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Nadine Nachabeh
*USJ*

Tony Daher
*saint joseph university*

Elie Maalouf Prof
*Lebanese University*

Khalil Kharma
*Saint Joseph University*

Eliane Kaydouh

*See next page for additional authors*

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## Authors

Nadine Nachabeh, Tony Daher, Elie Maalouf Prof, Khalil Kharma, Eliane Kaydouh, and Carina Mehanna

*ORIGINAL ARTICLE* / *ARTICLE ORIGINAL*

***Restorative Dentistry*** / *Dentisterie Restauratrice*

# ANALYSIS OF CHANGES IN GINGIVA-OCCLUSAL PARAMETERS AS PERCEIVED BY THREE MIDDLE-EAST POPULATION

**Nadine Nachabeh[1], DDS, MS | Tony Daher[2], DDS, MS | Elie Maalouf[3], DDS, MS, PHD | Khalil Kharma[4], DDS, MS | Eliane Kaydouh[5] | and Carina Mehanna[6], DDS, MS, PHD.**

**Purpose.** This study aims to compare the effect of various smile parameters (buccal corridor, gummy smile, midline to face discrepancy, with and without upper lip filling) on the perception of smile attractiveness by applying the digital modification of images judged by one hundred and eighty laypersons from different Middle East populations.

**Materials and Methods.** A frontal photo of a woman's smile is manipulated with Photoshop to modify each smile parameter gradually into 3 grades. The total number of smiles to be assessed is 18. One hundred and eighty participants divided into 3 groups (n=60: 30 men and 30 women): Lebanese, Syrian, and Egyptian laypersons are invited to assess the smile attractiveness before and after modification In addition, each evaluator must indicate which feature she or he finds most attractive in a face. Analysis of repeated measures variances followed by univariate analyses and multiple comparisons of Bonferroni are performed.

**Results:** Eyes and smile are the most attractive elements in the face. For midline to face discrepancy, only Lebanese laypeople and Egyptian women prefer the coincidence of the midline to face compared with other positions with significant difference (p value <0.05). For a gummy smile, women of the 3 populations and the Syrian men tolerate a 2 mm gummy smile, and Lebanese laymen dislike any gingival exposure (p value <0.05). Egyptian men demonstrate no preference (p value> 0.05). Concerning the buccal corridor, its size does not influence smile attractive (p value> 0.05). Upper lip filling affected the perception of smile aesthetics for the midline (for Syrians and Egyptians).

**Conclusion:** Sex and culture affect the perception of the smile attractiveness for certain parameters. Alteration of the buccal corridor does not seem to influence the smile attractiveness. Upper lip filling may be advantageous in some cases and unfavorable in others.

**Clinical significance:** Dentists should take into consideration cultural differences when restoring smile aesthetics.

**Keywords:** smile, midline, lip, attractiveness, esthetics.

**Corresponding author:**
Dr Nachabeh Nadine
Phone: 96170561261. Email: nadinenachabeh@hotmail.com

**Conflicts of interest:**
The authors declare no conflicts of interest.

1. Graduate Student, Graduate Prosthodontics, Department of fixed prosthodontics, Faculty of Dentistry, Saint Joseph University of Beirut, Lebanon. nadinenachabeh@hotmail.com
2. Visiting Clinical Professor, Faculty of Dental Medicine, Saint- Joseph University, Prosthodontist, Private Practice, LaVerne, California, USA. tonydaher@verizon.net
3. Professor, Department of Periodontology, Faculty of Dentistry, Lebanese University of Beirut, Lebanon. ea.malouf@hotmail.com
4. DDS, Graduate Prosthodontics, Department of Restorative and Esthetic Dentistry, Faculty of Dentistry, Saint Joseph University of Beirut, Lebanon. khalil.kharma@gmail.com
5. Master in Visual Arts – Audiovisuel: Multimedia and Animation, USEK, Beirut, Lebanon. eliane.kaydouh@hotmail.com
6. Professor, Director of post-graduate program, Department of Restorative and Aesthetic Dentistry, Faculty of Dentistry, Saint Joseph University of Beirut, Lebanon. carinamhanna@hotmail.com

***ORIGINAL ARTICLE** / ARTICLE ORIGINAL*

***Restorative Dentistry** / Dentisterie Restauratrice*

# *ANALYSE DU CHANGEMENT DES PARAMÈTRES OCCLUSO-GINGIVAUX TEL QUE PERÇU PAR TROIS POPULATIONS DU MOYEN-ORIENT*

**Objectif :** L'objectif de cet article est la comparaison de l'effet de la variation des paramètres du sourire (le corridor buccal, l'exposition gingivale et l'absence de coïncidence entre la ligne inter- incisive supérieure et la ligne médiane avec et sans gonflement des lèvres.) ,sur la perception de l'attractivité de ce sourire par modification numérique des images. Le jugement est fait par des profanes de différentes populations du Moyen-Orient (libanais, syriens et égyptiens).

**Matériels et Méthodes :** 180 participants sont divisés en 3 groupes (n=60 ; 30 hommes et 30 femmes) : profanes libanais, profanes syriens et profanes égyptiens.
Une photo frontale de la bouche d'une femme dont le sourire suit les normes standards est manipulée par Photoshop par modification graduelle de chaque paramètre en trois grades. Le nombre total de sourires évalués est de 18.
De plus, chaque évaluateur doit signaler dans le questionnaire ce qui l'attire le plus dans le visage de son interlocuteur. La comparaison des variables est réalisée par une analyse de variances à mesures répétées et est suivie par des analyses univariées et des comparaisons multiples de Bonferroni.

**Résultats :** Le sourire et les yeux sont les deux éléments les plus attirants dans le visage. Pour la ligne médiane inter-incisive, seuls les profanes libanais et les femmes égyptiennes favorisent la coïncidence de la ligne médiane inter-incisives avec celle de la face par rapport aux autres positions (différence significative p-value<0.05). Pour l'exposition gingivale au sourire, les femmes profanes des trois populations et les hommes syriens tolèrent un gummy smile de 2mm alors que les profanes libanais n'aiment aucune exposition gingivale (p-value<0.05). Les égyptiens n'ont aucune préférence spécifique(p-value>0.05). Pour le corridor buccal, sa taille n'influence pas l'attractivité du sourire (p-value>0.05).
Le gonflement de la lèvre a affecté la perception de l'esthétique du sourire pour la ligne médiane (chez les syriens et les égyptiens.)

**Conclusion :** Le sexe et la culture affectent la perception de l'attractivité du sourire pour certains paramètres. L'altération du corridor buccal ne semble pas influencer l'attractivité du sourire. Le gonflement de la lèvre supérieure peut être avantageux dans certains cas et défavorable dans d'autres.

**Mots clés :** sourire, lèvres, ligne médiane, esthétique.

## Introduction

Aesthetics is a subjective discipline that varies by person and is influenced by the personal experiences and social environment of each individual (e.g., ethnicity, age, sex, sociodemographic, psychological and cultural levels) [1,2,3].
The perception of the face by an observer has different components, for example, the eyes, nose, cheeks, teeth, lips [4]. The mouth (i.e., lips, teeth) is one of the most attractive elements of the face and plays a critical role in facial attractiveness judgments.
Society and media give body esthetics great importance, especially the face and smile. The esthetic component in the Index of Orthodontic Treatment Need shows that esthetic dentistry contributes to approximately 30% of the aesthetics of the face [1].
An esthetic smile has always been considered to play a critical role in the degree of perceived attractiveness and social relations. The restoration of esthetics increases patients' self-confidence because the attractiveness of their smile is improved.
The literature has suggested that the development of an esthetic smile lays out as many objective elements as possible, but does not clarify the importance of the smile's characteristics [4].
A hierarchy of smile characteristics has been observed and influences smile attractiveness. This finding implies that an aesthetic smile must be broken down, and each characteristic evaluated separately. This method helps determine the effect on and relative importance to the whole [5].
In-depth studies by orthodontists of the features necessary to design an attractive, well-balanced smile have guided dental treatment. However, each person perceives aesthetics differently [6].
Opinions may vary depending on whether the person perceiving is a professional or a layperson. For this reason, a dentist, when restoring a smile, should not underestimate her or his patients' different preferences for aesthetic standards.
Therefore, consideration of the subjective judgment of the patient is necessary when developing an ideal treatment plan [7].
Parekh conducted one of the first evaluations of acceptability of the smile by varying 2 parameters: smile arc and buccal corridor [4].
Studies in restorative dentistry and orthodontics have shown that dentists and laypersons detect differences in the characteristics of a smile, and for many variables, laypeople were less discriminating than practitioners; however, other studies have reported that the judgment of the attractiveness of the smile is similar [8].

Kerr focused on laypeople from different regions of the United States by including several smile variables [1].
Kokich and his colleagues postulated that an exaggerated occlusion plan can sometimes be an element of an extremely unpleasant smile, according to professionals and non-experts [8].
Rosenstiel et al, [9] suggested the following:

1. A small buccal corridor is critical in developing a smile.
2. A gummy smile does not seem to be well tolerated by the evaluators.
3. Deviations of the maxillary midline can disturb the balance and the esthetic of a smile.

According to the results presented by Vallittu, compared with men, women are more interested in the appearance of teeth, and for the same characteristic, compared with elderly individuals, young people are more interested [10].
According to our review of the literature, the effect of the buccal corridor on smile attractiveness remains controversial; this dispute may be due to differences in methodology or differences in perception among cultures. Thus, the influence of the social environment and the culture of a person on the perception of attractiveness should be investigated [6].
Notably, the best approach might be to have the patient, rather than the dentist, specify what is ideal and acceptable in smile esthetics [11]. However, the effect of varying smile parameters on the perceived level of attractiveness has rarely been evaluated in the Middle Eastern populations [6].
Computerized technology facilitates the task of smile component variation, to perform a quantifiable evaluation. The application of a computer methodology to modify dental morphology would be an effective method for exploring aesthetics because of the consistency and the control of manipulations [8]. Kokich et al were the first to use a computer to change the smile and make it evaluable; they attempted to quantify the criteria of acceptability of the smile by using images of smiling women [8]

Therefore, the objective of this study is to compare the effect of the variation of smile parameters (i.e., buccal corridor, gingival display, maxillary midline to face, with and without lip filling) on the perception of the attractiveness of the smile, after the digital modification of images, as judged by laypeople from different populations of the Middle East (i.e., Lebanese, Syrians, and Egyptians). The visual analog scale is used.
Three null hypotheses are proposed:

1) There is no significant difference in the appreciation of the esthetics of modified smiles between different populations of the Middle East.
2) There is no significant difference in the assessment of the esthetics of the modified smiles between men and women in this evaluation.
3) Filling the upper lip does not influence the perception of the attractiveness of a smile.

## Materials and methods

### Evaluators recruitment

The study was approved by the Ethics Committee of the Faculty of Dentistry at Saint Joseph University.
The aim of the study is to compare the esthetic preferences of laypersons from 3 countries in the Middle East: Syria, Egypt, and Lebanon. The 180 evaluators were randomly selected and then divided into 3 groups of 60 participants: 30 men and 30 women.

**Inclusion criteria for the study**
All evaluators were required to fulfill the following criteria: a similar sociodemographic level (possession of at least a bachelor's degree 2nd part), a resident of Lebanon for a maximum of 6 months (for the non-Lebanese), and aged between 20 and 40 years.

**Exclusion criteria for the study**
All evaluators were excluded based on the following criteria: aged > 40 years or <20 years, visual disturbances, excessive alcohol consumption, neurological problems or medications that affect the cognitive state and state of consciousness, and a resident of Lebanon for more than 6 months (for non-Lebanese).

**Smile selection and images manipulation**
A woman with a smile that follows the standard norms (i.e., golden rule and smile arc that follows the curvature of the lower lip) was asked to be the model for the image we used in this study [12].
She signed an informed consent form, in which she accepted the digital manipulation of her smile and its uses in this study.
A frontal photo of the smile, namely, the lower third of the face (figure 1) was taken with a professional digital camera (Canon 750D kit, Canon 100mm f2.8, Canon EL-100 flash system with R2-U Bracket), according to standardized norms [13]: place the patient in a natural head position and reveal the tip of the nose, labio-mental groove, and lips and teeth. This frontal image was bisected, and 1 side was manipulated then duplicated to eliminate asymmetry. Bilateral symmetry of the teeth and the lips was obtained (a technique similar to that of Parekh et al, [4] was used).
Figure 1.A is a reference photo that was later manipulated by software (Adobe Photoshop CS6, Adobe Systems Inc., San Jose, California, USA) to produce a series of images with the nose and chin removed to reduce the number of confusing elements.
Each parameter of the smile (variable) was gradually modified into 3 grades [14].
We used 3 variables: buccal corridor, gingival display, upper midline to face discrepancy.
Nine modified photos were created. They were then modified with software by increasing the vertical thickness of the upper lip at the vermilion level (2 mm; figure 1.B).

The number of photos of smiles was 18.

The modification of each of the variables was performed as follows:
The buccal corridor, defined as the amount of black space located between the buccal surface of the posterior teeth and the labial commissure, was calculated by the difference between the inter-commissural distance and the width of the maxillary teeth, divided by the inter-commissural distance. This ratio was expressed as a percentage. The ideal position was not to exceed 1/3 of the distance between the upper middle line and the upper canine [15,16].
The size of the buccal corridor was modified (Figure 2) by increasing or decreasing the number of visible posterior teeth (moving them medially or laterally, the inter-canine distance was kept constant to maintain an authentic appearance). Three modified smile photos, 1 each with an absent (0%), medium (10%), and excessive (20%) buccal corridor, were created.

Fig. 1A. Reference smile which follows the standards, it will be manipulated by the software

Fig. 1B. Reference smile with lip filling


Fig. 2. Buccal corridor manipulation with and without the upper lip filling: a. absence of buccal corridor (0%) - b. average size of the buccal corridor (10%) - c. large buccal corridor (20%)

A gummy smile, amount of gingiva visible above the collar of maxillary incisor [17], was manipulated by the software by moving the lip or the skeletal portion of the upper arch to obtain a smile without gingival exposure. Notably, an ideal smile has 2 mm of visible gum, and an excessive gingival smile has 4 mm of exposed gum (Fig. 3).

To manipulate the upper midline to the face (philtrum of the upper lip), it is sufficient to move the teeth to the left, keeping the buccal corridor stable (the morphology of the posterior teeth is changed) to obtain 3 digital photos with the coinciding (ideal) center lines, a 2 mm deviation from the center line, and a 4 mm deflection, respectively (Fig. 4).


Fig. 3. Gummy smile manipulation with and without the upper lip filling: a. Absence of gummy smile - b. 2mm of gummy smile - c. excessive gummy smile


Fig. 4. Midline to face manipulation with and without upper lip filling: a. No deviation (ideal) - b. 2mm discrepancy - c. 4mm discrepancy

**Survey**

Each evaluator must answer anonymously a demographic questionnaire (e.g., age, sex, profession, place of residence, level of education) and sign an informed consent that explains the methodology and aim of this study.

Each evaluator must also indicate which feature is most attractive in the face of the interlocutor.

The smile photos were displayed to each evaluator on a computer as a series of 3 photos that corresponded to the gradual variations of each parameter.

Each photo was accompanied by a visual analog scale (VAS) of 10 cm in length bounded from less attractive to more attractive from left to right, respectively (Fig. 5).

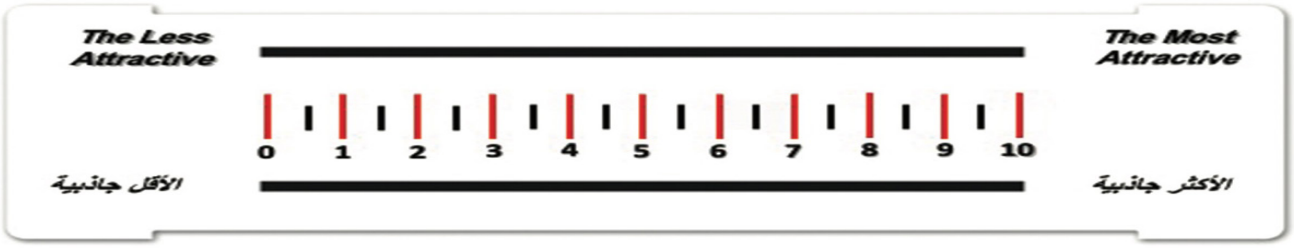


Fig. 5. The visual analogue scale (VAS)

The evaluator was asked to rate (between zero and 10) the esthetic degree of each smile in order of attraction.

The duration of the first evaluation (without lip filling) was approximately 10 minutes.

Next, the evaluator rested their eyes for 5 min before starting the second evaluation; for this evaluation, we presented the evaluator with a new series of photos of the same modified parameters but in which we filled the upper lip (the evaluator was not informed of this change and believed that they are reevaluating the same pictures).

The duration of the second evaluation was 10 minutes.

The studies were performed during the same interview session to avoid the loss of sight of the evaluators.

## Statistical analysis

**Statistical tests**

Analysis of repeated measures variances was conducted to compare each of the variables (i.e., buccal corridor, gingival exposure, midline to face discrepancy) according to the different populations (i.e., Lebanese, Syrian, Egyptian), to the different measures of each variable and sex.

These analyses were followed by univariate analyses and multiple comparisons of Bonferroni.

The statistical software SPSS version 2.0 was used for statistical analysis of the data. The significance level used corresponds to p value ≤0.05.

**Comparison of laypeople of the 3 countries of the Middle East**

Statistical Package Software for Social Sciences (SPSS for Windows, Chicago, USA, version 24.0) was used for the statistical analysis of data. The significance threshold used corresponds to -p value ≤0.05. Kolmogorov-Smirnov tests were performed to assess the normality of the distribution of the quantitative variables.

Friedman tests and repeated measures analysis of variance tests were conducted to compare the VAS score (visual analogue scale) between the different shapes of the same picture.

Mann-Whitney and Student tests for independent series were used to compare the EVA score between men and women.

Kruskal Wallis tests and analysis of variance followed by multiple analyses were used to compare scores across nationalities.

Whitney tests and Student tests for paired series were used to compare scores between photos with and without lip filling.

## 3 Results

**The most attractive element in the face**

Eyes and smile are the 2 most attractive elements in the face, respectively.

For Lebanese men, eyes (53.4%) and teeth (40.0%) were coded most frequently. For women, eyes (43.4%), smile (30.0%), and teeth (20.0%) were coded most frequently. The difference was significant between men and women (-p value <0.001).

For Syrian men, eyes (53.3%) and teeth (40.0%) were coded most frequently. For women, eyes (63.3%) were coded most frequently. The difference was significant between men and women (-p value <0.001).

For Egyptian men, smile (33.3%), eyes (26.7%), and teeth (26.7%) were coded most frequently. For women, eyes (50.0%), smile (30.0%), and teeth (23.3%) were coded most frequently. The difference was significant between men and women (-p value <0.001) (table 1).

| Nationality | | Sex | | Total |
|---|---|---|---|---|
| | | Male | Female | |
| **Lebanese** | Mouth | 1(3.3%) | 1(3.3%) | 2(3.3%) |
| | Teeth | 12(40.0%) | 6(20.0%) | 18(30.0%) |
| | Eyes | 16(53.3%) | 13(43.3%) | 29(48.3%) |
| | Smile | 1(3.3%) | 9(30.0%) | 10(16.7%) |
| | Lips | 0(0.0%) | 1(3.3%) | 1(1.7%) |
| | Face | 1(3.3%) | 1(3.3%) | 2(3.3%) |
| | Nose | 2(6.7%) | 1(3.3%) | 3(5.0%) |
| | Skin | 0(0.0%) | 2(6.7%) | 2(3.3%) |
| | ***Total*** | ***30(100.0%)*** | ***30(100.0%)*** | ***60(100.0%)*** |
| **Syrians** | Mouth | 1(3.3%) | 0(0.0%) | 1(1.7%) |
| | Teeth | 12(40.0%) | 4(13.3%) | 16(26.7%) |
| | Eyes | 16(53.3%) | 19(63.3%) | 35(58.3%) |
| | Smile | 6(20.0%) | 5(16.7%) | 11(18.3%) |
| | Lips | 0(0.0%) | 1(3.3%) | 1(1.7%) |
| | Face | 3(10.0%) | 2(6.7%) | 5(8.3%) |
| | Nose | 2(6.7%) | 0(0.0%) | 2(3.3%) |
| | Symmetry | 1(3.3%) | 0(0.0%) | 1(1.7%) |
| | ***Total*** | ***30(100.0%)*** | ***30(100.0%)*** | ***60(100.0%)*** |
| **Egyptians** | Mouth | 0(0.0%) | 1(3.3%) | 1(1.7%) |
| | Teeth | 8(26.7%) | 7(23.3%) | 15(25.0%) |
| | Eyes | 8(26.7%) | 15(50.0%) | 23(38.3%) |
| | Smile | 10(33.3%) | 9(30.0%) | 19(31.7%) |
| | Lips | 3(10.0%) | 2(6.7%) | 4(6.7%) |
| | Face | 0(0.0%) | 1(3.3%) | 1(1.7%) |
| | Nose | 0(0.0%) | 2(6.7%) | 2(3.3%) |
| | Symmetry | 5(16.7%) | 1(3.3%) | 6(10.0%) |
| | ***Total*** | ***30(100.0%)*** | ***30(100.0%)*** | ***60(100.0%)*** |

Table 1. distribution of percentages of the most attractive elements in the face of the interlocutor from the Lebanese, Syrians and Egyptians point of view

**Study results:**
One hundred and eighty participants (60 Lebanese, 60 Egyptians, and 60 Syrians) of average age 30.62 ± 8,742 years were included in the study.

**1-Assessment of the midline to face at the group level**
The mean and standard deviation of the midline to face score for the different nationalities are presented in table 2.

| Midline to Face | | | | | |
|---|---|---|---|---|---|
| **Lebanon** | | **Ideal** | **2mm Deviation** | **4mm Deviation** | **-p-value** |
| **Men** | Without lip filling | 8.00 ± 1.365[c] | 7.20 ± 1.584[b] | 6.47 ± 2.738[a] | 0.011 |
| | With lip filling | 7.93 ± 1.337[c] | 6.97 ± 1.956[b] | 6.17 ± 2.666[a] | 0.007 |
| **Women** | Without lip filling | 7.30 ± 2.087[c] | 6.97 ± 1.974[b] | 6.00 ± 2.304[a] | 0.046 |
| | With lip filling | 6.80 ± 1.955[c] | 6.10 ± 2.023[b] | 5.07 ± 2.716[a] | 0.001 |
| **Syria** | | **Ideal** | **2mm Deviation** | **4mm Deviation** | **-p-value** |
| **Men** | Without lip filling | 7.97 ± 1.273 | 7.67 ± 1.918 | 7.43 ± 2.417 | 0.464 |
| | With lip filling | 8.07 ± 1.617[c] | 7.17 ± 2.365[b] | 6.53 ± 2.862[a] | 0.018 |
| **Women** | Without lip filling | 7.37 ± 1.402 | 6.87 ± 1.655 | 6.57 ± 2.315 | 0.202 |
| | With lip filling | 7.27 ± 1.929[c] | 6.27 ± 2.333[b] | 5.60 ± 2.787[a] | 0.004 |
| **EGYPT** | | **Ideal** | **2mm Deviation** | **4mm Deviation** | **-p-value** |
| **Men** | Without lip filling | 8.10 ± 1.269 | 7.57 ± 1.305 | 7.63 ± 1.586 | 0.189 |
| | With lip filling | 7.73 ± 1.893[b] | 7.70 ± 1.985[b] | 7.07 ± 2.477[a] | 0.036 |
| **Women** | Without lip filling | 7.13 ± 1.592[b] | 6.13 ± 1.570[a] | 5.53 ± 2.224[a] | 0.005 |
| | With lip filling | 6.57 ± 1.942[b] | 6.23 ± 1.736[b] | 5.43 ± 2.128[a] | 0.032 |

*Different letters indicate the presence of significant difference between the positions of the midline*
Table 2. Midline to face evaluation by the 3 population of the Middle East

**Comparison of the midline positions**

For the Lebanese (men and women), the EVA score was significantly high when the midline was ideal, intermediate for the deviated midline of 2 mm, and smaller when deviated by 4 mm, in the presence and the absence of lip filling (-p value <0.05).

The difference was not significant between positions of the midline without lip filling for Syrian men (-p value = 0.464), Syrian women (-p value = 0.202), and Egyptians (-p value = 0.189).

The EVA score was significantly high when the midline was ideal, intermediate for the deviated midline of 2 mm, and smaller when deviated by 4 mm, in the presence of lip filling, for Syrian men and women (-p- value <0.05).

For Egyptian women, the score was significantly high when the midline was ideal, and the difference was not significant between the 2 mm and 4 mm deviations (-p value <0.05).

**2- Evaluation of the gummy smile at group level**

The mean and standard deviation of the smile line score for the different nationalities are presented in table 3.

| Gummy Smile | | | | | |
|---|---|---|---|---|---|
| **Lebanon** | | **zero** | **2 mm** | **4 mm** | **-p-value** |
| **Men** | Without lip filling | 7.67 ± 1.647 [c] | 6.73 ± 1.760 [b] | 5.67 ± 2.187 [a] | 0.001 |
| | With lip filling | 7.40 ± 1.940 [c] | 6.60 ± 1.329 [b] | 5.47 ± 2.177 [a] | 0.001 |
| **Women** | Without lip filling | 6.67 ± 1.971 [b] | 6.90 ± 2.510 [b] | 5.93 ± 2.728 [a] | 0.036 |
| | With lip filling | 6.30 ± 2.307 [b] | 6.17 ± 2.588 [b] | 5.43 ± 2.661 [a] | 0.049 |
| **Syria** | | **zero** | **2 mm** | **4 mm** | **-p-value** |
| **Men** | Without lip filling | 8.03 ± 1.671 [b] | 8.23 ± 1.633 [b] | 7.30 ± 2.507 [a] | 0.021 |
| | With lip filling | 7.87 ± 1.907 [b] | 7.77 ± 1.977 [b] | 6.93 ± 2.196 [a] | 0.016 |
| **Women** | Without lip filling | 7.47 ± 1.383 [b] | 6.73 ± 1.982 [b] | 5.97 ± 2.220 [a] | 0.030 |
| | With lip filling | 7.23 ± 2.112 [b] | 6.63 ± 2.042 [b] | 5.60 ± 2.749 [a] | 0.008 |
| **Egypt** | | **zero** | **2 mm** | **4 mm** | **-p-value** |
| **Men** | Without lip filling | 7.97 ± 1.402 | 8.27 ± 1.388 | 7.97 ± 2.141 | 0.234 |
| | With lip filling | 7.60 ± 1.694 | 7.47 ± 1.756 | 7.23 ± 2.128 | 0.633 |
| **Women** | Without lip filling | 6.53 ± 2.013 [b] | 6.57 ± 1.547 [b] | 5.33 ± 1.583 [a] | 0.000 |
| | With lip filling | 6.07 ± 1.946 | 5.93 ± 1.799 | 5.67 ± 2.468 | 0.780 |

*The different letters indicate the presence of significant difference between the positions of the gummy smile*

Table 3. Evaluation of the gummy smile by the 3 population of the Middle East

**Comparison of the positions of the gummy smile**

For Lebanese men, the EVA score was significantly low when the gummy smile was 4 mm, intermediate when the gummy smile was 2 mm, and higher for the zero gummy smile, in the absence (-p value = 0.001) and in the presence of lip filling (-p value = 0.001).

For Lebanese women and Syrian men and women, the EVA score was significantly low when the gummy smile was 4 mm, and the difference was not significant between a zero and a 2 mm gummy smile (-p value < 0.05), in the absence and presence of lip filling.

For Egyptian men, the difference was not significant (-p value> 0.05).

For Egyptian women, the score was significantly low for the 4 mm gummy smile, and the difference was not significant between a zero and a 2 mm gummy smile (-p value <0.05), in the absence of lip filling.

**3- Evaluation of the buccal corridor at group level**

The mean and standard deviation of the score of the evaluation of the buccal corridor for different nationalities are presented in table 4:

| Corridor Buccal | | | | | |
|---|---|---|---|---|---|
| **Lebanon** | | **0%** | **10%** | **20%** | **-p-value** |
| **Men** | Without lip filling | 7.60 ± 1.653 | 7.20 ± 1.769 | 7.23 ± 1.591 | 0.282 |
| | With lip filling | 7.17 ± 2.151 | 7.20 ± 1.584 | 7.00 ± 1.509 | 0.335 |
| **Women** | Without lip filling | 6.30 ± 2.423 | 6.30 ± 2.395 | 6.03 ± 2.593 | 0.522 |
| | With lip filling | 6.00 ± 2.407 | 6.00 ± 2.213 | 6.10 ± 2.482 | 0.932 |
| **Syria** | | **0%** | **10%** | **20%** | **-p-value** |
| **Men** | Without lip filling | 7.03 ± 2.399 | 6.83 ± 2.365 | 7.03 ± 2.414 | 0.570 |
| | With lip filling | 7.63 ± 1.732 | 7.80 ± 1.864 | 7.80 ± 1.789 | 0.606 |
| **Women** | Without lip filling | 6.90 ± 2.249 | 7.00 ± 1.722 | 6.63 ± 1.847 | 0.428 |
| | With lip filling | 7.03 ± 2.470 | 6.73 ± 2.067 | 6.47 ± 2.224 | 0.232 |
| **Egypt** | | **0%** | **10%** | **20%** | **-p-value** |
| **Men** | Without lip filling | 7.97 ± 1.691 | 7.83 ± 1.783 | 7.57 ± 2.063 | 0.282 |
| | With lip filling | 7.50 ± 2.177 | 7.60 ± 2.159 | 7.40 ± 2.111 | 0.443 |
| **Women** | Without lip filling | 6.33 ± 1.605 | 6.13 ± 1.570 | 5.70 ± 2.292 | 0.485 |
| | With lip filling | 6.30 ± 1.985 | 5.93 ± 2.083 | 5.67 ± 2.468 | 0.457 |

*Different letters indicate the presence of significant difference between the photos of the buccal corridor*

Table 4. Evaluation of the buccal corridor by the 3 population of the Middle East.

**Comparison of the photos of the buccal corridor**

EVA scores were not significantly different between the different forms of corridor among the Lebanese, Syrians, and Egyptians (-p value> 0.05).

Summary tables present the results obtained for the degree of attractiveness of the smiles for each modified parameter (table 5).

| MEP (preferences) | | | | | |
|---|---|---|---|---|---|
| Midline to face discrepancy | | | | | |
| Men | Syria | ND/ **ideal** | Women | Syria | ND/ **ideal** |
| | Lebanon | ideal | | Lebanon | ideal |
| | Egypt | ND/ **ideal; 2mm** | | Egypt | ideal / **ideal; 2mm** |
| Gummy smile | | | | | |
| Men | Syria | zero; 2mm | Women | Syria | zero; 2mm |
| | Lebanon | zero | | Lebanon | zero; 2mm |
| | Egypt | ND | | Egypt | zero; 2mm |
| Buccal Corridor | | | | | |
| Men | Syria | ND | Women | Syria | ND |
| | Lebanon | ND | | Lebanon | ND |
| | Egypt | ND | | Egypt | ND |
| **Lip filling influence on smile attractiveness threshold: preference without upper lip filling/ preference with upper lip filling** | | | | | |

Table 5.Summary table of the results of Middle- East population (MEP) preferences; ND: no difference

## Discussion

Nowadays, patients expect their dentist to fulfill their esthetic concerns, with conjunction to healing their oral diseases. Esthetics is the main field in dentistry that is based essential criteria mixed with individual and subjective perception.

Patients' esthetic perceptions may differ from those of their dentists or the ideal outcome. The success of prosthetic treatment depends on the patient's expectations and acceptance of the esthetic result; thus, 2 necessary steps are to examine their subjective judgment and to include their preferences in the treatment plan.

An esthetic smile can have divergent meanings in different cultures and social environments. Many factors, such as demographics, race, ethnicity, and culture can play a critical role in the perception of facial esthetics [18].

Mcleod[19] postulated that the difference between nationalities and cultures would result in different points of view on the parameters of a smile. He suggested that orthodontists in North America should not assume that patients from the United States (US) and Canadian would equally criticize the esthetics of a smile, because a significant difference has been found among Canadian and US laymen toward several components of smiles.

This study focused on the modification of the aspects of 3 parameters of the smile—the midline to face discrepancy, the amount of gingival exposure, and the buccal corridor—and compared the perception of aesthetics between laypersons from 3 countries in the Middle East: Lebanon, Syria, and Egypt.

Evaluators' recruitment was conducted inside and outside Lebanon, and each evaluator had to have at least a bachelor's degree. Thus, the evaluators were from different professions but comparable sociodemographic levels.

Each sample was equitably divided between men and women, and the perception of both sexes was considered separately: therefore, any risk of bias at this level was eliminated because in the results, the difference between the perception of men and women was statistically significant.

One of the strengths of this study is the large sample size: 180 evaluators. A second strength is this study's unique topic: a comparison of regional differences in the perception of smile esthetics among 3 Middle Eastern countries.

The laypersons had no statistically significant differences in their perception of features of the smile, but for others, the difference was significant. The influence of the media and popular culture may be responsible for this finding.

We compared the opinions of laypersons because they are the main consumers of dental care provided by dentists, and their point of view is paramount in any treatment plan.

Many researchers have applied computer-based techniques to modify dental morphology, and this appears to be an effective method in exploring dental esthetics because of the consistency of variable changes and its controlled presentation [1].

Kokich and his colleagues were the first to use the computer to quantify the threshold of acceptance for the smile parameters by using images of a woman's smile. They deduced that general dentists and laypersons can detect divergences in the parameters at different levels, and laymen were less discriminating than dentists [14].

The photos used in this study were limited to the mouth to reduce the effect of confusion. The inclusion of several features of the face, such as exposure of the entire face, demonstrates an interaction between the different tissues that condition the smile. Skin color, lipstick application, excessive cropping, and tooth shape can also affect the perception of the characteristics of a smile [14,20,21]. The results of Mcleod [19] demonstrated that laymen can reliably identify the ideal smile and determine the margin of acceptability when the lower third of the face is used in the evaluation. This finding enhanced the power of the method used in this study.

Moore et al. deduced that the size of the buccal corridor influences the attractiveness of the smile when the smile is in the context of the full face [22]. A difference in the perception thresholds or smile esthetics has been demonstrated in the many studies that have compared images of a smile confined to the lower third of the face with images that used a global approach, namely, the whole face (confer in annex) [23].

The photographs of the smiles were evaluated using the EVA VAS. Other studies have used a different scale based on different evaluation scores: very attractive, attractive, acceptable, unattractive, and very unattractive [24]. This method of esthetic evaluation produces simple, fast, and reproducible results, whereas according to some authors, the EVA method can result in different meanings for different evaluators, and the evaluators use part of the scale and ignore the rest [25]. However, many other studies (Roden-Johnson et al, [26] Parekh et al, [4] Krishnan et al, [27] Ioi et al, [21] based on the EVA method have demonstrated its reliability.

One of the weak points of our study could be the modification of each parameter by large increments (1 mm or more), which may have distorted the true threshold of acceptability.[1] However, this modification was intentional and performed to maintain the same number of photos for each variable and to avoid cluttering the evaluators, the large number of photos if the incremental variation was smaller, which can increase the risk of bias.

A computerized copy of the questionnaire was sent to each evaluator to facilitate access and communication.

During the investigation, the evaluators are unaware of the upper lip filling performed on the second set of photos; thus, they believed they were repeating the same test to ensure the results. This method was used to reduce bias by avoiding drawing the assessor's attention to an external parameter (the upper lip).

In this study, gender affected the results. This finding contradicts those of Moore et al, [22] and Ioi et al, [l21]

who suggest that men and women evaluate different aspects of the smile in the same manner. These studies were performed with samples of people from Japan and the United States, not from the Middle East; thus, our results may differ because there is a greater difference between girls' and boys' education in the Middle East than that in the United States or Japan. This difference could influence their esthetic apprehension later.

In our study, the null hypotheses were rejected for some parameters because we observed a significant difference between men and women and between laypersons.

For the general public, the smile is second to the eyes as the most attractive element of the face [28].

Many studies based on the eye movement of the evaluator have demonstrated that the gaze goes first to the eyes of the interlocutor; therefore, the eyes are the most attractive element of the face, followed by the mouth, when the evaluators examine a face for the first time [15,29,30]. By contrast, a recent study with Black and white evaluators demonstrated that the eyes and the nose, respectively, are the most attractive elements of the face [25]. Primacy is attributed to the eyes in the attention of observers, but the mouth has a similar impact when tooth attractiveness decreases [31].

In the inclusion criteria of this study, evaluators who have been in Lebanon for more than 6 months were excluded because over time, emigrants acquire the culture of the host country and therefore tend to modify their preferences in the sense of the entourage. This phenomenon was confirmed by Depalo et al, who recognized that the length of stay in the host country is a key factor in assessing immigrant integration [32]. Some schools postulate that immigrants must assimilate to the culture, values, and way of life of their new country [33].

**Determination of the attractiveness of the smile among the different groups for each parameter.**

**Midline to face discrepancy**

The maxillary midline is often compared with the facial midline according to the middle of the philtrum [17,34,35,36] and the nasion [34,35].

Alterations of the midline are the most egregious occlusal defects from the patient's point of view [37].

In this study, Egyptian women and the Lebanese preferred the coincidence of the midline with the lip philtrum, and the Syrian and Egyptian men were not too demanding.

These results show that the Lebanese laypersons are the most meticulous and the most difficult to satisfy, because they detected the slightest defect of the position of the midline and devalue it. Additionally, Egyptian women were always pushing the dentist to attempt to coincide the midline to the face to ensure the satisfaction of Lebanese patients and the Egyptian women with prosthetic rehabilitation.

Studies have demonstrated that the minimum margin tolerated by the layperson is 2 mm [26] and that the maximum threshold accepted is 4 mm [8].

Some authors [24,38,39,40] have shown that a deviation of the upper midline of 2 mm is likely to be noticed by laypersons, which is partly consistent (for Lebanese and Egyptian women) with this study in which a deviation of 2 mm was perceived; however, others [8,41] have found that the layperson could only perceive a difference starting at 4 mm. Others have reported that laypersons do not notice deviations of less than 3 mm [2,42].

According to Ker et al, the maximum acceptable value of the deviation of the midline should be 2.9 mm, although one third of the evaluators in their study accepted a 4.3mm difference [1].

In McLeod's study, Canadians identified a 1.1 mm deviation as the acceptable threshold of the midline, and this deviation was not perceived by people in the United States [55].

In a study conducted in Iran, the threshold of the acceptability of deviations was the same for orthodontists and laypersons (1 mm offset) and was 3 mm for general practitioners and dentists [43].

**Gummy smile**

The position of the gummy smile has been widely treated in the literature [8,14,34,44].

No consensus exists on the threshold that influences the aesthetics of the smile [8,14,44].

In this study, Lebanese men did not tolerate any gum exposure and preferred a smile without gummy exposure.

By contrast, Egyptian men expressed no specific preference for or against a gummy smile.

The women of the 3 populations and the Syrian men consider a smile esthetic if it has no gingival exposure or a gum exposure of 2 mm.

Therefore, compared with women, Lebanese men are more sensitive to this parameter.

Peck and Peck studied the difference between sexes in their evaluation of a gummy smile and concluded that the presence of a high smile line for women is twice as frequent as for men, which could explain the Lebanese men point of view in this study and the tolerance of women to a gummy smile, because they are more frequently exposed and accustomed to this type of smile [45].

Similarly, Vig and Brundo demonstrated a sexual dimorphism between men and women in the frequency of gum exposure for women more than men [46]

According to other researchers [29], compared with women, men focus more on the mouth, teeth, and nose.

Paula et al, [47] studied the self-perception of adolescents in Goiania (Brazil) regarding the exposure of their anterior teeth during the smile, and the results were contrary to those of our study, which implied a third-party evaluation of the gingival smile. They concluded that women consider the gummy smile attractive. Indeed, in Brazil, an excessive gingival dis-

play is a common feature, especially for women, and a low smile line is mainly characteristic for men, which could explain the obtained results.
According to Cracel et al, laypersons find a 4 mm gummy smile acceptable, but the same smile is considered not esthetic by dental students and dentists [48].
In the study by Elham S. et al, in Jordan [24], a gummy smile from 2 mm was statistically considered unsightly or unattractive by all groups, and individuals were less sensitive to a 1 mm change in gum exposure. Hunt et al, [49] found the same result in their study in Northern Ireland. These 2 studies confirm the results obtained in our study: the beginning of the dissatisfaction starts from 2 mm of gingival exposure for certain groups and from 4 mm for others. This finding is in line with that by Kokich [8], who reported that the amount of gingival exposure during the smile is detected by general practitioners or laypersons starting 4 mm and that orthodontists tolerate up to 2 mm; however, more recently [14], he deduced that the acceptable threshold can be 3 mm, and this was obtained after modifying this parameter by smaller increments. A similar result was demonstrated by McLeod et al, [19], who reported that the ideal value of gingival exposure was 2.1 mm in the US population and approximately 3 mm in the Canadian population, but this contrasts with Pithon et al, [50], who reported that a 3mm exposure of gum was considered unaesthetic by laypeople, students, and professionals in Brazil.

**Buccal corridor**

The reduction of the size of the buccal corridor is a topic treated by orthodontists to design large arches without the use of dental extractions [21].According to several studies, the ideal size of the buccal corridor varies between 2% [22] and 19% [44]; in the Ker et al, study, the ideal size of the negative lateral space was 16% with a range of acceptability from 8% to 22%, with a tendency for evaluators to approach to a buccal corridor of 19% [1].

In our study, among the men and women of the 3 nations, the size of the buccal corridor did not influence the attractiveness of the smile; therefore, it is not affected by the sex of the evaluators. This result is in agreement with other studies [20,21,22,51]. The results in Krishnan et al, [27] and loi et al, [21] have demonstrated that orthodontists and dental students have similar tendencies in their preference for the oral corridor. This similarity could be because they did not consider the gender of the evaluators, which may have biased the results.
A study in Japan concluded that orthodontists and laypersons perceive a difference between the sizes of the buccal corridors and like a broad smile with the smallest buccal corridor possible, with no difference between men and women [21].
This result could be because of the influence of the media, which brings stars with broad smiles to the foreground and even sometimes those with an oversized smile; thus, a subliminal message is transmitted to the viewer that beauty is closely linked to this type of smile.
Martin et al, [20] and Parekh et al, [4] have demonstrated that orthodontists and laypersons perceive the difference between negative spaces and prefer minimal buccal corridors.
A study conducted in Jordan [24] concluded that the wide corridor is unfavorable.
Moore et al, [22] aimed to assess laypersons' perception of the attractiveness of different variations in the size of the buccal corridor by exposing the evaluators to 5 sizes of a smile: narrow smile with a 28% oral corridor, moderately narrow smile with a 22% buccal corridor, medium smile with a negative lateral space of 15%, medium-wide smile with a 10% buccal corridor, and wide smile characterized by a 2% buccal corridor. The result showed that laymen prefer and find more attractive a wide smile with a small oral corridor.
Nevertheless, Roden-Johnson et al, [26] and Ritter et al, [44] have postulated that the size of the oral corridor is not a significant variable in the assessment of the attractiveness of the smile, and this result applies to the 3 populations of the Middle East in this study, which found no significant difference between the 3 modifications.
Mcleod [19] found that the tendency to decrease the oral corridor seems to be a more notable factor to treat in Canada compared with the United States (US patients were less sensitive to excessive buccal corridors).

**Influence of upper lip filling on the appreciation of the aesthetics of the smile.**

The positions of the lip and the underlying teeth are the most important components in the determination of the prosthetic result [52].
Filling of the lip affected the perception of a smile's aesthetics after the parameters were modified for the midline position: the defect was highlighted for the Syrian evaluators and the Egyptian men who had previously no preference regarding smiles without lip filling; after filling, these 2 groups preferred simultaneously an ideal midline to face position and tolerated a deflected line of 2 mm. Although the defect has been camouflaged among the Egyptians women, where they admitted that a beautiful smile was that with a 2 mm deviation of the midline and the ideal position of this line.
Therefore, the null hypothesis is partly rejected for the 3 populations of the Middle East, because the upper lip filling influenced only 1 of 3 parameters.
These results can be explained by the cultural differences in the judgment of the parameters of the smile between the 3 populations of the Middle East, and this is confirmed by McLeod et al, [19] Filling of the lips has been perceived as both advantageous and unfavorable, depending on the case.
According to Sadarhaghighi [43], increasing the vertical thickness of the lip has no significant effect on the aesthetics of the smile. By contrast, McNamara et al, [53] reported that the thickness of the lip influences the aesthetics of the smile and that the orthodontists' judgments in this regard were in agreement with those of the laypersons.

## Conclusion

In conclusion, esthetics has become an ethic in which being is reduced to appearance. The influence of the media and society has created a new concept of the appreciation of facial aesthetics, especially the smile.

Esthetics remains a subjective notion that varies by person and is influenced by culture, gender, and profession, and this was proven in our study.

Many parameters of the smile can affect its attractiveness; therefore, each should be studied separately. Margins of appreciation and tolerances exist for each of these parameters.

Three important parameters are treated in this study: buccal corridor, midline to face deviation, and gingival exposure.

Within the limitations of this study, we conclude the following:

There is a significant difference between the perception of men and women for certain parameters.

The perception of the 3 populations of the Middle East (i.e., Lebanese, Syrian and Egyptian) differs for some parameters (i.e., gummy smile and midline).

Alteration of the buccal corridor was not observed to influence the attractiveness of the smile.

Upper lip filling may be advantageous in some cases and unfavorable in others, especially in the case of detection of the deviation of the midline. Hence, the precise indication of the lip filling relative to each case is necessary to obtain an esthetic result.

A dentist must make the patient aware of the limitations and the margins of acceptability for each of the smile parameters in the treatment plan to provide the patient with a result that they consider completely satisfactory or beyond expectations.

This communication between dentist and patient is facilitated and simplified because of advancements in technology and other innovations in “Digital Smile Design,” a computer simulation concept that makes finding the appropriate smile for each patient possible, depending on her or his character and face. Thus, patients can participate in the conception of their smile and express their preferences and expectations concerning the smile they want, without focusing on a smile based on ideal standards.

**Clinical significance:** Dentists should take into consideration cultural differences when restoring smile aesthetics.

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