Factors associated with the beauty of soft-tissue profile

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Introduction: Factors affecting the attractiveness of soft-tissue profile have been assessed in only a few studies, with limited methodologies (such as few variables, small sample sizes) and bivariable analyses. Therefore, this study was conducted to elucidate esthetic factors of profile silhouettes among a long list of cephalometric variables with the use of multivariable analyses for the first time. **Methods:** Profile silhouettes of 70 Iranians (35 men and 35 women) with Class I/good occlusions and balanced faces were rated twice by 10 Iranian laypersons, and were given overall profile beauty scores (from 10 to 50). After careful landmark identification by 3 orthodontists, unrepeated cephalometric measurements (from Holdaway, Ricketts, Z-Merrifield, Epker, and Legan-Burstone analyses) were traced twice on all cephalographs. The effects of these variables (plus sex and age) on profile beauty scores were assessed with the use of Pearson coefficient and multiple linear regression. Cephalometric characteristics of Persian attractive profiles (scores from 40 to 50) were compared with Caucasian orthodontic norms ($\alpha = 0.05$). **Results:** The following variables were significant in the best models: soft-tissue facial angle ($\beta = -0.348$, $P = 0.016$), nose prominence ($\beta = -0.245$; $P = 0.044$), skeletal profile convexity ($\beta = 0.255$; $P = 0.052$), upper lip curvature ($\beta = 0.405$; $P = 0.042$), nasolabial angle ($\beta = 0.546$; $P = 0.000$), nasofacial angle ($\beta = 0.259$; $P = 0.028$), Z-angle ($\beta = 0.557$; $P = 0.015$), H-angle ($\beta = -0.360$; $P = 0.013$), upper lip to E-plane ($\beta = 0.691$; $P = 0.001$), lower lip to E-plane ($\beta = -0.674$; $P = 0.002$), Sn–lower lip ($\beta = 0.338$; $P = 0.055$), lower lip–menton ($\beta = -0.299$; $P = 0.025$), Sn FH-perp to upper lip ($\beta = -0.425$; $P = 0.001$), Sn-Stms:Stms-Me′ ($\beta = -0.372$; $P = 0.016$), facial convexity angle ($\beta = 0.710$; $P = 0.000$), lower lip protrusion ($\beta = -0.342$; $P = 0.005$), and interlabial gap ($\beta = -0.179$; $P = 0.050$). Sex and age were not associated with profile attractiveness ($P > 0.75$). **Conclusions:** More convex skeletal and soft-tissue profiles, less prominent noses with higher tips, subnasales anterior to the upper lip, more protruded upper lips, less prominent lower lips, smaller interlabial gaps, and more protruding chins might improve profile esthetics. (Am J Orthod Dentofacial Orthop 2019;155:832-43)

Facial beauty is associated with psychosocial well-being and success,[1,2] and the main motivation of patients for visiting orthodontic offices is shifting to enhancement of appearance.[3-5] Therefore, esthetics is a principal goal in orthodontics.[2,6,7] Although the literature is replete with studies on cephalometric norms, most of them are merely the average cephalometric properties of people having good occlusions[8] and well balanced faces.[1,4,8-17] Such standards represent the norm but not the profile attractiveness.[8,15] The latter might be more relevant to orthodontic treatments and orthognathic or plastic surgeries. Therefore, identification of factors associated with esthetics of soft-tissue profile is of significant clinical value.

Despite the importance of this matter, relevant studies are rare and limited by methodology.[1,6-9,11] For example, the largest sample sizes were 62 and 60,[1,18] followed by 30 and smaller[1]; furthermore, some studies did not elucidate factors affecting beauty,[7,9] with certain ones having judges evaluate a few drawings (instead of photographs or silhouettes of real subjects)[6,9] and some studying only men.[11] And the number of evaluated variables were very restricted in several investigations.[7-9,18] Finally, all such studies used bivariable statistics to identify factors associated with soft-tissue profile beauty, which are flawed in evaluating interconnected cephalometric or photographic parameters.

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The present study was conducted because comprehensive and even moderate-size studies on factors contributing to beauty of soft-tissue profile are scarce, they are controversial,[7,11,18,19] and factors associated with the attractiveness of soft-tissue profile have not been assessed with the use of multivariable statistics. The research questions were (1) which factors might contribute to the attractiveness of soft-tissue profiles of Iranians (who are Caucasian), and (2) which of the parameters pertaining to Iranian attractive individuals might differ from the values proposed for Holdaway, Ricketts, Z-Merrifield, Epker, and Legan-Burstone soft-tissue analyses in textbooks or original reports concerning the norms of Caucasians of European ancestry.[14,20-23]

MATERIAL AND METHODS

This prospective study was performed on 70 Persian dental students. The subjects were sequentially acquired from about 180 volunteer students selected randomly, until 35 men and 35 women were enrolled. Two subjects (1 man and 1 woman) were excluded after the initial inclusion because of poor radiographic qualities. They were subsequently replaced with new subjects. There were no missing data. The first step was clinical examination and assessment of the occlusion and dentoskeletal conditions. The inclusion criteria comprised: (1) the subjects' willingness to participate (knowing the risks of x-ray and still wanting to be screened for orthodontic and surgical or pathologic problems based on the prepared cephalograph), (2) being of Persian ethnicity with Persian parents, (3) having Class I molar and canine relationships with a normal overjet and overbite, (4) having a symmetric face (determined subjectively by an orthodontist), with no history of facial plastic surgery (rhinoplasty or orthognathic surgery), (5) no history of missing teeth or tooth extraction except for the third molars, (6) no or minor crowding of the anterior teeth, (6) no history of orthodontic or prosthodontic treatment, and (8) no history of trauma to the face or craniofacial deformities. The study protocol was approved by the Research Ethics Committee of the university according to the Helsinki declaration. Signed written consents were taken from the subjects after thorough oral explanation. They could leave the study at will. Because the volunteer students wanted to use cephalographs as a screening tool to diagnose potential orthodontic or surgical issues, no injuries were identified during the course of study.[24]

Lateral cephalographs were taken from all selected subjects in natural head position with the eyes looking straight ahead and the FH plane positioned parallel to the floor with the teeth in maximum intercuspation and the lips in repose; the ear rods and frontal head holder were positioned in the best place without any force to maintain the head during cephalography (supervised by the first author). The first author was present in the room if she was needed to assist in keeping a proper head position. Cephalographs were taken at 80 kV and 25 mA/s in a dental radiology clinic (PM2002, Planmeca; EC Proline, Helsinki, Finland).[24]

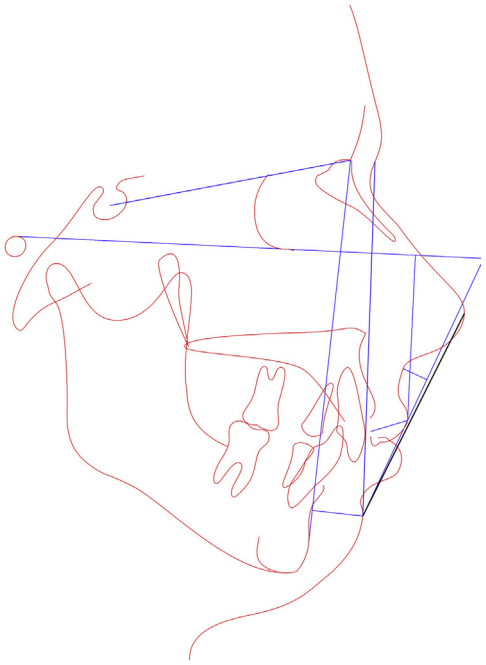

Fig 1. The Holdaway, Z-Merrifield, and Ricketts analyses modified from the output of the Onyx Ceph program (Image Instruments, Chemnitz, Germany).

Utmost care was taken in tracing and analyzing, which were undertaken by the first author at the Department of Orthodontics. Lateral cephalographs were traced manually on 0.003-mm matte acetate papers. First, the landmarks were identified manually, and landmarking errors were minimized by identifying the landmarks again 2 weeks later by the same author. On some more difficult images or landmarks, this was done for a third time as well. To improve the landmarking accuracy, all landmarks on all 70 images were confirmed by 2 other orthodontists in the department. If there was controversy among the 3 orthodontists regarding landmark positions, the correct landmark spot would be determined through discussion. Based on the identified landmarks, 49 nonoverlapping angular, linear, and relative (ratio) measurements were established from Ricketts, Holdaway, Z-Merrifield, Epker, and Legan-Burstone soft tissue analyses[14,20-23]

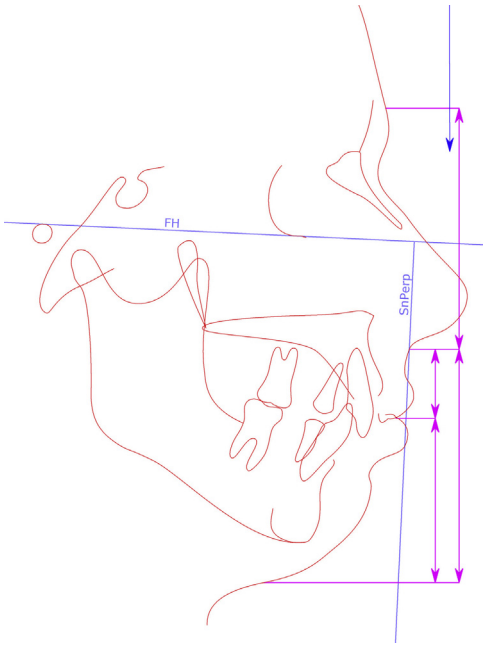

Fig 2. The Epker analysis (Onyx Ceph).

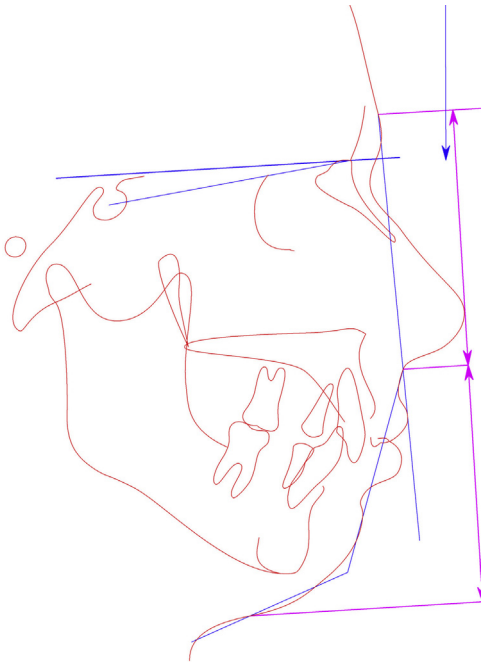

Fig 3. The Legan-Burstone analysis (Onyx Ceph).

and recorded (Figs 1-3). The tracings were performed twice. The average value for both instances of each measurement was considered as the main value.

The outline of the soft-tissue profile was traced and scanned. To minimize the effect of other facial features (such as hair style and color, facial makeup, or form of the eyes and eyebrows) the scanned profiles were converted into soft-tissue silhouettes against a white background (Adobe Photoshop 7, San Jose, CA).

A panel of 10 Persian laypersons (5 women, 5 men) at different ages (average 35.2 ± 9.1 years) and having different jobs (Table I) observed and assessed all 70 slides. The laypersons were randomly selected from the general public and their occupations were not related to the perception of beauty.

Each silhouette was presented to each referee in a dark room for 30 seconds, without mentioning the subject's sex or age. Each judge rated all images twice in 2 sessions with 1-week intervals. In each session, each slide was evaluated as very pleasant (5 points) pleasant (4 points), average (3 points), unpleasant (2 points), or very unpleasant (1 point) by each judge. The average of both sessions (a score ranging from 1 to 5) was calculated and assigned to each silhouette rated by each judge.

The scores given by all 10 judges to each subject were summed up, rounded, and assigned to that subject.

Table I. The panel of referees

Occupation	*Age*	*Sex*
Salesperson	47	Female
Computer programmer	34	Female
Secretory at a dental school	25	Male
Teacher	32	Male
Housewife	30	Female
Post office manager	42	Male
Police officer	36	Male
Housewife	28	Female
Laboratory technician	26	Female
Worker	52	Male

Therefore, soft-tissue profile beauty score of each subject could theoretically be a value from 10 to 50.

Only profiles that had scores ≥ 40 points were selected as attractive. This group consisted of 15 profiles (Fig 4).

Statistical analysis and method error

The sample size was predetermined based on a pilot study to obtain test powers >95% for some interethnic comparisons.[24] Cephalometric tracing errors were assessed using the Dahlberg formula[25] on 12 randomly selected cephalographs. The errors ranged from 0.24 to 0.59 for angular measurements and from 0.16 to 0.24 for linear measurements. Two of the variables were remeasured by the same observer for all 70 subjects.

Fig 4. All silhouettes of the attractive group.

According to the Cronbach alpha, the intrarater reliabilities for both variables were ≥99% ($P = 0.000$).

Descriptive statistics and 95% confidence intervals (CIs) were calculated for the esthetically pleasing group (n = 15). Each of its average cephalometric values was compared with the standard values proposed for normal (but not necessarily attractive) Caucasians[14,20-23] with the use of a 1-sample *t* test.

A Pearson correlation coefficient along with a chi-square and an unpaired *t* test were used to check the bivariable associations between the attractiveness and the independent variables (age, sex, and cephalometric measurements). To examine multivariable associations, the variables in the analyses Holdaway + Z-Merrifield, Epker + Ricketts, and Legan-Burstone were modeled separately with the use of a multiple linear regression analysis of SPSS 25 (IBM, Armonk, NY). After manually optimizing the models, they were adjusted further using the backward-selection stepwise algorithm to identify variables contributing to the attractiveness of soft-tissue profile. The level of significance was set at 0.05.

RESULTS

The mean (±SD) age of the students was 22.97 ± 2.47 years (range 20−29, median 22, interquartile range [IQR] 21−25) with a 95% CI of 22.38−23.56 years. The average age of the ideal group was 22.20 ± 3.08 years, and it was 22.91 ± 2.31 years in the remainders (unpaired *t* test: $P = 0.689$). The numbers of women and men in the ideal group were 7 and 8, respectively, and there were 28 women and 27 men in the rest of the subjects (chi-square: $P = 0.771$). The mean score of profile attractiveness was 32.33 ± 7.358 (range 16.50−46.00, median 32.25, IQR 26.00−37.88) with a 95% CI of 30.57−34.08. The average profile attractiveness score in men was 32.41 ± 7.18 (range 19.00−46.00, 95% CI 29.95−34.88), and in women it was 32.24 ± 7.63 (range 16.50−46.00, 95% CI 29.62−34.86). The independent-samples *t* test did not indicate a significant difference between profile attractiveness scores of the sexes ($P = 0.923$).

The measurements of the ideal group were compared with the norms proposed for Caucasians (based on orthodontic features and not on the basis of profile attractiveness),[14,20-23] and the following parameters were larger in the ideal group: angle of skeletal convexity (more convex profiles in the ideal group), H-angle, superior sulcus depth, inferior sulcus to H-line, thickness of soft-tissue chin, nasolabial angle, nasofacial angle, subnasale–lower lip:lower

lip–menton ratio, subnasale to the line perpendicular to the upper lip, facial convexity angle (indicative of more convex profiles), lower face throat angle, mentolabial sulcus, and lower vertical height-depth ratio.

The following measurements were smaller in the ideal group compared with the Caucasian norms: upper lip to E-plane (indicating less protruded lips in the ideal group compared with the Caucasian norms), nose prominence, nasomental angle, Z-angle, subnasale-stomion:stomion-menton ratio, interlabial distance, subnasale to the line perpendicular to the chin, and interlabial gap.

Caucasian norms were not different statistically from the following measurements in the ideal group: lower lip to E-plane, soft tissue facial angle, subnasale to H-line, subnasale to the line perpendicular to the lower lip, lower lip to H-line, basic upper lip thickness, upper lip thickness, upper lip length, upper lip strain, upper lip curvature, upper lip protrusion, lower lip protrusion, maxillary incisor exposure, maxillary prognathism, mandibular prognathism, middle third height:lower third height, and vertical height ratio (Table II).

The Pearson correlation coefficient indicated positive significant associations between the profile attractiveness scores of all subjects (n = 70) with the variables skeletal profile convexity, nasolabial/nasofacial angles, and facial convexity angle ($r > 0.2$; $P < 0.05$; Table III). There were negative bivariable associations between the attractiveness scores with the parameters soft-tissue subnasale to H-line, nasomental angle, upper lip, lower lip, and chin to the vertical line passing through subnasale and perpendicular to FH, upper lip protrusion, and lower lip protrusion ($r < -0.2$; $P < 0.05$; Table III).

The results of the optimized regression analysis with the use of Holdaway + Z-Merrifield measurements (n = 70; adjusted $r^2 = 0.375$; $P = 0.000$) indicated that profile silhouettes with smaller soft tissue facial angles (more convex soft-tissue profiles or less concave ones), greater skeletal profile convexities (more convex skeletal profiles), less prominent noses, greater upper lip curvatures (more prominent upper lips), greater nasolabial angles (noses with higher tips controlling for the lip position), greater nasofacial angles (indicative of less prominent chins or a more convex profile when the position of nose is controlled for), and greater Z-angles (ie, less protruded lower lips [controlling for the position of upper lips], more protruded chins, or greater lower vertical heights) could be preferred by the judges (Table IV). In case the H-angle was included instead of the Z-angle, the H-angle would become significant as well ($\beta = -0.360$; $P = 0.013$, indicative of more protruded chins or less protruded lips), although the model would be overall less explanatory.

The regression model with the use of Epker + Ricketts measurements (adjusted $r^2 = 0.224$; $P = 0.001$) demonstrated that the judges may admire silhouettes that have more protruded upper lips and less protruded lower lips, a greater distance between subnasale and lower lip, a smaller distance between the lower lip and soft-tissue menton, more advanced subnasales (when the position of the upper lip was already controlled for), and smaller Sn-Stms:Stms-Me′ ratios (indicative of a vertical posterior maxillary excess, a long two-thirds of the lower face, or, in case those dimensions were controlled for, indicative of a short upper lip[22]; Table V).

The optimized model with the use of Legan-Burstone measurements (adjusted $r^2 = 0.516$; $P = 0.000$) indicated that greater profile convexity angles (more convex profiles), greater nasolabial angles, less protruded lower lips, and smaller interlabial gaps can favor the attractiveness of soft-tissue profile (Table VI).

DISCUSSION

This study attempted to recognize what profile features might contribute to its esthetics. The identified factors can be used in transforming an unpleasant profile into an attractive one by means of orthodontic treatments, orthognathic surgery, or plastic surgeries of the lips, chin, or nose. More convex profiles with fuller lips may imply youth in modern women[4] and thus might be preferable in them.[1,4] In men, a more straight profile with less protruded lips might be more desirable.[1,2,8-11] However, some authors think that nowadays, under the influence of media such as fashion magazines, more convex profiles with fuller lips may be more favorable for men as well.[4,12] Reports on lip positions are controversial, because their contribution to the esthetics of profile can be affected by culture, ethnicity, and gender of judges and subjects.[6,7,11,13,15,18] Compared with African judges, referees from Hispanic-American or Japanese ethnic backgrounds might prefer less protruded lips.[6] For a male American of European ancestry, retruded lips may be more acceptable, whereas for an African-American or a Japanese subject, more prominent lips would be perceived as more attractive.[6,18] Some authors suggest that well established Class I cases would be more beautiful.[3] Still, many studies have shown that fuller lips in addition to smaller noses are more appealing.[1,4,5,8,12,13,18,26,27] Ricketts E-line is recommended for discerning beautiful profiles.[1,10,18,28] Usually, lips posterior to the E-line are most favorable.[6,13] In the present study, attractive upper lips were found to be more protruded (or less

Table II. Comparison of soft-tissue cephalometric values of reference Caucasian norms (Holdaway, Ricketts, Z-Merrifield, Epker, and Legan-Burstone) with the attractive profile group, by means of 1-sample *t* test

		Attractive profiles (n = 15)						*Orthodontic norms*		
Parameter	*Units*	*Mean*	*SD*	*95% CI*		*Min*	*Max*	*Mean*	*SD*	P
Ricketts										
Upper lip to E-plane	mm	−5.80	1.49	−6.63	−4.97	−8.50	−3.50	−4	–	0.000*
Lower lip to E-plane	mm	−2.73	2.02	−3.85	−1.61	−6.00	1.00	−2	0.60	0.183
Holdaway + Z-Merrifield										
Soft tissue facial angle	°	90.87	1.68	89.94	91.80	88.00	93.00	91	7	0.764
Nose prominence	mm	16.26	1.65	15.35	17.17	13.00	20.00	19	5	0.000*
Superior sulcus depth	mm	4.50	1.07	3.91	5.09	2.50	6.50	3	–	0.000*
Subnasale to H-line	mm	4.30	1.96	3.21	5.39	0.00	8.00	5	2	0.189
Skeletal profile convexity	mm	3.37	2.77	1.84	4.90	−1.00	7.00	0	–	0.000*
Basic upper lip thickness	mm	16.03	2.23	14.80	17.26	12.00	19.00	15	–	0.095
Upper lip thickness	mm	14.33	2.33	13.04	15.62	10.00	18.00	14	–	0.588
Upper lip strain	mm	1.70	2.01	0.59	2.81	−1.50	6.00	1	0.5	0.200
Upper lip curvature	mm	2.90	0.87	2.42	3.38	1.50	4.50	2.5	1.5	0.097
H-angle	°	14.50	3.17	12.74	16.26	8.00	19.00	11	1.5	0.001*
Lower lip to H-line	mm	0.97	1.36	0.21	1.72	−1.50	3.50	0.5	1.5	0.204
Inferior sulcus to H-line	mm	5.93	1.44	5.13	6.73	3.00	8.50	5	1	0.025*
Soft tissue chin thickness	mm	13.53	2.81	11.97	15.09	10.00	19.00	11	1	0.004*
Nasolabial angle	°	105.80	9.21	100.70	110.90	90.00	121.00	100	–	0.029*
Nasofacial angle	°	35.93	2.66	34.46	37.40	32.00	40.00	32.5	–	0.000*
Nasomental angle	°	123.30	3.49	121.37	125.23	117.00	130.00	126	–	0.009*
Z-angle	°	74.13	5.08	71.31	76.94	60.00	84.00	80	–	0.001*
Epker										
Middle third height:lower third height	–	0.98	0.07	0.94	1.02	0.83	1.09	1	–	0.238
Subnasale-stomion:stomion-menton	–	0.42	0.03	0.41	0.43	0.37	0.46	0.5	–	0.000*
Subnasale–lower lip:lower lip–menton	–	0.83	0.09	0.78	0.88	0.07	0.99	1.11	–	0.001*
Interlabial distance	mm	0.83	0.24	0.70	0.96	0.50	1.00	1.5	1.5	0.000*
Subnasale FH-perp to upper lip	mm	1.07	1.64	0.16	1.98	−1.50	3.50	0	2	0.025*
Subnasale FH-perp to lower lip	mm	−2.33	1.38	−3.09	−1.57	−4.50	0.00	−2	2	0.367
Subnasale FH-perp to chin	mm	−9.07	3.80	−11.17	−6.97	−14.00	−1.00	−4	2	0.000*
Upper lip length	mm	22.03	2.70	20.53	23.53	19.00	28.50	21	2	0.161
Legan-Burstone										
Facial convexity angle (G-Sn-Pog′)	°	15.60	5.41	12.60	18.60	3.00	24.00	12	4	0.022*
Maxillary prognathism [G-Sn(HP)]	mm	7.97	4.09	5.70	10.23	1.50	15.00	6	3	0.084
Mandibular Prognathism [G-Pog′(HP)]	mm	−0.37	5.09	−3.19	2.45	−9.00	7.00	0	4	0.784
Lower face throat angle (Sn-Gn′-C)	°	105.00	4.99	102.24	107.76	90.00	111.00	100	7	0.002*
Upper lip protrusion (Ls to Sn-Pog′)	mm	3.47	1.58	2.59	4.34	0.00	6.50	3	1	0.270
Lower lip protrusion (Li to Sn-Pog′)	mm	2.73	1.65	1.82	3.64	0.00	5.50	2	1	0.106
Mentolabial sulcus (Si to Li-Pog′)	mm	6.23	1.59	5.35	7.11	3.00	8.50	4	5	0.000*
Maxillary incisor exposure (Stms-Ui)	mm	2.70	1.60	1.81	3.59	0.00	5.00	2	2	0.113
Interlabial gap [Stms-Stmi(VP)]	mm	0.83	0.24	0.70	0.97	0.50	1.00	2	2	0.000*
Vertical height ratio [G-Sn/Sn-Me′(VP)]	–	0.98	0.07	0.94	1.02	0.83	1.09	1	–	0.266
Lower vertical height-depth ratio (Sn-Gn′/C-Gn′)	–	1.47	0.32	1.29	1.65	0.93	1.95	1.2	–	0.006*
Vertical lip-chin ratio (Sn-Stms/Stmi-Me′)	–	0.43	0.03	0.41	0.44	0.38	0.47	0.5	–	0.000*

*$P \leq 0.05$.

retruded, indicated by the E-line as well as the upper lip curvature) and pleasant lower lips were more retruded (or less protruded) even when the convexity of profile had been accounted for; still, in the ideal group, both of the lips were posterior to the E-line, and even more posterior than what had been suggested for Caucasian norms. Our findings were in contrast to research on Persians and Yemenis who did not find lip positions to be contributing to profile esthetics.[11,18] Also, it was observed in this study that the existence of gaps between the lips might reduce the beauty of profile.

In this study, prominent noses were less attractive. In other reports as well, it has been suggested as a factor negatively affecting the appearance either directly or indirectly by making the lips look less protruded.[1,10,18,28]

Table III. Results of the Pearson correlation coefficient (*r*)

Variable	*r*	P
Age	−0.039	0.752
Male Sex	−0.012	0.923
Upper lip to E-plane (Ls to E-Plan)	0.018	0.440
Lower lip to E-plane (Li to E-Plan)	−0.126	0.149
Soft tissue facial angle (G′-Sn-Pog′)	−0.120	0.161
Nose prominence (Pn to Ls perpendicular)	0.090	0.230
Superior sulcus depth (SLs to H Line)	−0.148	0.110
Soft-tissue subnasale to H-line (Sn to H Line)	−0.296	0.006*
Skeletal profile convexity	0.206	0.043*
Upper lip thickness	0.011	0.465
Upper lip strain	−0.056	0.322
Upper lip curvature	−0.135	0.133
H angle	−0.047	0.350
Lower lip to H-line (Li To H Line)	−0.034	0.390
Inferior sulcus to H-line (ILs To H Line)	0.144	0.117
Soft tissue chin thickness (Pog To Pog′)	0.033	0.393
Nasolabial angle (Cm-Sn-Ls)	0.507	0.000*
Nasofacial angle	0.348	0.002*
Nasomental angle	−0.271	0.012*
Z–angle	0.089	0.464
Upper lip length (Sn-St)	−0.124	0.153
Interlabial distance (Ulv-Llv)	−0.038	0.379
Upper lip to the vertical line passing through subnasale and perpendicular to FH (Sn-T-ULv)	−0.337	0.002*
Lower lip to the vertical line passing through subnasale and perpendicular to FH (Sn-T-Llv)	−0.427	0.000*
Chin to the vertical line passing through subnasale and perpendicular to FH (Sn-T-Pg′)	−0.214	0.038*
Middle third height:lower third height [Vertical height ratio (G-Sn:Sn-Me′)]	0.093	0.221
Subnasale-stomion:stomion-menton (Sn-Stms:Stms-Me′)	−0.048	0.347
Subnasale–lower lip:lower lip–menton (Sn-Llv:Llv-Me′)	0.064	0.300
G-Sn(VP) (middle third height)	−0.036	0.385
Sn-Me′(VP) (lower third height)	−0.118	0.165
Sn-St (subnasale-stomion)	−0.124	0.153
St-Me′ (stomion-menton)	−0.126	0.148
Sn-Llv (subnasale-lower lip)	−0.015	0.450
Llv-Me′ (lower lip–menton)	−0.127	0.147
Facial convexity angle (G-Sn-Pog′)	0.543	0.000*
Maxillary prognathism [G-Sn(HP)]	−0.001	0.993
Mandibular prognathism [G-Pog′(HP)]	−0.158	0.191
Sn-Me′(VP)	−0.126	0.300
Lower face throat angle (Sn-Gn′-C)	0.003	0.978
Sn-Gn′	−0.001	0.994
Throat length (C-Gn′)	−0.078	0.523
Upper lip protrusion (Ls to Sn-Pog′)	−0.298	0.012*
Lower lip protrusion (Li to Sn-Pog′)	−0.299	0.012*
Mentolabial sulcus (Si to Li-Pog′)	0.045	0.714
Upper lip length (Sn-Stms)	−0.114	0.349
Lower lip and chin length (Stmi-Me′)	−0.125	0.304
Maxillary incisor exposure (Stms-Ui)	0.016	0.892
Interlabial gap [Stms-Stmi(VP)]	−0.100	0.410
Vertical height ratio [G-Sn/Sn-Me′(VP)]	0.099	0.416
Lower vertical height-depth ratio (Sn-Gn′/C-Gn′)	0.076	0.532
Vertical lip-chin ratio (Sn-Stms/Stmi-Me′)	−0.034	0.777

*$P \leq 0.05$.

In addition, our results in terms of the nasolabial angle was consistent with studies on Chinese,[13] Persian,[18] Brazilian,[29] and Saudi Arab[11] subjects, that found more obtuse nasolabial angles to be more attractive because they indicate higher nose tips.[18] In the past 7 decades, such noses have become especially more important for profile beauty of women, along with fuller lips.[18,27] The only study in contrast to these was one regarding the profile attractiveness of Italian adolescents.[12] Controlling for lip positions, more advanced subnasales would be perceived as more attractive. This was in line with the results suggesting esthetic merits of convex profiles.

One of the most crucial factors contributing to the attractiveness of soft-tissue silhouette in this sample was facial convexity: More convex profiles or less concave ones may be admired more, regardless of gender. This was in line with studies on Turkish and German women, in which subjects with convex profiles looked more attractive.[1,2] The position of jaws can affect numerous variables of the overlying soft tissues; controversial results have been reported for the position of maxilla: Persian men (but not women) with prognathic maxillas may look more attractive,[18] although the profile of Turks and Yemeni men might not be affected by the advancement of the maxilla.[11,15] Previous investigations have found less retruded mandibles as more desirable.[11,18] Yet, an excessively prognathic mandible would look unappealing as well, even if it is ethnically common, for example in Japan,[7] unless it accompanies a prognathic maxilla, which can reduce the profile concavity caused by the advanced mandible.[7,18,19] When the profile convexity was controlled for in the present study, maxillary and mandibular positions did not significantly affect the profile esthetics. In contrast, a study in another city of Iran found that local judges would perceive more straight and less convex profiles as marginally significantly more beautiful.[18] The difference might be attributable to potential subethnic or cultural variations. Perhaps methodological dissimilarities, such as having some artists and dental professionals among judges in the other study,[18] might be the case, because opinions of laypeople might differ from that of professionals, eg, in terms of mandible position,[19] although not all authors agree on this.[30] It should be noted that severely convex profiles with retruded chins may still look unattractive.[2,8,10,18]

The Z-angle was positively associated with profile beauty in this sample, whereas the H-angle was negatively correlated with it, both meaning that controlling for the position of the lips and their distance to the chin, a more prominent chin would be pleasant in

Table IV. Results of the multiple linear regression on Holdaway + Z-Merrifield variables

Model		B	SE	β	P	95% CI	
1	(Constant)	55.162	94.865		0.563	−135.031	245.355
	Soft tissue facial angle	−1.216	0.554	−0.363	0.033	−2.327	−0.105
	Nose prominence	−0.699	0.458	−0.240	0.133	−1.617	0.219
	Superior sulcus depth	−1.358	1.625	−0.223	0.407	−4.616	1.899
	Soft-tissue subnasale to H-line	0.157	0.838	0.048	0.853	−1.524	1.837
	Skeletal profile convexity	0.531	0.457	0.214	0.250	−0.386	1.448
	Upper lip thickness	−0.922	0.632	−0.279	0.150	−2.189	0.344
	Upper lip strain	−0.044	0.573	−0.012	0.939	−1.192	1.104
	Upper lip curvature	3.586	1.764	0.478	0.047	0.050	7.123
	Lower lip to H-line	0.787	0.726	0.178	0.283	−0.667	2.242
	Inferior sulcus to H-line	0.660	0.583	0.172	0.263	−0.509	1.829
	Soft tissue chin thickness	0.334	0.487	0.110	0.496	−0.642	1.309
	Nasolabial angle	0.401	0.132	0.598	0.004	0.136	0.666
	Nasofacial angle	0.449	0.487	0.230	0.360	−0.526	1.425
	Nasomental angle	−0.055	0.468	−0.035	0.906	−0.993	0.883
	Z-angle	0.650	0.338	0.533	0.060	−0.028	1.328
5	(Constant)	44.191	41.220		0.288	−38.319	126.701
	Soft tissue facial angle	−1.167	0.471	−0.348	0.016*	−2.111	−0.223
	Nose prominence	−0.712	0.346	−0.245	0.044*	−1.406	−0.019
	Superior sulcus depth	−0.890	1.306	−0.146	0.498	−3.504	1.725
	Skeletal profile convexity	0.633	0.319	0.255	0.052*	−0.006	1.273
	Upper lip thickness	−0.718	0.468	−0.217	0.131	−1.655	0.220
	Upper lip curvature	3.040	1.463	0.405	0.042*	0.111	5.969
	Lower lip to H-line	0.895	0.676	0.202	0.191	−0.459	2.249
	Inferior sulcus to H-line	0.751	0.546	0.195	0.174	−0.342	1.843
	Nasolabial angle	0.366	0.082	0.546	0.000*	0.202	0.530
	Nasofacial angle	0.507	0.225	0.259	0.028*	0.058	0.956
	Z-angle	0.679	0.271	0.557	0.015*	0.136	1.222

*$P \leq 0.05$ in the optimized model.

subjects still having more convex or less concave profiles. More prominent chins have been associated positively with the profile esthetics of Turks or Italian boys.[2,12] Mentolabial sulcus did not contribute to profile esthetics, whether accounting for chin and lip positions (in this study) or not controlling for any other variables in previous research on Brazilians, Yemenis, or Persians.[11,18,29]

The vertical position of the lips between the chin and nose may matter as well, and its knowledge might have clinical implications in orthodontic or orthosurgical treatments.[18,31] Each of the distances between the lips and the nose, or between the lips and the chin independently predicted profile beauty: Greater nose-lips distances or smaller lips-chin distances could be preferable. This was in contrast to results pertaining to Iranian women[18] but not Iranian or Yemeni men.[11,18] On the other hand, larger Sn-Stms:Stms-Me′ ratios were found to be more desirable; without noticing the rest of variables, this might seem self-contradictory, but controlling for the distances among the nose, lips, and chin, this finding implies that an excessive vertical posterior maxilla or a shorter upper lip[22] might look more esthetic. However, due to the complex nature of interrelated geometric variables at play, this deduction needs more evidence and data for verification.

Limitations and advantages

Various factors can affect the definition of an ideal face or soft-tissue profile, such as demographics, geographic areas, current fashions, socioeconomic status, education, or even morphologic properties of faces of the referees.[1,2,4,6,7,12,15,18,27,29,32] Therefore, the results obtained in this study or any other research on esthetics of the face or soft-tissue profile are limited by cultural and esthetic preferences of the local judges. Still, because Western media (eg, Hollywood) might have a considerable influence on people's esthetic taste worldwide, it may be expected to find similarities between the opinions of Iranian laypeople and those of referees from many other cultures. We have included the silhouettes of the attractive group within the report (Fig 4), in order for the international reader to be able to judge the attractiveness of the profiles directly. It is also possible to invite international peers from other

Table V. Findings of the multiple linear regression on Epker + Ricketts measurements

Model		*B*	*SE*	*Beta*	P	*95% CI*	
1	(Constant)	89.600	18.403		0.000	52.789	126.410
	Upper lip to E-plane	2.453	0.721	0.691	0.001	1.011	3.895
	Lower lip to E-plane	−2.249	0.646	−0.837	0.001	−3.542	−0.956
	Middle third height	−0.351	0.192	−0.250	0.073	−0.736	0.033
	Sn-LLv (Sn–lower lip)	0.599	0.330	0.327	0.075	−0.061	1.259
	LLv-Me′ (lower lip–menton)	−0.369	0.214	−0.235	0.091	−0.798	0.060
	Interlabial distance	−1.511	3.004	−0.058	0.617	−7.520	4.498
	Sn FH-perp to upper lip	−1.185	0.660	−0.309	0.078	−2.504	0.135
	Sn FH-perp to chin	−0.514	0.368	−0.276	0.167	−1.250	0.221
	Sn-Stms:Stms-Me′	−66.783	26.581	−0.394	0.015	−119.953	−13.612
4	(Constant)	70.286	13.720		0.000	42.868	97.704
	Upper lip to E-plane	2.452	0.708	0.691	0.001*	1.038	3.866
	Lower lip to E-plane	−1.810	0.569	−0.674	0.002*	−2.946	−0.674
	Sn-LLv (Sn–lower lip)	0.618	0.316	0.338	0.055	−0.014	1.250
	LLv-Me′ (lower lip–menton)	−0.470	0.205	−0.299	0.025*	−0.879	−0.060
	Sn FH-perp to upper lip	−1.631	0.459	−0.425	0.001*	−2.548	−0.715
	Sn-Stms:Stms-Me′	−63.106	25.586	−0.372	0.016*	−114.234	−11.977

*$P \leq 0.05$ in the optimized model.

cultures to review the attractiveness of all our silhouettes and together assess the impact of culture on esthetic preferences.

Studies in this regard are scarce, all with bivariable statistics, mostly with few photographic or cephalometric parameters as well as many other methodologic flaws, such as a lack of matching, sex balance, considering good occlusion as an inclusion criterion, using facial photographs (which are not very related to profile), or recruiting one sex only.[8,11,18,33] Furthermore, there were sample size limitations, with the largest studies being of 62 and 60 subjects and the rest being much smaller.[1,18] Although this is the largest research in the literature on factors relevant to profile attractiveness, it could have been larger to improve the reliability, based on powers calculated directly for the assessment of predictors of beauty. Nonetheless, the number of significant results and the effect sizes still indicated a proper level of control over confounders as well as sufficient powers. Unlike most previous studies,[1,4,6-15] but similarly to another one,[18] we also reported CIs and did not rely on significance testing alone. Moreover, we avoided including judges with jobs related to esthetics (dentists, orthodontists, painters, artists, etc) to evaluate the factors of beauty not from practitioners' perspective but in laypeople's eyes. Profile esthetics might be perceived differently among various groups,[7,26] and attitudes of laypeople might reflect cultural influence better than do biased attitudes of professionals.[7,18,26] The exclusion of cases with maxillary or mandibular prognathism or retrognathism in this study could limit the generalizability of the study to Class I–only cases, which is not applicable to all cases in the clinic; however, this was a limitation of all previous studies, and the results might be considered as reference values for orthognathic surgeries and orthodontic treatments. Another limitation was recording of some hard-tissue landmarks which might not strongly reflect soft-tissue changes.[5,33,34] Nevertheless, most of our numerous variables were already soft-tissue related, and we included the hard-tissue variables to improve our analyses. This was valuable, because skeletal profile convexity was found to be relevant to attractiveness, even independently from soft-tissue profile properties. Compared with other studies, which had evaluated few variables (eg, 12 items[18]), the number of the evaluated variables in this study was unique and far greater than in all other investigations. As another strength, this was the only study adopting multivariable analyses, which are much needed for such interconnected systems of cephalometric measurements. Also treating beauty as a continuous variable, rather than dichotomizing the subjects to attractive or less attractive may be unique in the literature. However, analyzing this number of interwoven continuous variables involved were much more complicated, and their correct modeling and interpretation required cautiously taking into account several statistical and theoretical points.

Computer software could be used to facilitate the tracing and improve the accuracy.[35] Yet there are studies showing similar accuracies for both conventional and digital approaches.[36] Another limitation was exposing healthy subjects to x-rays without treatment needs, which could raise ethical concerns.[18] Conversely, all these volunteer dental students did intend to have diagnostic cephalography and a full

Table VI. Multiple linear regression results pertaining to Legan-Burstone measurements

Model		B	SE	Beta	P	95% CI	
1	(Constant)	33.369	21.249		0.122	−9.198	75.937
	Facial convexity angle (G-Sn-Pog′)	1.052	0.196	0.719	0.000	0.660	1.444
	Maxillary prognathism [G-Sn(HP)]	−0.373	0.293	−0.198	0.209	−0.960	0.215
	Mandibular prognathism [G-Pog′(HP)]	0.315	0.217	0.230	0.153	−0.120	0.751
	Lower face throat angle (Sn-Gn′-C)	−0.084	0.087	−0.114	0.339	−0.257	0.090
	Nasolabial angle	0.181	0.088	0.270	0.044	0.005	0.357
	Upper Lip Protrusion (Ls to Sn-Pog′)	0.435	0.630	0.110	0.493	−0.826	1.696
	Lower lip protrusion (Li to Sn-Pog′)	−1.394	0.552	−0.408	0.014	−2.498	−0.289
	Mentolabial Sulcus (Si to Li-Pog′)	0.099	0.472	0.023	0.835	−0.847	1.044
	Maxillary incisor exposure (Stms-Ui)	−0.463	0.525	−0.093	0.382	−1.515	0.590
	Interlabial gap [Stms-Stmi(VP)]	−4.397	2.643	−0.159	0.102	−9.691	0.897
	Vertical height ratio [G-Sn/Sn-Me′(VP)]	−10.360	9.648	−0.120	0.288	−29.688	8.968
	Lower vertical height-depth ratio (Sn-Gn′/C-Gn′)	−0.222	3.388	−0.008	0.948	−7.008	6.564
	Vertical lip-chin ratio (Sn-Stms/Stmi-Me′)	−1.593	18.819	−0.010	0.933	−39.291	36.105
6	(Constant)	27.287	11.235		0.018	4.822	49.752
	Facial convexity angle (G-Sn-Pog′)	1.039	0.179	0.710	0.000	0.681	1.397
	Maxillary prognathism [G-Sn(HP)]	−0.391	0.262	−0.208	0.141	−0.914	0.133
	Mandibular prognathism [G-Pog′(HP)]	0.330	0.197	0.241	0.100	−0.065	0.725
	Nasolabial angle	0.154	0.080	0.231	0.057	−0.005	0.314
	Lower lip protrusion (Li to Sn-Pog′)	−1.168	0.402	−0.342	0.005*	−1.972	−0.365
	Maxillary incisor exposure (Stms-Ui)	−0.443	0.448	−0.089	0.327	−1.338	0.452
	Interlabial gap [Stms-Stmi(VP)]	−4.972	2.483	−0.179	0.050*	−9.936	−0.007
	Vertical height ratio [G-Sn/Sn-Me′(VP)]	−9.175	8.077	−0.106	0.260	−25.325	6.975

*$P \leq 0.05$ in the optimized model.

diagnosis of numerous dental, orthodontic, and surgical indications based on it. Several excluded students used their radiographs to begin orthodontic or dental treatments.

In this study, age and sex did not predict beauty. Our failure to find a role for age might be attributable to the narrow range of the participants' ages. The absence of a role for sex is more difficult to interpret, especially in light of the sex dimorphism existing among Iranians;[16,17] perhaps blinding the referees to subjects' sexes might contribute to this result. Future studies are warranted to assess this.

CONCLUSIONS

In Class I Persian subjects with normal overjets and overbites, more convex (or less concave) profiles, less prominent noses with higher tips, more advanced subnasales, more prominent upper lips, less protruded lower lips, smaller or no interlabial gaps, and more prominent chins might look more attractive to Iranian laypeople. Sex might not play a role in the attractiveness of silhouettes, and the effect of age was inconclusive. It is possible that shorter upper lips, and lips positioned farther away from the nose or closer to the middle of the nose-chin distance be perceived as more attractive, but these need more evidence.

Many Caucasian orthodontic norms (not necessarily established on esthetics) might not look attractive to Iranian laypeople, or they might be different ethnically from Persian orthodontic norms.

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Fataneh Ghorbanyjavadpour conceived the hypothesis #2 (the comparison of measurements of attractive Iranian profiles with Caucasian norms), controlled the radiography imaging, landmarked and traced the

cephalographs for numerous times, prepared and digitized the silhouettes, had them judged, reported the ideal-norm comparisons, and drafted the original Methods section. Vahid Rakhshan conceptualized the hypothesis #1 (the assessment of factors contributing to the attractiveness of soft-tissue profile using multivariable analyses), redesigned the study, asked for detailed data regarding cephalometric measurements, gender, age, and beauty scores of each student, requested for the addition of Legan-Burstone cephalometric tracing, checked the correctness and consistency of the data (and asked for cephalometric re-evaluations), estimated the intraobserver agreements, re-analyzed and corrected the comparisons between the ideal and Caucasian norms, designed/implemented/optimized the analyses and models, interpreted the findings and discussed them, prepared the figures and tables, revised the Methods section, drafted/revised the article, and responded to reviewers.

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