

Evaluation of the Effect of Changing Gingival Features on Individuals' Perception of Smile Aesthetics

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Abstract

Background: Smile aesthetics significantly influence social perception, self-esteem and professional opportunities. While dental aesthetics traditionally focused on tooth morphology, periodontal factors particularly gingival features are increasingly recognized as critical determinants of smile harmony. This study aimed to quantify the impact of specific gingival alterations on layperson aesthetic perception.

Methods: 150 patients were included in the study (82 women, 68 men; mean age 27.69 ± 6.12 years) who evaluated 34 digitally modified smile photographs depicting gingival recession (1-3 mm), papillary defects (black triangles) and hyperpigmentation using a Q-sort method. Statistical analysis was performed using SPSS 26, with significance set at $p < 0.05$.

Results: Papillary defects (3 mm black triangles between central incisors) received the lowest aesthetic scores (-3.25 ± 1.24), followed by gingival recession ≥ 2 mm (-2.88 ± 1.13). Hyperpigmentation had minimal impact (mean scores: -0.15 to $+0.50$). Gender differences were significant: women rated 3 mm lateral recession lower than men (-0.82 vs. 0.07 ; $p = 0.003$), while men rated 1 mm lateral recession higher than women (1.01 vs. 1.83 ; $p = 0.004$).
Conclusion: Papillary defects and recession ≥ 2 mm are the most detrimental to smile aesthetics. Current treatments for papillary defects lack standardization, highlighting the need for evidence-based protocols. Preventive strategies and early intervention are critical for maintaining periodontal aesthetics.

Keywords: Smile Aesthetics; Gingival Recession; Papillary Defects; Hyperpigmentation; Q-Sort

Citation: Çelenli Y, et al. Evaluation of the Effect of Changing Gingival Features on Individuals' Perception of Smile Aesthetics. *J Dental Health Oral Res.* 2026;7(1):1-8.

<https://doi.org/10.46889/JDHOR.2026.7109>

Received Date: 08-01-2026

Accepted Date: 08-02-2026

Published Date: 15-02-2026



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Introduction

Smile aesthetics is a cornerstone of facial attractiveness, with profound implications for social interactions, self-confidence and professional success [1]. Studies indicate that individuals with attractive smiles are perceived as more trustworthy, competent and socially appealing, influencing outcomes in job interviews, academic admissions and interpersonal relationships [2-4]. Historically, dental aesthetics focused primarily on tooth alignment and morphology; however, contemporary research emphasizes the role of periodontal tissues in smile design [5].

The gingiva contributes significantly to smile harmony through its contour, color and anatomical relationships with teeth and soft tissues [6]. Alterations such as recession, papillary defects ("black triangles") and hyperpigmentation can disrupt aesthetic balance, yet their relative impact on layperson perception remains underexplored [7]. While orthodontists and prosthodontists have extensively studied dental aesthetics, periodontal aspects particularly gingival features have received less attention in subjective aesthetic evaluations [8,9].

Previous studies have documented the clinical significance of gingival recession and papillary defects but few have quantified their impact on aesthetic perception using validated methodologies like Q-sort [10-12]. This study addresses this gap by evaluating how specific gingival alterations influence aesthetic judgments among laypersons, providing evidence to guide clinical decision-making and patient counseling.

Materials and Methods

Study Design and Participants

A cross-sectional study was conducted with 150 participants recruited from the Department of Periodontology at Zonguldak Bülent Ecevit University Faculty of Dentistry. Sample size was calculated using G Power 3.1, with an effect size of 0.3, alpha = 0.05 and power = 80%, requiring a minimum of 140 participants [13].

Inclusion Criteria

- Age 18-40 years
- No dental education or orthodontic treatment history
- No prior aesthetic dental procedures (e.g., veneers, crown lengthening)
- Absence of psychological disorders or visual impairments
- Willingness to participate

Exclusion Criteria

- History of periodontal surgery or systemic conditions affecting gingival health
- Current use of medications altering gingival color (e.g., antimalarials)
- Incomplete survey responses

Ethical Statement

All participants provided written informed consent. The study was approved by the university's Ethics Committee (Ref: 2021/01-05).

Photograph Preparation

Thirty-four digital smile photographs were created using Adobe Photoshop 9 (Adobe Systems, San Jose, CA, USA). A single patient's smile was photographed with a Canon EOS 250D DSLR camera (Canon Inc., Tokyo, Japan) equipped with a 100 mm macro lens and dual flash system (Meike MK-GT620II and MK-R200 II), adhering to standardized dental imaging protocols [14].

Modifications Included

Gingival recession: 1-3 mm unilateral/bilateral recession in central incisors, lateral incisors and canines

Papillary defects: Black triangles of 1-3 mm between central incisors or across six maxillary anterior teeth

Hyperpigmentation: Band-shaped, irregular or generalized discoloration

Two periodontists validated the modifications to ensure clinical accuracy. Photographs were printed on 75 × 50 mm cardstock and randomized for evaluation.

Data Collection

Participants evaluated photographs using a Q-sort method [15]. They ranked images from most to least aesthetically pleasing, assigning scores from +4 (most attractive) to -4 (least attractive). The process involved:

1. Placing the two most attractive images in the +4 column
2. The two least attractive in the -4 column
3. Iteratively sorting remaining images into +3, -3, +2, -2, +1, -1 and 0 columns

Demographic data (age, gender, education, social media usage) were collected via a structured questionnaire.

Data Analysis

Data were analyzed using IBM SPSS Statistics 26 (IBM Corp., Armonk, NY, USA). Normality was assessed via Shapiro-Wilk test. Non-parametric tests (Mann-Whitney U, Kruskal-Wallis) were applied for non-normally distributed data, while One-Way ANOVA compared categorical variables. Descriptive statistics are reported as median (interquartile range). Significance was set at $p < 0.05$.

Results

Demographic Characteristics

The study included 150 participants (82 women, 68 men; mean age 27.69 ± 6.12 years). Most had university education (67.3%), followed by high school (22.7%), middle school (5.3%) and primary school (4.7%). Social media usage was high (91.3%), with 87% reporting daily Instagram/Facebook use.

Aesthetic Ratings

Table 1 summarizes aesthetic scores across 1-3 mm unilateral/bilateral gingival recessions, papillary conditions and pigmentations. The lowest score among all photographs was photograph with a score of -3.25 that has 3mm dark triangular areas in the upper anterior six teeth due to papillary loss. There was no significant difference between the groups in the scoring of this photograph ($p > 0.005$). The photograph with the 2nd lowest score was photograph with a score of -3.15 that has 3 mm dark triangular area between two central incisors due to papillary loss in the midline. There was no significant difference between the groups ($p > 0.005$). The photograph with the 3rd lowest score was photograph with a score of -2.88 that has a 2 mm dark triangular area between two central incisors due to papillary loss in the midline. There was no significant difference between the groups ($p > 0.005$). The photograph with the highest score was photograph with a score of 1.79 that has 1 mm gingival recession on the lateral incisor on one side. It received similarly high scores from all groups. There was no significant difference between the groups ($p > 0.005$). The photograph with the 2nd highest score was photograph with a score of 1.63 that has 1 mm gingival recession on the canine tooth on one side. Similar results were obtained between the groups and no significant difference was observed ($p > 0.005$). The photograph with the 3rd highest score was photograph with a score of 1.51 that has a 2 mm gingival recession on the unilateral canine tooth. There was no significant difference between the groups ($p > 0.005$) (Fig. 1). In the photograph that has 3 mm bilateral gingival recessions on the lateral incisors and in the photograph that has 1mm bilateral gingival recession on the lateral incisor, there were significant difference between female and male groups ($p = 0.003$; $p = 0.004$ respectively) (Fig. 2).

	Gender	N	Average	95% Confidence Interval		P-value
				Lowest Score Awarded	Highest Score Awarded	
1 mm unilateral canine gingival recession	woman	82	1,89	1,43	2,35	0,503
	man	68	1,68	1,25	2,11	
	Total	150	1,79	1,48	2,11	
1 mm unilateral lateral gingival recession	woman	82	1,09	,71	1,46	,009
	man	68	1,78	1,42	2,14	
	Total	150	1,40	1,14	1,66	
. 1 mm unilateral central gingival recession	woman	82	-3,07	-3,38	-2,77	,425
	man	68	-3,25	-3,57	-2,93	
	Total	150	-3,15	-3,37	-2,94	
1 mm bilateral canine gingival recession	woman	82	1,00	,58	1,42	,160
	man	68	1,46	,96	1,95	
	Total	150	1,21	,89	1,53	
1 mm bilateral lateral gingival recession	woman	82	-1,35	-1,72	-,99	,010
	man	68	-,59	-1,05	-,13	
	Total	150	-1,01	-1,30	-,71	
1 mm bilateral central	woman	82	-1,32	-1,65	-,98	

gingival recession	man	68	-1,50	-1,81	-1,19	
	Total	150	-1,40	-1,63	-1,17	,429
1 mm generalized gingival recession	woman	82	-,56	-,90	-,23	
	man	68	,04	-,42	,50	
	Total	150	-,29	-,57	-,01	,032
2 mm bilateral canine gingival recession	woman	82	-3,28	-3,56	-3,01	
	man	68	-3,22	-3,54	-2,90	
	Total	150	-3,25	-3,46	-3,05	,777
2 mm bilateral lateral gingival recession	woman	82	-,82	-1,18	-,45	
	man	68	,07	-,41	,55	
	Total	150	-,41	-,71	-,11	,003
2 mm bilateral central gingival recession	woman	82	-,34	-,65	-,03	
	man	68	,22	-,15	,59	
	Total	150	-,09	-,33	,15	,021
2 mm generalized gingival recession	woman	82	,60	,24	,96	
	man	68	,50	,15	,85	
	Total	150	,55	,30	,80	,702
2 mm unilateral canine gingival recession	woman	82	1,83	1,46	2,20	
	man	68	1,01	,60	1,43	
	Total	150	1,46	1,18	1,74	,004
2 mm unilateral lateral gingival recession	woman	82	-2,55	-2,88	-2,22	
	man	68	-2,68	-2,91	-2,45	
	Total	150	-2,61	-2,81	-2,40	,546
2 mm unilateral central gingival recession	woman	82	,83	,52	1,14	
	man	68	,75	,41	1,09	
	Total	150	,79	,56	1,02	,734
3 mm bilateral canine gingival recession	woman	82	1,06	,67	1,45	
	man	68	,51	,18	,85	
	Total	150	,81	,55	1,08	,041
3 mm bilateral lateral gingival recession	woman	82	,84	,48	1,20	
	man	68	1,07	,77	1,38	
	Total	150	,95	,71	1,19	,343
3 mm bilateral central gingival recession	woman	82	,38	-,10	,86	
	man	68	-,13	-,68	,42	
	Total	150	,15	-,21	,51	,165
3 mm generalized gingival recession	woman	82	,66	,21	1,11	
	man	68	,75	,23	1,27	
	Total	150	,70	,36	1,04	,791
3 mm unilateral canine gingival recession	woman	82	1,27	,83	1,71	
	man	68	1,19	,80	1,59	
	Total	150	1,23	,94	1,53	,799
3 mm unilateral lateral gingival recession	woman	82	,63	,36	,91	
	man	68	1,06	,66	1,46	
	Total	150	,83	,59	1,06	,077
3 Mm Unilateral Central	woman	82	-,20	-,53	,14	

Gingival Recession	man	68	-,49	-,80	-,17	
	Total	150	-,33	-,55	-,10	,211
Bilateral Prominent Gingival Contour	woman	82	1,56	1,26	1,86	
	man	68	1,46	1,04	1,87	
	Total	150	1,51	1,27	1,76	,677
Bilateral Indistinct Gingival Recession	woman	82	1,09	,71	1,46	
	man	68	,66	,24	1,08	
	Total	150	,89	,62	1,17	,133
Unilateral Prominent Gingival Contour	woman	82	1,33	1,01	1,65	
	man	68	1,59	1,23	1,94	
	Total	150	1,45	1,21	1,68	,282
Unilateral Indistinct Gingival Contour	woman	82	-,16	-,49	,17	
	man	68	-,28	-,61	,05	
	Total	150	-,21	-,45	,02	,612
. 1 mm black triangular space between two centers	woman	82	1,22	,89	1,55	
	man	68	1,09	,70	1,48	
	Total	150	1,16	,91	1,41	,604
2 mm dark triangle between two central	woman	82	1,83	1,45	2,21	
	man	68	1,40	1,02	1,78	
	Total	150	1,63	1,36	1,90	,114
3 mm black triangular space between two centrals	woman	82	-1,93	-2,17	-1,69	
	man	68	-1,66	-1,91	-1,41	
	Total	150	-1,81	-1,98	-1,63	,130
2 mm dark triangle between maxillary anterior 6 teeth	woman	82	,38	,02	,73	
	man	68	-,34	-,68	,01	
	Total	150	,05	-,20	,31	,005
3 mm dark triangle in the maxillary anterior 6 teeth	woman	82	,50	,18	,82	
	man	68	,32	-,07	,72	
	Total	150	,42	,17	,67	,484
1 mm dark triangular area on the maxillary anterior six teeth	woman	82	,82	,49	1,14	
	man	68	1,04	,60	1,49	
	Total	150	,92	,65	1,19	,406
Band-Shaped Pigmentation	woman	82	-1,23	-1,57	-,90	
	man	68	-1,60	-1,99	-1,21	
	Total	150	-1,40	-1,65	-1,15	,149
Irregular Pigmentation	woman	82	-1,29	-1,56	-1,02	
	man	68	-1,26	-1,57	-,96	
	Total	150	-1,28	-1,48	-1,08	,890
Generalized Pigmentation	woman	82	-2,77	-3,04	-2,50	
	man	68	-3,01	-3,25	-2,78	
	Total	150	-2,88	-3,06	-2,70	

Table 1: Aesthetic scores for various gingival alterations by gender.

Papillary defects received the lowest scores ($p < 0.001$ vs. other categories). Recession ≥ 2 mm was significantly less aesthetic than recession 1 mm ($p = 0.002$). Hyperpigmentation had minimal impact ($p = 0.12$).

Gender Differences

- Women rated 3 mm lateral recession significantly lower than men (-0.82 vs. 0.07; $p = 0.003$)
- Men rated 1 mm lateral recession higher than women (1.01 vs. 1.83; $p = 0.004$)

No significant differences were observed for age or education groups ($p > 0.05$)



Figure 1: Upper Left to right: the photos that have the lowest score, lower left to right: the photos that have the highest score.

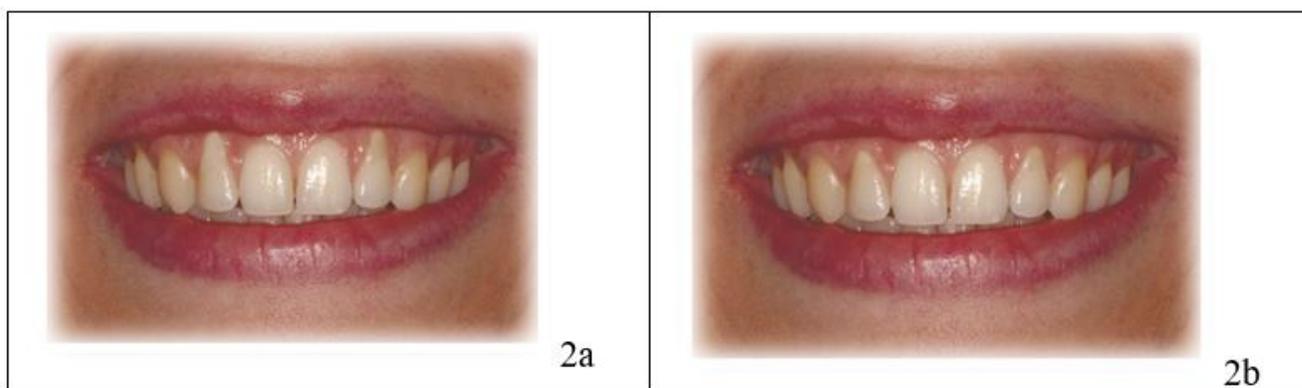


Figure 2: In these 2 photographs a significant difference was observed between female and male groups ($p < 0.005$). a: Men liked the photo and women did not. ($p = 0,003$; b: Women liked the photo more than men did ($p = 0,004$)

Discussion

Papillary Defects as the Primary Aesthetic Concern

Papillary defects (black triangles) received the lowest aesthetic scores and an important issue in modern esthetic, consistent with prior studies [16,17]. Chow, et al., in their study demonstrated that competent papillae presence is decreased with age and associated with crown width proximal contact length bone crest-contact point and interproximal gingival tissue thickness [18]. Our findings align with Zucchelli, et al., who noted that papillary defects are perceived as more disruptive than gingival recession due to their association with "unhealthy" aesthetics and food trapping [19,20].

The clinical relevance of this finding is profound: current treatments for papillary defects lack standardization [21]. While surgical techniques like tunneling and connective tissue grafts show promise, outcomes vary significantly based on biotype, interproximal bone height and tooth morphology [22-24]. Our results underscore the urgency for evidence-based protocols to address papillary defects, particularly in the anterior region where aesthetic demands are highest.

Gingival Recession Thresholds

Recession ≥ 2 mm was consistently rated as less aesthetic than recession < 2 mm (* $p^* = 0.002$), supporting clinical guidelines recommending intervention at this threshold [25]. This aligns with Carranza's Clinical Periodontology, which states that recession > 2 mm is visually noticeable and often associated with root sensitivity and plaque retention [26].

Notably, gender differences emerged: women were more sensitive to lateral recession (Fig. 2), while men rated mild lateral recession (Fig. 2) more favorably. This may reflect social expectations women often prioritize detailed smile aesthetics, whereas men may focus on overall symmetry [27,28]. Similar gender disparities were reported by Al-Saleh, et al., who found women rated gingival display more critically than men [29].

Hyperpigmentation: Minimal Impact

Hyperpigmentation had negligible impact on aesthetic scores ($p = 0.12$), contrasting with prior assumptions [30]. This aligns with Holtzclaw, et al., who noted that patients prioritize structural defects over color variations [31]. Clinically, this suggests that hyperpigmentation treatment should be secondary to addressing papillary defects or recession unless requested by the patient for cosmetic reasons [32].

Limitations and Future Directions

Limitations include reliance on digital photographs (not clinical evaluations) and a homogeneous sample (single-center, Turkish population). Future studies should:

1. Use clinical evaluations with diverse ethnicities
2. Investigate the impact of combined gingival alterations (e.g., recession + papillary defects)

Conclusion

Papillary defects and gingival recession ≥ 2 mm are the most significant determinants of smile aesthetics among laypersons. Current treatments for papillary defects lack standardization, highlighting the need for evidence-based surgical protocols. Preventive strategies such as proper oral hygiene, regular dental check-ups and early intervention for recession are critical for maintaining periodontal aesthetics. Clinicians should prioritize these factors in treatment planning to enhance patient satisfaction and social confidence.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding Statement

This work was supported by Bülent Ecevit University Research Foundation in Zonguldak Project No: 2021/01-05.

Acknowledgement

None

Data Availability Statement

Not applicable.

Ethical Statement

The study was approved by the Zonguldak Bülent Ecevit University's Ethics Committee (Ref: 2021/01-05).

Informed Consent Statement

All participants provided written informed consent prior to participation.

Authors' Contributions

YC and MIC conceived the study, designed the methodology, performed data analysis and drafted the manuscript. All authors reviewed and approved the final manuscript.

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