

# Assessment of facial harmony among Caucasian Spaniards 18 to 60 years of age and its relationship with the golden ratio

José Francisco Ballester Ferrandis<sup>1</sup> · Francisco Martínez Soriano<sup>2</sup> ·  
Maria Isabel Ribera Vega<sup>3</sup> · Juan José Font Ferrandis<sup>4</sup>

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## Abstract

**Background** Throughout history, the perception and definition of beauty and attractiveness have changed and have been influenced by cultural norms. This article analyzes the concept of “facial normality” (faces that are considered normal by 90% of respondents and, therefore, do not require esthetic surgery) among Spaniards of Caucasian ancestry. We also sought to determine the relationship between faces that are considered “normal” and the golden ratio.

**Methods** We surveyed 54 respondents (equal numbers of women and men) between the ages of 18 and 60. The surveys followed the visual analog scale (VAS) protocol, and 13,514 responses were obtained. The respondents were asked to evaluate up to nine photographed faces according to their degree of attractiveness.

**Results** According to the data obtained, “facial normality” or facial beauty can be defined by the following characteristics: (a) the sizes of the three facial segments (equal in proportion), (b) the width of the nose (narrow in women and average in men), and (c) the profile (straight or slightly retracted in women and straight or slightly prominent in men). In addition, five

specific facial proportions were directly related to the golden ratio. Thus, the concept of “normal” can be applied to 90% of faces whose proportions fall within distinct ranges that encompass the value of the golden ratio.

**Conclusions** We conclude that a standard perception of “facial normality” and facial beauty does exist. We also observed a general correlation between specific facial proportions and the golden ratio.

Level of Evidence: Not ratable.

**Keywords** Facial beauty · Divine proportion · Golden ratio · Orthognathic surgery

## Introduction

“The beautiful is that which pleases universally without a concept”

Immanuel Kant

The question underlying this study is whether the parameters of facial beauty can be defined.

What is considered beautiful has changed throughout history and has been influenced by fashion trends, interests, and needs. In ancient history, the ideals of beauty were synonymous with fertility and nutritional reserves, as can be appreciated in the sculpture “Venus of Willendorf” (approximately 25,000 BC), in which the genitals are perfectly detailed. Because of fat reserves, the circumference of the hips is equal to the total height of the statue. However, the statue does not have a face.

In Ancient Egypt (2955–332 BC), the need to represent divinities and the abundance of food resources led to the development of the first esthetic concept of beauty: the ideal

✉ José Francisco Ballester Ferrandis  
jfballester@me.com

<sup>1</sup> Plaza de España, 5 pta 10., 46007 Valencia, Spain

<sup>2</sup> Department of Anatomy and Human Embryology, Faculty of Medicine and Dentistry, Avda Blasco Ibáñez, 15, Valencia 46010, Spain

<sup>3</sup> Department of Reconstructive Dentistry, Faculty of Dental Sciences, University Alfonso X of Madrid, Campus de Villanueva de la Cañada, Avd. Universidad, 28691 Madrid, Spain

<sup>4</sup> Department of Mathematics, University Jaume I of Castellón, Campus del Riu Sec, s/n, 12071 Castellón, Spain

female figure was slender, with small limbs, a modest bosom, and wide hips.

The notion of beauty is intimately linked to the Maslow pyramid (1943) [1] (Fig. 1) and the characteristics of the universe: symmetry and proportion (Phi number = 1.618).

Thus, beauty has a place among human “needs.” There is a subjective component in the appreciation of beauty by the individual which is molded by the individual’s cultural system and by the survival needs and esthetic tastes of the culture and time.

If we accept that a subjective component is involved in what is considered beautiful, are there also objective, quantifiable and measurable parameters associated with the concept of beauty? [2].

Measuring beauty, understanding it, and framing it have been constant goals throughout human history. Many concepts of beauty have existed in different civilizations, some of which have differed greatly. An attempt to establish a universal law has been made with the divine proportion, which is found in nature, artistic creations, designs, and, of course, the human body itself.

The divine proportion is defined by the golden ratio ( $\phi = \frac{1+\sqrt{5}}{2} = 1.6180339\dots$ ) (Fig. 2), which is an irrational number that has been used since antiquity. This value is obtained by dividing a segment in two by using the following proportions:  $a/b = 1.618$ .

In ancient Greece, Plato (427–347 BC) related beauty with kindness and considered these two ideals synonymous. His book, “*The Banquet*,” in which beauty is widely discussed, is subtitled, “*About the Good*.”

Although Aristotle (384–322 BC) had already related the concept of beauty to proportion and symmetry by linking art with mathematics, the first person to study the golden ratio was Euclid (325–265 BC) in “*The Elements*” (definition 3 of the sixth book).

In the Middle Ages, Christianity dominated every aspect of life in the Western world, and the concept of beauty was overruled by divine intervention (St. Thomas Aquinas, 1223–1274 AD).

In “*Human Figure*” (1489), Leonardo da Vinci envisions anatomical drawings not only as art but also as scientific observations. He uses deformed faces to illustrate the

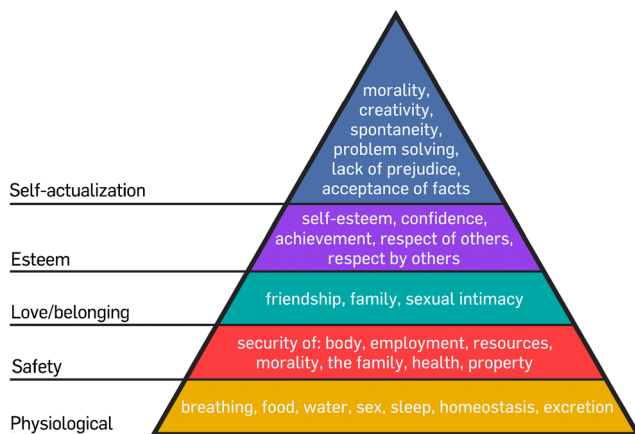


Fig. 1 Maslow pyramid

“grotesque” and the changes that elderly or deformed people undergo. His standard continues to this day, and when we look for beauty in a face, we assume that we are referring to a young face, not an elderly one.

The economic growth of Venice and Florence during the Renaissance facilitated a new concept of beauty. In “*Vitruvian Man*,” which dates to 1489, Leonardo da Vinci conceives of his anatomic drawings not only as art but also as scientific observations.

Before the Industrial Revolution, clothing was tailor-made for each individual. During the nineteenth century, however, clothing became standardized, with sizes and proportions that excluded people who were not physically adapted to them. From that point on, individuals instead had to adapt to their clothing. Thus, individuals began a quest to be included in the “normal” group to avoid being classified, on the basis of the now-standardized clothing, as “unattractive.” This mentality continues today with a concept of beauty that has been diffused globally through mass media. As a result, not having a standard size has become synonymous with being “unattractive” and has contributed to increasing numbers of individuals living with a sense of exclusion and social anxiety.

Currently, the media create the desire to emulate this model, not only by making people want to buy accessories (e.g., purses, watches, jewelry, and shoes) but also by making them want their physical traits (e.g., nose, smile, eyes, and body) to conform to a standardized ideal. Hönn [3] delineates how beauty ideals are subject to certain fluctuations depending on fashion trends.

Even if the concept of “beauty” changes throughout history, it tends to remain generally constant over the course of several generations. Thus, we can consider it a cultural phenomenon, as noted by Farkas [4], which depends on ethnicity [5].

The repeated use of the divine proportion from da Vinci’s era up through modern times in the world of art and its relationship with beauty that extends beyond temporary trends encourages a deeper study of this concept.

The purpose of this article is not to determine what is beautiful or which measurements and proportions define beauty, but rather to determine whether a “beauty norm” is accepted in our culture. Do Spanish people identify the same picture of a face as beautiful? If so, the notion of beauty could be thought of as a universal concept throughout Spain. Thus, whether it has a relationship with the golden ratio, as stated by Ricketts [6], Preston [7], and Amoric [8], or on the contrary, if the golden ratio should not be a reference in the search for “attractive” features, as suggested by Baker and Woods [9],

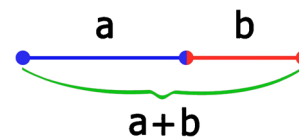


Fig. 2 The divine proportion. The total length, “ $a + b$ ,” is to the longest section “ $a$ ” what “ $a$ ” is to the shortest section “ $b$ ”

Shell and Woods [10], Holland [11], Rossetti [12], and Rajiv and Juhi [13], can be investigated. Another article will define the measurements and proportions of the “beauty norm,” if such a norm does in fact exist.

Our main objective is to determine whether there is a beauty “norm” that is widely accepted by our society and to assess whether it has any relationship with the golden ratio.

Secondary objectives are, in the case of a positive relationship between the beauty “norm” and the golden ratio, to determine the intervals of “normality” in the golden ratio and to determine what types of nose, smile, jaw, chin, and profile are considered the beauty “norm.”

## Materials and methods

### Method design and study population

A non-randomized, prospective study was performed between September 2015 and December 2015 and was structured in five phases:

#### Question creation

A questionnaire comprising all of the elements relevant to facial esthetics (i.e., profile, forehead, nose, cheekbones, eyes, lips, chin, and smile) was created according to the visual analog scale score (VASS) protocol.

The questionnaire consisted of three parts. The first part contained 15 questions analyzing the models from a front view, the second part consisted of 14 questions about the models viewed from the side, and the third part included five questions assessing the suitability of surgical interventions.

In each part, the questions required a Likert-type answer with five categories, wherein 1 meant “very attractive,” and 5 meant “very unattractive.” In the questions using a visual scale, 0 meant “very unattractive,” and 10 meant “very attractive.”

Within the context of the present study, “neutral” was the central position of a given scale (e.g., in the aforementioned Likert-type answer with five categories, “neutral” would be 3). Additionally, “normal” comprised responses of “very attractive,” “attractive” and “neutral.”

The questionnaire was designed so that the respondents would reveal their subjective impression of the image. Our goal was not to have them assess the measurements and proportions but rather to determine whether the respondent considered the image (or parts of it) “very attractive,” “attractive,” “neutral,” “unattractive,” or “very unattractive.”

#### Selection of the images

The studied images were taken from advertising models and fashion magazines, among other sources, and exclusively

included models of Caucasian ancestry who appeared commonly in “gossip magazines” and were between 18 and 60 years old. The total number of models studied was nine.

Because this article does not aim to determine “what is beautiful” but, rather, whether or not the “beauty criteria” are uniform, whether the images of the models shown were modified using a computer program was irrelevant. Indeed, we could have shown drawings, and the results would have been the same.

#### Data collection

A total of 54 people replied, and of those who replied, 50 filled out nine questionnaires, one filled out eight questionnaires and three filled out six questionnaires. In total, 466 questionnaires and 13,514 questions were answered by participants who were randomly selected (i.e., without consideration of their educational background). Both sexes were equally represented, and all participants were between 18 and 60 years of age.

#### Data processing

A database was prepared by using a Windows Excel 2016 (Microsoft) spreadsheet from the data collected in the survey and was then exported to the statistical package R.3.2.2 for Windows (open software created by the R Foundation) for analysis.

#### Statistical analysis

The frequencies and percentages of qualitative variables and the means and standard deviations of quantitative variables were calculated. To study the relationships among qualitative ordinal variables, we used the Kendall coefficient of correlation, which is based on the Kendall tau coefficient and is normally used in the analysis of concordance for attributes.

To determine whether relationships existed among the quantitative variables, the Pearson correlation coefficient was calculated between the variables and used as a dimension reduction technique. Additionally, an analysis of the main components was considered.

### Analysis of the survey of facial harmony, balance, beauty and normality: results

#### A study of facial harmony and balance (Q.1, 2, 13, 14, 15, 16, 17, 28, and 29)

##### General appearance (Fig. 3 and Table 1)

If we classified the individuals shown in the pictures into five groups—“very attractive,” “attractive,” “neutral,”

“unattractive,” and “very unattractive”—we obtained a broad spectrum of results. The results suggested that there is no overall accepted concept of beauty (Fig. 3).

However, if we combined the “very attractive,” “attractive,” and “neutral” responses (i.e., those in which an orthognathic surgical intervention would not be justified in any case) under the label “normal” (score 1) and keep the labels “unattractive” (score 2) and “very unattractive” (score 3) separate, the distribution of the scores related to the pictures is shown in Table 1.

Table 1 shows that 90.09% indicated “normal,” 9.2% indicated “unattractive,” and 0.71% indicated “very unattractive.”

The top percentages for “normal” were obtained for pictures 1 and 3 (98.15%), and the worst result was found for picture 8 (63.64%).

Therefore, we can conclude that our beauty model clearly differentiates between what is attractive and what is not, but it does not differentiate the various degrees of attractiveness or unattractiveness.

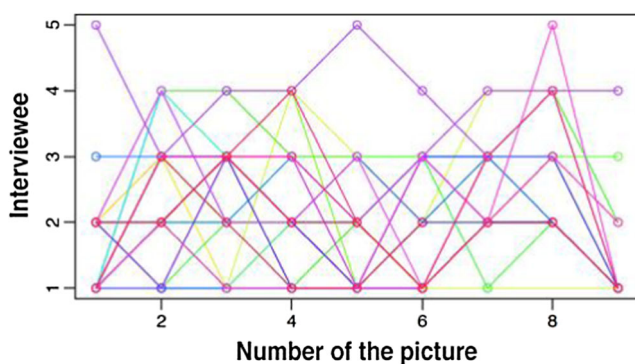
*Facial harmony and balance (Fig. 4)*

Questions 2 and 17 assess the harmony and balance of the face (front view and profile, respectively). When comparing the answers related to these aspects, we obtained a “Kendall’s rank correlation tau” of 0.635. Hence, we conclude that these parameters are closely correlated.

*Assessment of facial length (front view) (Fig. 5)*

The images considered “very attractive” had a “neutral length” in 68.4% of the cases. The result was considered very attractive by 95% of respondents when we combined the concepts of neutral and elongated facial length.

“Unattractive” was associated with “very elongated” (37%) or “very short” faces (40%). Thus, 77% of the



**Fig. 3** There is a wide spread in the results when the models are rated as “very attractive,” “attractive,” “neutral,” “unattractive,” and “very unattractive”

**Table 1** Classification into three categories: “normal” (score 1), “unattractive” (score 2) and “very unattractive” (score 3). Comparison of the group of normal men (“very attractive,” “attractive,” and “neutral”) with the groups of unattractive men (“unattractive” and “very unattractive”) reveals homogenous judgment

Score	Picture n°									Total
	1	2	3	4	5	6	7	8	9	
1	53	45	51	47	53	51	31	20	31	382 (90.09%)
2	0	9	3	7	0	2	5	12	1	39 (9.2%)
3	1	0	0	0	1	0	0	1	0	3 (0.71%)
Total	54	54	54	54	54	53	36	33	32	

respondents considered the face “very unattractive” if it was determined to be “very long” or “very short.”

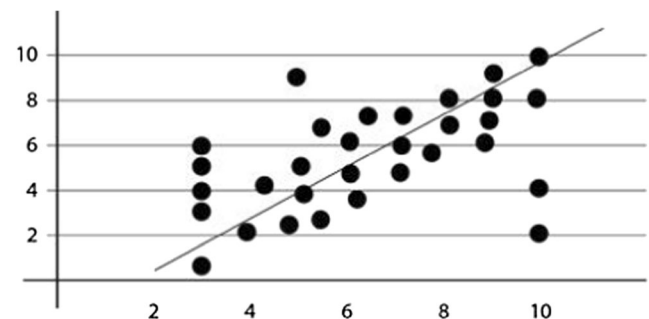
Clear associations were found between attractiveness with neutral or elongated facial length and between “very unattractive” and faces that were perceived to be “very long” or “very short.”

*Facial width*

The survey respondents found a “very narrow” face to be “unattractive” (42%) or “very unattractive” (40%), and 91% thought that attractive faces were “wide” (34%), “neutral” (43%) or “narrow” (14%).

*Balance of the horizontal thirds of the face (front view) (Fig. 6)*

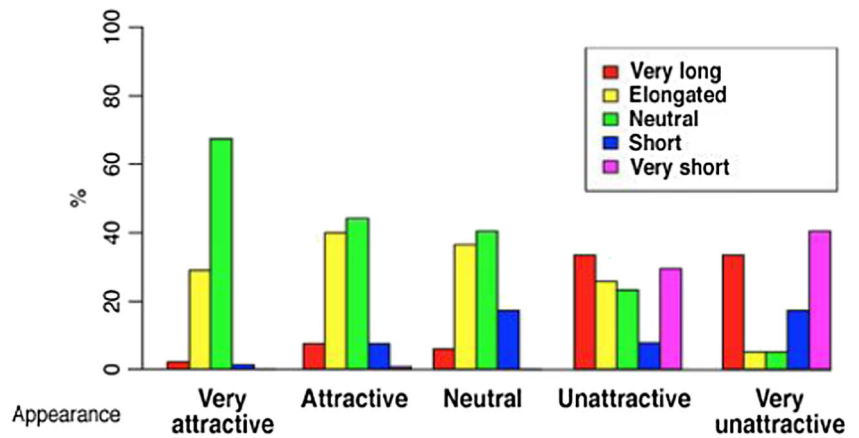
The question asked to develop Fig. 6 was as follows: Which third of the face appears to be dominant? Beauty was related to balanced faces or faces that were dominated by the upper third of the face in 76.4% of the cases. Indeed, 98% of those who considered the image to be “very unattractive” (68%) or “unattractive” (30%) judged that the lower third dominated the image. Thus, as the importance of the lower third of the face increases, so does the perception of it being “unattractive.”



**Fig. 4** Facial harmony and balance. Harmony and facial balance were very closely related when considering both the front view and the profile



**Fig. 5** Facial length (front view). Faces considered to be of “neutral” length were deemed “attractive” or “very attractive.” Faces considered to be “very long” or “very short” were deemed “unattractive” or “very unattractive”



*Assessment of the profile (Fig. 7)*

More than 98% of the respondents who deemed the model shown in the picture to be “very attractive” considered the model to have a “very attractive” profile.

This percentage decreased considerably in the rest of the cases. Indeed, almost 100% of the people who considered the model to be “very unattractive” deemed the profile to be “very unattractive.”

*Assessment of facial length (profile) (Fig. 8)*

None of the respondents identified a face of “neutral” length as “very unattractive,” whereas 90% of them considered faces that were of “neutral” length to be “very attractive.”

*Assessment of “beauty” in relation to profile (Fig. 9)*

The “unattractive” rating was related to “very sunken” or prominent profiles in 89% of the cases. A prominent profile was considered “unattractive” (40%) and “very unattractive” by 49%. None of the models was considered “very unattractive” when the profile was considered

“neutral,” and none of the respondents who judged the profile to be “prominent” thought that the model was “very attractive.”

**Assessment of the forehead (Q.3 and 18) (Fig. 10)**

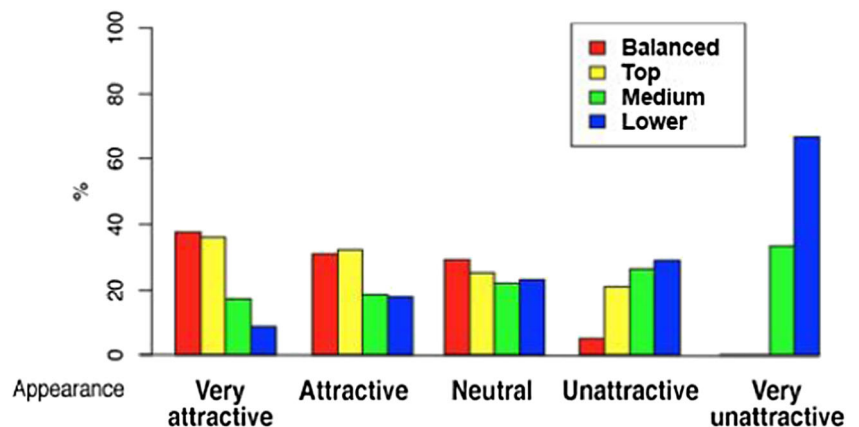
A “small” or “very small” forehead was related to the “unattractive” rating (82%), whereas a “neutral” or “large” forehead was related to beauty (76.5%).

In the side view, 91% correlated “small” or “very small” foreheads with “unattractive” or “very unattractive.” None of the respondents related a “small” forehead with the “very attractive rating.”

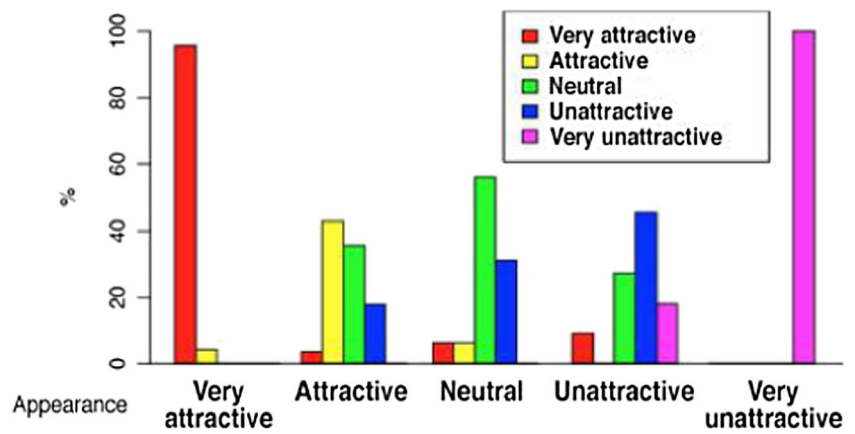
**Assessment of the eyebrows (Q.5)**

Almost 80% of those who thought the models were “very attractive,” “attractive” or “neutral” judged the gap between the eyebrows as “neutral.” When the models were seen as “unattractive” or “very unattractive,” over 100% of respondents thought that the eyebrows were “too close.”

**Fig. 6** Balance of the horizontal thirds of the face (front view). Faces with balance among the thirds were considered “attractive” or “very attractive,” whereas those with a predominant lower third were considered “unattractive” or “very unattractive”



**Fig. 7** Assessment of the profile. Models with a “very attractive” profile were considered “very attractive,” and those with a “very unattractive” profile were considered “very unattractive”



**Assessment of the eyes (Q.6–20) (Fig. 11)**

Almost 57% of those who considered the model to be “very unattractive” thought that the eyes were “small,” and 100% of respondents correlated “sunken” or “very sunken” eyes with a “very unattractive” rating. In contrast, 100% of those who thought that the model was “very attractive,” “attractive,” or “neutral” reckoned that the eyes were of “regular” or “big” size.

**Assessment of the nose (Q.7, 8, 21, and 22)**

Of those who thought that the model was “very attractive,” “attractive,” or “neutral,” 97.3% considered the size of the nose to be “neutral” or “small.” However, almost 100% of the respondents who considered her “very unattractive” thought that the nose was “big” or “very big.”

Regarding the width of the nose, almost 80% of those who judged it “unattractive” or “very unattractive” concluded that it was “very wide.” In contrast, 75% of those who said that the model was “very attractive” considered the nose to be “very narrow.”

*Nose size (front view) (Fig. 12)*

“Large” or “very large” noses were associated with the “unattractive” rating. “Small” or “neutral” noses were associated with the “attractive” and “very attractive” ratings.

*Nasal width (Fig. 13)*

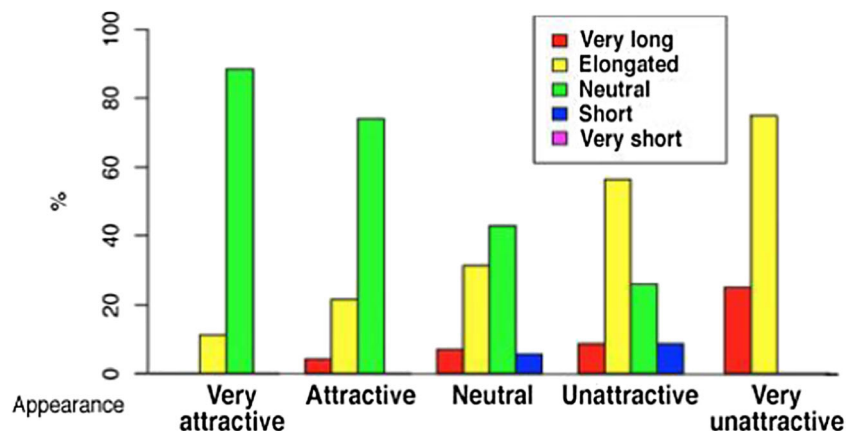
“Very wide” noses were considered “unattractive” or “very unattractive” (80%), whereas “neutral” or “narrow” noses were considered “attractive” or “very attractive” (70%). “Very narrow” noses were never considered “unattractive” or “very unattractive.”

**Assessment of the lips (Q.9, 10, 22, 24, and 25):**

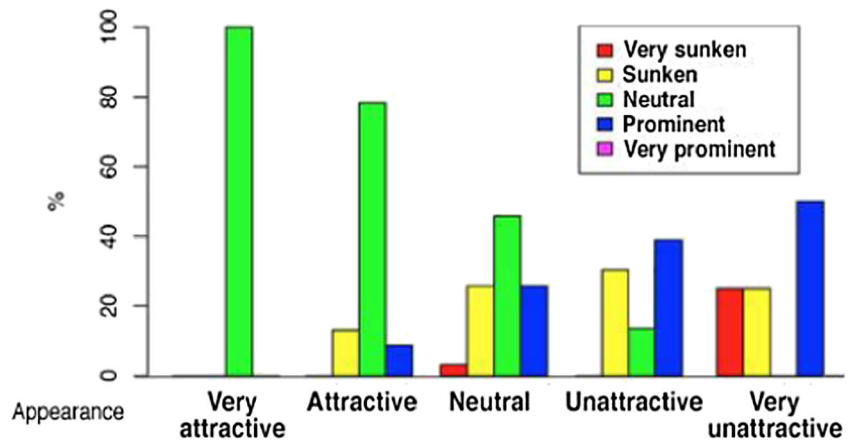
*Lip thickness (Fig. 14)*

Of those who qualified the model as “very unattractive,” 100% noted that the model’s lips were “thin” or “very thin.” However, almost 95% of those who qualified the model as “very attractive” stated that the model’s lips were “neutral,” “thick,”

**Fig. 8** Assessment of facial length (profile). A “neutral” length was never associated with a “very unattractive” appearance



**Fig. 9** Assessment of “beauty” in relation to the facial profile. “Very sunken” faces were considered “very unattractive.” “Prominent” faces were deemed to be “unattractive” or “very unattractive.” Faces that qualify as having a “neutral” profile were considered “very attractive” or “attractive”



or “very thick.” None of the people who described the lips as “thick” thought that the model was “very unattractive.”

*Lip protrusion (Fig. 15)*

Those who qualified the lips as “protruding” found the model to be “very attractive” at the rate of 80%. All of the surveyed respondents indicated that the model was “very unattractive” when the lips pictured were “sunken” or “very sunken.” None of those who classified the lips as “protruding” associated the model with being “very unattractive.”

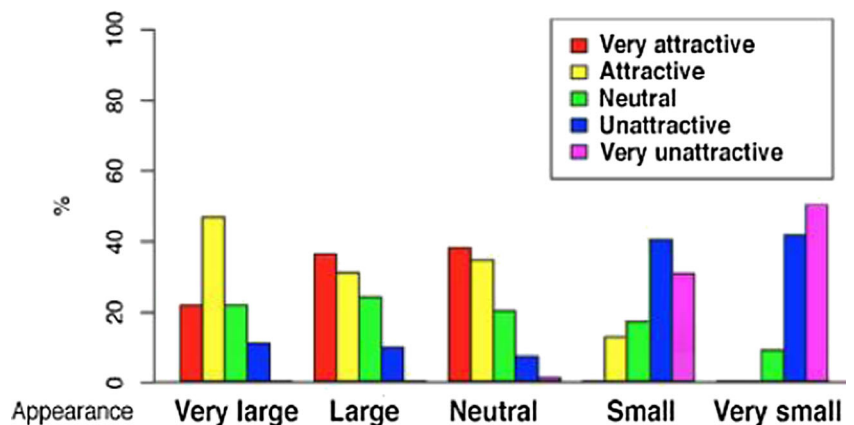
*Assessment of the upper lip (Fig. 16)*

The respondents associated a “very attractive” model with a “thick” upper lip at the rate of 80% and 0% associated a “very attractive” rating with a “very thin” upper lip.

*Protrusion of the upper lip (Fig. 17)*

“Sunken” lips were considered “very unattractive” for 79% of the respondents. In contrast, 100% of the respondents considered “protruding” or “neutral” lips to be “attractive.”

**Fig. 10** Assessment of the forehead. “Small” and “very small” foreheads were considered “unattractive” or “very unattractive”



**Assessment of the smile (Q.11 and 26)**

Those who considered the model “very attractive,” “attractive,” or “neutral” thought that the smile was “very attractive” at a rate of 98%. Similarly, 87% of those who judged the model to be “very unattractive” or “unattractive” considered the smile to be “very unattractive” or “unattractive.”

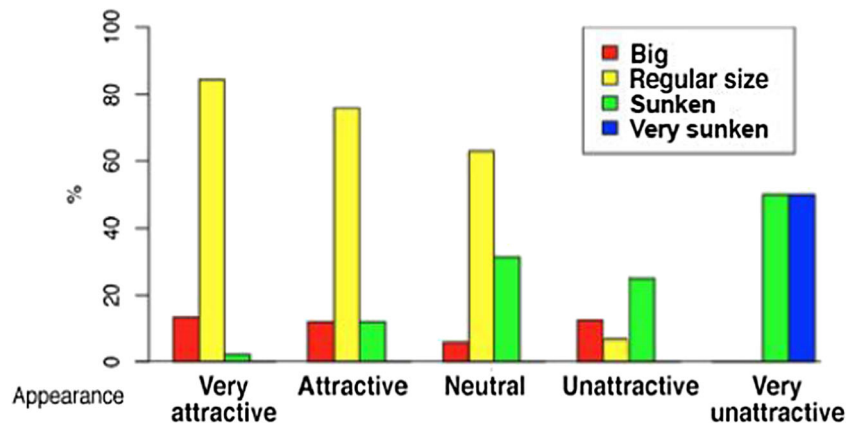
*Smile assessment (front view) (Fig. 18)*

None of the people who qualified the smile as “very attractive” considered the model to be “very unattractive.” Thus, the smile is a key factor in the appreciation of beauty.

*Smile assessment (profile) (Fig. 19)*

From the side view, 100% of the people who considered the smile to be “unattractive” or “very unattractive” stated that the model’s profile was “unattractive” or “very unattractive.”

**Fig. 11** Assessment of the eyes. Sunken or very sunken eyes were rated “unattractive” or “very unattractive”



**Assessment of the chin (Q.12 and 27) (Fig. 20)**

A very prominent chin or very retracted chin was considered “unattractive” or “very unattractive” in every instance.

The percentage of respondents who considered a “neutral” or “prominent” chin as “very attractive,” very high: over 90%. Almost 100% of the people who qualified the chin as “very prominent” or “very sunken” described the model as “unattractive” or “very unattractive” (Fig. 20).

**Study on the predisposition to undergo a surgical intervention (Q.30 and 33) (Figs. 21 and 22)**

Of those who considered the model to be “very attractive” or “attractive,” 95% did not think that they would want to be operated on if they were in the model’s situation. However, 70% of those who deemed the model to be “unattractive” or “very unattractive” indicated that they would want surgery (Fig. 21).

When we related the desire to be operated on with the appreciation of beauty, we obtained a “Kendall’s rank correlation tau” of 0.825.

For the question, “If you were the person in the picture, would you undergo surgery?,” we limited the possible answers to “Yes” or “No.” When asked this question, 95% of respondents gave a negative answer when the model was seen as “very attractive,” and 80% gave a positive answer when the model was seen as “very unattractive.” Figure 22 clearly shows that the desire to undergo surgery decreased as the degree of perceived attractiveness increased and that as the perception of unattractiveness increased, the desire to undergo surgery also increased.

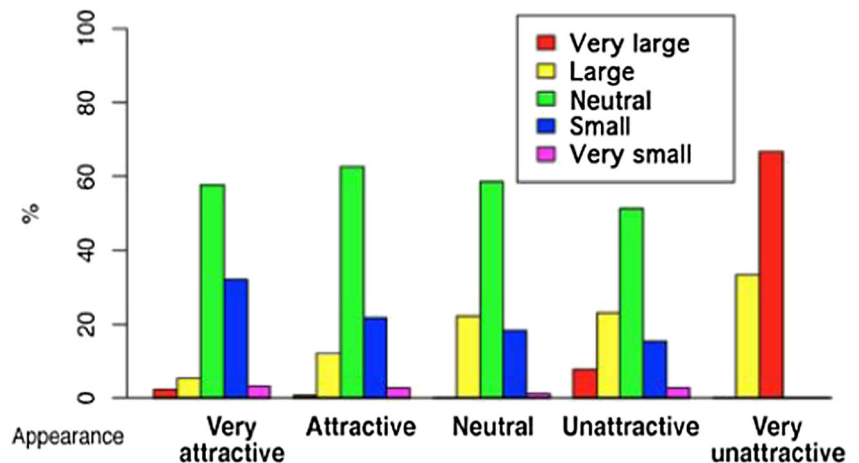
**Analysis of the golden ratio according to Ricketts**

*Method design and study population*

*Selection of candidates*

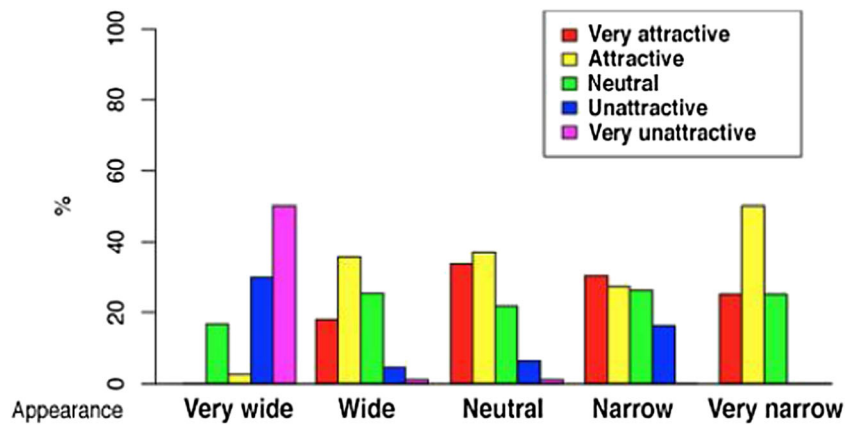
The study design was descriptive. We chose 65 female models and 50 male models of Caucasian ancestry who were 18 to 60 years of age and had appeared in fashion magazines, and

**Fig. 12** Size of the nose (front view). “Big” and “very big” noses were considered “unattractive” or “very unattractive”





**Fig. 13** Nasal width. “Narrow” and “very narrow” noses were associated with “attractive” and “very attractive” faces



who were assessed as “normal” by at least 75% of the respondents. Measurements were made in December 2015.

*Selection of proportions*

Six proportions (Fig. 23) were measured according to Ricketts; an additional seventh proportion on profile pictures was also determined (Fig. 24).

- PD1 Trichion–pupil to pupil–chin
- PD2 Trichion–base of the nose to base of the nose–chin
- PD3 Bi–pupil line–base of the nose to base of the nose–chin
- PD4 Bi–pupil line–lip corner to lip corner–chin
- PD5 Bi–pupil line–base of the nose to base of the nose–lip corner
- PD6 Base of the nose–lip corner to lip corner–chin
- PD7 Base of the ear–lateral canthus to lateral canthus–base of the nose

*Data processing*

A database was prepared in an Excel 2016 for PC (Microsoft) spreadsheet that contained the seven measurements

determined for each picture. The database was then exported to the statistical package R.3.2.2 for Windows (open software created by the R Foundation).

*Statistical analysis*

The two most highly correlated variables are PD2 and PD3, which exhibited a correlation of  $-0.67$ , and the least correlated variables are PD1 and PD5, with a correlation of  $0.01$  (Table 2).

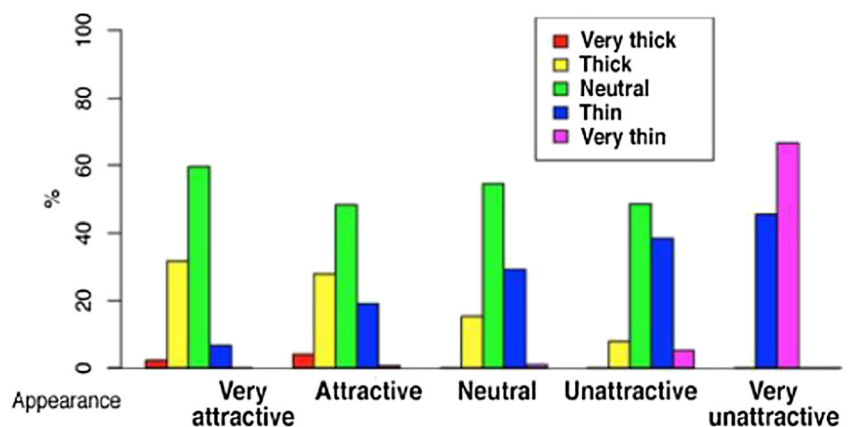
For  $N = 115$ , from 0.4 onward, the Pearson correlation coefficient was significant at 99%. The graphic representation can be seen in Fig. 25.

Considering the sex of the models (Table 3):

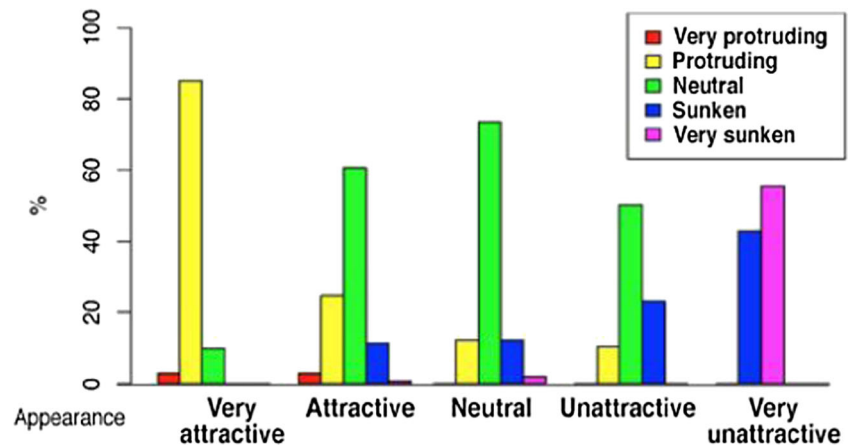
For men ( $N = 50$ ), the results were significant at a confidence level of 99%, corresponding to a coefficient of  $0.5$ . For women ( $N = 65$ ), the results were significant based on a coefficient of  $0.45$ .

- PD1 did not have a strong correlation in either sex with any other variable. This measurement will need to be studied further.
- PD2 was correlated with PD3 and PD4 in both sexes, although the correlations were stronger in men. Hence, we further studied only one of these three variables (Fig. 26).

**Fig. 14** Lip thickness. “Thin” and “very thin” lips were associated with “unattractive” and “very unattractive” faces. “Thick” lips were associated with “attractive” and “very attractive” faces



**Fig. 15** Lip protrusion. “Sunken” and “very sunken” lips were associated with “unattractive” or “very unattractive” faces. “Protruded” lips were linked to “attractive” faces



- PD5 and PD6 had correlations stronger than 0.5 in both groups. The graphic representation can be seen in Fig. 27.
- The third main component refers to variable PD1, which explained 17.12% of the variability.

*Analysis of main components*

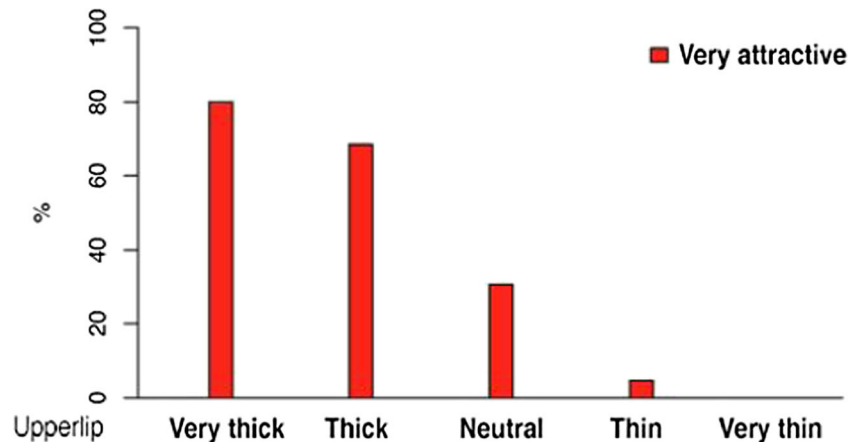
For the data on men, 97% of the data variability was explained by three main components:

- The first main component refers to variables PD2, PD3, and PD4, which explained 49.22% of the variability.
- The second main component refers to variables PD5 and PD6, which explained 29.57% of the variability.
- The third main component refers to variable PD1, which explained 18.43% of the variability.

For the data on women, three main components explained 91% of the data variability:

- The first main component refers to variables PD2, PD3, and PD4, which explained 46.66% of the variability.
- The second main component refers to variables PD5 and PD6, which explained 26.93% of the variability.

**Fig. 16** Assessment of the upper lip. A “very thin” upper lip was never considered “attractive”



**Discussion**

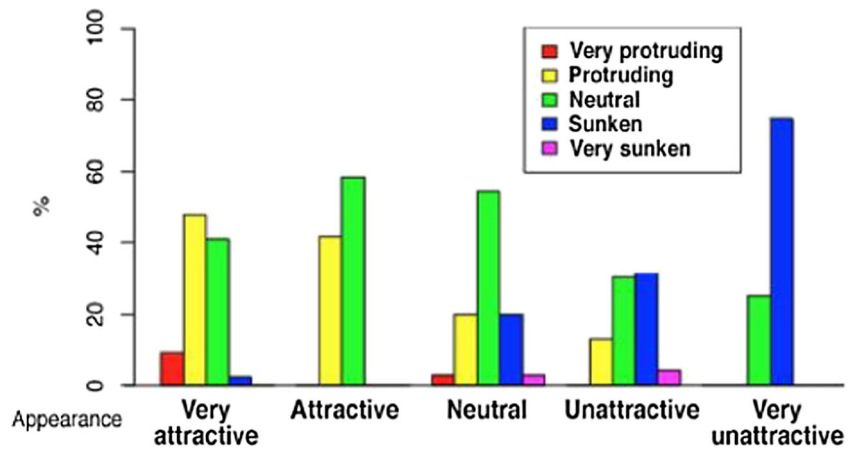
**Analysis of the survey on facial normality**

Questions 1, 2, 13, 14, 15, 16, 17, 28, and 29 investigated the perceptions of harmony and facial balance.

The first and second questions led us to think, similarly to Perrett [14], that not everyone applies the same criteria to the same picture. However, combining the “very attractive,” “attractive,” and “neutral” responses resulted in a “normal” interval accounting for 90.07% of the answers. Thus, we can state, as has Duggal [15], that “facial normality” does, in fact, exist.

However, Anic-Milosevic [16] has found that a facial beauty standard that is applicable to different Caucasian populations does not exist. In his study, almost all of the variables relating to soft tissues differed significantly ( $P = 0.000$ ) between Croatian and Caucasian American women, except for the true vertical line (TVL)-nasal tip (NT) measurement

**Fig. 17** Protrusion of the upper lip. A “very sunken” upper lip was qualified as “very unattractive.” A “protruded” or “neutral” upper lip was linked to “attractive” or “very attractive” faces



(0.096). Among men, the nose-lip angle was the only variable that did not differ significantly between the two populations.

A face that is of “neutral” length or “slightly long” (questions 13 and 28) was related to “beauty,” whereas “very long” or “very short” faces were associated with the “unattractive” rating.

Michiels [17] studied the facial attractiveness of Caucasian women and has observed that as the vertical measurement increases, class II became more important.

Regarding the width of the face, (questions 14 and 16), ratings of “very attractive,” “attractive,” and “neutral” (which we have combined under the heading of “normal”) were associated with “neutral” width or “slightly wide.” In contrast, “unattractive” or “very unattractive” faces were deemed to be either “too narrow” or “too wide.”

Correlating variables relating to the front view and profile balance (questions 2 and 17), Kendall’s rank correlation tau confirmed that our correlation hypothesis is true because the parameter differs from 0. The value is 0.635.

Facial symmetry was studied by Prokopakis [18]. However, in our study, facial symmetry was not considered. Soler [19] has found that, among Spaniards, a certain degree of asymmetry with a right side prominence is considered “attractive” among men. Similarly, Swaddle [20] has stated that symmetry is not always a synonym for beauty. Although some beauty is related to symmetry, perfect symmetry is

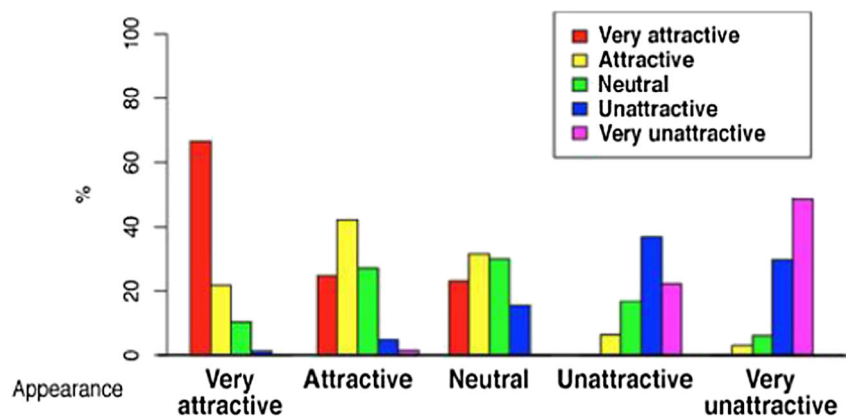
displeasing and is associated with an artificial face or one that is “cold” and lacking humanity.

The side view (question 16) is tightly linked with beauty: people are equally deemed to be either “very attractive” or “very unattractive” on the basis of their profile or side view.

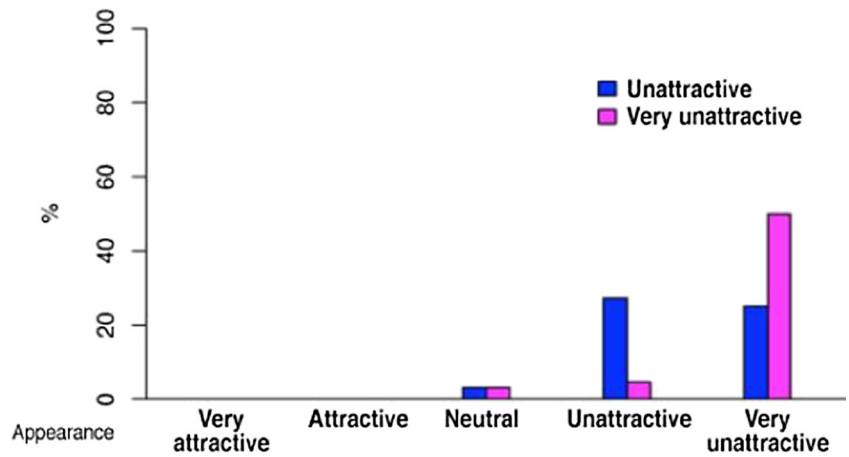
As the side view evolves toward “very prominent” or “very sunken,” the perception of unattractiveness increases. Filho [21] conducted an interesting study in which the side views of five pictures were modified with the program Deformer 2.0, and a before/after comparison when adapting it to a ratio close to 1.618 was performed. Chi-square analysis revealed a positive correlation between the golden ratio and esthetic appreciation. Knight [22] has observed that increments of over five degrees of the A point, nasion, B point (ANB) angle are considered less attractive. Furthermore, an increase in the length of the bottom third of the face is considered less attractive in women, whereas a decrease in that length makes men less attractive. Erbay [23] has studied Anatolic Turkish women, for whom an attractive side view was defined by a small nose, protruding lips (according to the Ricketts norm) and a slightly sunken profile.

Analyzing the balance among each third of the face (question 15) demonstrated that balanced faces corresponded to people who were judged to be “very attractive,” whereas unbalanced faces were deemed “very unattractive.”

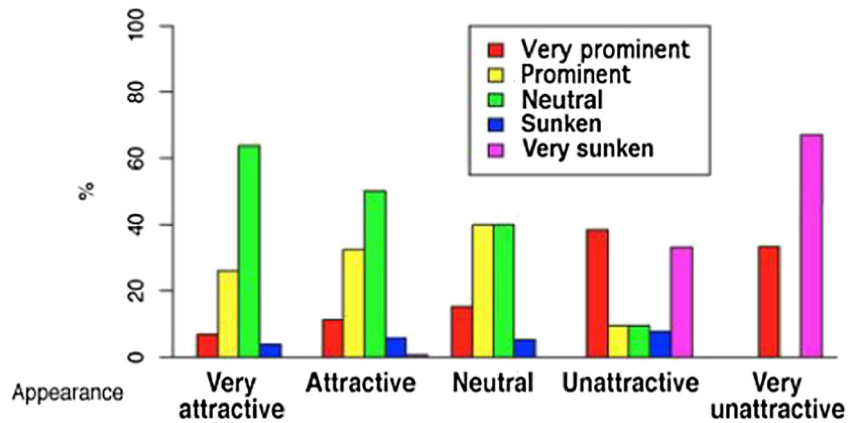
**Fig. 18** Smile assessment (front view). When the smile was rated as “very attractive,” the model was also considered “very attractive”



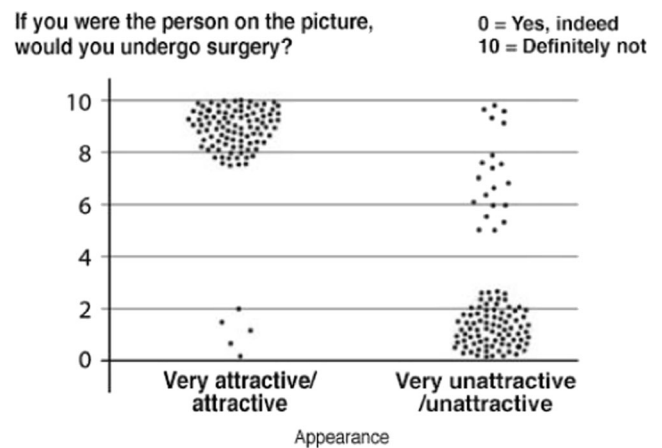
**Fig. 19** Smile assessment (profile). 75% of the respondents qualified the model as “unattractive” if the smile was rated as “unattractive” or “very unattractive”



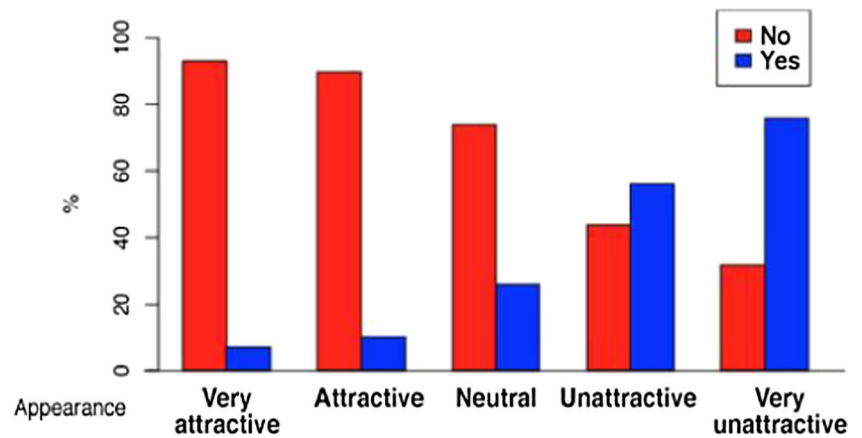
**Fig. 20** Assessment of the chin (front view). 90% of the respondents qualified “prominent” chins as being “unattractive” or “very unattractive.” Similarly, 78% of the respondents who considered the chin to be “very prominent” rated the model as “unattractive” or “very unattractive”



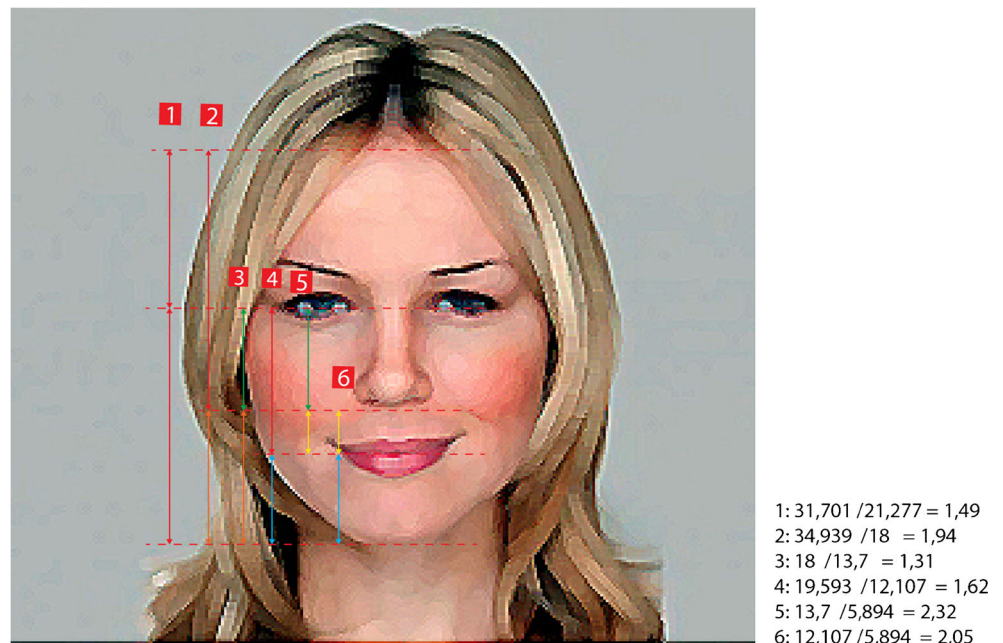
**Fig. 21** Predisposition for undergoing surgical intervention. The perception of unattractiveness was related to the predisposition for undergoing surgery with a Kendall’s rank correlation coefficient of 0.825



**Fig. 22** “If you were the person on the picture, would you undergo surgery?” Over 95% of those who considered the model to be “attractive” or “very attractive” would not undergo surgery, whereas 73% of those who considered the model to be “very unattractive” would

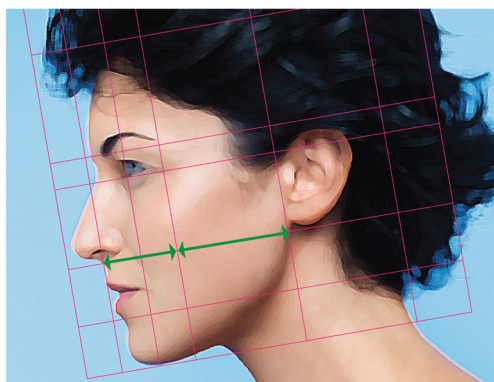


**Fig. 23** Divine proportion, front view



Johnston [24] found that a decrease in the lower third is perceived as more attractive than an increase in the lower third. Sheideman [25] further found that the length of the horizontal soft tissues of the mandibular protuberance has an effect similar to that explained by the balance among the thirds.

Mesaros [26] has evaluated attractiveness by using an image-based questionnaire and has found that faces are considered “more attractive” when the top third is dominant and “less attractive” when the bottom third is dominant. This finding corroborates the inverse correlation between beauty perception and the desire to be operated on (question 33) obtained in this work.

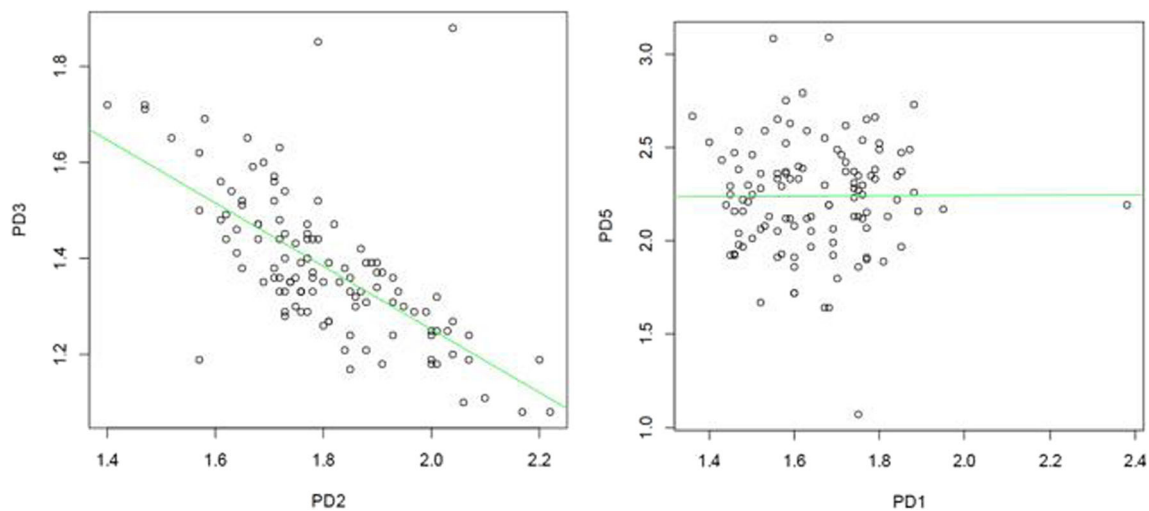


**Fig. 24** Divine proportion, lateral view

**Table 2** Correlation with the divine proportion according to Ricketts

	PD1	PD2	PD3	PD4	PD5	PD6
PD1	1.00	-0.55	0.10	-0.19	0.01	0.22
PD2	-0.55	1.00	-0.67	0.64	0.52	-0.23
PD3	0.10	-0.67	1.00	-0.58	-0.63	0.06
PD4	-0.19	0.64	-0.58	1.00	0.16	-0.59
PD5	0.01	0.52	-0.63	0.16	1.00	0.54
PD6	0.22	-0.23	0.06	-0.59	0.54	1.00





**Fig. 25** Correlation calculations:  $PD3-PD2 = -0.67$ .  $PD1-PD5 = 0.01$

The forehead of the face was assessed in questions 3 and 18. When the forehead was “big” or “neutral,” the model was seen as “very attractive,” and as the forehead became smaller, it was considered to be “unattractive.”

The eyebrows were covered in questions 4, 5, and 19. Eyebrows were considered “normal” in 80% of the cases when they were a certain distance apart and thin. The percentage of “unattractive” and “very unattractive” answers increased to 100% as the eyebrows became closer and thicker.

The eyes were assessed in question 6. Clear correlations were found between eye size and beauty, on one hand, and between how sunken the eyes were and “unattractiveness,” on the other hand (question 20). Neutral or large eyes were seen as “attractive” or “very attractive,” whereas small or sunken eyes were seen as “unattractive” or “very unattractive.” Rhee [27] investigated the configuration of beautiful eyes among different races.

Mc Curdy [28] considers the eyes to be the most important element in beauty perception.

In our study, we did not consider the effect of the distance between the eyes. Faure [29] modified facial images through “morphing” the distance between the eyes and discovered that facial esthetics are negatively affected as the distance increases.

This effect has been found to be significant by using analysis of variance (ANOVA) and *T* test ( $P < 001$ ).

The nose was assessed in questions 7 and 21. “Neutral” or “slightly small” noses were considered to be “very attractive” or “attractive,” whereas “big” or “very big” noses were considered “unattractive.” When studying the width of the nose (question 8), beauty was found to be associated with “neutral” or “narrow” noses.

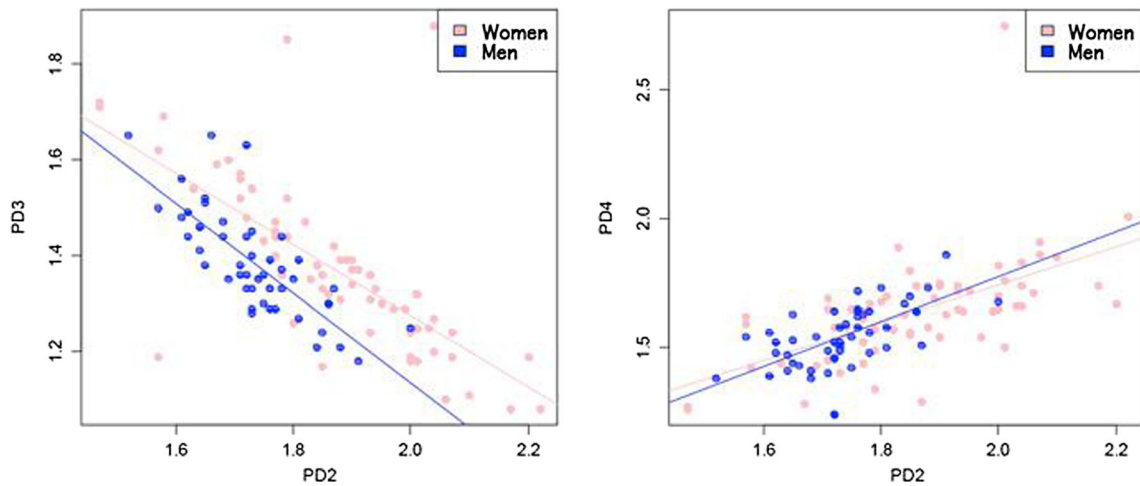
Devicic [30] investigated the relationship between nasal projection and facial attractiveness and found a positive correlation with the ideal measurements proposed by Good and Crumley and no correlation with those proposed by Simons, Baum, and Powell.

The lips were studied in questions 9, 10, 23, 24, and 25. “Neutral” or “thick” lips were associated with beauty, and “thin” or “very thin” lips were associated with an “unattractive” rating.

Regarding protrusion of the lips (question 24), a relationship was found between “very attractive” and “attractive” and protruded or very protruded lips, a result consistent with findings of Yu Xin [31]. Modarai [32] has studied the position of the lower lip in relation to the chin and has found that a protruding position of the lower lip is usually preferred.

**Table 3** Correlation calculations considering gender

	Men						Women					
	PD1	PD2	PD3	PD4	PD5	PD6	PD1	PD2	PD3	PD4	PD5	PD6
PD1	1.00	-0.56	0.07	-0.11	0.03	0.09	1.00	-0.36	0.05	-0.06	-0.04	0.06
PD2	-0.56	1.00	-0.81	0.70	0.42	-0.26	-0.36	1.00	-0.68	0.59	0.70	-0.03
PD3	0.07	-0.81	1.00	-0.74	-0.66	0.16	0.05	-0.68	1.00	-0.55	-0.62	-0.01
PD4	-0.11	0.70	-0.74	1.00	0.10	-0.74	-0.06	0.59	-0.55	1.00	0.24	-0.49
PD5	0.03	0.42	-0.66	0.10	1.00	0.52	-0.04	0.70	-0.62	0.24	1.00	0.57
PD6	0.09	-0.26	0.16	-0.74	0.52	1.00	0.06	-0.03	-0.01	-0.49	0.57	1.00



**Fig. 26** Correlation calculations. PD2–PD3: ♂ = -0.81 and ♀ = -0.68. PD2–PD4: ♂ = 0.70 and ♀ = 0.59

Questions 11 and 26 addressed the smile. A large percentage (70%) of the respondents in our study associated a “very attractive” model with a “very attractive” smile.

Murthy [33] determined that 25% of “attractive” smiles follow the golden ratio in terms of their width from the front view. However, Mahshid [34] did not find a correlation between the golden ratio and an esthetically pleasant smile.

The chin was studied in questions 12 and 27. We found that in 60% of cases, a “neutral” or “slightly protruded” chin was associated with a “neutral,” “attractive” or “very attractive” model.

Macías Gago [35] used Wilcoxon’s *W* non-parametric test (median comparison) technique, and Modarai [32] found that “more attractive” women have a slightly retruded jaw compared with the maxillary (tendency to class II). In contrast, men who were deemed “more attractive” had a more “straight” or “aligned” face with a “prominent” chin (tendency to class III).

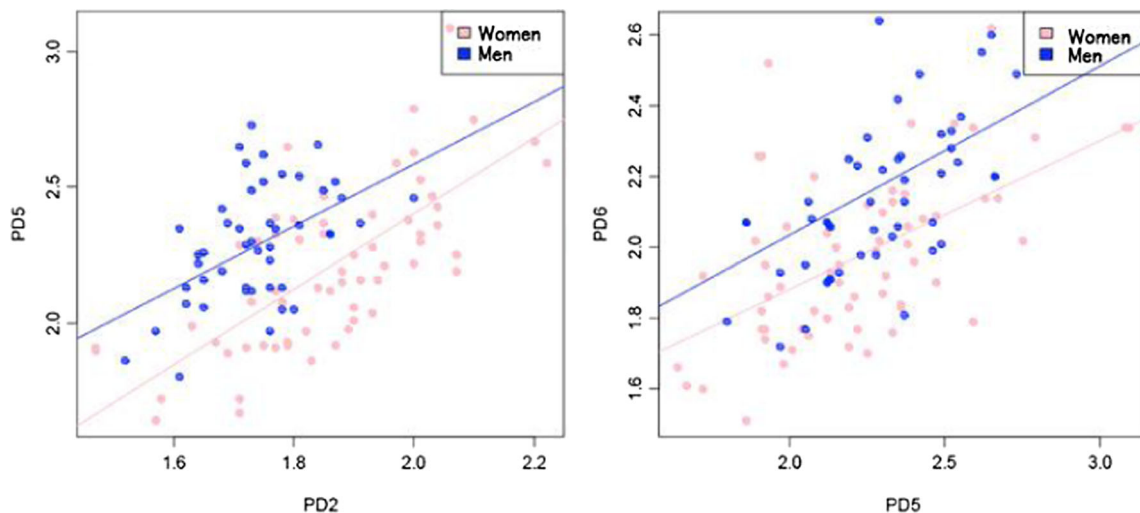
The chin, upper lip and nose were identified as the parts of the face with the greatest effect on the perception of beauty.

Lastly, Nomura [36] studied the side view of the face and found quantifiable differences ( $P < 0.001$ ) depending on the ancestry and sex of the surveyed respondents.

In contrast, Zhao [37] has found that, within the Han ethnic group, the facial proportions considered attractive are similar to those deemed to be attractive in Caucasian populations.

**The golden ratio**

When investigating the relationship between beauty and the golden ratio, two goals were defined: first, to determine whether an interval existed within which there was a qualified majority and, second, to determine whether correlations might exist that could allow the number of variables we study to be decreased.



**Fig. 27** Correlation calculations. PD2–PD5: ♂ = 0.42 and ♀ = 0.70. PD5–PD6: ♂ = 0.52 and ♀ = 0.57

**Table 4** Confidence intervals by gender

	Men			Women		
	90%	95%	99%	90%	95%	99%
PD1	[1.56–1.90]	[1.53–1.93]	[1.47–1.99]	[1.34–1.83]	[1.29–1.88]	[1.20–1.97]
PD2	[1.56–1.89]	[1.53–1.92]	[1.46–1.99]	[1.59–2.13]	[1.54–2.19]	[1.44–2.29]
PD3	[1.20–1.59]	[1.16–1.62]	[1.09–1.70]	[1.09–1.66]	[1.03–1.72]	[0.92–1.83]
PD4	[1.32–1.74]	[1.28–1.78]	[1.20–1.86]	[1.30–1.99]	[1.23–2.06]	[1.10–2.19]
PD5	[1.82–2.72]	[1.73–2.81]	[1.57–2.97]	[1.69–2.73]	[1.59–2.83]	[1.40–3.03]
PD6	[1.76–2.57]	[1.68–2.65]	[1.52–2.80]	[1.58–2.36]	[1.51–2.43]	[1.36–2.58]

### Table of correlations

As the correlation between two variables increases, the Pearson coefficient approaches 1 or  $-1$ . If the variables are independent, this coefficient will be 0. The two variables that were most closely correlated are PD2 and PD3 ( $-0.67$ ), and the variables that were least strongly correlated are PD1 and PD5.

When we differentiated by sex, PD1 did not have a strong correlation with any other variable. In contrast, PD2 correlated with PD3 and PD4 in both sexes. Furthermore, PD5 and PD6 maintained a correlation greater than 0.5 in both sexes.

Analyzing the main components allowed us to reduce the dimensions for both men and women to four variables in the front view images (PD1, PD2, PD5, and PD6, thus explaining 97% of the data variability) and PP1 in the side-view pictures.

### Confidence interval (Table 4)

Pancherz [38] identified the interval from 0.3 to 7.8 for men and from 0.2 to 11.2 for women. Jahanbin [39] obtained a

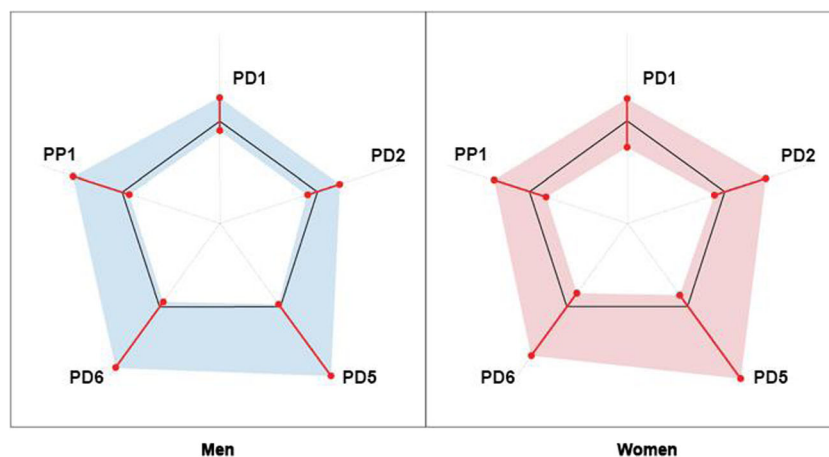
value of 1.58 for trichion–pupil to pupil–chin and for trichion–base of the nose to base of the nose–chin.

In our study, the intervals differed for each variable and sex. The values are shown in Table 4, thus allowing us to visualize them by using a pentagon to help quickly observe the model's facial balance. With 99% confidence, the golden ratio was within virtually every interval (Fig. 28).

### Conclusion

The goal of this article was not to determine the nature of beauty quantitatively but rather to verify whether a “model of beauty” in Spanish society exists. Thus, the selection of the pictures shown to the respondents was not key to the study because its purpose was simply to identify whether all of the respondents perceived the models' traits as beautiful. That is, this work aimed not to elucidate what constitutes a “thick lip” but rather to determine whether everyone perceived that the lip in a given picture looks “thick.”

From a surgical perspective, this issue is important. If this uniform general appreciation does indeed exist, we could



**Fig. 28** Intervals of normality for the divine proportion



**Fig. 29** Before and after surgery

quantify it and then later determine the therapeutic procedures that should be considered to achieve the “common ideal.” If there is no canon, the physical traits that are considered “beautiful” might be entirely subjective.

We can consider the case in which a surgical candidate adheres to one ideal of beauty and hopes that surgery will correct a perceived physical flaw or impediment. However, this ideal may not be technically feasible. In this case, both the candidate and surgeon must make informed and well-considered choices regarding the surgical procedures to attain the most healthful and satisfactory outcomes.

On the basis of our results, we conclude that the concept of beauty is not linear. Instead, it comprises intervals within which we can define a face as balanced and that can be further subdivided into “neutral,” “attractive,” and “very attractive.”

Khosravanifard [40] published a study describing how a retruded jaw is linked to unattractiveness and how beauty is linked to slightly prominent noses, protruded upper lips, and an inter-lip line located halfway between the chin and the nose. Additionally, that study indicated that straight side-view profiles or profiles with slightly protruding chins are considered more attractive in men.

Within a balanced face, partial disproportions can exist and constitute a harmonic whole if they are compensated for by other pleasing elements on the face. Even if the face is partially unbalanced, it can be perceived as attractive. The cultural

system in which the individual is immersed also influences their perception of beauty. Although we perceive it unconsciously, some “liking” occurs when we observe faces whose proportions closely resemble the golden ratio. An attractive face must also be perceived as having a balanced composition.

According to our study, a balanced face has the following characteristics (Fig. 29):

#### Men

1. Balanced facial thirds
2. Neutral nose or slightly narrow
3. Eyes not sunken
4. Protruded lips
5. Straight side-view profile or chin slightly protruding or slightly back

#### Women

1. Balanced or lower third slightly diminished
2. Narrow nose
3. Big eyes that are not sunken
4. Very protruded lips
5. Straight side profile or chin slightly protruding or slightly back

The notion of esthetics or a balanced face is slightly correlated with the golden ratio.

Among the proportions proposed by Ricketts, we can restrict studies to four front-view proportions:

1. PF1: scalp–pupil to pupil–chin
2. PF2: scalp–base of the nose to base of the nose–chin
3. PF5: bi-pupil line–base of nose to base of nose–lip corner
4. PF6: base of nose–lip corner to lip corner–chin

To these, we should add another proportion in the side-view profile:

5. PP1: base of the ear–palpebral angle to palpebral angle–base of the nose

Each one of these proportions should be associated with a “normality interval” (Table 4).

The desire to improve one’s appearance by means of surgery is intimately linked to appreciating a proportion as “very unattractive.” In this case, “unattractiveness” is recognized, and people are aware that it can be improved through surgery.

#### Compliance with ethical standards

**Conflict of interest** José Francisco Ballester Ferrandis, Francisco Martínez Soriano, Maria Isabel Ribera Vega, and Juan José Font Ferrandis declare that they have no conflict of interest.



**Patient consent** Patients provided written consent for the use of their images.

**Informed consent** For this type of study formal consent is not required.

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## References

- Maslow AH (1943) A theory of human motivation. *Psychol Rev* 50(4):370–396
- Bashoure M (2006) An objective system for measuring facial attractiveness. *Plast Reconstr Surg* 118:757–774
- Hönn M, Göz G (2007) The ideal of facial beauty: a review. *J Orofac Orthop* 68(1):6–16
- Farkas LG, Katic MJ, Forrester CR et al (2005) International anthropometric study of facial morphology in various ethnic groups/races. *J Craniofac Surg* 16:615–646
- Jefferson Y (1993) Facial esthetics-presentation of an ideal face. *J Gen Orthod* 4(1):18–23
- Ricketts RM (1982) Divine proportion in facial esthetics. *Clin Plast Surg Ovt* 9(4):401–422
- Preston JD (1993) The golden proportion revisited. *J Esthet Dent* 5(6):247–251
- Amoric M (1995) The golden number: applications to cranio-facial evaluation. *Funct Orthod* 12(1):18–21 24–25
- Baker BW, Woods MG (2001) The role of the divine proportion in the aesthetic improvement of patients undergoing combined orthodontic/orthognathic surgical treatment. *Int J Adult Orthodon Orthognath surg* 16(2):108–120
- Shell TL, Woody MG. (2004) Facial aesthetics and the divine proportion; a comparison of surgical and non. surgical class II treatment. *Aust. Orthod. J* 20 (2), 51–63
- Holland E (2008) Marquardt's Phi mask: pit falls of relying on fashion models and the golden ratio to describe a beautiful face. *Aesthetic Plast Surg* 32:200–208
- Rossetti A, De Menezes M, Rosati R, Ferrario VFS, Forza C (2013) The role of the golden proportion in the evaluation of facial aesthetics. *Angle Orthod* 83(5):801–808
- Rajiv A, Jui Y (2014) Golden proportions as predictors of attractiveness and malocclusion. *Indian J Den Rev* 25(6):788–793
- Perrett D., May Ka, Yoshikawa S. (1994). Facial shape and judgements of female attractiveness. *Nature*. 17, 368 (6468) 239–242
- Duggal S, Kapoor DN, Verma S, Sagar M, Lee Y-S, Moon H, Rhee SC (2016) Photogrammetric Analysis of attractiveness in indian faces. *Arch plast surg* 43(2):160–171
- Anić-Milosëvić S, Lapter-Vargha M, Dumancic J, Slaj M (2011) Analysis of the soft tissue profile in Croatians with normal occlusions and well- balanced face. *Eur J Orthod* 33(3):305–310
- Michiels G, Sather A (1994) Determinants of facial attractiveness in a sample of White women. *Int J Adult Orthodon Orthognath Surg* 9(2):95–103
- Prokopakis EP, Vlastos JM, Picavet VA, Noist Trenite G, Thomas R, Cingi C, Helliges PW (2013) The Golden ratio in facial symmetry. *Rhinology* 51(1):18–21
- Soler C, Kekäläinen J, Núñez M, Sancho M, Núñez J, Yaber I, Gutiérrez R (2012) Male facial anthropometry and Attractiveness. *Perception* 41 (20), 1234-1245.
- Swaddle JP, Cuthiel IC (1995) Asymmetry and human facial attractiveness: Symmetry may not always be beautiful. *Proc Bill Sci* 261(1360):111–6
- Medici Filho E, Martins MV, Dos Santos Da Silva MA, Castilho JC, De Moraes LC, Gil CT (2007) Divine proportions and facial aesthetic after manipulation of frontal photographs. *World J Orthod* 8(2):103–108
- Knight H, Keith O (2005) Ranking facial attractiveness. *Eur J Orthod* 27(4):340–348
- Erbay EF, Canikloglu CM (2002) Soft tissue profile in Anatolian Turkish adults; part II. Comparison of different soft tissue analyses in the evaluation of beauty. *Am J Orthod Dentofacial Orthop* 121(1):85–72
- Johnston DJ, Hunt O, Johnston (1), Burden DJ, Stevansson M, Hepper P. (2005) The influence of lower face vertical proportion on facial attractiveness. *Eur J Orthod* 27 (4), 349–354
- Scheideman GB, Bell WH, Legan HL, Finn RA, Reisch JS (1980) Cephalometric analysis of dentofacial normals. *Am J Orthod* 78(4):404–420
- Mesaros A, Cornea D, Cioara L, Dudea D, Mesaros M, Badea M (2015) Facial attractiveness assessment using illustrated questionnaire. *Clujul Med* 88(1):73–78
- Rhee SC, Woo KS, Kwon B (2012) Biometric study of eyelid shape and dimensions of different races with references to beauty. *Aesthet Plast Surg* 36(5):1236–1245
- Mc Curdy JA (2006) Beautiful eyes: characteristics and application to aesthetic surgery. *Facial plastic surgery* (3):204–214
- Faure JC, Rieffe C, Maltha JC (2002) The influence of different facial components on facial aesthetics. *Eur J Orthod* 24(1):1–7
- Devic Z, Rayikanti BA, Hevia JP, Popenki NA, Karimik, Wong BJ (2011) Nasal tip projection and facial attractiveness. *Laryngoscope* 121(7):1388–1394
- Yu XN, Bai D, Feng X, Lin YH, Chen WJ (2016) Correlation between cephalometric measures and end-of-treatment facial attractiveness. *J Craniofac Surg* 27(2):405–409
- Modarai F, Donaldson JC, Naini FB (2013) The influence of lower lip position on the perceived attractiveness of chin prominence. *Angle Orthod* 83(5):795–800
- Murthy BV, Ramani N (2008) Evaluation of natural smile: golden proportions, RED or golden percentage. *J Conserv Dent* 11(1):16–21
- Mahshid M, Khoshvaghti A, Varshosaz M, Vallael N (2004) Evaluation of “golden proportion” in individuals with an esthetic smile. *J Esthet Restor Dent* 16(3):183–193 discussion 193
- Macías Gago AB, Romero Manoto M, Crego A (2012) The perception of functional aesthetics in a young spanish population. *Eur J Orthod* 34(3):335–339
- Nomura M, Motegi E, Hatch JP, Gakunga PT, Ngángá PM, Rugh JD, Yamaguchi H (2009) Esthetic preferences of European American, Hispanic american, Japanese, and African judges for soft tissue profiles. *Am J Orthod Dentofacial Orthop* 135(4 suppl):S 87–S 95
- Zhao Q, Zhou R, Zhang X, Sun H, Lu X, Xia D, Song M, Liang Y (2013) Morphological quantitative criteria and aesthetic evaluation of eight female han face types. *Aesthetic Plast Surg* 37(2):445–453
- Pancherz H, Knapp V, Erbe C, Heiss AM (2010 Spring) Divine proportions in attractive and non attractive face. *World J Orthod* 11(1):27–36
- Jahanbin A, Basafa M, Alizadeh Y (2008) Evaluation of the divine proportion in the facial profile of young females. *Indian J Dent Res* 19(4):292–296
- Khosravanifard B, Ralkhshan V, Raeesi E (2013) Factors influencing attractiveness of soft tissue profile. *Oral Surg Oral Med Oral Pathol Oral Radiol* 115(1):29–37