INÊS ADELAIDE PELICANO PAULOS DE CASTRO ALVES

# COMPARISON BETWEEN ORTHODONTISTS AND LAYPERSONS IN THE PERCEPTION OF ORTHODONTICALLY MODIFIABLE SMILE PARAMETERS

## SYSTEMATIC REVIEW

Universidade Fernando Pessoa

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Porto, 2020

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**SYSTEMATIC REVIEW**

Atesto a originalidade do trabalho

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Trabalho apresentado à Universidade Fernando Pessoa

como parte dos requisitos para obtenção

do grau de Mestre em Medicina Dentária.

# ABSTRACT

The aim of this Systematic review was to assess whether or not an acceptability threshold can be established for different smile parameters and to evaluate if the differences in perception between orthodontists and adult laypersons are significant. The laypersons group could represent potential adult patients.

A systematic search was performed between May-July 2020, limited to the last 10 years. With regards to the following smile parameters and the perception of orthodontist and laypersons: Buccal Corridors, Gingival Display Maxillary Incisor Position, Smile Arc, Midline Discrepances and Midline Diastema.

An acceptability threshold was established for certain smile parameters by comparing the significance in the scores obtained, as well as an understanding of the extent to which preferences differed. This may provide clinical guidance for borderline cases where an "ideal" smile may not be achievable.

**Keywords:** orthodontics, smile parameters, orthodontic treatment, perception, laypersons, orthodontists

# RESUMO

Esta Revisão Sistemática tem como objectivo determinar a possibilidade de estabelecer um limiar de aceitabilidade para diferentes parâmetros do sorriso e avaliar se as diferenças de perceção entre ortodontistas e pessoas leigas são significativas. O grupo de pessoas leigas pode representar potenciais pacientes adultos.

Realizou-se uma pesquisa sistemática entre Maio e Julho de 2020 limitada aos últimos 10 anos visando os seguintes parâmetros do sorriso e a perspetiva de ortodontistas e pessoas leigas: Corredores Bocais, Exposição Gengival, Posição dos Incisivos Maxilares, Arco do Sorriso, Discrepâncias da Linha Média e Diastema da Linha Média.

Foi possível estabelecer um limiar de aceitabilidade para certos parâmetros por comparação da significância dos valores obtidos, assim como concluir acerca das diferenças de perceção entre ortodontistas e pessoas leigas. Pretende-se com esta revisão sistemática criar um auxiliar clínico para casos em que o sorriso ideal não seja alcançável.

**Palavras-Chave:** ortodontistas, parâmetros do sorriso, tratamento ortodôntico, perceção, pessoas leigas,

## DEDICATÓRIA

Dedico este trabalho aos meus avós.

Os meus segundos pais e o meu maior exemplo de vida.

Sem eles afogava-me e com certeza não seria

capaz de escrever em inglês.


Obrigada por me terem carregado ao longo de todo este caminho,

agora é a minha vez de vos levar comigo.

## AGRADECIMENTOS

À minha Orientadora prof. Doutora Mónica Pinho e à minha Co-Orientadora prof. Doutora Conceição Manso. Obrigada por nunca terem desistido de mim sobretudo no período conturbado em que vivemos e com toda a adversidade que enfrentamos. Obrigada por terem sido uma peça tão fundamental na conclusão deste objetivo. Nunca esquecerei toda a disponibilidade e paciência. São valores que levo comigo para a vida.

Aos meus pais, que lutam comigo todas as minhas batalhas, que me põem à disposição todos os recursos e me apoiam nos momentos mais difíceis. Espero um dia ser metade dos pais que vocês, hoje, são.

Ao meu namorado, Sam que torna o meu mundo um lugar mais bonito. Obrigada acima de tudo, obrigada por nunca me deixares desistir e me relembrares constantemente quem sou, por me tornares uma pessoa melhor e seres o melhor companheiro de aventuras que alguém pode ter.

Por último, mas não menos importante, aos meus amigos e amigas que estão sempre presentes para me ajudar quando todo o resto falha. Em especial à Marie Coriaty, Sara Rodrigues e à Alexandra Costa que foram as minhas grandes companheiras nesta jornada, a qualquer hora do dia e da noite.

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## ABBREVIATIONS

BCS                        Buccal Corridor Spaces

B&W                       Black and White

cm                         Centimeter

FA                         Facial Action Point

GALL                    Goal Anterior Limit Line

GD                        Gingival Display

MD                       Midline Diastema

MIP                     Maxillary Incisors Position

mm                       Millimeter

PRISMA             Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SA                         Smile Arc

SR                         Systematic Review

VAS                     Visual Analog Scale

Comparison between orthodontists and laypersons in the perception of orthodontically modifiable smile parameters. Systematic review

## I. INTRODUCTIONS

Over the past decades, the world has witnessed a growing concern with dental aesthetics. This may be due to the fact that individuals are constantly exposed to mass media portrayals of perfect smiles(Russello, 2009) or possibly due to the fact that an aesthetically pleasant smile is often associated with higher social and/or educational levels (Reisine and Bailit, 1980). Regardless, the demand for adults aiming for an aesthetically pleasant smile and seeking orthodontic treatment has grown rapidly(Christensen and Luther, 2015).

Patients motivations for seeking treatment can be classified as external (motivated by pressure from the social environment) or internal (motivated by a desire to treat or correct a problem perceived by self) (Pabari, Moles and Cunningham, 2011). In either case it is always up to the orthodontist to elaborate a treatment plan meeting the patients desires and expectations. With this in mind, evaluating the individual influence of major smile components can be crucial when developing a specific treatment plan which includes "a thorough knowledge in the perception of " (Sriphadungporn and Chamnannidiadha, 2017) the smile variables and components. This could also help "guide orthodontists in preparing an appropriate treatment plan especially for more borderline cases" (Sriphadungporn and Chamnannidiadha, 2017).

As observed by V. O. Kokich ( Kokich, Kiyak, and Shapiro, 1999) in 1999 orthodontists tend to be more critical of dental discrepancies than the layperson. Acknowledging this difference in perception could contribute to meeting patients expectations more efficiently. This could also help diminish the impact of the orthodontic treatment on the patient's quality of life.

It is important to consider parameters such as patient satisfaction and patient expectation as vital to the measure of clinical effectiveness of treatment (Christou *et al.*, 2019). It has also been shown that factors such as total duration of the treatment and perceived levels of discomfort can also have a marked impact in overall satisfaction of treatment in adult patients. (Al-Omiri and Alhaija, 2006; Wong *et al.*, 2018). Thus analyzing the differences between the perception of orthodontists vs. laypersons would ultimately facilitate the obtention an attractive smile (the main motivation for the patient), while still achieving optimal functional occlusion. In order to asses the degree to which these perceptions diverge sufficient information was gathered to establish an acceptability threshold for what is aesthetically pleasing for patients and well as for orthodontists. Furthermore, it is important to include demographic factors such as national/cultural background, age, education level, among others as these can impact in

"individual perception of smile aesthetics." (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011; McLeod *et al.*, 2011; Nimbalkar *et al.*, 2018).

The purpose of this systematic review (SR) is to provide a statistical tool which may serve a guideline for orthodontists when designing treatment plans for patients.

### 1. Materials and Methods

This Systematic Review was outlined according to PRISMA Guidelines for Transparent Reporting of Systematic Reviews as Meta-Analysis.

**Search strategy**: An electronic search was done in Pubmed and B-ON for articles in English language using the following expression ((smile parameters OR (buccal corridors) OR (gingival display) OR (Gingival Margin) OR (Incisor Inclinations) OR (Smile Arc) OR (Midline)) AND (orthodontics)OR (orthodontic treatment) AND ((Perception) OR (laypeople perception) OR (dental professionals perception) OR (orthodontists perception)). The search was performed between May-July 2020 and limited to the last 10 years as the concept of beauty tends to be subject and fluctuate over time, something referred to as the many faces of beauty (Atiyeh and Hayek, 2008). Moore et al. 2005 *cit. in* Christou et al. 2019 noted that the specific components of the smile that are valued for esthetics have changed in the last 50 years. Other sources and hand searching reference sections of potential studies were also searched. Unpublished/ grey literature was not included.

**Eligibility**: Studies considering the perspective of both orthodontists and laypersons regarding Buccal Corridors Space, Gingival Display, Maxillary Incisors Inclinations, Smile Arc, Midline Diastema and Midline Deviation. All inclusion criteria are fully explained in Table 1.
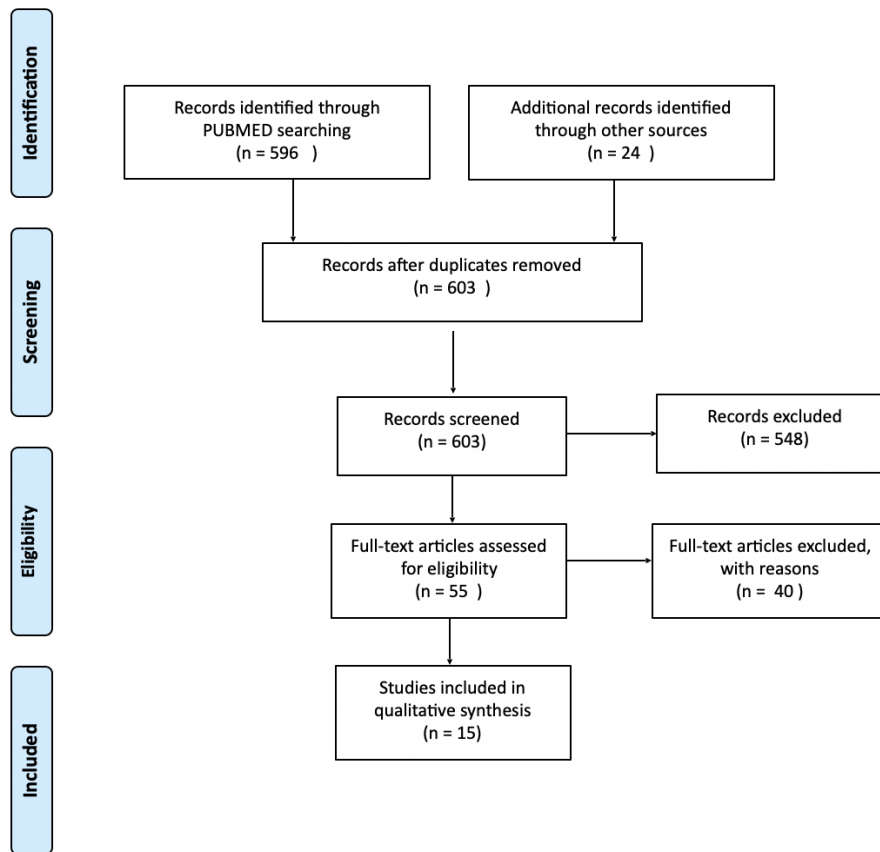
**Figure 1.** Prisma flow chart.

The exclusion criteria were summarized in table 1. Of the fifty-five full-text articles assessed for eligibility, forty were excluded due to reasons explained in appendix 1. Nine articles were excluded due to the 2nd inclusion criteria, eight due to the 3rd inclusion criteria, four due to the 4th inclusion criteria, one due to the 5th inclusion criteria, one due to the 1st exclusion criteria, one due to 3 rd. exclusion criteria and five due to the 5th exclusion criteria.

**Table 1** –Inclusion and exclusion criteria for selection and eligibility of articles included for review.

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| 1. Studies published over the last 10 years | 1. Perspective of dental students and other dental professionals |
| 2. Studies considering the perspective of orthodontists and laypersons | 2. Images comparison made through photographs of multiple patients |
| 3. Studies regarding 1 or multiple of the following parameters: Buccal Corridors Space, Gingival Display, Maxillary Incisors Inclinations, Smile Arc, Midline Diastema and Midline Deviations | 3. Patients who underwent maxillofacial surgery or orthodontic retreatment |
| 4. Images of digitally altered smiles modified individually and obtained from pictures of individuals | 4. Clinical Cases of patients considered for maxillofacial surgery |
| 5. Studies using VAS or any other grading method, allowing perception comparison or measurement of acceptability threshold | 5. Insufficient demographic data regarding the participants of the study |

From the total of Titles/abstract screened only full-text articles were retained. Full-text articles were independently assessed for eligibility by two other reviewers (second and third authors). Both reviewers independently assessed all full-text articles for quality and subsequently agreed on eligibility for inclusion.

## II. RESULTS

Studies were retained for this review when a series of images were obtained from digitally modified photographs of frontal or profile views of one or two subjects. The series of images were then presented to a panel of judges consisting of orthodontists and/or laypersons that scored each image either separately (to avoid comparison), or together (to gauge the most attractive). It is important to mention that laypersons did not have any prior experience in orthodontic treatment in order to meet the true status of "lay".

The studies considered eligible also had to present a statistical comparison between groups or enough data for statistical analysis *a posteriori.*

Through the search strategy, 596 articles and studies were initially collected by a preliminary selection on PUBmed and 24 other articles were later added from other sources and by hand search. After removal of duplicates and based on the inclusion and exclusion criteria outlined in table 1, a total of 15 article were considered eligible for the purpose of this SR (Figure 1).

The systematic search provided enough information regarding all selected parameters. However, the parameter "midline deviation" could not be assessed because no studies analyzing the orthodontist's perspective on this parameter were found. Therefore, and according to inclusion criteria n°2, these studies were omitted from this SR.

Tables 2, 3, 4, 5 and 6 summarize the information collected, one for each of the 5 parameters under analysis.

**Table 2** - Buccal Corridors

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results | |
|---|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | | |
| (Mollabashi et al., 2018) | 22 Laypersons. Age = 25.63 (7.87)y | 15 Orthodontists with at least 1 year of clinical experience. Age = 34.73 (7.54) Years of Clinical Experience = 5.86 (1.39)y | Frontal Coloured 1 Young Female 1 Young Male Both had mesoprosopic facial type (according to facial index used), consonant smile arc and medium buccal corridor size (15%). | 9 Different Combinations: 3 Buccal Corridors Spaces (2% narrow, 15% normal, 28% wide). - 3 Facial Types: short, normal and long | 18 different images (9 female, 9 male) Full Face Framing Coloured images | 10 cm VAS, from 0 least attractive to 10 most attractive. Comparison was possible. | Regardless of Facial Type | Narrow BC (2%): LP=4.91 (0.22) \| Orth=6.41 (0.26); p**<0.001**\* Normal BC (15%): LP=5.57 (0.20) \| Orth=5.56 (0.23); p=0.889\* Wide BC (28%): LP=4.79 (0.20) \| Orth=4.21 (0.24); p**<0.001**\* |
| | | | | | | | Short Face | Narrow BC (2%): LP=4.91 (0.40) \| Orth=4.93 (0.41); p=0.883\* Normal BC (15%): LP=4.45 (0.32) \| Orth=4.07 (0.30); p**<0.001**\* Wide BC (28%): LP=4.73 (0.38) \| Orth=3.50 (0.44); p**<0.001**\* |
| | | | | | | | Normal Face | Narrow BC (2%): LP=6.14 (0.37) \| Orth=7.73 (0.38); p**<0.001**\* Normal BC (15%): LP=6.80 (0.31) \| Orth=7.13 (0.36); p**<0.001**\* Wide BC (28%): LP=5.34 (0.30) \| Orth=4.97 (0.41); p=**0.003**\* |
| | | | | | | | Long Face | Narrow BC (2%): LP=5.50 (0.34) \| Orth=6.67 (0.40); p**<0.001**\* Normal BC (15%): LP=5.45 (0.32) \| Orth=5.47 (0.35); p=0.858\* Wide BC (28%): LP=4.32 (0.34) \| Orth=4.17 (0.35); p=0.201\* |
| (Oz et al., 2017) | 69 Laypersons, Age=22.8 (3.7)y | 60 orthodontists, Age=30.5 (4.6)y | Frontal Photo 1 Female model 1 Male model | Increments of 4% in width from 0% to 24% | 7 different smiles for each subject. A total of 14 images/subject | 10 cm VAS, 5 seconds per viewing. Images presented randomly | Female photo | 0%: LP=59.45 (23.08) \| Ortho = 34.57 (12.58); p=NS 4%: LP =58.39 (22.73) \| Ortho = 30.87(13.00); p=NS 8%:: LP=57.86 (21.98) \| Ortho =30.18(12.81); p=0.03 12%: LP=55.10(22.41) \| Ortho=39.66(8.46); p=0.044 16%: LP=50.37 (24.06) \| Ortho= 26.88(7.45); p=NS 20%: LP= 55.65 (22.72) \| Ortho=24.16(6.71); p=0.026 24%: 49.53(25.21) \| Ortho=26.34(6.13); p=NS |
| | | | | | | | Male photo | 0%: LP=38.36(20.57) \| Ortho=35.83(8.11); p=NS 4%: LP=41.44(21.85) \| Ortho=40.85(8.61); p=NS 8%: LP=39.04(22.08) \| Ortho=36.68(8.24); p=NS 12%: LP=40.92(21.86) \| Ortho=37.40(7.83); p=0.010 16%: LP=44.11(21.85) \| Ortho=38.78(9.52); p=NS 20%: LP:40.05(23.43) \| Ortho: 32.83(8.38); p= NS 24%: LP=40.18(22.35) \| Ortho=24.46(5.31); P=NS |

Comparison between orthodontists and laypersons in the perception of orthodontically modifiable smile parameters. Systematic review

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| (Al Taki *et al.*, 2016) | 47 Laypersons, without dental affiliations, majority were colleges educated males. Age=32.0 (9.5)y | 28 orthodontists, Average 8 years of experience. Age=36.0 (8.6) | 2 Female smiles | A - Excessive buccal corridors B- control smile with ideal buccal corridors C - broad smile with no BC (Hollywood smile) | 26 images Mouth Framing Colored images | VAS from 1 to 5 (1 most attractive, 5 least attractive) | The orthodontists preferred Holly wood smile (92.86%) the most, followed by ideal buccal corridor (7.14%) Approximately, 38% of laypersons chose ideal buccal corridor followed by Hollywood smile (31.91%) and excessive buccal corridor (29.79%) suggesting that for most laypersons an excessive buccal corridor was not a deterrent for an attractive smile. |
| (Zange *et al.*, 2011) | 42 Laypersons: 22 Females and 20 Males | 41 orthodontists: 5 Female and 26 Male | 4 short face individuals 4 long face individuals Colored smiling photos | 5 different smiles for each subject: - Narrow (28%) - Medium Narrow (22%) - Medium (15%) - Medium Wide 10%) - Wide (2%) | 5 photos of each individual Full face framing Colored smile images | 100 mm VAS from Unattractive to Attractive | <u>2%:</u><br>Short Face: LP=48.88(23.09) \| Ortho=64.08(21.74); p=**0.002***<br>Long Face: LP=47.78(21.78) \| Ortho=56.96(23.28); p=0.063*<br><u>10%</u><br>Short Face: LP=44.08(22.42) \| Ortho=56.06(22.77); p=**0.016***<br>Long Face: LP=47.08(22.13) \| Ortho=57.09(23.28); p=**0.040**<br><u>15%</u><br>Short Face: LP=40.47(25.35) \| Ortho= 47.33(20.22); p=0.168*<br>Long Face: LP= 41.74(19.76) \| Ortho=42.24 (19.83); p=0.907*<br><u>22%</u><br>Short Face: LP= 32.89(21.24) \| Ortho=33.85(19.05); p=0.826*<br>Long Face: LP=34.75(21.22) \| Ortho=30.62(18.68); p=0.340*<br><u>28%</u><br>Short Face: LP=18.62(15.62) \| Ortho=16.69(13.03); p=0.535<br>Long Face: LP=15.84(14.92) \| Ortho=13.71(12.69); p=0.447* |
| (Badran and Mustafa, 2013) | 104 Jordanian Laypeople 52 women and 51 men, Ages between 17-65, mean age 28.7y | 52 Orthodontists 19 women and 33 men | Coloured Frontal Female Smile | From 0% to 25%, 5% increments | 6 different images B&W Mouth Framing | Attractiveness Rate from 1 to 10 (1 least attractive, 10 most attractive) Comparison not allowed Images showed randomly and individually | <u>0%:</u> LP=7.42(1.873) \| Ortho=7.06(1.650); p=0.234<br><u>5%:</u> LP=6.85(1.863) \| Ortho=6.73(1.374); p=0.693<br><u>10%:</u> LP=6.64(1.983) \| Ortho=6.33(1.677); p=0.270<br><u>15%:</u> LP=6.71(1.909) \| Ortho=5.60(1.807); p=0.001<br><u>20%:</u> LP=6.67(1.983) \| Ortho=5.85(1.786); p=0.012<br><u>25%:</u> LP=5.94(2.293) \| Ortho=4.46(2.453); p=0.000 |
| (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011) | 200 Jordanian laypersons selected randomly: 100 Females, 100 Males Age=26.6 (6.4)y | 160 Jordanian Orthodontists: 40 Females, 120 Males Clinical Experience =10 (2.5)y | Young Female smile Natural head position | Buccal Corridors Wide / Narrow | 10 different smiles and 1 control picture (ideal) B&W images Mouth Framing | Rating from 1 to 5 (1 very attractive, 5 very unattractive) | Narrow:<br>LP=1.66 (0.94) \| Orth=1.59 (0.65); p=0.405*<br>Wide:<br>LP=2.37 (0.92) \| Orth=2.36 (0.67); p=0.905*<br>Ideal:<br>LP=2.22 (0.94) \| Orth=2.18 (0.81); p=0.607* |

*p-values calculated by the author using the OpenEpi free and open source software for epidemiologic statistics (t-test). Mean and standard deviation were shown as "Mean (Standard deviation)"; NS: Not Significant

**Table 3**- Gingival Display

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| (Tosun and Kaya, 2020) | 105 Laypersons: 60 Female and 45 Male Age=33.6 (8.7)y Patients of dental areas which had not received orthodontic treatment | 101 Orthodontists: 57 Female and 44 Male, Age=30.9 ( 6.4)y Orthodontists had at least 2 years in residency with a maximum of 30 years in practice. | Colored photo Young female smile | constant -2 mm the coverage of maxillary incisor edges by the lower lip and gradually altering the maxillary gingival display amount (-2mm, -1.5mm, -1mm, -0.5mm and 0.0mm. This alteration represents intrusion or extrusion of maxillary teeth by orthodontic mechanics. | 10 Different images Colored Mouth Framing | Raters were asked to not compare these images and to rate them using a VAS from 0 to 100. | -2mm: LP=48.8(22.1) \| Ortho=22.7(12.1) -1.5mm: LP=52.4(22.4) \| Ortho=32.8(16.1) -1mm: LP=53.8(21.7) \| Ortho=39.3(17.0) -0.5mm: LP=58.7(21.0) \| Ortho=44.9(17.4) 0.0mm: LP=60.5(23.3) \| Ortho=50.8(18.5) The highest scores were obtained at 0 mm maxillary central incisor coverage by upper lip, and the lowest scores were obtained at –2 mm maxillary gingival display among all rater groups. Smile attractiveness scores decreased progressively as the maxillary gingival display amount increased in all rater groups. The laypersons' scores were higher than that of orthodontists |
| (Al Taki *et al.*, 2016) | 47 Laypersons, without dental affiliations, the majority were colleges educated males. Age = 32 (9.53)y | 28 orthodontists, Average 8 years of experience. Age = 36 (8.62)y | 2 Female smiles | Gingival Display was altered by increasing 1mm to the gingiva of the maxillary incisor to upper lip distance. A - control B – 1 mm C – 2mm D – 3mm E – 4 mm | 26 images Mouth Framing Colored images | VAS from 1 to 5 (1 most attractive, 5 least attractive) | Orthodontists (75%) mostly preferred the control image (0mm gingival display), followed by 1 mm of gingiva show. Similar to orthodontists, the LP also preferred the control image (55.32%), followed by 1 mm (27.66%) of gingiva show. They have also rated the gingiva show up to 4.0 mm as attractive. As their second choice, the LP preferred 1 mm (44.68%) of gingiva show followed by 2 mm (27.66%). No significant difference between the orthodontist and layperson. |
| (Pinzan-Vercelino *et al.*, 2020a) | 31 Laypersons: 14 Male, 17 Female Age = 34.75 (7.32), range=25-54y | 31 Orthodontists with 2 + years of experience as a specialist: 14 Male, 17 Female Age = 37.25(7.99), range=27-63y Years as Specialist = 6.80 (5.60), range=2-20y | Frontal Smile Photos 1 Female Model 1 Male Model | A = -3 (3mm of gingival exposure) B = -1 (1mm of gingival exposure) C = +5 (5mm of central incisor coverage D = -5 (5mm of gingival exposure) E= +3 (3mm of central incisor coverage) | Mouth Framing 5 Images for each subject Colored images | VAS of 100mm. 20s per viewing and comparison was not permitted | Female Smile -3mm: LP=65.34 (15.15) \| Orth=55.80 (20.08); p=0.128* -1mm: LP=67.56 (18.15) \| Orth=63.41 (22.10); p=0.554* +5mm: LP=58.45 (17.83) \| Orth=37.51 (23.10) p=**0.006*** -5mm: LP=41.45 (20.91) \| Orth=21.96 (16.81); p=**0.005*** +3mm: LP=60.79 (16.52) \| Orth=46.46 (26.69);p=0.069* |
| | | | | | | | Male Smile -3mm: LP=59.65 (19.73) \| Orth=28.71 (22.10); p<**0.001*** -1mm: LP=65.63 (20.21) \| Orth=52.32 (24.42); p=0.128* +5mm: LP=51.80 (19.15) \| Orth=26.62 (21.60); p=**0.003*** -5mm: LP=38.07 (21.48) \| Orth=18.04 (22.46); p=**0.023*** +3mm: LP=57.12 (21.27) \| Orth=54.10 (27.27);p=0.747* |
| (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011) | 200 Jordanian laypersons selected randomly: 100 Females, 100 Males Age = 26.6 (6.4)y | 160 Jordanian Orthodontists: 40 Females, 120 Males | Young Female smile Natural head position | Gingival Display measures: - 1 mm - 2 mm - 3 mm | 10 different smiles and 1 control picture (ideal) B&W images | Rating from 1 to 5 (1 very attractive, 5 very unattractive) | Ideal: LP=2.22 (0.94) \| Orth=2.18 (0.81); p=0.670* 1mm: LP=1.80 (0.82) \| Orth=1.94 (0.75); p=0.096* 2mm: LP=2.13 (0.92) \| Orth=2.37 (0.83); p=**0.011*** 3mm: LP=2.40 (0.93) \| Orth=2.31 (0.82); p=0.337* 4mm: LP=2.36 (0.96) \| Orth=2.49 (0.86); p=0.182* |

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
|---|---|---|---|---|---|---|---|
| | | Years of Clinical Experience = 10 (2.5)y | | - 4 mm<br>- Ideal | Mouth Framing | | |
| (Alyami *et al.*, 2018) | 30 Saudi Arabian Laypersons living in Riyad, mean age 27,40; SD 4,38 | 30 Saudi Arabian Orthodontists living in Riyadh, mean age 33,07; SD 5,87 | Smile photo of a young male Full face framing Frontal and profile perspectives | Gingival Display measures:<br>- 0 mm<br>- 2 mm<br>- 4 mm | 9 photos for each view) | The observers could give 4 different answers no difference, most, moderate and least attractive | Frontal View:<br>Participants reported no difference:<br>LP=3(10%) \| Ortho=25(83.3%); p<0.001<br>Participants reported difference:<br>LP=27(90%) \| Ortho = 5(16.7%); p<0.001<br>Profile View:<br>Participants reported no difference:<br>LP=4(13.3%) \| Ortho=28(93.3%); p<0.001<br>Participants reported difference:<br>LP=26(86.7%) \| Ortho=1(3.3%) |
| (Kumar, Gandhi and Valiathan, 2012) | 40 Laypersons, 20 males and 20 females. Mean Age 31.3y | 40 Orthodontists, 20 males and 20 females. Mean Age 29.4y | Frontal Female Smile | The gingival display was modified by increments of 1 mm in upper lip to gingival margins distance "gingiva-to-lip distance". | 25 Different images Mouth Framing | VAS 0-10, they were also asked their opinion regarding each parameter not just the overall appearance of each image | 0 mm: LP=5.85 (2.23) \| Orth=6.3 (1.63); p=0.306*<br>1 mm: LP=6.4 (1.96)\| Orth=4.85 (1.95); p<0.001*<br>2 mm: LP=4.75 (1.33)\| Orth=4.7 (1.87); p=0.891*<br>3 mm: LP=5.7 (2.34)\| Orth=4.65 (1.98); p=0.033*<br>4mm:LP=5.7 (2.30) \| Ortho=4.08(2.07) |
| (Oz *et al.*, 2017) | 69 Laypersons, Age 22.8 (3.7)y | 60 orthodontists, Age 30.5 (4.6)y | Frontal Photo 1 Female model 1 Male model | GD was modified by increments of 1mm from -3 to +3<br><br>-3mm -> 3mm of upper lip coverage<br>+3mm -> 3mm of gingival show | 7 different smiles for each subject and a total of 14 different images. | 10 cm VAS, 5 seconds per viewing Images presented randomly — Female Photo | -3mm:LP=43.42(21.95) \| Ortho=27.81(7.20); p<0.001<br>-2mm:LP=36.18(20.84) \|Ortho=21.80(7.17); p=NS<br>-1mm:LP=37.50(20.99) \| Ortho=32.78(10.45); p=NS<br>0 mm: LP=34.95(21.17)\| Ortho=21.68(7.99); p=NS<br>+1mm: LP=38.49(23.09) \| Ortho=30.68(7.06); p= NS<br>+2mm: LP=40.97(22.25) \| Ortho=36.75(8.13); p=0.010<br>+3mm:LP=28.50(20.28); Ortho=11.35(6.18); p=NS |
| | | | | | | Male Photo | -3mm:LP=25.36(19.65) \| Ortho=21.35(7.78); p=NS<br>-2mm: LP=31.08(21.56) \| Ortho=26.83(8.83); p<0.001<br>-1mm: LP=31.01(21.04) \| Ortho=29.91(6.48); p<0.001<br>0 mm: LP=29.69(21.31) \| Ortho=37.60(9.08); p=NS<br>+1mm: LP=32.27(21.35) \| Ortho=28.80(6.45); p=0.002<br>+2mm: LP=29.98(20.01) \| Ortho=25.01(6.63); p=0.017<br>+3mm: LP=24.04(19.35) \| Ortho=20.11(5.60); p=NS |

*p-values calculated by the author using the OpenEpi free and open source software for epidemiologic statistics (t-test). )". ** data extracted from the paper and retreated with a Chi-square test using the OpenEpi. Mean and standard deviation were shown as "Mean (Standard deviation)

**Table 4**- Smile Arc

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| (Badran and Mustafa, 2013) | 104 Jordanian Laypeople 52 women and 51 men, Ages between 17-65, mean age 28.7y | 52 Orthodontists 19 women and 33 men | Coloured Frontal Female Smile | Types of Smile Arc generated: - Consonant - Flat - Reversed | 6 different images B&W Mouth Framing | Attractiveness Rate from 1-10 (1 least attractive, 10 most attractive) Comparison not allowed Images showed randomly and individually | Consonant Smile Arc: LP= 7.13(2.029) \| Ortho=8.21(1.819); p=0.002 Flat Smile Arc: LP=6.13(1.984) \| Ortho=5.46(1.985); p=0.051 Reverse Smile Arc: LP=2.65(1.853) \| Ortho=2.31(1.869); p=0.362 |
| (Al Taki *et al.*, 2016) | 47 Laypersons, without dental affiliations, the majority were colleges educated males. Age = 32 (9.53)y | 28 orthodontists, average 8 years of experience. Age=36 (8.62)y | 2 Female smiles | Modified images obtained by reversing and accentuating the curvature of the anterior teeth in relation to the curvature of the lower lip. A - flat with large gingival display in the posterior region compared to that in the anterior region B - ideal smile arc, that is parallel to the curvature of the lower lip C - excessive smile arc, causing lower teeth to be displayed | 26 images Mouth Framing Colored images | VAS from 1 to 5 (1 most attractive, 5 least attractive) | all the orthodontists (100%) have rated the ideal smile arc as the most acceptable. A significant proportion of laypersons (61.7%) had also rated the ideal smile arc as their most preferred one. Next to ideal smile arc, laypersons also chose excessive smile arc (27.66%) over flat one (10.64%). There was a significant difference between orthodontists and laypersons orthodontist and laypersons ($p < 0.003$, $p < 0.008$) was revealed |

**Table 5** - Maxillary Incisors Position

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| (Cao *et al.*, 2011) | 66 Laypersons: 33 Males and 33 Females, Average age = 20 years old, representing younger generation which contains the greatest potencial in terms os patients seeking orthodontic treatment. | 21 Orthodontists: 14 Males and 9 Females | Facial smiling profile photograph of a young Chinese woman Class I occlusion, and a Class I skeletal pattern | Picture Group A, the maxillary incisors were inclined: - labially 5º, 10º and 15º - lingually 5º, 10º and 15º Picture Group B the maxillary incisors were moved: - anteriorly 1, 2, 3 and 4 mm - posteriorly 1, 2, 3 and 4mm Picture Group C the maxillary incisors labioinclination was altered with FA (Facial Axial Point) 2mm anterior to | 29 images Profile view Full Face | VAS of 100 mm | The smiling profile with the highest score was the one with 5º lingual inclination, while the ones with 15º labial inclination or 4-mm retrusion had lower scores than the others. Maxillary incisor protrusion and lingual inclination were preferable compared with retruded or flared incisors. There was no significant discrepancy between the professional and nonprofessional groups in terms of their assessments. |

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| | | | | GALL (Goal Anterior Limit Line), until FA on GALL. Picture group D the maxillary incisors labioinclination was altered with FA 2mm posterior to GALL, until FA on GALL. | | | |
| (Tosun and Kaya, 2020) | 105 Laypersons: 60 Females and 45 Males , Age: 33.6 (8.7)y Patients of dental areas which had not received orthodontic treatment | 101 Orthodontists: 57 Females and 44 Males, Age: 30.9 (6.4)y All orthodontists had at least 2 years in residency with a maximum of 30 y practice. | Colored photo Young female smile | "The changes were realized by altering the position of teeth in 10 smile images, which represents intrusion or extrusion of maxillary teeth by orthodontic mechanics." | 10 Different images Colored Mouth Framing | Raters were asked to not compare these images and to rate them using a VAS from 0 to 100. | This alteration represents intrusion or extrusion of maxillary teeth by orthodontic mechanics. Orthodontists prefer 0 to 11 mm mandibular incisor exposure and maxillary central incisor coverage by upper lip. Laypersons prefer 10.5 to 12.5 mm mandibular incisor exposure and maxillary central incisor coverage by the upper lip. |
| (Machado et al., 2013) | 60 Laypersons, 32 males and 28 females. College educated with no dental background | 60 Orthodontists, 37 males and 23 females. | Smile colored photograph of a young adult woman (27 years old) | Altered vertical position of the maxillary central incisors by increments of 0.5 mm. Characteristics of the Smiles used: A: 0 mm alteration, control image. Central gingiva margins matching the canines and central incisor edges 1mm below the laterals B: 0.5 mm Extruded. Central gingiva margins 0.5 mm below the canines and central incisor edge 1.5 mm below the laterals. C: 1.0 mm Extruded. Central gingiva margins 1.0 mm below the canines and central incisor edge 2.0 mm below the laterals. D: 1.5 mm Extruded. Central gingiva margins 1.5 mm below the canines and central incisor edge 2.5 mm below the laterals. E: 0.5 mm Intruded. Central gingiva margins 0.5 mm above the canines and central incisor edge 0.5 mm below the laterals. F: 1.0 mm Intruded. Central gingiva margins 1.0 mm above the canines and central incisor edge matching the laterals. | 6 different smile images The images were presented to the raters randomly in 3 different views - gingival close up excluding incised edges - incised close up, excluding gingival margins - full smile For the purpose of this systematic review only the last two views were considered. | The participants were asked to rate each image, presented randomly, according to a 100mm VAS. | Full Smile 0mm Ext: LP= 80.2 (13.2)\| Orth: 76.58 (12.92); p=0.132* **0.5mm** Ext: LP= 86.27 (9.79)\| Orth=85.13 (6.93); p=0.463* 1mm Ext: LP= 77.1 (13.3)\| Orth=66.83 (16.34); p<**0.001*** 1.5mm Ext: LP= 61.18 (15.56)\| Orth=46.56 (15.56); p<**0.001*** 0.5mm Int: LP= 60.91 (14.9)\| Orth=34.23 (15.87); p<**0.001*** 1mm Int: LP= 39.6 (12.61)\| Orth=19.9 (14.76); p<**0.001*** <br><br> Incisal Close-up 0mm Ext: LP=74.15 (18.23) \| Orth: 79.53 (14.07); p=0.073* **0.5mm** Ext: LP=84.63 (12.45) \| Orth=84.54 (9.83); p=0.965 1mm Ext: LP=76.02 (12.46) \| Orth=73.28 (15.69); p=0.292* 1.5mm Ext: LP=59.62 (23.33) \| Orth=46.5 (14.28); p<**0.001*** 0.5mm Int: LP=70.27 (14.88) \| Orth=43.57 (16.92); p<**0.001*** |

Comparison between orthodontists and laypersons in the perception of orthodontically modifiable smile parameters. Systematic review

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
|---|---|---|---|---|---|---|---|
| (Ghaleb, Bouserhal and Bassil-Nassif, 2011) | 9 Males and 21 Females, mean age 35,87 SD= 9,605. (the article doesn't address differences in cultural perception, all participants were above 18 years old of age and no gender control was taken into considerations | 21 Males and 9 females, mean age 35,87 SD = 7.523 all orthodontists had completed their training, no gender control was taken into consideration | Colored lateral smiling photograph of young female (22 years old) Canine Classe I of Angle and Molar Classe II of Angle. | Alterations to the maxillary incisor inclination according to the following angles: Tg/Hr and Tg/Sn-Pg. | 7 Different images with variations from -15º, -10º, -5º, 0/initial, +5º, +10º, +15º. | The participants were asked to not compare the photos nor to return to previous photo after rating. 100 mm VAS. VAS was anchored by the descriptors 'very unattractive', 'unattractive', 'average', 'attractive', and 'very attractive' | 1mm Int: LP=51.12 (17.52) \| Orth= 22.72 (16.64); p<**0.001**\*<br><br>Orthodontists, gave highest score to angulation +5º (71.67 (12.16)) and lowest score to -15º (25.79 (12,39)).<br>Laypeople gave the highest score to +5º (65.66 (14.29)) and the lowest score to +15º (29.97 (19.42)). |
| (Chirivella *et al.*, 2017) | 20 Laypersons, undergraduate dental students below the age of 20 | 20 Orthodontists, minimum 3 years clinical experience | Profile colored photos of 3 young male subjects with 3 different facial types: dolichofacial, brachyfacial and mesofacial. | 1. Labiolingual inclination and anteroposterior displacement:<br> - Maxillary incisor crown inclined labially (+5º, +10º, +15º)<br> - Maxillary incisor crown inclined lingually (-5º. -10º, -15º)<br>2. Maxillary Incisors moved:<br> - Anteriorly/Protrusive (+1,+2,+3,+4mm)<br> - Posteriorly/Retrusive (-1,-2,-3, -4 mm) | Two series of images were created from those photographs by digital modifications creating 15 images per facial type and decided into 2 sets of images: | The raters were given 1 minute per viewing and then asked to rate each image according to a 100mm VAS (from 0 "least attractive" to 100 "most attractive" | Significant differences among the participants were more marked in dolichofacial and brachyfacial facial types and the rating among the panels closely matched to one another for most of the simulations in the mesofacial types (original photo). There was a significant difference in rating the attractiveness among the panels for the labiolingual inclination in the dolichofacial pattern ($P < 0.05$) and the A/P positioning of the maxillary incisors ($P < 0.05$) in the brachyfacial face. However, in all the facial types, the simulations + 15°, −5°, −10°, −15° were marked in unison by all the panels of judges as the esthetic profiles. Accordingly, most of the high mean scores were found around these simulations with orthodontists rating the + 15° as the highest in all the facial patterns. The highest scores in the study were given by nonprofessional panel for −5° for all the three patterns. Likewise, while rating the unesthetic profiles, all the examiners were concordant in relation to the simulations of + 3 mm, +4 mm. |

*p-values calculated by the author using the OpenEpi free and open source software for epidemiologic statistics (t-test))". ** data extracted from the paper and retreated with a Chi-square test using the OpenEpi. Mean and standard deviation were shown as "Mean (Standard deviation)

**Table 6** - Midline Diastema

| Author (Years) | Samples Characterization - Laypersons | Samples Characterization - Orthodontists | Materials and Methods | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Original Photograph | Digital Alterations | Obtained Images | Rating System | |
| (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011) | 200 Jordanian laypersons selected randomly: 100 Females, 100 Males Age =26.6 (6.4)y | 160 Jordanian Orthodontists: 40 Females, 120 Males Years of Clinical Experience = 10 (2.5) | Young Female smile Natural head position | | 10 different smiles and 1 control picture (ideal) B&W images Mouth Framing | Rating system similar to VAS from 1 to 5 (1 very attractive, 5 very unattractive) | Ideal: LP=2.22 (0.94) \| Orth= 2.18 (0.81); p=0.670* 1mm: LP=2.58 (0.96) \| Orth=2.50 (0.73); p=0.370* 2mm: LP=2.93 (0.90) \| Orth=2.90 (0.70); p=0.722* 3mm: LP=3.53 (0.78) \| Orth= 3.40 (0.91); p=0.146* 4mm: LP=3.40 (0.91) \| Orth= 3.56 (0.62); p=**0.035*** |
| (Al Taki *et al.*, 2016) | 47 Laypersons, without dental affiliations, the majority were colleges educated males. Age = 32 (9.53)y | 28 orthodontists, Average 8 years of experience. Age = 36 (8.62)y | 2 Female smiles | Midline diastema was generated by a 0.5mm increment. A - control, no diastema B - 0.5 mm C - 1 mm D - 1.5 mm E - 2 mm | 26 images Mouth Framing Colored images | VAS from 1 to 5 (1 most attractive, 5 least attractive) | A small amount of space between the maxillary central incisors was not rated as unattractive by any group. All the three groups preferred control image with no midline diastema (71.4% orthodontist and 85.10% laypersons), followed by the presence of 0.5 mm midline diastema (25% orthodontists and 12.8% laypersons). A very small group of orthodontists and laypersons also rated the presence of 1 mm and 1.5 mm of diastema as an attractive smile in their first choice. |
| (Kumar, Gandhi and Valiathan, 2012) | 40 Laypersons, 20 males and 20 females. Mean Age 31.3y | 40 Orthodontists, 20 males and 20 females. Mean Age 29.4y | Frontal Female Smile | The midline diastema was modified by increments of 0.5mm between superior central incisors. | 25 Different images Mouth Framing | VAS 0-10, they were also asked their opinion regarding each parameter not just the overall appearance of each image. | 0mm: LP=6.85 (1.57) \| Orth=5.85 (1.98); p**<0.001*** 1mm: LP=4.60 (2.04) \| Orth= 4.85 (1.66); p=0.550* 2mm: LP=4.20 (1.64) \| Orth= 4.35 (1.63); p=0.683* 3mm: LP=4.05 (1.96) \| Orth= 3.40 (1.47); p=0.097* 4mm: LP=3.25 (1.12) \| Orth= 3.05 (1.76); p=0.546* |

*p-values calculated by the author using the OpenEpi free and open source software for epidemiologic statistics (t-test). ). Mean and standard deviation were shown as "Mean (Standard deviation)

## III. DISCUSSION

The parameters retained for this SR were selected through analyses of parameters most often presented in cross-sectional studies of perception, other systematic reviews and as well as previous clinical experience. (Kokich, Asuman, and Shapiro, 1999; Springer *et al.*, 2011; Witt and Flores-Mir, 2011; Del Monte *et al.*, 2017).

To the authors' best knowledge no other SR considering both the perception of orthodontists and the perception of potential adult orthodontic patients has been published to date.

It is important to note that many articles of reference in the field were excluded due to the time imposition (published in the last 10 years) instated by inclusion criteria. It was fundamental to do so, considering the increase in papers with data on both perceptions over the last 10 years. Nearly half of the studies included are less then 5 years old.

The main hypothesis of this SR was partially supported. It is possible to establish a general acceptability threshold for certain parameters (regardless of gender and facial type) such as Buccal Corridor Space, Gingival Display and Maxillary Incisors Position.  It is not however, possible for all the parameters, notably Smile Arc and Midline Deviation.

For Buccal Corridor Spaces (BCS), the orthodontists' opinion seemed more affected by alterations in this parameter consistently attributing lower scores than the layperson's group (Badran and Mustafa, 2013; Al Taki *et al.*, 2016). Most studies agree on the fact that a narrow BCS, associated with a wider, broader smile is more attractive (Zange *et al.*, 2011; Al Taki *et al.*, 2016). This is particularly evident when the analyses is qualitative instead of quantitative. (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011). Nevertheless, it is difficult to find a specific value amongst studies since most of them use different percentages to quantitively assess the attractiveness of BCS. Despite the statistical differences found between the perception of orthodontists and laypersons, it can be established that a BCS wider than 16% is considered unattractive (Oz *et al.*, 2017) in both groups and therefore the acceptability threshold lies between 0-16%.

Gingival Display (GD), appears to play an important role in smile attractiveness on both frontal and profile views (Alyami *et al.*, 2018). Though there were statistical differences found between group's perceptions, it remains unclear whether or not orthodontists were more affected by alterations in this parameter.  Nonetheless, it is possible that orthodontists may be more critical

of smiles because of their specialty training in evaluating faces (Pinzan-Vercelino *et al.*, 2020b). For this parameter, the acceptability threshold can be placed between -1 mm and +1 mm.

The Maxillary Incisors Position (MIP), vertical and horizontal, is the parameter where the least statistical differences were found between both groups (Cao *et al.*, 2011; Ghaleb, Bouserhal and Bassil-Nassif, 2011; Tosun and Kaya, 2020) and where the facial type appears to be more relevant (Machado *et al.*, 2013; Chirivella *et al.*, 2017). The consensus between studies shows that it is possible to establish an acceptability threshold for horizontal position at -5º to +5º. Literature has also demonstrated that in borderline cases, anterior/labial inclination of the maxillary incisors is preferable to posterior/lingual inclination (Cao *et al.*, 2011; Ghaleb, Bouserhal and Bassil-Nassif, 2011) and a MIP is considered unattractive from +3mm or +4mm onwards (Chirivella *et al.*, 2017). In regards to vertical position an acceptability threshold can't be established due to insufficient literature. It is only possible to conclude that a slight extrusion is preferable (Machado *et al.*, 2013; Tosun and Kaya, 2020).

Both groups agree that the presence of a midline diastema (MD) can significantly and proportionally reduce the attractiveness of the smile – the bigger the diastema the less attractive the smile (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011; Kumar, Gandhi and Valiathan, 2012; Al Taki *et al.*, 2016). However, an MD of up to 0.5 mm can still be tolerated by both groups (Al Taki *et al.*, 2016).

For the Smile Arc (SA), no acceptability threshold could be established due to insufficient studies considering the perception of orthodontists but also due to a lack of unanimity between existing studies. However, it can be assessed that the SA appears to have a bigger impact in the perception of smile by laypersons than other parameters. The perception of this parameter may be more dependent on socio-cultural factors inherent to the observer. Additionally, statistical differences between the two groups are more significant.

The hypothesis brought up by Machado et al 2013 seems to apply to most smile parameters - "an ideal smile arrangement can easily be recognized by any group of raters, but when smaller deviations are included, they start to show differences in their judgments".

## 1. Limitations

For other parameters – Midline Diastema and Smile Arc – no information was found comparing the changes in perception regarding gender and/or facial type.

It is worth noting that on account of the design of the studies selected, it was only possible to gauge the perception of smile parameters for the social smile and not for the spontaneous smile. However, literature suggests that laypersons are much more superficial judges of the smile and for that reason this may not change their overall perception as much. (Dindaroglu, Ertan Erdinc and Dogan, 2017).

Most studies do not consider simulation of social distance which is influenced by cultural factors and therefore may have an impact on overall the perception of smile.

### 2. Suggestions for Clinical Practice and Future Studies

In future clinical practice, orthodontists should consider the use of charts or the use of digital tools such as image modification through sliders enabling patients to demonstrate the shape they consider to be more attractive. This is particularly relevant for SA which was found to be the parameter where the opinion between orthodontists and layperson differed the most.

Future studies should consider the simulation of social distance adjusted to culture (Yang *et al.*, 2015; Sadrhaghighi *et al.*, 2017), as well as a time limitation for the analyses of the pictures. Henderson 1998 *cit in* Richards et al., 2015 states that facial attractiveness is determined within the first 2 seconds of observation which implies that longer periods could affect the scores given.

Lastly, future studies should assess the perception of orthodontists and laypersons observing MD and SA.

Additional findings regarding facial types and gender can be found in appendix 2 - Additional Discussion.

### IV. CONCLUSION

The establishment of an acceptability threshold for smile parameters is possible, however it does not supersede the patient's personal preference.

Differences between the perception of orthodontists and laypersons are generally significant enough for the patients opinion to be considered, especially for borderline cases where "ideal" is not achievable.

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Zange, S. E. *et al.* (2011). Perceptions of laypersons and orthodontists regarding the buccal corridor in long- and short-face individuals. *Angle Orthodontist*, 81(1), pp. 88–92.

Dindaroglu, F., Ertan Erdinc, A. M. and Dogan, S. (2017). Perception of Smile Esthetics by Orthodontists and Laypersons: Full Face and A Localized View of The Social and Spontaneous Smiles. *Turkish Journal of Orthodontics*, 29(3), pp. 59–68.

Sadrhaghighi, A. H. *et al.* (2017). Esthetic preferences of laypersons of different cultures and races with regard to smile attractiveness. *Indian Journal of Dental Research*, 28(2), pp. 156–161.

Yang, S. *et al.* (2015). Effect of mesiodistal angulation of the maxillary central incisors on esthetic perceptions of the smile in the frontal view. *American Journal of Orthodontics and Dentofacial Orthopedics*. American Association of Orthodontists, 148(3), pp. 396–404.

Richards, M. R. *et al.* (2015). Contribution of malocclusion and female facial attractiveness to smile esthetics evaluated by eye tracking. *American Journal of Orthodontics and Dentofacial Orthopedics*. American Association of Orthodontists, 147(4), pp. 472–482.

# APPENDIX 1

## Full-text articles excluded, with reasons - Reasons:

<u>Articles Excluded due to the impossibility of assessment of smiles components perception separately:</u>

1.An, S. M., *et al.* (2014). Comparing esthetic smile perceptions among laypersons with and without orthodontic treatment experience and dentists. *The Korean Journal of Orthodontics*, *44*(6), 294-303.

2. Kaya, B., and Uyar, R. (2016). The impact of occlusal plane cant along with gingival display on smile attractiveness. *Orthodontics & Craniofacial Research*, *19*(2), 93-101.

3.Machado, R. M., *et al.* (2016). Variations between maxillary central and lateral incisal edges and smile attractiveness. *American Journal of Orthodontics and Dentofacial Orthopedics*, *150*(3), 425-435

4. Julián-Castellote, G., *et al*. (2016). A comparative study of aesthetic perceptions of malocclusion among general practice dentists, orthodontists and the public using a visual analogue scale (VAS) and the IOTN-AC. *Journal of clinical and experimental dentistry*, *8*(5), e584.

5. Kaya, B., and Uyar, R. (2013). Influence on smile attractiveness of the smile arc in conjunction with gingival display. *American Journal of Orthodontics and Dentofacial Orthopedics*, *144*(4), 541-547.

<u>The authors were contacted to request the statistical data necessary for this Systematic Review, however unsuccessfully:</u>

6. Ioi, H., *et al.* (2013). Effects of Vertical Positions of Anterior Teeth on Smile Esthetics in Japanese and Korean Orthodontists and Orthodontic Patients. *Journal of Esthetic and Restorative Dentistry*, *25*(4), 274-282.

Articles Exluced for not meeting inclusion criteria nº2 (Studies considering the perspective of orthodontists and laypersons):

7. Sadrhaghighi, A. H., *et al.* (2017). Esthetic preferences of laypersons of different cultures and races with regard to smile attractiveness. *Indian Journal of Dental Research*, *28*(2), 156.

8. Aldhorae, K., *et al.* (2020). Perception of dental students and laypersons to altered dentofacial aesthetics. *Journal of International Society of Preventive & Community Dentistry*, *10*(1), 85.

9. Nimbalkar, S., *et al.* (2018). Smile attractiveness related to buccal corridor space in 3 different facial types: A perception of 3 ethnic groups of Malaysians. *The Journal of prosthetic dentistry*, *120*(2), 252-256.

10. McLeod, C., *et al.* (2011). Esthetics and smile characteristics evaluated by laypersons: a comparison of Canadian and US data. *The Angle Orthodontist*, *81*(2), 198-205.

11. Springer, N. C., *et al.* (2011). Smile esthetics from the layperson's perspective. *American Journal of Orthodontics and Dentofacial Orthopedics*, *139*(1), e91-e101.

12. Sriphadungporn, C., and Chamnannidiadha, N. (2017). Perception of smile esthetics by laypeople of different ages. *Progress in orthodontics*, *18*(1), 1-8.

13. Pinho, T. (2013). Assessment of the perception of smile esthetics by laypersons, dental students and dental practitioners. *International Orthodontics*, *11*(4), 432-444.

14. Ferreira, J. B., *et al.* (2016). Perception of midline deviations in smile esthetics by laypersons. *Dental press journal of orthodontics*, *21*(6), 51-57.

15. Noureddine, A., *et al.* (2014). Laypersons 'esthetic perception of various computer-generated diastemas: A pilot study. *The Journal of prosthetic dentistry*, *112*(4), 914-920.

16. Williams, R. P., Rinchuse, D. J., and Zullo, T. G. (2014). Perceptions of midline deviations among different facial types. *American Journal of Orthodontics and Dentofacial Orthopedics*, *145*(2), 249-255.

Articles Excluded for not meeting inclusion criteria nº3 (Articles containing 1 or multiple of
the following parameters: Buccal Corridors Space, Gingival Display, Maxillary Incisors
Inclinations, Smile Arc and Midline Deviations):

17. Machado, A. W., Moon, W., and Gandini Jr, L. G. (2013). Influence of maxillary incisor
edge asymmetries on the perception of smile esthetics among orthodontists and
laypersons. *American Journal of Orthodontics and Dentofacial Orthopedics*, *143*(5), 658-664.

18. Batra, P., *et al.* (2018). Impact of altered gingival characteristics on smile esthetics:
Laypersons' perspectives by Q sort methodology. *American Journal of Orthodontics and
Dentofacial Orthopedics*, *154*(1), 82-90. (The gingival characteristics are not related to the field
of orthodontics)

19. Ngoc, V. T. N., *et al.* (2020). Perceptions of Dentists and Non-Professionals on Some Dental
Factors Affecting Smile Aesthetics: A Study from Vietnam. *International Journal of
Environmental Research and Public Health*, *17*(5), 1638.

20. Al Taki, A., *et al.* (2017). Smile esthetics: Impact of variations in the vertical and horizontal
dimensions of the maxillary lateral incisors. *European journal of dentistry*, *11*(4), 514.

21. Hamdan, A. M., *et al.* (2019). Does overbite reduction affect smile esthetics?. *The Angle
Orthodontist*, *89*(6), 847-854

22. Cheng, H. C., and Cheng, P. C. (2017). Factors affecting smile esthetics in adults with
different types of anterior overjet malocclusion. *The Korean Journal of Orthodontics*, *47*(1),
31-38.

23. Pithon, M. M., *et al.* (2013). Esthetic perception of black spaces between maxillary central
incisors by different age groups. *American Journal of Orthodontics and Dentofacial
Orthopedics*, *143*(3), 371-375.

24. Kearney, M. K., Pandis, N., and Fleming, P. S. (2016). Mixed-methods assessment of
perceptions of mandibular anterior malalignment and need for orthodontic
retreatment. *American journal of orthodontics and dentofacial orthopedics*, *150*(4), 592-600.

Articles Excluded for not meeting inclusion criteria nº4 (Images of altered smiles featured digitally modified individually and obtained from pictures of individuals):

25. Bolas-Colvee, B., *et al.* (2018). Relationship between perception of smile esthetics and orthodontic treatment in Spanish patients. *PloS one*, *13*(8), e0201102.

26. Yin, L., *et al.* (2014). Differences in facial profile and dental esthetic perceptions between young adults and orthodontists. *American Journal of Orthodontics and Dentofacial Orthopedics*, *145*(6), 750-756.

27. Zheng, B., *et al.* (2018). Comparison of perceptions on the dental aesthetics of different malocclusions between orthodontists and schoolchildren. *Saudi medical journal*, *39*(9), 946.

28. Salehi, P., *et al.* (2019). Influence of Age on Perception of Best Esthetical Profile. *Journal of Dentistry*, *20*(1), 16.

29. Singh, H., *et al.* (2017). Subjective and objective evaluation of frontal smile esthetics in patients with facial asymmetry—a comparative cross-sectional study. *Orthodontics & craniofacial research*, *20*(1), 8-20.

30. Dindaroğlu, F., Erdinç, A. M. E., and Doğan, S. (2016). Perception of smile esthetics by orthodontists and laypersons: full face and a localized view of the social and spontaneous smiles. *Turkish journal of orthodontics*, *29*(3), 59.

31. Carneiro, E. N., *et al.* (2018). Perception of facial profile attractiveness of a brown subject displaying different degrees of lip projection or retrusion, in the city of Salvador/Bahia. *Dental press journal of orthodontics*, *23*(2), 62-67.

32. Lauria, A., *et al.* (2014). Perception of oral and maxillofacial surgeons, orthodontists and laypersons in relation to the harmony of the smile. *Journal of Cranio-Maxillofacial Surgery*, *42*(8), 1664-1668.

Articles Excluded for not meeting inclusion criteria nº5 (Studies using VAS or any other grading method, allowing perception comparison or measurement of acceptability threshold):

33. Prasad, K. N., *et al.* (2018). Comparison of the influence of dental and facial aesthetics in determining overall attractiveness. *International orthodontics*, *16*(4), 684-697.

Articles Excluded because of exclusion criteria nº1:

34. Macías Gago, A. B., Romero Maroto, M., and Crego, A. (2012). The perception of facial aesthetics in a young Spanish population. *The European Journal of Orthodontics*, *34*(3), 335-339.

Articles Excluded because of exclusion criteria nº3 (Patients who underwent maxillofacial surgery or orthodontic retreatment):

35. Kearney, M. K., Pandis, N., and Fleming, P. S. (2016). Mixed-methods assessment of perceptions of mandibular anterior malalignment and need for orthodontic retreatment. *American journal of orthodontics and dentofacial orthopedics*, *150*(4), 592-600.

Articles Exlcluded of exclusion criteria nº5 (Insufficient demographic data regarding the participants of the study):

36 Almanea, R., *et al.* (2019). Perception of smile attractiveness among orthodontists, restorative dentists, and laypersons in Saudi Arabia. *Journal of conservative dentistry: JCD*, *22*(1), 69.

37. Sadrhaghighi, H., *et al.* (2017). Esthetic perception of smile components by orthodontists, general dentists, dental students, artists, and laypersons. *Journal of investigative and clinical dentistry*, *8*(4), e12235.

38. Gaikwad, S., *et al.* (2016). Influence of Smile Arc and Buccal Corridors on Facial Attractiveness: A Cross-sectional Study. *Journal of clinical and diagnostic research: JCDR*, *10*(9), ZC20.

39. Simões, D., *et al.* (2019). Does the vertical position of maxillary central incisors in men influence smile esthetics perception?. *American Journal of Orthodontics and Dentofacial Orthopedics*, *156*(4), 485-492.

40. Menezes, E. B. C., Bittencourt, M. A. V., and Machado, A. W. (2017). Do different vertical positions of maxillary central incisors influence smile esthetics perception?. *Dental press journal of orthodontics*, *22*(2), 95-105.

# APPENDIX 2

## Additional Discussion

**Additional Information Regarding Facial Type and Gender**

**2.1. Buccal Corridors:**

For shorter facial types alterations in Buccal Corridor Space (BCS) are not relevant to the overall appreciation of the smile (Zange *et al.*, 2011; Mollabashi *et al.*, 2018)

For longer faces, the changes in BCS only appear to be relevant for BCS' wider than 28% (Zange *et al.*, 2011).

For male smiles, differences in perception of BCS between both groups were more significant: orthodontists preferred BCS 4% while laypersons preferred BCS16%. For female smiles, orthodontists considered BCS 12% to be more attractive, whereas laypersons considered BCS 0% as more attractive (Oz *et al.*, 2017).

Therefore, laypersons will still consider the smile attractive despite a wider BCS, whereas orthodontists are more likely to rate a smile as unattractive when associated with a wider BCS. This suggests that orthodontists smile perception is more influenced by BCS than laypersons (Al Taki *et al.*, 2016).

**2.2. Gingival Display:**

As mentioned in the main discussion, Gingival Display (GD) is the parameter where most differences were found between studies, indicating a lack of consistency between their findings.

No data was found on the impact of gingival display regarding facial type.

Significant differences between genders were found. It is possible that women as observers are more sensitive to a "gummy smile" than men (Abu Alhaija, Al-Shamsi and Al-Khateeb, 2011). For male smile, laypersons preferred +1mm and orthodontists preferred 0 mm, whereas for the female smile, the best scores where obtained at -3mm by laypersons (meaning 0 gingival

display and 3mm of lip incisors coverage) and +2mm by orthodontists (meaning 2 mm of gingival display) (Oz *et al.*, 2017)

Even though it was possible to asses approximately which values were aesthetically pleasing, it was not clear at which values of GD the smile was no longer considered attractive. While the study of Abu Alhaija, Al-Shamsi and Al-Katheeb (2011) states that from +2mm of GD the smile is no longer considered attractive, Oz *et al*. (2017) says +3mm is the limit, Al Taki (2016) says it is considered tolerable until +3 to +4 mm.

## 2.3. Maxillary Incisors Position

The majority of participants were susceptible to changes in this parameters meaning it can be considered as an important parameter in the assessment of smile attractivity. (Ghaleb, Bouserhal and Bassil-Nassif, 2011).

The studies analyzed do not mention significant differences as far as gender is concerned. However, according to Chirivella *et al*. (2017), significant differences can be found between face patterns.

For the mesofacial patterns the data collected is equivalent to the data collected from similar studies such as Cao *et al*. (2011).

For the brachyfacial pattern, or for shorter face patterns, the position of maxillary incisors should be limited to 2mm from GALL (Chirivella *et al.*, 2017).

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Chirivella, P. *et al.* (2017). Comparison of the effect of labiolingual inclination and anteroposterior position of maxillary incisors on esthetic profile in three different facial patterns. *Journal of Orthodontic Science*, 6(1), p. 1.

Ghaleb, N., Bouserhal, J. and Bassil-Nassif, N. (2011). Aesthetic evaluation of profile incisor inclination. *European Journal of Orthodontics*, 33(3), pp. 228–235.

Mollabashi, V. *et al.* (2018). Smile attractiveness perception regarding buccal corridor size among different facial types. *Dental and Medical Problems*, 55(3), pp. 305–312.

Oz, A. A. *et al.* (2017). Smile Attractiveness: Differences among the Perceptions of Dental Professionals and Laypersons. *Turkish Journal of Orthodontics*, 30(2), pp. 50–55.

Al Taki, A. *et al.* (2016). Perceptions of Altered Smile Esthetics: A Comparative Evaluation in Orthodontists, Dentists, and Laypersons. *International Journal of Dentistry*. Edited by C. R. Leles. Hindawi Publishing Corporation, 2016, p. 7815274.

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