bias that should be kept in mind. In treatment planning we should take into consideration that soft tissue parameters in this age (12 years) are almost similar in both groups. Additional studies will be useful for further definitions of other age groups mean values.

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