Three-dimensional facial morphometry of attractive Italian women

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Objectives. To identify reference standards and possible esthetic features in facial proportion and form of Italian adult women. Methods and Subjects. A three-dimensional electromagnetic digitizer was used to collect the coordinates of 50 facial landmarks (forehead, eyes, nose, cheeks, mouth, jaw, ears) in 71 healthy, reference women (18-30 years old) and in 48 coetaneous "attractive" women selected during a beauty competition; soft tissue facial angles, distances and volumes were computed. Results. Attractive women had wider faces with a relatively larger upper facial third (forehead); a larger facial width relative to facial height. The mouth was larger, and lips were more prominent; the interlabial angle was reduced. Overall, the soft-tissue profile was more prominent, with a larger maxillary prominence relative to the mandible. Faces in the attractive women were more flat in the horizontal plane. For several of the analyzed measurements, similar patterns were observed for the 36 women participants to the semi-final stage of the beauty competition, the 12 finalists, and the winner. The winner of the beauty competition deviated from the reference women more than the other two groups of attractive women. Conclusion. Esthetic reference values were determined for a population of 18-30 year olds that reflect contemporary society.

Key words: Face; attractiveness; soft tissues.

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Introduction

Scientific investigations on the esthetic implications of dental and orthodontic treatments are becoming appearing more in the literature[1-4]. A search on PubMed database using the key word "Esthetics" produced 14945 entries in the period 1950-2007; using "Esthetics and face", a total of 2477 entries was obtained, and the combination "Esthetics and orthodontics" produced 1633 entries (www.pubmed.gov, accessed on Feb, 21, 2007). Of these last ones, three papers were published between 1950 and 1959, and 55 papers between 1960 and 1969. In the subsequent years, a rapid increase in the number of publications occurred, with 178 papers in the '70s, 222 papers in the '80s, 579 papers in the '90s, and 598 papers in the first seven years of the XXI Century (Figg. 1a, b).

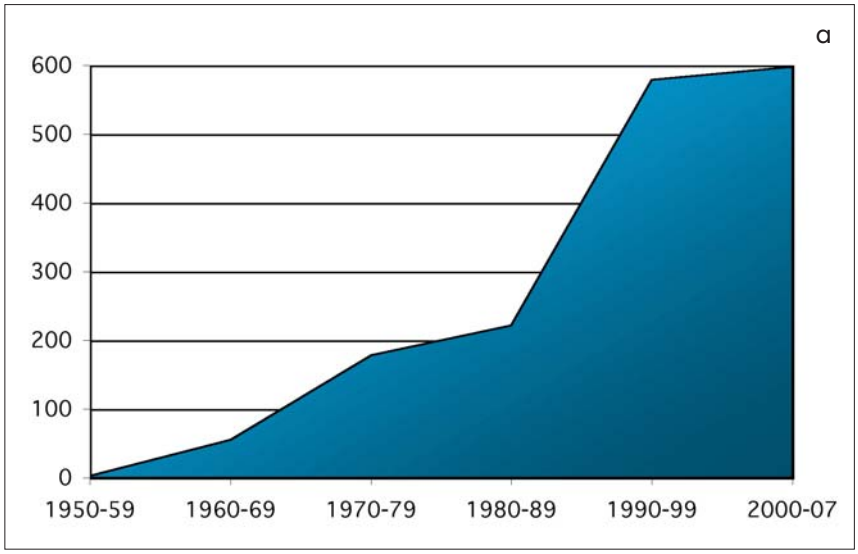
Indeed, esthetic analyses cannot be limited to the teeth and dental arches, but they should involve the entire facial skeleton and soft tissues, considering the composite, resultant morphology obtained in the single individual by bones, muscles, cutaneous and subcutaneous layers[5].

Apart from single case reports of selected orthodontic, orthopedic or surgical techniques, most studies focused on the psychological bases of the esthetic perception[1,4,6-10], and only a few investigations reported actual numerical values of faces (or of parts of faces) considered more or less attractive[2,3,11-23].

In synthesis, psychological investigations found that the esthetic appraisal of adult female faces de-

Obiettivi. Identificare eventuali canoni estetici nella forma e dimensioni della faccia delle donne adulte italiane. Metodi e Materiali. Un digitalizzatore elettromagnetico tridimensionale ha permesso di raccogliere le coordinate di 50 punti di repere facciali (fronte, occhi, naso, guance, bocca, mandibola, orecchie) in 71 donne normali (18-30 anni) e in 48 coetanee partecipanti alle fasi finali di un concorso di bellezza ("attraenti"); sono stati calcolati angoli, distanze, e volumi facciali. Risultati. Le donne attraenti hanno la faccia più larga, con un maggiore sviluppo della fronte; le dimensioni orizzontali della faccia sono prevalenti rispetto a quelle verticali. Le bocca è di maggiori dimensioni negli donne attraenti, con labbra più sporgenti, ed un angolo interlabiale ridotto. Nel complesso, il profilo cutaneo è più sporgente, con una maggiore prominenza mascellare rispetto alla mandibola. Le facce delle donne attraenti sono risultate più piatte sul piano orizzontale. Per diverse delle misure considerate, si sono osservati pattern simili per le 36 donne selezionate per la semi-finale, le 12 finaliste, e la vincitrice. La vincitrice del concorso di bellezza è risultata quella più diversa dalle donne normali di riferimento. Conclusione. La definizione di parametri estetici di riferimento può fornire indicazioni per individuare modalità e finalità di trattamento ortodontico ottimali.

Figs 1a, b Number of papers in PubMed database selected using the key words "Esthetics and orthodontics" (www.pubmed.gov, accessed on Feb, 21, 2007); occurrences were divided for publication year *(a)* decades between 1950 and 2007; *(b)* single years between 1990 and 2007.



Objectifs. L'objectif est d'identifier des normes de référence et des détails esthétiques possibles dans la proportion faciale de femmes italiennes adultes. Méthodes et Subjets. Un convertisseur analogique/numérique électromagnétique tridimensionnel a été utilisé pour rassembler les coordonnées de 50 points faciales (front, yeux, nez, joues, bouche, mâchoire, oreilles) dans 71 femmes en bonne santé, de référence (18-30 ans) et dans 48 femmes "attirantes" avec la meme age choisies pendant une concours de beauté ; des angles faciaux, les distances et les volumes de tissus mous ont été calculés. Résultats. Les femmes attirantes ont eu des visages plus larges avec un tiers supérieur relativement plus grand (front) ; l'hauteur faciale relative plus grande de la largeur faciale. La bouche était plus grande, et les lèvres étaient plus en avant; l'angle interlabial a été réduit. De façon générale, le profil de tissus mous était plus en avant, avec une plus grande prominence maxillaire relativement à la mâchoire inférieure. Les visages dans les femmes attirantes étaient plus plats dans le plan horizontal. Pour plusieurs measures analysées, on a observé des résultats pareils pour les 36 participantes à la finale du concours de beauté, des 12 finalistes, et des gagnantes. Les gagnantes du concours de beauté a dévié des femmes de référence davantage que les deux autres groupes de femmes attirantes. Conclusion. Des valeurs de référence esthétiques ont été déterminées sur une population des femmes de 18-30 ans qui reflètent la société contemporaine.

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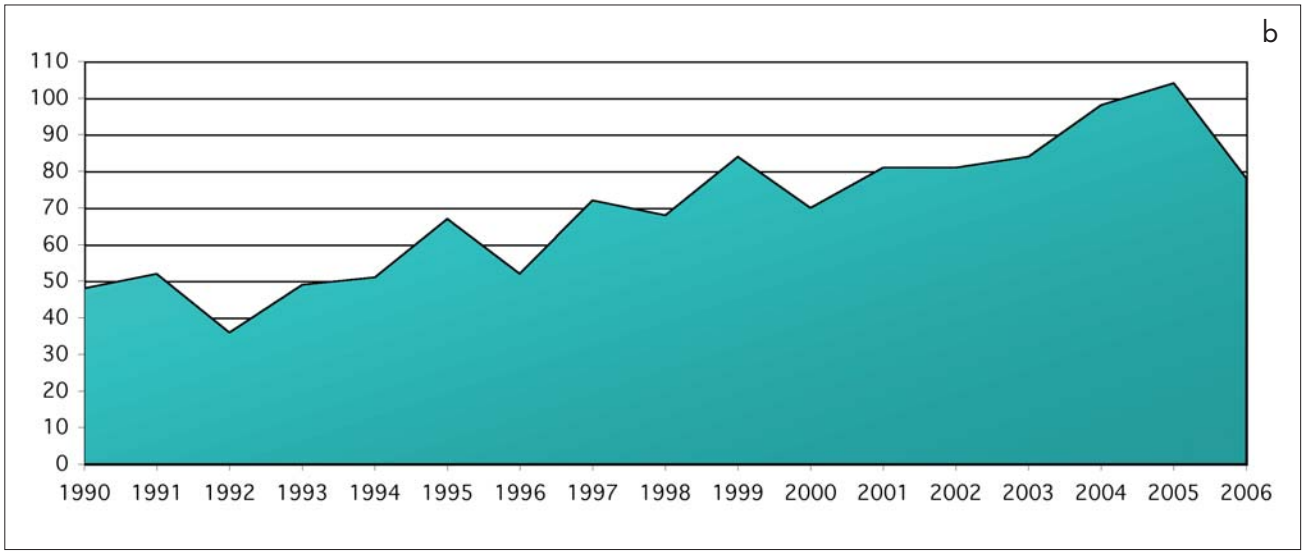

Objetivos: Fueron tomados en consideración un grupo de mujeres adultas Italianas , para identificar estándares posibles de la proporción facial en referencia a las características estéticas. Materiales y métodos: Fue utilizado un digitador electromagnético tridimensional para acumular las coordenadas de 50 puntos faciales (frente, ojos, nariz, mejillas, boca, quijada, oídos) en 71 mujeres sanas, entre (18-30 años) y en 48 mujeres "atractivas coetáneas seleccionados durante una competición de belleza; de esta forma fueron computarizados los ángulos faciales, las distancias y los volúmenes del tejido blandos. Resultados: Las mujeres atractivas tenían unas caras más anchas con un tercio superior(frontal) relativamente más grande del facial; una altura facial en relación con de una anchura facial más grande. La boca era más grande y los labios eran más prominentes; el ángulo interlabial era mas reducido. En general, el perfil de los tejidos blandos era más prominente, con una prominencia del maxilar con respecto a la mandíbula. Las caras en las mujeres atractivas eran más angostas sobre el plano horizontal. Patrones similares fueron observados en varias de las medidas analizadas; para las 36 participantes en la etapa semi-final, las 12 finalistas y la ganadora de la competición de la belleza. Para la ganadora de la competición de belleza fue diferente, con respecto a los otros dos grupos de mujeres atractivas. Conclusión: Los valores de referencia estéticos fueron determinantes para una población de 18-30 años que reflejan finalmente una sociedad contemporánea.

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pends on various combinations of average appearance, symmetry, neoteny (baby like appearance) and youthfulness[1,2,8,13]. In contrast, facial attractiveness in adult men interweave perceptions of masculinity, health, developmental stability and social dominance[1,24-26]. The cultural background and secular trends are thought to influence the perception of beauty, at least for adult women[7,11,14,18,27,28]. Current esthetic opinions for adult Caucasian women seem to prefer a prominent facial middle third, with full lips; a relatively large face with a reduced mandible and increased forehead; reduced vertical development[1,2,4,11,12,15,18,20]. Overall, attractive women seem to maintain several facial characteristics of baby like appearances. In contrast, in adult men attractiveness seems to be positively influenced by facial markers of high testosterone levels, with a relative increment of the facial lower third[1,2,4,20,24,26].

In previous investigations, we analyzed attractive and normal children and adolescents, and found that attractive children and female adolescents maintained several facial characteristics of baby like appearance: a large face, with relatively large maxilla and forehead, and reduced vertical dimensions. Lips were more voluminous and prominent, and the soft-tissue facial profile was more convex in attractive children, with a more prominent maxilla relative to the mandible, than in the normal coetaneous22,23,29. In contrast, attractive male adolescents aged 15 to 17 years had more masculine characteristics than their reference peers, with a relatively more prominent chin, and less prominent lips. In the current investigation, the three-dimensional facial characteristics of adult women considered "attractive" (semi-finalists in a beauty competition) were measured with a non-invasive computerized instrument, and several measurements obtained. Data were compared to those collected in healthy women of the same age and ethnicity, selected using criteria of dentofacial normality11,18,27. The possible presence of measurable esthetic characteristics was assessed.

Materials and subjects

Subjects

One hundred and 19 white Caucasian, Northern Italian women aged 18-30 years were analyzed. A first group, "reference" women, was made of 71 healthy women. All women had normal dentofacial dimensions and proportions; they had no previous history of craniofacial trauma or congenital anomalies. These women were either staff or students at Milan University, and part of their data had already been published30,31.

A second group, "beautiful" or "attractive" women, comprised 48 women selected during a national beauty competition. These women were those admitted at the semi-final selection; 12 of them were further selected for the final stage, and one was the winner (Miss no. 17). The women were measured just before the semi-final stage; they were identified with numerical codes, and all subsequent calculations were made blindly to the final result of the beauty competition.

All the analyzed women gave their informed consent to the experiment. All procedures were non-invasive, did not provoke damages, risks or discomfort to the subjects, and were preventively approved by the local ethic committee.

Collection of facial landmarks

All the procedures were non-invasive, not potentially harmful, did not provoke pain and did not use any instrument or energy currently considered to be potentially dangerous to the present or future health of the subjects or of her offspring.

A two-step data collection procedure was used; all mathematical calculations were performed off-line32. At first, a set of 50 standardized soft-tissue landmarks was identified by inspection and/or palpation on the face of each woman33. A liquid, black eye-liner was used to mark the landmarks on the cutaneous surface, and a single operator marked all women. During landmark marking, the women sat relaxed in a position suitable for a correct

Figure 2. Digitized facial landmarks: midline landmarks: tr, trichion; g, glabella; n, nasion; prn, pronasale; c', columella; sn, subnasale; ls, labiale superius; sto, stomion; li, labiale inferius; sl, sublabiale; pg, pogonion; me, menton; ex, exocanthion; en, endocanthion; os, orbitale superius; or, orbitale; ft, frontotemporale; zy, zygion; chk, cheek; t, tragion; pra, preaurale; sa, superaurale; pa, posturale; sba, subaurale; al, alare; ac, nasal alar crest; itn, inferior point of the nostril axis; stn, superior point of the nostril axis; cph, crista philtri; ch, cheilion; go, gonion; pra, preaurale; sa, superaurale; pa, postaurale; sba, subaurale.

identification of facial features. For each woman, this phase lasted less than 5 minutes.

In the second step, the three-dimensional (x, y, z) coordinates of the 50 facial landmarks were obtained with a computerized electromagnetic digitizer (3Draw, Polhemus Inc., Colchester, VT) that supplies real metric data independent from external reference systems. During data collection, the women sit in a natural head position in a chair with a backrest; their head was fixed by cephalostat with vertically and horizontally movable systems to accommodate for different sitting heights and head dimensions. The women were asked to close their eyes and lips, to keep their teeth in contact, and to not move for the duration of the data collection (approximately 1 minute32).

Before discharging the subject, the correct reconstruction of facial morphology was controlled on the computer video, where the three-dimensional coordinates of the collected landmarks were shown to assess the correct sequence of landmarks, and any motion artifact. The procedure was repeated immediately in 1% of acquisitions.

The reproducibility of landmark identification, marker positioning and the reproducibility of the data collection procedure have been reported32, with a random error of 0.95 mm, corresponding to 1.05% of the nasion-mid tragion distance.

Files of the three-dimensional coordinates of the landmarks were obtained, and original computer programs were used for all the subsequent off-line calculations.

Data analysis

The following 50 facial soft tissue landmarks were collected on each subject (Fig. 2):

- midline landmarks: tr, trichion; g, glabella; n, nasion; prn, pronasale; c', columella; sn, subnasale; ls,

labiale superius; sto, stomion; li, labiale inferius; sl, sublabiale; pg, pogonion; me, menton;
- paired landmarks (right and left side noted r and l): exr, exl, exocanthion; enr, enl, endocanthion; osr, osl, orbitale superius; orr, orl, orbitale; ftr, ftl: frontotemporale; chkr, chkl, cheek; zyr, zyl, zygion; tr, tl, tragion; alr, al-l, alare; acr, acl, nasal alar crest; itnr, itnl, inferior point of the nostril axis; stnr, stnl, superior point of the nostril axis; cphr, cphl, crista philtri; chr, chl, cheilion; gor, gol, gonion; prar, pral, preaurale; sar, sal, superaurale; par, pal, postaurale; sbar, sbal, subaurale.

The three-dimensional coordinates of the 50 landmarks were used to estimate a set of linear distances, ratios, angles, and facial volumes as detailed elsewhere15,22,23,30-33. Euclidean geometry was used for all calculations; the volumes of facial structures were estimated from the sum of several tetrahedra, with the 50 landmarks serving as nodes (vertices of the tetrahedra). In particular, the following were computed:
- distances (unit, mm): forehead height (tr-n); facial height (n-pg); upper facial width (ex-ex); lower facial width (go-go); middle facial depth (sn-t); mandibular corpus length (pg-go); mouth width (ch-ch); upper lip to E-line distance, ls-(prn-pg); lower lip to E-line distance, li-(prn-pg);
- ratios (unit, percentage): middle facial width to facial height (t-t / n-pg);
- angles (unit, degrees): facial convexity excluding the nose (n-sn-pg); middle face convexity (t-sn-t); lower face convexity (go-pg-go); maxillary prominence, soft tissue analog of skeletal ANB angle (sl-n-sn); nasolabial (prn-sn-ls); interlabial (sn-ls^sl-pg);
- volumes (unit: mm3): total facial volume (volumes of all facial structures from the external cutaneous surface up to a quasi-frontal plane passing through trichion, tragi and gonia), subdivided into facial upper third volume (forehead), facial middle third volume (maxilla), facial lower third volume (mandible); upper and lower lip volumes.

Statistical calculations

The attractive women were divided into two groups: 36 admitted at the semi-final selection but not selected for the final stage ("Beauties"), and 12 further selected for the final stage ("Best 12"). Descriptive statistics (mean and standard deviation) were computed for each group, angular data were assessed using their rectangular components (sine and cosine). Data of the winner (Miss no. 17) were also separately assessed.

Data were compared to those collected in reference subjects by computing z-scores. The z-score is a measure of the distance between a subject datum and the reference mean expressed in standard deviation units: z-score = (subject value – mean value of the reference group) divided by the standard deviation of the reference group. Positive z-scores indicate than the measurement is larger in the subject than in the reference population; in contrast, negative z-scores indicate a smaller measurement in the subject than in the reference population; by definition, the reference population has a mean z-score of 0, with a standard deviation of 1.

For a global comparison of the facial characteristics of two groups ("Beauties" vs. "Best 12", "Beauties" vs. Winner, "Best 12" vs. Winner) a correlation analysis between the paired z-scores of the two groups was run: high correlation coefficients indicate very similar patterns34,35.

Significance of the z-scores was assessed by Student's t tests (if the subject value is equal to the mean value of the reference group, the z-score is zero; the null hypothesis of the test is that the z-scores are null); the significance level was set at 5% ($p < 0.05$).

Results

For several of the analyzed measurements, similar patterns of the z-scores were observed for the 36 women participant to the semi-final stage of the beauty competition ("Beauties"), the 12 finalists ("Best 12"), and the winner (Miss 17), and the correlation analyses found very high r values ("Beauties" vs. "Best 12", $r = 0.838$; "Beauties" vs. Winner, $r = 0.887$; "Best 12" vs. Winner, $r = 0.933$). In most occasions, the calculated z-scores

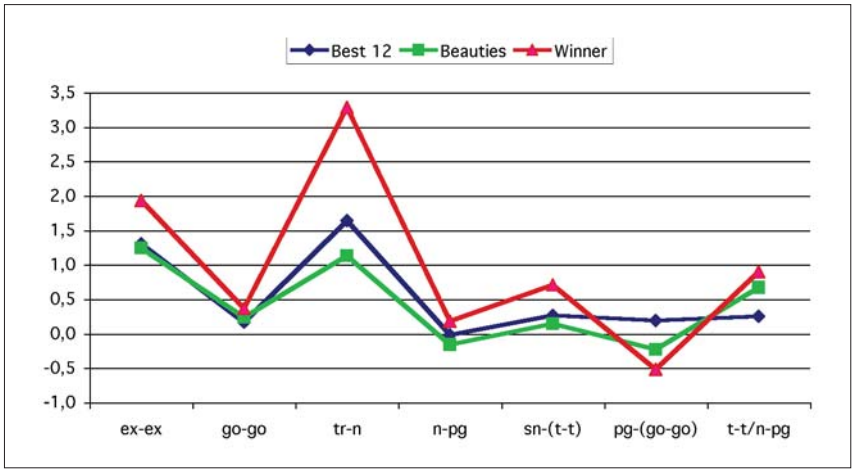

Fig. 3 Facial distances in the analyzed women (unit: z-score). Mean z-scores for participants to the semi-final stage of the beauty competition ("Beauties", 36 women), finalist women ("Best 12", 12 women), and winner. Z-scores were computed using values collected in 71 reference women (mean value = 0 for all variables).

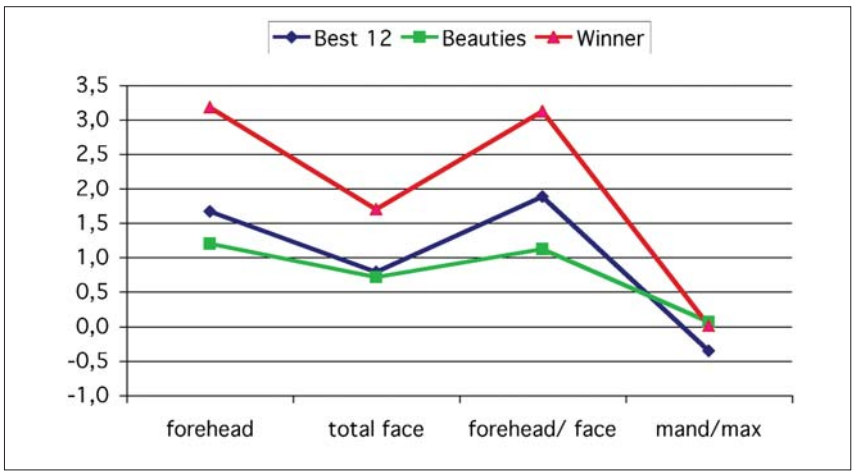

Fig. 4 Facial volumes and ratios in the analyzed women (unit: z-score). Mean z-scores for participants to the semi-final stage of the beauty competition ("Beauties", 36 women), finalist women ("Best 12", 12 women), and winner. Z-scores were computed using values collected in 71 reference women (mean value = 0 for all variables).

placed the "Beauties" at some distance from the reference women, the "Best 12" women somewhat more distant (larger z-scores), and the winner at the top, with the most apart values.

"Attractive" women had a larger face than reference women (Fig. 3); the difference was particularly evident for the upper facial third width (ex-ex; for both "Beauties" and "Best 12" women, $p < 0.001$, Student's t test for paired samples), and less manifest in the lower facial third (go-go; "Beauties", $p = 0.036$). Forehead height (tr-n) was larger in attractive women ("Beauties" and "Best 12" women, $p < 0.001$), while facial height (n-pg) was similar ("Best 12") or somewhat reduced ("Beauties" and winner), than in reference women. The winner of the beauty competition had the most deviant z-scores.

Overall, "attractive" women had faces that were more developed in the left-right direction (facial width) than in the vertical direction (facial height), with middle facial width-to-facial height ratios all larger than 133% (t-t/ n-pg; "Beauties", $p = 0.002$). The values were larger than those computed in the reference women, with positive z-scores; the winner of the beauty competition deviated from the reference women more than the other two groups of attractive women.

Middle facial depth (sn-t) was somewhat increased in "attractive" women as compared to reference women. In contrast, a slight reduction was observed for mandibular corpus length (pg-go). For

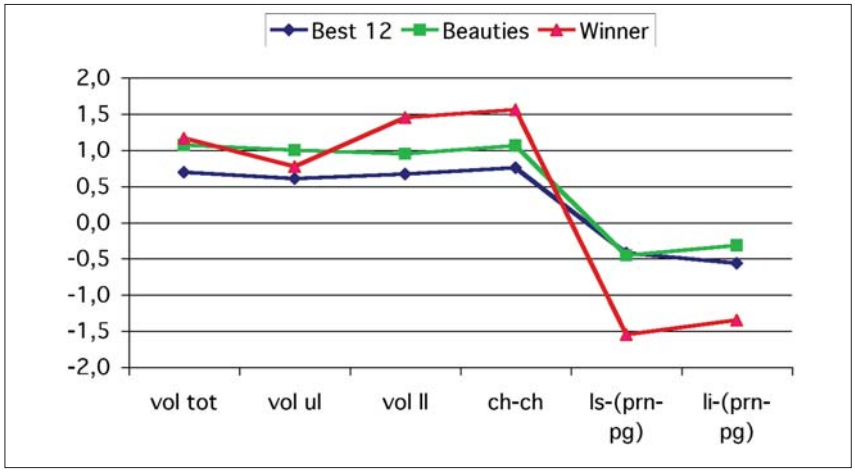

Fig. 5 Lip characteristics (total volume, upper and lower lip volume, mouth width, upper and lower lip to E-line distances) in the analyzed women (unit: z-score). Mean z-scores for participants to the semi-final stage of the beauty competition ("Beauties", 36 women), finalist women ("Best 12", 12 women), and winner. Z-scores were re computed using values collected in 71 reference women (mean value = 0 for all variables).

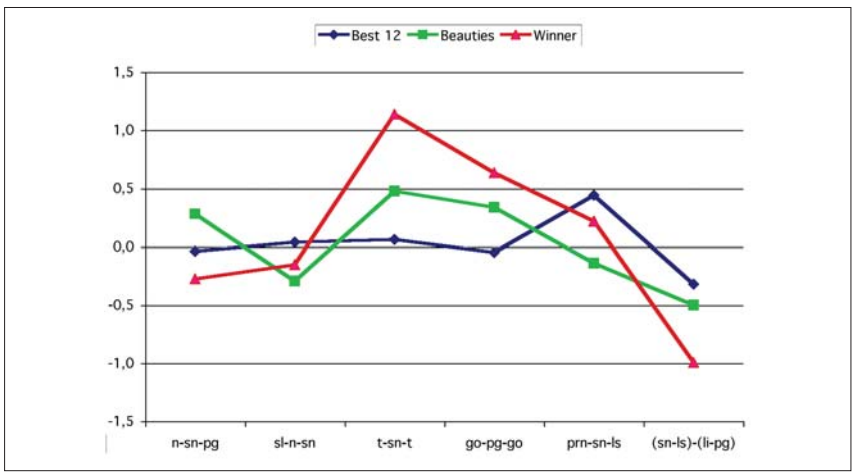

Fig. 6 Soft-tissue facial angles in the analyzed women (unit: z-score). Mean z-scores for participants to the semi-final stage of the beauty competition ("Beauties", 36 women), finalist women ("Best 12", 12 women), and winner. Z-scores were computed using values collected in 71 reference women (mean value = 0 for all variables).

both measurements, the differences observed in the "Beauties" and in the "Best 12" were not significant ($p > 0.05$); the winner had the most deviant z-scores.

Total facial volume was significantly larger in "attractive" women than in their reference peers ($p < 0.005$), and the difference increased in the women selected for the final stage of the beauty competition: the mean z-score was 0.71 in the 36 "Beauties", 0.79 in the "Best 12" women and 1.7 in the winner (Fig. 4). A different arrangement of facial thirds was observed in the attractive women when compared to the reference ones, with a significantly larger upper (forehead) third ($p < 0.001$). Indeed, the forehead (facial upper third) occupied a larger part of the face in all attractive women ($p < 0.001$); in the winner of the beauty competition, the forehead-to-face volume ratio was 3.12 z-scores larger than in the reference women. The mandibular-to-maxilla volume ratio was similar (winner, "Beauties"), or somewhat reduced ("Best 12"), in the attractive and reference women.

Attractive women had more voluminous lips (total lip volume, upper and lower lip volumes; all z-scores significantly differed from the expected values of 0, $p < 0.003$) (Fig. 5), with a larger mouth ($p < 0.001$), than reference women; both lips were nearer to the esthetic E-line (prn-pg) than in reference women (upper lip, "Beauties", $p = 0.006$; lower lip, "Best 12", $p = 0.042$). The effect

was particularly evident in the winner of the beauty competition, with similar patterns of the z-scores in the analyzed attractive women (r values for lip measurements: "Beauties" vs. "Best 12", r = 0.989; "Beauties" vs. Winner, r = 0.98; "Best 12" vs. Winner, r = 0.984).

The winner of the beauty competition had a more acute soft tissue profile than reference women with a smaller angle of facial convexity excluding the nose (n-sn-pg); the value was slightly increased in the 36 "Beauties" (Fig. 6). Accordingly, Miss 17 had a larger maxillary prominence relative to the mandible, with a reduced soft tissue analog of skeletal ANB angle (sl-n-sn). In the middle and lower parts of the face, a slightly increased nasolabial (prn-sn-ls) and reduced interlabial (sn-ls^sl-pg; p = 0.003 in the "Beauties") angles characterized attractive women, who presented with relatively more prominent lips. The largest deviation from the norm was observed in Miss 17. In attractive women, the face was relatively more flat in the horizontal plane, with larger angles of middle face convexity (t-sn-t; p = 0.004 in the "Beauties"), and lower face convexity (go-pg-go; p = 0.002 in the "Beauties").

Discussion

In the contemporary western society, the perception of attractiveness is significanty influenced by media: television, cinema, advertisements, fashion industries, all enter in our life conveying facial "standards" that should portray perceptions of beauty, healthiness, fitness, mixed with feelings of social achievement, intelligence, richness, and happiness: a beautiful face becomes the key to the success[3,7,9]. The clinical specialists devoted to the facial area could therefore be asked by patients not only to correct major disfigurements[8,13], but also to provide medical and surgical modifications of those dentofacial physiognomies considered as non attractive[8,17,27]. As a result, orthodontists, maxillofacial and plastic surgeons should have a deep understanding of those quantifiable, objective facial characteristics that are currently considered by the public as "attractive"[2,8,21,23].

Objective data on the three-dimensional facial morphology of adult women considered "attractive" are still scanty, and most investigations focused on dentolabial characteristics, or obtained only two-dimensional records. Three-dimensional measurements were provided exclusively in Northern America[14], and in Italy[15], and published more than 10 years ago. Considering that secular trends and cultural variations may influence the perception of beauty[1,7,11,15,18,27,28], the assessment of present opinions seemed necessary.

In the current investigation, we analyzed a group of women considered "beautiful" and "attractive", and selected for the semi-final stage of a beauty competition. These women came from Northern Italy, and were admitted to this phase of the competition after a series of selections. Therefore, they should represent what is currently considered "attractive", "positive" and "acceptable"[4]. Similar procedures were followed in the past for both adult women[11-13,19], and children[23,29]. The selection was independently made by judges who were even unaware that the women were to be measured in a scientific investigation.

Thus, the specialized opinions of dental and surgical professionals were avoided. Not only they are often relatively more critical in their assessment of facial esthetics than non-professionals[3,4,6,7,10,27], but, also, it is felt that esthetics should be evaluated by the laypersons, who actual seek (and finally judge) orthodontic or maxillofacial treatment[10,27].

Overall, the attractive women analyzed in the current study shared several of the facial characteristics previously reported in the literature[1,2,4,11-13,18,20]: relatively large forehead and more prominent maxilla, voluminous lips, more prominent soft-tissue facial profile, increased horizontal dimensions relative to the vertical ones. Therefore, attractiveness in adult Caucasian women is partly explained by facial characteristics suggesting babyness[1,2]. Similar results were found for attractive children[23], and attractive adolescent girls[29]. Furthermore, attractive women, children of both sexes, and adolescent girls share a relatively more flat face in the horizontal plane, with larger angles of facial convexity[23,29].

A good consistency in the facial arrangements of the women considered "attractive" was found: for several of the analyzed measurements, similar patterns of the z-scores were observed for the three sub-samples (women participant to the semi-final stage of the beauty competition, finalists, and winner), with highly significant correlation analyses between paired measurements[34,35]. Pattern profile analysis was introduced for the assessment of craniofacial malformations to find out patients with similar phenotype, but it can be applied to the appraisal of any biological variation: high correlation coefficients indicate very similar patterns of deviation of paired measurements from the norm[34,35].
In particular, a high consistency was found for measurements in the mouth area, thus confirming the esthetic importance of lips: a large mouth, with prominent lips, is always associated with positive feelings, and convey attractiveness and youthfulness[12,14,15,18,21,23]. This feeling is widely shared by the general public in all Western society, and explains the considerable diffusion of cosmetic lip modifications, and the industry of the various kinds of lip fillers.
Among the other cues that people are thought to use to establish facial attractiveness[1,2,8,13], the current results do not support the hypothesis of an 'average' concept. Indeed, for most of the analyzed measurements, the calculated z-scores placed the "Beauties" at some distance from the reference women, the "Best 12" women somewhat more distant (larger z-scores), and the winner at the top, with the most distant values. Therefore, the winner of the beauty competition seemed the woman who differed the most from the population average. Indeed, in the current investigation the jury analyzed single women, and not composite, computerized faces as made in previous studies[2], and the findings may not be completely comparable.
Symmetry, one of the other elements contributing to the perception of attractiveness[1,2,8,13], was not assessed in the current study, but it could be matter of future investigations[7,19,21], together with quantifications of facial shape independently from dimensions[26,30,36]. Also, a wider set of angles and distances should be analyzed, with the inclusion of all facial structures, comprised eyes and ears[1,2].
A further limitation of the present investigation is the assessment of a single group of attractive women. It may be possible that in a different beauty competition different kinds of attractive faces might be preferred, even if the good accord between the current findings and literature reports makes the selected facial pattern sufficiently trustworthy.
In conclusion, when compared to reference subjects of the same age and sex, attractive women (semi-finalists, finalists and winner of a beauty competition) had:

- wider faces with relatively larger upper facial third (forehead);
- larger facial width relative to facial height;
- a larger mouth with more prominent lips, with a reduced interlabial angle;
- more prominent soft-tissue profile, and maxilla relative to the mandible;
- more flat faces in the horizontal plane.

Clinical implications

Esthetic guidelines are useful tools for those professionals who can modify the facial appearance of their patients[1,2,8,17,27], providing indications for the best kind, timing and goals of orthodontic, orthopedic, and surgical treatments. They also offer information about the esthetic preferences of the general public[2,4], and possibly about the wishes and desires of the patients. Nevertheless, esthetic guidelines should not be imposed on each face, or followed blindly. Even when they have been created on subjects of the same age, sex and ethnic group of the patients, and updated considering the evolution of the esthetic canons within a given society1,10,11, they remain only a part of the treatment goals.
On the other hand, when restoring harmony in the dental arches, the effect of teeth position on facial soft tissues[27,31,37] should always be considered within the global framework of facial esthetics[2,8,10,11].

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