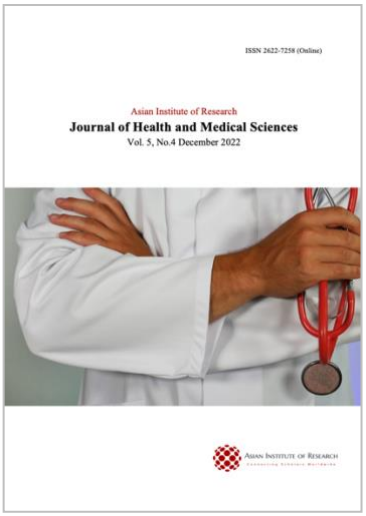

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Assessment of Smile Dimensions in an Adult Moroccan Population

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Abstract
Background: This study aimed to assess the smile dimensions according to gender, age, and the perception of the overall quality and attractiveness of the smile. Methods: A cross-sectional study including 204 Moroccan men and women distributed over five age categories was conducted between January and September 2021. Gender, age, satisfaction and auto-evaluation of the smile were collected using questionnaire. Then, two images of each participant, one at rest and one upon the largest smile were taken. The following distances were measured on the images: length of the lips and width of the mouth at rest and upon smile, gingival and maxillary central incisor displayed upon smile. Results: Dimensions were significantly more important in men. Women displayed significantly more gingiva. With age, the length of the upper lip at rest increased significantly until the age of 50 and the width of the mouth upon smile continued increasing significantly. 74% of the participants were satisfied with their smile. Participants' satisfaction with their smile was not associated with the degree of gingival display. Conclusion: Males have more important dimensions of the lips and the mouth. Females display more gum than males. Age influences the upper lip length at rest which increases up to the age of 50, and the mouth width upon smile which continues to increase with age. Practical Implications: The definition of specific facial norms for each ethnic group considering gender and age groups is essential to establish diagnoses and orthodontic treatment plans.

Keywords: Facial Expression, Smiling, Tooth Components, Periodontium, Lip, Morocco

1. Introduction

The diagnosis and treatment in modern orthodontics are no longer limited to the evaluation of the skeletal framework of the face and the dental occlusion. Nowadays, they give a capital importance to the smile appearance and the facial aesthetics (Sarver DM, 2015). Moreover, the classic Angle paradigm which considered dental occlusion to be the key word for successful orthodontic treatment has been replaced by the "soft tissue paradigm" aimed at restoring both facial aesthetics and the functions of the manducatory system (Dickens ST et al., 2002). Thus, the aesthetic outcome represents the main motivation of patients seeking an orthodontic treatment (Gazit-Rappaport T et al., 2010).

The major issue of modern orthodontics is to re-establish facial aesthetics that respect the beauty canons of different ethnical groups (Blatz MB et al., 2019). Malocclusion and the need for orthodontic treatment have been associated with oral health-related quality of life and thus with the impact on the patient's overall quality of life (Liu Z et al. 2009).

The soft tissues of the face and perioral region influence therapeutic decision making in orthodontics (Sarver DM, 2015). Adult patients present more challenges to the therapeutic choice process than adolescents and pre-adolescents (Dickens ST et al., 2002). The soft tissue profile that should be obtained after treatment must be adapted to the age and/or gender of the patients (Sarver DM, 2015).

With age, there is an increase in the length of the upper lip and a decrease in the exposure of the maxillary incisors, especially in men (Drummond S & Capelli J, 2016). Studies have shown that with ageing, there is a redistribution without total loss of volume of the upper lip, by decreasing its thickness and increasing its length (Iblher N et al., 2012). While, histomorphometric analysis revealed thinning of the upper lip with evidence of atrophy of the orbicularis muscle (Penna V et al., 2009).

The "normal" values in orthodontics, known as norms, are generally derived from populations of Caucasian origin. These norms cannot be extrapolated to other ethnic groups without proper validation. Johnson’s studies (Johnson PF, 1992) showed the existence of ethnic variations, hence the need to establish aesthetic standards for each ethnically diverse population in order to guide treatment plans and optimize outcomes.

The objective of this study was to evaluate the dimensions of the smile in an adult Moroccan population taking into account gender and different age categories.

2. Materials and Methods

We carried out a cross-sectional study to assess the smiling dimensions in a Moroccan adult population according to age and gender. The study was conducted between January and September 2021 and the sample was made up of 204 people. The inclusion criteria were as follows: Moroccan men and women, over 20 years old, who presented at least 4 anterior teeth including the maxillary central incisors. Patients with craniofacial syndrome and a history of craniofacial trauma, patients who received facial fillers, injections, plastic or orthognathic surgery, were excluded. An anonymous questionnaire collecting the following items was submitted for each participant. Which were classified according to the following five age ranges: less than 20 years, between 20 and 30 years, between 30 and 40 years, between 40 and 50 years, between 50 and 60 years and over 60 years. The participants' satisfaction or not with their own smile, as well as the evaluation they gave to their smile according to the Likert scale: Bad - Not bad - Good - Very good. Two full face photos of each participant, one at rest and one with the widest smile, were taken using a Canon EOS Kiss x4 camera. In order to obtain reproducible data, the same parameters were respected when taking all the images: an automatic “portrait” mode, a focal length of 55mm and a distance of 1.5m between the participant and the operator. The head was positioned so as to have a Frankfurt plane parallel to the ground. A ruler held between the fingers and under the chin was used as a reference for magnification measurement. On each snapshot at rest and when smiling, we measured the following variables in centimeters (Figure 1):

- The length of the upper lip (from the sub-nasal point to the lowest point of the upper lip),

- The width of the mouth (from commissure to commissure)
- The length of the lower lip (from the highest point of the lower lip to the sub-labial point).

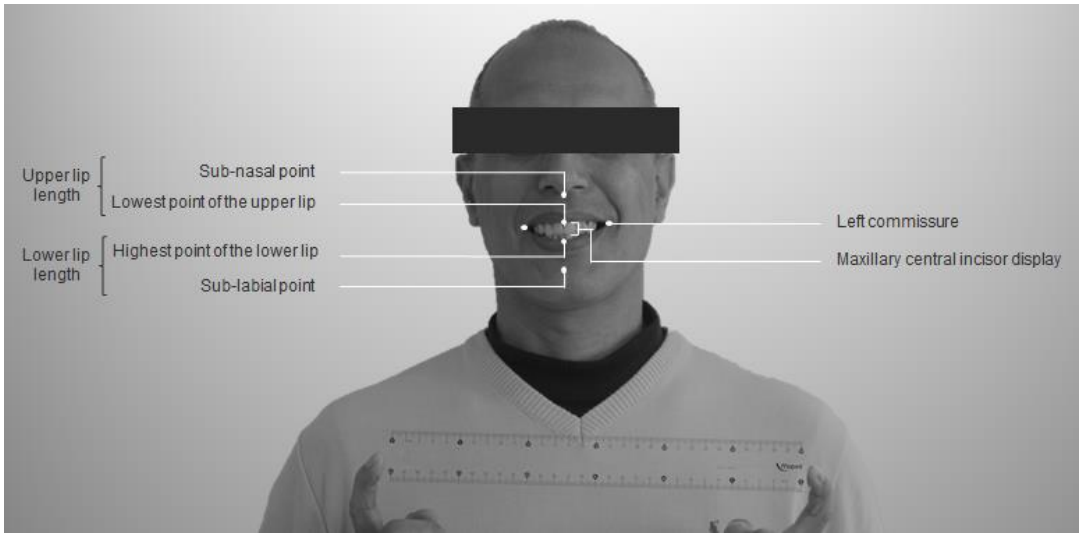

Figure 1: Plot of landmarks on a photo with the widest smile with no gingival display. The same marks were applied to the photos at rest with the exception of the gingival and the maxillary central incisor displays.

On the smiling images, we also measured the gingival and the maxillary central incisor displays. The measurements were carried out using the "ImageJ" software. The statistical analysis was carried out using the software jamovi project (2021) (version 2.0). We used the student's t test to compare the dimensions of the smile according to gender. Mann-Whitney U test was used when Student's t test was not applicable. To compare the dimensions of the smile according to age, we used the ANOVA test. When this was not applicable, we used the Kruskal-Wallis test. We used the Mann-Whitney U test to analyze the relationship between gingival display and the participants' satisfaction. A p-value of 0.05 was defined for the significance of the statistical results. Ethical clearance was obtained from the Ethics Committee (Number 09/21). All participants gave their free and informed consent to participate in this study, after explaining and discussing the objectives of the study and the anonymous and confidential nature as to the use of patients' personal data.

3. Results

204 people participated in this study with 22.5% (46) in each following age groups: >20-30, >30-40, >40-50, >50-60 and 9.8% (20) in the age group >60. Both genders were evenly split with a proportion of 50%. (Table 1) The majority of the participants were satisfied with their smile with a proportion of 74% (Figure 2). 41.2% of the participants attributed the evaluation "not bad" to their smile, followed respectively by the evaluations "good" (32.4%), "very good" (18.1%) and "bad" (5.9%). A minority of 2.9% was not concerned by this evaluation (Figure 3). At rest, the average values of the upper lip length, the mouth width and the lower lip length in centimeters were respectively: 2.09 +/ - 0.29, 4.83 +/- 0.38 et 1.67 +/- 0.32. Upon smile, these average values were respectively: 1.60 +/- 0.29, 5.89 +/- 0.51 et 1.67 +/- 0.29. The average value of the maxillary central incisor's display was 0,81 +/- 0,19cm. The gingival display varied from 0 to 0.55cm (Table 2). Gender distribution showed a significant difference for all the smiling and non-smiling dimensions except the crown display. Males presented longer and wider lips than females. The maximal gingival display value was more important in females (Table 3). The distribution by age groups showed a significant difference for the upper lip length at rest that increased with age then decreased after the age of 50. Mouth width upon smile increased significantly with age. All other dimensions did not significantly change with age (Table 4). Every increase of 1cm of the gingival display resulted in a significant average increase of 0.4 cm of the maxillary central incisor display (Table 5). Comparison of satisfaction in relation with gingival display did not show significant results: the gingival display did not significantly influence participants' satisfaction with their smile (Table 6).

Table 1: Sample characteristics

	Number	Percentage (%)
Age group		
>20-30	46	22,5
>30-40	46	22,5
>40-50	46	22,5
>50-60	46	22,5
>60	20	9,8
Females	102	50,0

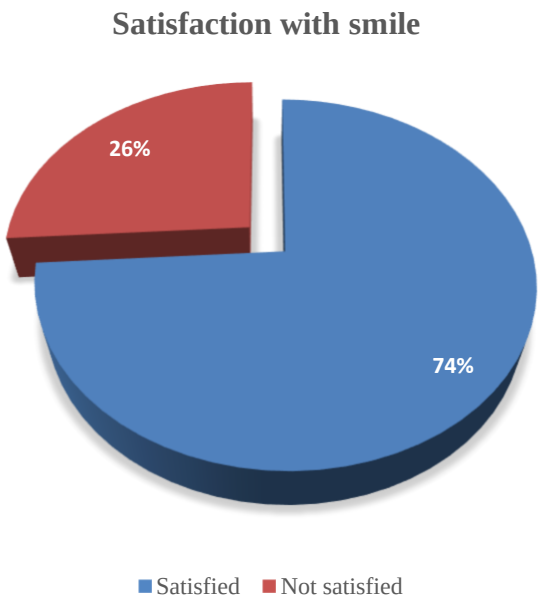

Figure 1: Distribution of participants according to their satisfaction with their smile

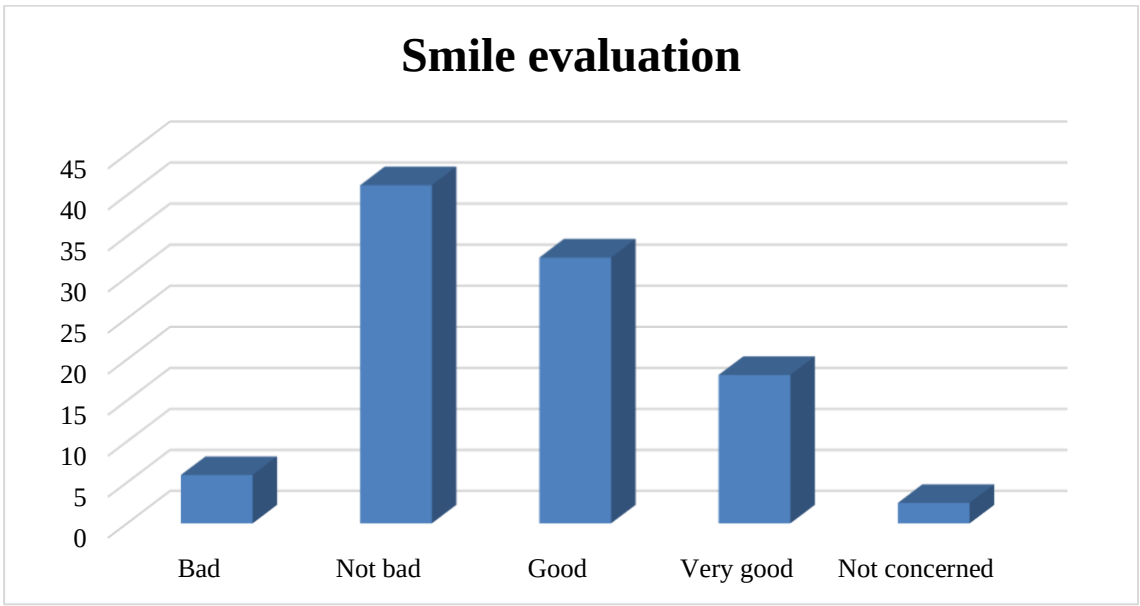

Figure 2 : Distribution of participants according to their smile evaluation

Table 2: Average smile dimensions

	Mean (SD) Median (min - max)*
Non-smiling	
Upper lip length (cm)	2,09 (0,29)
Mouth width (cm)	4,83 (0,38)
Lower lip length (cm)	1,67 (0,32)
Smiling	
Upper lip length (cm)	1,60 (0,29)
Mouth width (cm)	5,89 (0,51)
Lower lip length (cm)	1,67 (0,29)
MCI display (cm)	0,81 (0,19)
Gingival display (cm)*	0,00 (0,00 – 0,55)

MCI, maxillary central incisor

Table 3: Comparison of smile dimensions by gender

	Males **Mean (SD) Median* (min – max)**	**Females** **Mean (SD) Median* (min – max)**	***p*-value**
Non-smiling			
Upper lip length (cm)	2,18	2,01	<0,001
Mouth width (cm)	4,92	4,74	<0,001
Lower lip length (cm)	1,73	1,62	0.019
Smiling			
Upper lip length (cm)	1,68	1,51	<0,001
Mouth width (cm)	5,98	5,81	0.021
Lower lip length (cm)	1,76	1,58	<0,001
MCI display (cm)*	0,84 (0,00 – 1,10)	0,86 (0,27 – 1,21)	0.463
Gingival display (cm)*	0,00 (0,00 – 0,45)	0,00 (0,00 – 0,55)	0.005

MCI, maxillary central incisor

Table 4: Comparison of smile dimensions by age groups

	>20-30 **Mean (SD) Median* (min – max)**	**>30-40** **Mean (SD) Median* (min – max)**	**>40-50** **Mean (SD) Median* (min – max)**	**>50-60** **Mean (SD) Median* (min – max)**	**>60** **Mean (SD) Median* (min – max)**	***p*-value**
Non-smiling						
Upper lip length (cm)	2,01 (0,21)	2,05 (0,30)	2,16 (0,32)	2,15 (0,28)	2,12 (0,31)	0,036
Mouth width (cm)	4,88 (0,36)	4,80 (0,35)	4,86 (0,37)	4,90 (0,33)	4,58 (0,53)	0,120
Lower lip length (cm)	1,66 (0,21)	1,62 (0,24)	1,73 (0,30)	1,67 (0,26)	1,73 (0,66)	0,437
Smiling						
Upper lip length (cm)	1,59 (0,24)	1,54 (0,30)	1,61 (0,34)	1,65 (0,31)	1,58 (0,23)	0,522
Mouth width (cm)	6,28 (0,43)	5,85 (0,45)	5,84 (0,46)	5,78 (0,47)	5,50 (0,47)	<0,001

Lower lip length (cm)	1,64 (0,27)	1,63 (0,27)	1,75(0,33)	1,67 (0,27)	1,68 (0,33)	0,379
MCI display (cm)*	0,87 (0,58-1,16)	0,86 (0,27-1,21)	0,84 (0,00-1,07)	0,83 (0,13-1,12)	0,86 (0,23-1,05)	0,071
Gingival display (cm)*	0,00 (0,00-0,28)	0,00 (0,00-0,45)	0,00 (0,00-0,36)	0,00 (0,00-0,38)	0,00 (0,00-0,55)	0,144

MCI, maxillary central incisor

Table 5: Results of the linear regression of the maxillary central incisor display according to the gingival display

	B	***p*-value**
Gingival display	0,401	<0,001
Constant	0,790	<0,001

Table 6: Comparison of participants' satisfaction with their smile according to the gingival display

	Satisfied Median (min – max)	**Not satisfied Median (min – max)**	***p*-value**
Gingival display (cm)	0,00 (0,00-0,55)	0,00 (0,00-0,45)	0,117

4. Discussion

The aim of this study was to evaluate the dimensions of the smile in an adult Moroccan population according to gender and age, as well as the participants' satisfaction and perception of their smile. The results showed that gender influenced smile measurements: men had larger lip and mouth dimensions. Women in this study displayed more gum tissue than men. The degree of visibility of the maxillary central incisor during smiling, however, was not affected by gender. Age influenced the upper lip length at rest, which increased up to age 50, as well as the mouth width upon the largest smile, which continued to increase with age. The other dimensions were not affected by age.

We distributed the sample of our study according to the overall demographic distribution of the Moroccan population published by the High Commission for Planning. This distribution shows a sex ratio of around 1: 1, hence the parity between men and women in our sample. The first four age groups have an equal distribution of around 22.5% each, unlike the last age group which represents around 10% of the total population.

The results of our study showed a significant difference between both genders for the lips and mouth dimensions ($p \leq 0.05$): men have higher values than women both at rest and when smiling. These results agree with those found in the literature. (Souccar N et al., 2019; Sforza C et al., 2010; Gibelli D et al., 2015); Dickens ST et al., 2002; Drummond S & Capelli J, 2016) On the other hand, the results of our study were significant for the gingival display ($p = 0.005$) but not significant for the maxillary central incisor display ($p = 0.463$). The study conducted by Souccar N et al., 2019 on an African American and Caucasian population showed that the length of the lips and the width of the mouth were greater in males at rest and upon smile. A difference in certain landmarks and in the methods used in this study is to be noted: the calculation of the lengths was based on the upper stomion and the lower stomion instead of the lowest point of the upper lip and the highest point of the lower lip; the study of Souccar N et al., 2019 was performed through three-dimensional surface images instead of two-dimensional images as in our study. On the other hand, our study revealed a significant difference ($p = 0.005$) for the gingival display between the two genders, contrary to the results obtained by Souccar N et al., 2019

A study carried out by Sforza C et al., 2010 from the three-dimensional coordinates of facial landmarks on an Italian population also showed a significant sexual dimorphism for the total height of the lips and the width of the mouth: men had higher values than women.

Regarding gingival display, the results of our study are in agreement with those of studies carried out by Al-Habahbeh R & Al-Shammout R, 2009 and Al-Jabrah et al., 2010 on a Jordanian population which revealed that women displayed significantly more gum when smiling than men. In addition, the study of Al-Habahbeh R & Al-Shammout R, 2009 revealed that the anterosuperior teeth display when smiling was significantly greater in women, unlike our study.In disagreement with our study, Kapagiannidis D et al., 2005 found a significant difference between the two genders for the central incisor display, with higher values in women. In line with our results, (Drummond & Capelli, 2016) showed that gingival display was a female trait. The same authors also found that the maxillary incisor display upon smile characterized women, which disagrees with our results. A full explanation of the sexual dimorphism in the gingival smile line's frequency has yet not been determined (Peck S et al., 1992). Previous data confirms the need to establish gender-specific standards in order to individualize orthodontic treatment while respecting female and male characteristics. On the other hand, the absence of significant results for the maxillary incisor display upon smile, according to our study, suggests that it can be generalized for both genders.

Our study revealed a significant difference between the age groups only for the length of the upper lip at rest, which increased until the age of 50 ($p = 0.036$), and the width of the mouth upon smile which increased with age ($p < 0.001$). The lower lip, according to our study, did not significantly change in length with age, either when smiling ($p = 0.379$) or at rest ($p = 0.437$). Also, the variations in the upper lip length upon smile and the width of the mouth at rest according to age were not significant ($p = 0.522$ and $p = 0.120$). These results did not fully correspond to the results found in the literature. (Souccar N et al., 2019; Sforza C et al., 2010; Dickens ST et al., 2002; Drummond & Capelli, 2016; Desai S et al., 2009; Singh B et al., 2013; Dindaroğlu F et al., 2011; Van der Geld P et al., 2008) Our results differed from those of Souccar et; al.'s study 2019 which showed that gingival and maxillary incisor display decreased significantly with age. The same study also found that the upper lip length upon smile and the mouth width at rest significantly increased with age.

The study conducted by Drummond & Capelli, 2016 on four age groups: 19-24, 25-34, 35-44 and 45-60, revealed a significant decrease in the gingival and the maxillary incisor display with age. On the other hand, the same study showed an increase in the upper lip length at rest with age, with larger values in the latter group.ST (Dickens et al., 2002) found that the gingival and the incisor display decreased after the age of 20. Sforza C et al., 2010 reported that mouth width increased significantly with age while the total lip height remained relatively stable in adulthood. (Desai S et al., 2009) showed that the inter-commissural distance at rest differed significantly between age groups. The results of this study for the length of the upper lip were not significant at rest and slightly significant when smiling, which contradicts with our results. According to the same study, a significant difference was noted for the display of the maxillary incisors which decreased from 1.5 to 2mm with age. A study conducted by Singh B et al., 2013 on three age categories: 15-25, 30-40 and 45-55, showed that gingival display did not significantly change with age, which agrees with our results. As for the maxillary incisor display, this study showed a slightly significant decrease in men and no significant result in women. The study also showed that the upper lip length upon smile increased significantly with age for both genders, while at rest it increased significantly for women. Our results agree with those of the study carried out by Dindaroğlu F et al., 2011 on three age groups (17 to 55 years), which showed a significant difference for the upper lip length at rest, with higher values between 38 and 55 years. A significant increase of the inter-commissural width upon smile with age was also reported by this study. In line with our study, Chetan P et al.,2013 found that the upper lip length at rest increased significantly with age. According to their study, this increase also affected the inter-commissural width at rest. It is important to consider the effect of aging on the soft tissues of the perioral region and therefore on the smile. The variations of the upper lip dimensions with age have been histologically explained by the redistribution of its total volume. This redistribution results in the increase of its length and the decrease of its thickness. The aging upper lip also experiences a degeneration of the elastic fibers and collagen fibers which affects its elasticity. (Iblher N et al., 2012; Penna V et al., 2009) In addition, Perenack JD & Biggerstaff T 2006 explained the lengthening of the aging upper lip by a generalized loss of volume following the muscle's atrophy as well as a progressive weakening of the facial attachments suspending the soft tissues of the lip. Chetan P et al.,2013 attributed the increase of the resting upper lip length to the loss of the muscle tonus at rest, the increased flaccidity and the redundancy with aging. They also explained the increase of the inter-commissural width and the commissures' height with age by the sagging of the mouth angles following the increase of muscle length at rest. In our study, these factors

influenced the upper lip length at rest and the mouth width when smiling without noticeable effect on the other parameters. The majority of the participants in our study were satisfied with their smile (74%). The majority of the participants rated their smile as "Not bad" (41.2%) while only 5.9% found their smile to be "bad". These results can be linked to a psychological and socio-cultural component. Van der Geld P et al., 2007 described two dimensions of self-perception of the smile: a social dimension defining the attractiveness of the smile by cultural norms and the judgment of others and an individual dimension related to the satisfaction of the appearance of one's own smile. Other studies have correlated the perception of smile with age, gender, level of education or level of oral hygiene (Strajnic L et al., 2016; Khanna S 2014). The Alkhatib MN et al., 2005's study conducted in the United Kingdom found results consistent with our study. Three-quarters of the participants (76%) were satisfied with their smile and two-thirds (67%) were satisfied with their teeth color. Azodo C & Ogbomo A. 2014 also found that among 399 participants, 79.4% were satisfied with their smile. The study of, Enabulele JE & Omo JO 2017 on a Nigerien population showed that 45.1% were dissatisfied with the general appearance of their smile. Other studies have found opposite results, with higher prevalence of dissatisfaction (Khanna S 2014; (Isiekwe GI & Aikins EA 2019; Hassel AJ et al., 2011). The scientific literature is very rich with studies showing an association between the patients' satisfaction with their smile and the characteristics of the latter, in particular the size, shape, alignment, color and visibility of teeth, the gingival display, the desired treatment etc (Van der Geld P et al., 2007; Alkhatib MN et al., 2005; Azodo C & Ogbomo A. 2014; Enabulele JE & Omo JO 2017; Isiekwe GI & Aikins EA 2019; Tin-Oo MM et al., 2011; Hassel AJ et al., 2011; Al-Zarea BK 2013). However, additional research is needed to assess these factors in the Moroccan population in order to better understand the results of our study. The results we found showed that the maxillary incisor display significantly increased with the increase of the gingival display. Peck S et al., 1992 and Al-Jabrah et; al. 2010, found that participants displaying gingiva in their respective studies had slightly shorter maxillary central incisors, but these results were not significant in both studies. Further studies are necessary to better determine the type of relationship between gingival display and maxillary central incisor display. Our study showed that participants' satisfaction was not significantly correlated with gingival display. Contrary to our results, a study conducted by Antoniazzi et; al. 2017; Antoniazzi RP et al., 2017) showed that the percentage of people who were satisfied with their smile and had excessive gingival display did not exceed 21.1%. Van der Geld et al., 2007 also found that gingival display was a critical factor in people's satisfaction with their smile: a total dental display with a gingival display of 2 to 4mm was considered the most aesthetic according to their study. Other studies in which participants evaluated the smiles presented in images with different gingival display levels showed that the latter significantly influences the perception of the smile attractiveness (Kaya B & Uyar R 2013; Sriphadungporn C & Chamnannidiadha N 2017; Sybaite J et al., 2020; Hunt O 2002; (Tosun H & Kaya B 2020). Excessive gingival display (6 mm) is generally considered the least attractive (Sriphadungporn C & Chamnannidiadha N 2017; Sybaite J et al., 2020).

The results of our study, eliminating gingival display as a factor influencing participants' satisfaction with their smile, suggest the involvement of other factors for the Moroccan population. The literature has studied the association of several dental parameters with smile satisfaction, including the size, shape, display, alignment and color of teeth. The latter is generally the most influencing factor in the self-perception of the smile (Alkhatib MN et al., 2005; Enabulele JE & Omo JO 2017; Isiekwe GI & Aikins EA 2019; Tin-Oo MM et al., 2011; Hassel AJ et al., 2011; Al-Zarea BK 2013). It is therefore necessary to study these parameters and their relation with the satisfaction of the smile among the Moroccan population.

5. Conclusion

Gender influences smile dimensions: males have more important dimensions of the lips and the mouth. Females display more gum than males. The maxillary central incisor display is not affected by gender. Age influence the upper lip length at rest which increases up to the age of 50, and the mouth width upon smile which continues to increase with age. The other dimensions were not affected by age. The majority of the participants were satisfied with their smile. The maxillary central incisor display increased with the gingival display. Participants' satisfaction with their smile is not influenced by gingival display. Further studies are required in order to better study the influence of age on the smile dimensions of the Moroccan population as well as the factors implied in its satisfaction with the smile.

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