

Effect of dental midline, buccal corridor, and gingival display on perception of smile esthetics by orthodontists and laypersons among Sudanese population

Abstract

Background: A smile is the most attractive feature of the human face, and it is influenced by traditions, beliefs, and personal preferences.

Aesthetically pleasing smiles can be achieved interestingly by orthodontic treatments and these can only be successful if there are adequate understanding and compromise of the views of both the patient and the dentist. This study investigates the perception of smile aesthetics among Sudanese populations, focusing on the dental midline, buccal corridors, and gingival display.

Material & methods: A cross-sectional study was conducted involving 258 Sudanese participants (60 orthodontists and 198 laypeople).

Each participant rated an image of a female photo, idealized in terms of dental midline position, buccal corridor size, and gingival display. All images were digitally modified and the Modified images were rated on their attractiveness. The ranking Scores were calculated and statistical analyses were used to compare the different groups of participants using the Mann Whitney test, with a significance level of 0.05 to assess whether there were statistical different in their rating.

Results: There was statistically significant difference between orthodontists and laypeople concerning perception of smile aesthetics.

Orthodontists were more sensitive to midline deviations beyond 2 mm compared to laypersons. orthodontists appeared to be more concerned with minor details like the repositioning of the dental midline and the degree of gingival display, while lay people focused less on these aspects. Both groups, however, had similar preferences for the buccal corridor width, in both cases, a restrictive width was favored in order to achieve symmetry in the smile.

Conclusion: Understanding the great diversity that exists between the professionals and laypeople in their perceptions when evaluating the smile in orthodontic treatment plans is indispensable. Noticing these differences would help orthodontists to provide a more appropriate treatment that meets patients' needs and cultural background.

Keywords: smile aesthetics, orthodontics, dental midline, buccal corridor, gingival display, laypersons, orthodontists, esthetic perception

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Introduction

Smile esthetics play an essential role in orthodontic diagnosis and treatment planning, being closely related to patients' self-confidence and social acceptance.¹ Key determinants of smile attractiveness include the buccal corridor, gingival display, and midline alignment.²⁻⁴ Perception of beauty is subjective and influenced by gender, age, education, and cultural background.^{5,6}

Facial and smile attractiveness are strongly connected since attention during social interactions is mainly directed toward the mouth and eyes.⁷ With advances in digital imaging, controlled manipulation of smile variables such as buccal corridor, gingival display, and midline position has become possible, allowing objective assessment of aesthetic perceptions among dentists and laypersons.⁸⁻¹⁰ Previous studies have shown that well-aligned teeth and harmonious smiles are perceived as more attractive and socially favourable.^{11,12}

In particular variation in gingival display dental midline deviation and buccal corridor width have been shown to influence the perception of smile attractiveness across different populations.¹³⁻¹⁷ Recent studies have further highlighted the growing importance of these variables in orthodontic diagnosis and treatment planning. These studies emphasize that the perception smile aesthetics and laypersons and may also vary across different cultural backgrounds.¹⁸

Objectives

General objectives

To investigate the effect of dental midline, buccal corridor, and gingival display on the perception of smile esthetics by orthodontists and laypersons among Sudanese population.

Specific objectives

- To determine the perception of smile esthetics among orthodontists and laypersons, concerning the amount of maxillary midline shift.
- To study the effects of the width of buccal corridors on the perceptions of smile esthetics by orthodontists and laypersons.
- To evaluate the influence of the amount of gingival display on smile esthetics as it relates to orthodontists and laypersons.

Methodology

A cross-sectional study was conducted using an anonymous, self-administered questionnaire. The first section of the questionnaire collected **sociodemographic information** (age, gender, educational level, and professional background), while the second section recorded participants' responses to a set of digitally modified smile photographs.

A standardized frontal smile photograph of a female subject with well-aligned maxillary teeth was taken using a **digital camera (Canon D1300)**. After obtaining informed consent, the image was digitally manipulated using **Adobe Photoshop (CS version 8.0; Adobe Systems, San Jose, Calif)** to create controlled variations in three esthetic parameters:

- Dental midline shift:** from 0 mm (ideal) to 5 mm, in 1 mm increments (Figure 1).
- Buccal corridor width:** adjusted according to the ratio of visible maxillary dentition width to commissural width, resulting in values ranging from **2% (narrow)** to **28% (broad)** (Figure 2).
- Gingival display:** adjusted by moving the maxillary teeth relative to the upper lip to produce exposures ranging from **0 mm to 7 mm** (Figure 3).



Figure 1 Series of 7 images illustrating the range of dental midline created: narrow (0 mm), medium narrow (1mm), medium (2mm), medium board (3 mm), board (4 mm), extra board (5mm).



Figure 2 Series of 7 images illustrating the range of buccal corridors created: narrow (2%), medium narrow (10%), medium (15%), medium- board (22%), board (28%).



Figure 3 Series of 7 images illustrating the range of gingival display created: narrow (0 mm), medium narrow (1mm), medium (3 mm), medium board (5 mm), board (7 mm).

To minimize confounding variables, the **nose and chin were cropped** from the photographs for buccal corridor and gingival display evaluation, while a portion of the nose was retained in midline evaluations to provide a facial reference. In total, **21 experimental images** were produced across the three groups, along with duplicated control images to assess rater reliability.

Participants were instructed to rank the attractiveness of the images using a **Visual Analogue Scale (VAS)** from 0 to 10, where 0 represented “least attractive” and 10 “most attractive.” The ratings were classified as follows:

≤1 (very bad), 1.1–3 (bad), 3.1–5 (average), 5.1–7 (good), and >7 (very good).

To assess **intra-rater reliability**, one duplicate image from each set was randomly included without the participants' awareness.

Results

The study included a total of 258 Sudanese participants, consisting of 60 orthodontists and 198 lay people, with a majority (52.7%) aged 31-40 years, indicating a younger population. The calculated minimum sample size was 189 participants based on the formula for estimating the mean using a confidence level of 95% and margin of error of 5%. To improve statistical power and compensate for potential non-response, the sample size was increased to 198 laypersons. Additionally, 60 orthodontists were included through full coverage sampling, resulting in a total sample size of 258 participants. The majority of the sample were females (84.1%), resulting in a female-to-male ratio of 5.3:1.

The sample size for each group determined through the following equation

$$n = Z^2 \times p(1 - p) / d^2$$

Where:

n = required sample size

Z = standard normal deviation at 95% confidence level (1.96)

p = estimated proportion based on previous studies

d = margin of error

Rating of dental midline photo

The picture shows the mean scores of dental midline evaluations for seven groups (G1a to G1g), each consisting of 258 participants. The scores range from 6.95 in group G1a, the highest, to 4.63 in group G1f, the lowest. There is a noticeable decline in the mean scores from G1a to G1f, with a slight increase in G1g (5.23) as it was a duplicated photo (Figure 4).

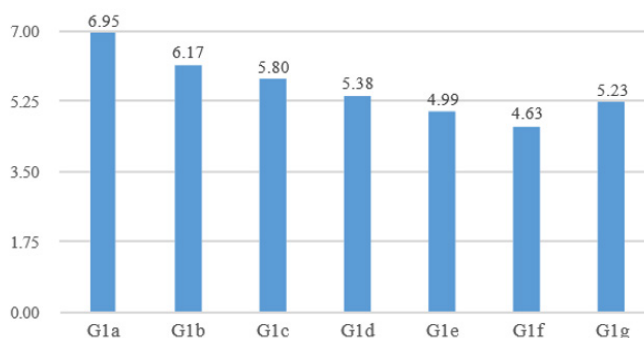


Figure 4 Scores of dental midline photo by Sudanese subjects (n=258).

Rating of Buccal corridor photo

The picture outlines the mean buccal corridor scores for seven groups (G2a to G2g), each consisting of 258 participants scores remain

fairly consistent across the groups, with minor fluctuations, suggesting little variation in the buccal corridor assessments among these groups (Figure 5).

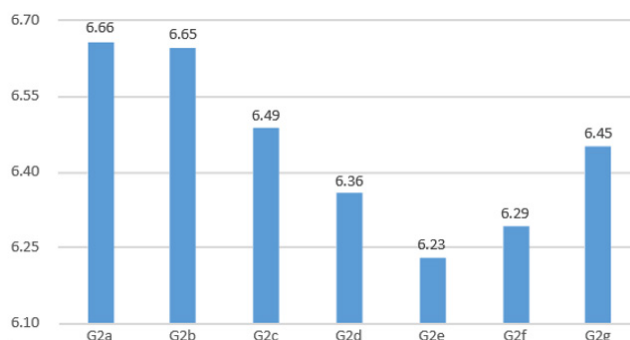


Figure 5 Scores of Buccal corridor photo by Sudanese subjects (n=258).

Rating of gingival display photo

The participants gave G3a higher scores of 7.91 which gradually declined to 5.60 in g3f, indicating a general decrease in gingival

display across the groups. The pattern suggests a steady reduction in gingival display from g3a to g3f (Figure 6).

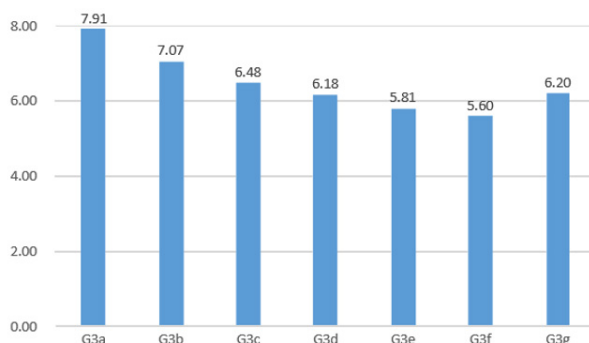


Figure 6 Scores of gingival displays by Sudanese subjects (n=258).

Comparison of orthodontists and laypeople on various metrics using the Mann-Whitney test

Tables 1, 2 and 3 compare the mean, median, and standard deviation of orthodontists and laypeople across seven groups for

different metrics. The Mann-Whitney test was used to determine significant differences between the two groups for each metric.

In most comparisons, G1a to G1d show no significant differences between the two groups, and group G1e to G1f, exhibit statistically significant differences (Table 1).

Table 1 Comparison of orthodontists and laypeople on Rating of dental midline photo (n=258)

Midline photos	Occupation						P-value
	Orthodontist			laypeople			<0.05
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation	Maan Whitney test
G1a	6.8	7.0	2.5	7.0	7.0	2.5	0.54
G1b	6.0	6.0	2.7	6.2	7.0	2.4	0.74
G1c	5.5	6.0	2.4	5.9	6.0	2.5	0.36
G1d	4.8	5.0	2.1	5.5	5.0	2.7	0.06
G1e	4.0	4.0	2.1	5.3	5.0	2.8	0.01
G1f	3.4	3.0	2.3	5.0	5.0	3.0	0.01
G1g	4.4	4.0	2.5	5.5	5.0	2.9	0.01

There were significant differences in opinions or scores found in groups G2d, G2e, G2f, and G2g, whereas no significant differences are observed in groups G2a, G2b, and G2c (Table 2).

Table 2 Comparison of orthodontists and laypeople rating of buccal corridor photos (n=258)

Buccal corridor photos	Occupation						P-value
	Orthodontist			Laypeople			<0.05
	Mean	Median	Std. deviation	Mean	Median	Std. deviation	Maan Whitney test
G2a	6.4	7.0	2.2	6.7	7.0	2.5	0.43
G2b	6.5	7.0	2.2	6.7	7.0	2.3	0.72
G2c	6.0	6.0	2.1	6.6	7.0	2.3	0.07
G2d	5.5	5.5	2.0	6.6	7.0	2.3	0.01
G2e	4.8	4.0	2.4	6.7	7.0	2.4	0.01
G2f	5.0	5.0	2.7	6.7	7.0	2.5	0.01
G2g	5.1	5.0	2.6	6.9	7.0	2.4	0.01

There were differences in responses observed in groups g3a, g3c, g3d, g3e, g3f, and g3g, while no significant difference is found in group g3b (Table 3).

Table 3 Rating of gingival display photo (n=258)

Gingival display photos	Occupation						P-value
	Orthodontist			laypeople			<0.05
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation	Maan Whitney test
G3a	7.60	8.00	1.976	8.01	9.00	2.289	0.02
G3b	6.87	7.00	2.103	7.14	8.00	2.484	0.23
G3c	5.82	6.00	2.127	6.68	7.00	2.524	0.01
G3d	5.30	5.00	2.338	6.44	7.00	2.738	0.01
G3e	4.72	5.00	2.443	6.14	6.00	2.904	0.01
G3f	4.13	4.00	2.375	6.05	6.00	3.001	0.01
G3g	5.47	6.00	2.397	6.42	7.00	2.967	0.01

Discussion

This study explored the perception of smile aesthetics among Sudanese orthodontists and laypeople, focusing on three main parameters: **dental midline deviation, buccal corridor width, and gingival display**. The digitally manipulated smile photographs proved to be a reliable method for evaluating aesthetic preferences.¹⁹⁻²³

Dental midline

Orthodontists demonstrated greater sensitivity to midline deviations than laypeople, particularly when shifts exceeded **2 mm**, aligning with findings by Janson et al.¹⁹ and Pinho et al.²² This heightened awareness reflects orthodontists' professional focus on precision, whereas laypeople were more tolerant, emphasizing overall facial harmony. Similar conclusions were reported by Beyer et al.,²⁴

Johnston et al.,²⁵ and Ferreira et al.²⁷ Differences across studies (e.g., Kokich et al.,⁷ McLeod et al.,³³ Ker et al.³⁴) may stem from varying photographic methods and population diversity. The finding of this study demonstrated that orthodontists were more sensitive to dental midline deviations compare with laypersons. This observation is consistent with previous studies that reported dental professionals tend to detect minor deviations they may not be perceived by the general public. Al taki et al.,³⁵ reported that orthodontists identified midline discrepancies greater than 1-2 mm, while laypersons tolerated deviations up to 3-4mm. This difference may be attributed to professional training and clinical experience.

Buccal corridor

Both groups preferred **narrower buccal corridors**, consistent with Parekh et al.,²¹ Sultan et al.,³⁰ Najarzadegan et al.,³¹ and Sayahpour et al.³² The lack of significant differences between orthodontists and laypeople suggests shared aesthetic preferences regarding buccal corridor width. These findings support prior research advocating minimal buccal corridors for an attractive smile (Ritter et al.,²⁰ Parekh et al.,²¹ although some authors (Rodén-Johnson et al.²² found little influence of this parameter on smile appeal.

Gingival display

Smiles with **0–2 mm gingival display** was rated most attractive, while excessive display (>3 mm) was considered less esthetic. This aligns with Geron & Atalia,²³ Sarver & Jacobson,²⁸ and Gracco et al.²⁴ Orthodontists were more critical of excessive gingival exposure than laypeople, reflecting professional aesthetic standards. Similar thresholds (3–4 mm) were reported in Canadian and Dutch populations (McLeod et al.,³³ Van der Geld et al.,¹ Kokich et al.,⁷ Ker et al.³⁴ Interestingly, recent trends toward natural aesthetics may explain minor cross-cultural differences in perception.

Previous studies demonstrated that dental professionals tend to evaluate smile aesthetics more critically than laypersons. Differences in perception were particularly evident when evaluating gingival display, dental alignment, and other micro esthetic features. For example, Aldeeri et al.³⁶ reported that orthodontists and dentists were significantly more sensitive to alterations in smile characteristics compared with laypersons. Similarly, Almori et al.³⁷ found that gingival micro esthetic parameters significantly influence smile attractiveness perception among both professionals and the general public. Recent studies have also confirmed that variations in dental spacing and alignment affect perceived smile esthetics among dentists and laypersons.³⁶⁻³⁸

Gender consideration

Although gender differences were not a primary focus, the predominance of female participants (84.1%) might have influenced results, as prior studies suggest women show greater concern for facial aesthetics.

Overall, the findings emphasize that while **orthodontists apply more stringent criteria, laypeople focus on harmony and naturalness**. These insights highlight the importance of incorporating patients' perceptions into orthodontic treatment planning for achieving optimal esthetic outcomes.

Conclusion

This study demonstrated significant differences between orthodontists and laypersons in the perception of smile aesthetics among the Sudanese population. Orthodontists were more sensitive

to dental midline deviations and gingival display, whereas laypersons showed less sensitivity to minor discrepancies. However, both groups demonstrated similar preferences regarding buccal corridor width. These findings highlight the importance of considering patients' perceptions when planning orthodontic treatment to achieve optimal aesthetic outcomes.

Recommendations

- Orthodontists should consider patients' aesthetic perceptions during treatment planning.
- Future studies should include larger and more diverse samples from different regions of Sudan.
- Additional research evaluating other smile components such as smile arc and tooth proportions is recommended.

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None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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