



(REVIEW ARTICLE)



Lip position in the smile aesthetic: Literature review

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Abstract

Objective: Determine the lip position influence on dental aesthetics in adults older than 19 years according to academic publications in the last 5 years.

Material and methods: A systematic research was carried out in the medical literature (UNAM, Cochrane, BVS, Scielo, PubMed), using the following search strategy: (lip line) OR (smile line) AND (parameters) AND (analysis) AND (evaluation) to identify articles that reported data on lip position parameters that influence dental aesthetics. The results of each study were extracted and classified as follows: smile line or lip line, length of the lip with the smile line, gingival display, smile arc, smile type and upper lip curvature.

Results: From the 4497 articles analyzed, 17 studies were selected for the final review process. Considering the studies in this literature review, the most frequent criteria are: a midline smile, a low gummy smile line, a consonant smile arc, a static smile, a commissural type of smile, and an upward curvature of the upper lip.

Conclusions: An aesthetically attractive smile includes different parameters, among those that have a positive influence are a high or medium anterior smile line, a parallel smile arc, straight or upward upper lip curvature, type of commissural smile and a gingival exposure less than 2 mm.

Keywords: Esthetics, Dental; Smile; Lip; Gingiva; Tooth

1. Introduction

The desire to have an attractive and pleasant smile increases progressively, leading dental professionals to examine facial structures characteristics, evaluating each patient according to their needs and expectations.

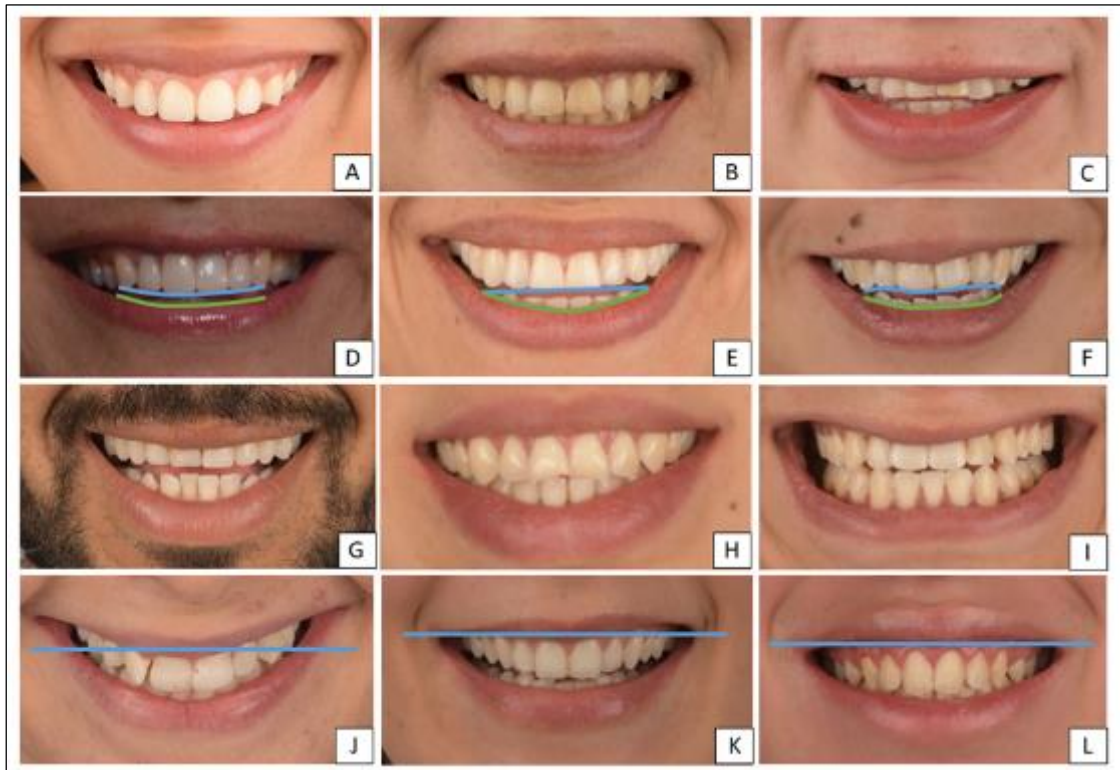
The aesthetic perception of the smile is multifactorial, including white (teeth), pink (gums) and black (contours) aesthetics. There are aesthetic patterns that allow a satisfactory treatment, finding the upper lip curve, smile line, lip line, smile arc, smile width, gingival exposure, buccal corridor, facial and dental midline, size, shape, color and longitudinal axis of the teeth, nasolabial angle, occlusal plane, length of the maxillary lip, golden ratios, among others. All components of the smile are important to achieve an optimal result, influencing personality, social relationships and job success.

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1.1. Smile line or lip line

One of the parameters that influence smile aesthetics is the smile line, labial line [1-2] or intercommissural line, this is an imaginary curved line that accompanies the trajectory of the edges of the 4 incisors and maxillary canines' cusps, extending from the left commissure to the right one.

Smile line can be classified as: Low smile line, where the upper lip extends from mid-length of incisors crowns to the incisal edge [3–4]. Reveals less than 75% of the maxillary incisors without visible gingival tissue [1, 5-6]. At the mid-smile line, 1–2 mm of toothed gingiva is visible [3–4]. Reveals 75-100% of the incisors and interproximal papillae [1, 5-6]. At the high smile line, it exposes 100% of the incisors and a continuous band of maxillary gingiva [1, 5-6]. Figure 1 (A, B, C).



Source: Carpio, L; Carpio, K; Jaramillo, F; Palacios, A

Figure 1 Classification of smile line, smile arc, smile types, and upper lip curvature. (A) High smile line, (B) Medium smile line, (C) Low smile line, (D) Parallel smile arc, (E) Straight smile arc, (F) Reverse smile arc, (G) Type of commissural smile, (H) Type of canine smile, (I) Type of complex smile, (H) Upwards upper lip curve, (J) Straight upper lip curve, (K) Downwards upper lip curve

There is another classification [7]: In class I or very high smile line, more than 2 mm of marginal gum is visible [8]. In class II or high smile line, 0 to 2 mm of marginal gingiva is visible [9]. In class III or medium smile line, only the gingival embrasures are visible and in class IV or low smile line, the gingival embrasures are not visible [7].

It can also be categorized as positive, when the edges of the upper anterior incisors are below the canines' cusps, obtaining a convex curve. Neutral, when the edges of the maxillary anterior incisors coincide with the tips of the canines' cusps. And negative, when the edges of the maxillary central incisors are above the canines' cusps [4].

1.1.1. Interdental and gingival smile line

On the other hand, the interdental and gingival smile line should be considered. The gummy smile line considers the midfacial gingiva and the interdental papilla in relation to the vermilion border, measured from the zenith of the gingiva to the lower vermilion border of the upper lip.

A high gingival smile line is considered if the midfacial gingiva of the maxillary anterior teeth is visible, a low gingival smile line is considered if there is no visible part of the midfacial gingiva, and a cupid's bow gingival smile line is

considered if there is no visibility of the midfacial gingiva for the central incisors, but is visible for the lateral incisors and additional lateral teeth. Figure 2 (A, B, C).



Source: Carpio, L; Carpio, K; Jaramillo, F; Palacios, A

Figure 2 Gingival and interdental smile lines and upper lip length. (A) High gingival smile line, (B) Low gingival smile line, (C) Cupid's bow gingival smile line, (D) High interdental smile line, (E) Low interdental smile line, (F) Cupid's bow interdental smile line, (G) Lip length measured from subnasal to the lowest portion of the upper lip in the midline at rest (H) and spontaneous

The interdental smile line is the position of the vermilion of the upper lip in relation to the gingival interdental papilla, measured from the tip of the interdental papilla to the vermilion border of the upper lip. It is considered: a high interdental smile line if the interdental papillae of the maxillary anterior teeth are visible, a low interdental smile line if the interdental papillae are not visible, and a cupid's bow interdental smile line if the interdental papillae of the maxillary anterior teeth are visible, except for the central papilla. Figure 2 (D, E, F).

1.1.2. Maxillary lip length with the smile line

Another parameter is the maxillary lip length with the smile line that influences the visibility of teeth and gums. Figure 2 (G, H). It is measured from subnasal to the lowest portion of the upper lip in the midline, at rest and when smiling. The values of the nasolabial angle and the length of the lip are greater at rest than when smiling.

1.1.3. Gingival display

Likewise, the maxillary gingival display is the amount of gingival display between the upper lip line and the incisor expressed in millimeters [10]. An excessive gingival exposure or "gummy smile" is an overexposure of the maxillary gingival band during a voluntary or involuntary smile [11], considered less attractive.

1.2. Smile arc

On the other hand, the smile arc is defined as the relationship of the curvature of the upper incisors' incisal edges with the lower lips during a social smile [2, 12-16].

The smile arc is a curve whose trajectory follows the incisal edges of the central incisors up and back to the incisal edges of the lateral incisors and the tips of the canines, it must be in harmony with the upper edge of the lower lip [15].

The smile arc is classified as a consonant arc, where the curvature of the upper incisal edges is parallel to the edge of the lower lip during smiling [16-18]. And a non-consonant arc where these two lines diverge [19-20].

There is another classification of the smile arc, a parallel arc, a straight arc and a reverse arc, where the curvature of the upper incisal edges is parallel, flat and inverse to the lower lip edge when smiling, respectively [21-22]. Figure 1 (D, E, F).

1.3. Smile types

The smile can be classified as a spontaneous smile, based on emotions, involuntarily, with facial movements such as squinting and a maximum elevation of the lips [23-26]. The second was a social, posed, or static smile that is voluntary. Reproducible in social situations or photographed, not related to emotions [12, 23-27]. Figure 3.



Source: Carpio, L; Carpio, K; Jaramillo, F; Palacios, A

Figure 3 Difference between posed and spontaneous smile. Posed smile visualized through digital photographs and spontaneous smile through video clips

There is another classification of the type of smile and it is divided into three. The first is the commissural smile where the corners of the mouth are curved upwards by the zygomaticus major and the lips appear diamond-shaped [28]. The second is the canine smile, when the mouth commissures are not curved and the upper lip is raised [28]. And third, the complex smile, where the lower lip moves down without upper lip commissures curling up [28]. Figure 1. (G, H, I).

1.4. Upper lip curvature

We have another aesthetic parameter, which is the upper lip curvature, for which a straight line is drawn through the midpoint of the upper lip lower edge and its relationship with the position of the mouth commissures [27-28].

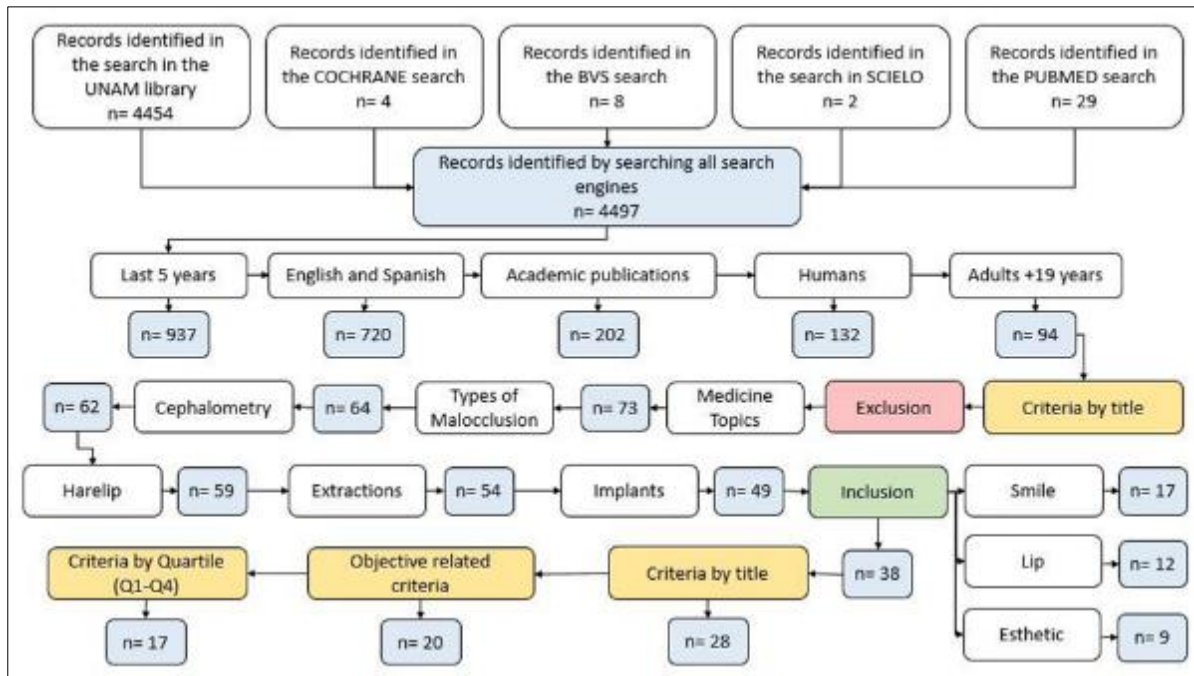
Thus, in the upward curve of the upper lip, the lip commissures are higher than the center of the lower edge of the upper lip. Straight when the lips commissures and the center lower edge of the lip are in a straight line. And down when the lips commissures are lower than the center of the lower border of the upper lip [11, 28]. Figure 1 (J, K, L).

Therefore, the objective of this literature review is to determine the influence of lip position on dental aesthetics in adults over 19 years of age according to the academic publications of the last 5 years.

2. Material and methods

In November 2021, a literature review was started to identify all articles reporting data about parameters that relate to lip position in smile esthetics. To retrieve lists of potential articles, research was conducted in PubMed, Scielo, UNAM, Cochrane and BVS, using the following search strategy: (lip line) OR (smile line) AND (parameters) AND (analysis) AND (evaluation).

The authors performed the bibliographic search, title selection and abstracts to select articles according to various inclusion and exclusion criteria. The inclusion criteria by search were: last 5 years, languages in English and Spanish, academic publications, studies carried out in humans, and adults older than 19 years. While the exclusion criteria by title were: studies containing medicine topics, types of malocclusion, cephalometry, cleft lip, extractions and implants. The inclusion criteria by title were: studies that contain themes of smile, lip and aesthetics. Finally, studies were included and excluded according to abstract criteria, by studies related to the objective of this research, and by criteria belonging to a quartile (Q1, Q2, Q3 or Q4). Disagreements were resolved by discussion between all authors. The article selection procedure has been described in Figure 4.



Source: Carpio, K; Jaramillo, F; Palacios, A

Figure 4 Flowchart for search and selection of articles.

3. Results and Discussion

From the 4,497 articles found in the search, 17 were selected for the final review process, which are shown in **Table 1**.

Table 1 Final list of articles with their relevant characteristics

	Qualification	Features
1	Evaluation of the maxillary midline, curve of the upper lip, smile line and tooth shape: a prospective study of 140 Caucasian patients.	The 80% of the sample in this study presented a consonant smile line. The curvature of the upper lip was upwards in 47.1% of the cases, followed by a straight curve in 41.4%. Most of the people (84.3%) presented a midline smile. There were no significant differences between men and women.
2	Association of the nasolabial angle and lip length with the gingival and interdental smile line—A gender-based evaluation.	The mean values of lip length at rest and when smiling was found to be higher in men. The majority of the study population exhibited a low and high gingival smile line. The mean values of visible midfacial gingiva and interdental papilla in women were higher than in men. Lip length influences the amount of gingival exposure in the maxillary anterior teeth.
3	The evaluation of different smile parameters in the Turkish population.	Labial length influences the amount of gingival exposure in the maxillary anterior teeth. The amount of gingival display when smiling is an important feature in periodontal, implant, restorative, and smile design procedures. Lip length correlates with the amount of gingival tissue displayed in both the midfacial and interdental regions.

4	Morphological features of smile attractiveness and related factors influence perception and gingival aesthetic parameters	High or medium anterior smile line, parallel smile arc, upward curvature of the upper lip scored high on smile attractiveness. Factors including the raters' profession, gender, and age had almost no impact on their perception of aesthetics. Smile attractiveness features and gingival aesthetic parameters have clinical applicability to patient care.
5	Smile attractiveness of Persian women after orthodontic treatment.	The correlation of lip line and study group was significant, so that 60% of patients in group B had a moderate lip line. The space of the buccal corridor and the line of the lips are important factors that affect the attractiveness of the smile of Persian women. According to the opinion of the interviewees, the moderate line of the lips produces a more attractive smile.
6	The Influence of Varying Gingival Display of Maxillary Anterior Teeth on the Perceptions of Smile Aesthetics	Regarding the gingival architecture, the respondents defined that Class III is the most attractive (65.3%). Class IV gingival architecture with loss of interdental papillae (black triangles) was recorded as the least attractive of the three groups (71.8%).
7	Esthetics and smile-related characteristics assessed by laypersons.	Male attractive smiles demonstrated higher frequencies of low or medium anterior smile line (90.9%), low or medium posterior smile line (72.7%), upper lip upward curvature (50.0%) and corner smile pattern (72.7%) that made male subjects smile unattractive. For female full-smile images, attractive subjects demonstrated significantly higher frequencies of low or average anterior smile line (86.4%), low or average posterior smile line (77.3%), and upper lip curvature towards higher (54.5%) than unattractive subjects.
8	An Evaluation of Benchmarks for Esthetic Orientation of the Occlusal Plane.	Measured occlusal plane angles in natural dentition patients demonstrated a relatively small mean deviation from both the horizontal plane and Camper's plane when the superior border of the tragus was used as the distal reference point, but the range was quite wide and could be misleading. in an unacceptable occlusal deviation.
9	Comparing the use of static versus dynamic images to evaluate a smile.	The most frequent type of posed smile was class III (53.9% of the total) for both sexes. The least frequent type was class I (5% of the total) for both women (7.9%) and men (0.6%). Regarding the spontaneous smile, class II smile is the most frequent (45.3% total) for both sexes, followed by class I (women 36.1% and men 16.3%), class III (women 44 .9%; men 45.7%). 18.9% and men 32.7%), and finally, class IV (2.1% total; 0% women and 5.2% men).
10	Analysis of smile aesthetics using the SmileCurves digital template.	SCT is made up of diagrams representing the six maxillary anterior teeth, with the main elements being the central incisors. The width of the lateral incisors corresponds to 71% of the width of the central incisors; and that of the canines, 71% of that of the lateral incisors (regressive proportion).
11	Dynamic Documentation of the Smile and the 2D/3D Digital Smile Design Process.	Medical and dental histories, clinical examination, study models and photographs provide the data for a proper diagnosis and treatment plan for cosmetic dentistry. However, dentolabial parameters vary according to lip dynamics and are influenced by both a static smile and a moving smile captured on video. The use of dynamic smile documentation (DDS) allows rehabilitative aesthetic planning from a facial perspective, improved communication with the patient, integration between specialists and predictable quality of treatments.
12	The influence of varying maxillary central incisor vertical dimension on perceived smile aesthetics.	The types of smile found were: Smile I: difference of 1.5 mm between central and lateral incisors; Smile II: a difference of 1 mm between the central and lateral incisors; Smile III: no height difference between central and lateral incisors; Smile IV: slight negative difference (-1 mm) in height between central and lateral incisors; V smile: difference in height (-1.5 mm) between lateral and central incisors and inverted arc. As a result, Smile I was

		considered the most aesthetic with 40.7% (n = 55), while Smile III was the least aesthetic 4.4% (n = 6).
13	Analysis of different characteristics of smile.	A 45.2% of the participants presented consonant smile arcs, canine smiles in 45.9%, upward curvature of the lip in 43.9% and, maxillary anterior teeth not covered by the lower lip in 60.5%. Differences based on gender were not statistically significant except for smile arc. There was a significant relationship between lip curvature and smile pattern and lip curvature and smile arc, which reveals that upward curvature of the lips was associated with commissure-type smiles and consonant smile arcs.
14	Influence of lightness of teeth and lip position of a posed smile on the perception of its attractiveness.	The least attractive smiles were those with a lip position greater than 3 mm above the cervical line. Lower lip positions with a distance of 0 to 1 mm from the upper incisal line are considered more attractive. Zero or small distances are considered more attractive. The greater the distance, the less attractive the smile is considered. Gender, occupation, and level of education did not affect perceived attractiveness differently due to lower lip positions, but age did.
15	Impact of assessing smile parameters as part of orthodontic treatment planning - a survey-based analysis.	The 91.5% of those surveyed agreed that a consonant smile favors the aesthetics of the smile. The negative effect of the reverse smile arc on smile aesthetics was agreed by 91.6% of the participants. Also, the majority of participants maintain that a flat smile arc gives an aged appearance.
16	A review on smile arc - An orthodontist's perspective.	By having aesthetics as an objective, a balanced composition must be achieved in the various aesthetic elements of the smile. There are eight major components of a smile: the lip line, smile arc, upper lip curvature, smile symmetry, lateral negative space, frontal occlusal plane, dental components, and gingival components.
17	Perception of aesthetic parameters of the smile in dentists, dental students and patients of the Santiago Major University, Chile.	Regarding Lip Line A, both dentists (67%) and students (77%) found a smile with 2 mm of gingival exposure more attractive, 67% of the patients opted for 1 mm of gingival exposure. For Lip Line B, 1 mm of gingival exposure was considered more attractive.

Source: Carpio, K; Jaramillo, F; Palacios, A

There are different methods available for smile analysis including photographs [1, 2, 29, 30], measuring directly on human beings [29], videos [2, 29, 31], or using three-dimensional (3D) stereophotogrammetrical images [31]. A spontaneous smile is difficult to obtain with static photographs, and the use of videos improves the aesthetic evaluation. The use of methods to capture the smile can be complemented with digital tools, using templates such as SmileCurves (SCT), based on the superimposition of intraoral photographic images of smile, facilitating the visualization of dental and oral aesthetic needs, with information of the positions and proportions of the teeth, gums and lips [32].

The perception of beauty is subjective and depends on personal experience, the media [33], ethnicity [31, 34-35], culture [33-35], age [31, 33, 36], sex, or level of education [33, 36]. However, according to Pham, T. & Nguyen P. [34], as well as Khan, M. et al. [35] the profession, sex and age of the evaluators did not affect perception. Despite this, Sakellaropoulos, O & Lagouvardos P. [29] established that age does have an influence.

According to studies by Kolte, A. et al.; Sybaite, J. et al.; Melo, M. et al.; Khan, M. et al. and Sakellaropoulos, O. et al. [29, 31, 35, 37, 38] the most frequent smile line is the average; followed by low and high. This may vary depending on the study location, in Saudi Arabia and Korea, the majority of the population agreed with the mid-smile line as the most frequent, followed by the high and low [39]. However, there are no studies carried out in our environment, so it is recommended to carry out new investigations to be able to observe and compare which are the most frequent aesthetic parameters that we can find at the level of our population.

According to Köseoğlu. Metal. [39], regarding the gummy smile line; we find: low, high and cupid's bow. In the interdental smile line, it was found: high, low and Cupid's bow. Likewise, Kolte, A. et al. and other studies [12-16, 31, 37, 40, 41], determined that the high smile line is more common among women and the low one was more prevalent among men.

According to Köseoğlu M. et al. [39], a variable that can influence the smile line is gender because men tend to have a low interdental smile line, in contrast to women who tend to have a medium or high smile line, according to Mahn, E. et al. [40]. Another variable discussed by the latter author and Melo, M. et al. [31] is age, since height decreases due to loss of supporting tissues.

According to Köseoğlu M. et al. [39], the proportion of men with a low interdental smile line is twice than women, thus men have greater lip length and thickness. Corroborated by Sakellaropoulos, O. & Lagouvardos, P. [9], who indicate that women tend to have a medium or high smile line, explained by a shorter upper lip and greater lip muscle tone. The nasolabial angle and length of the maxillary lip influence the amount of gingival exposure in the maxilla.

Mahn, E. et al. and other authors [10, 33-34, 40], allege that the marginal gingiva should have a maximum height of 2 mm. However, Melo, M. et al. together with other authors [21, 29, 31, 33] indicate that the teeth are exposed together with approximately 1 mm of gingival tissue. Unlike del Monte, S. et al. [3], who determined that a smile that does not expose more than 0.4 mm is considered aesthetically pleasing. On the contrary, Sybaite, J. et al. [38] state that no particular amount of gingival display is universally perceived as attractive, although high frown lines are disliked.

Likewise, Golshah A, et al. [29] pointed out that an unattractive smile exposes more than 3 mm of gingival tissue. Sybaite, J. et al. [38] reaffirmed the previous study, stating that 6 mm of exposed gingiva is considered the least attractive.

According to Köseoğlu M. et al. [39] the mean value of the visible interdental papilla in women is 3.29 mm compared to men, which is 3.00 mm. However, Mahn, E. et al. [40] differs with an average of 2.24 mm for men and 2.25 mm for women.

According to Melo, M. et al & Lira dos Santos, E. [31, 35], the smile arc is usually of the consonant type. Unlike the classification proposed by Khan, M. et al [35] reported that the straight smile arc was the most common finding, followed by parallel and inverted smile arcs.

Pham, T. & Nguyen P. [34] showed that the arc of the smile considered attractive is parallel to that of the lower lip, in contrast to a straight or reverse arc that is less attractive. These data were corroborated by Wang, C. [2] and other researchers [31, 33, 36].

Melo, M. et al. [31] reported that the smile arc is related to the age of the individual. In youth, the central incisors are more prominent, generating a curve that is parallel and consonant with the lower lip, while in older people the curve tends to straighten as a result of wear. Priest, G. & Wilson M [20] report that the maxillary occlusal plane influences the smile arc, because if it is tilted upwards, the incisal edges are in reverse curve of Spee, obtaining a non-consonant smile arc, which is less attractive.

For Mahn, E. et al [40], the forced or static smile is the most frequent in the male and female population. On the other hand, the spontaneous smile was found in a lower percentage. According to Köseoğlu M. et al. [39] the commissural smile is the most frequent in the population, followed by the canine smile and the complex smile. The commissural smile is considered to be the most attractive compared to the complex smile, which is the least attractive.

Pham, T. & Nguyen, P. [34] refer to the upward curvature of the upper lip as the most common. Khan, M. et al [35] corroborated this information. The curvature of the upper lip was moderately frequent straight, while Wang, C. et al. [2] contrary to the previous study, they determined that the straight curve was the most frequent, followed by the upward curve. Pham, T. & Nguyen, P. & Wang, C. et al. [30, 34] agreed that the downward curve was the least frequent and less aesthetic, while the curve up and straight are more attractive [42].

4. Conclusion

From the review and the contrast carried out, it is concluded that the position of the lips influences dental aesthetics through parameters that show us that there are more attractive smiles than others. Therefore, highly preferred smiles have a high or medium anterior smile line, a parallel smile arc, and a straight or upturned upper lip curve. While an unattractive smile has a medium or very high anterior smile line, a parallel or straight smile arc, and a downward or straight curvature of the upper lip.

A multidisciplinary and comprehensive approach is required to evaluate, diagnose and resolve aesthetic complications efficiently without relying solely on appearance, considering the patient-dentist relationship. Additionally, it must be considered that the perception of what is considered aesthetically “beautiful” can vary greatly depending on gender,

age, profession, culture and personal preferences. Therefore, every clinician with esthetics as a goal should strive for a balanced composition of the various esthetic elements of the smile.

Compliance with ethical standards

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Disclosure of conflict of interest

There were no major conflicts of interest during the performing of this article.

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