Aesthetic perception of gingival display on smiling among laypeople seeking dental treatment

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Objective: The present study aimed to determine the influence of gingival display on smile perception of adult patients seeking dental treatment.

Materials and methods: A smiling photograph was digitally modified to simulate gingival exposures from -4 mm to +4 mm, each in 2 mm increments. Using a validated questionnaire, 117 subjects were recruited and asked to rate the attractiveness of the smile displayed by the photographs. Friedman tests were applied to compare the perceptions of the overall subjects in addition to subjects within each category. Kruskal–Wallis tests were used to compare perceptions between the genders, different ages, and ethnicity. Statistical significance was set at $P < 0.05$.

Results: The most aesthetic gingival display was at -2 mm and the least aesthetic at -4 mm among all subjects. Females were more critical in evaluating smiles than males. Subjects 50 years or older and the Chinese ethnicity were less sensitive to the range of gingival displays.

Conclusions: Smile perception of varying gingival display among adult laypeople was found to be the most aesthetic at -2 mm, least aesthetic at -4 mm and was influenced by gender, age, and ethnicity.

(Aust Orthod J 2023; 39: 136 - 144. DOI: 10.2478/aoj-2023-0036)

Received for publication: August, 2023
accepted: November, 2023.

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Introduction

Facial attractiveness is strongly influenced by an individual's smile.[1] It has been found that smile aesthetics contributes as much as 25–31% of facial attractiveness.[2] Gingival display is an important factor that influences a person's perception of smile and facial attractiveness.[3–5] It is defined as the appearance of the gingival tissues and teeth, which, in turn, is influenced by upper lip position.[6]

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Figure 1. Smile with -4 mm gingival display.

An appraisal of the literature has indicated that smile perception in relation to gingival display has wide variation.[1,4,7–10] To many, smiles with a gingival display of 0 to 2 mm are the most attractive.[8,10–15] Nevertheless, recent studies from Asia have reported a gingival display of -2 mm to be the most attractive.[1,16–18] Regarding the least aesthetic smile, many studies have found that a smile with an excessive gingival display of 3 mm or more, termed a 'gummy smile', to be the least attractive.[4,6,8,10,12,19] There are also studies that have reported -4 mm to be the least attractive gingival display.[8,10,16] As these studies were conducted in different countries and with subjects from different demographic backgrounds, the perception of smile aesthetics depended heavily on ethnicity and each country's demographic composition. To date, no studies have investigated the influence of gingival display on smile perception among Malaysian adult laypeople seeking dental treatment.

Therefore, the purpose of the present study was to determine the influence of gingival display on smile perception among adult patients seeking dental treatment from the primary dental care centres of three universities in Malaysia. The objectives were to:

1. Using a Likert scale, identify the perception of patient smiles of different gingival display and,
2. Assess the correlation of age, gender, and ethnicity on smile perception of patients using a digitally modified smiling photograph.



Figure 2. Smile with -2 mm gingival display.

Methodology

This study was approved by the Research Ethics Committee of the National University of Malaysia (UKM) [Reference Number JEP-2020-400], University of Malaya (UM) [Reference Number DF CD2021/0106 (L)], and Universiti Teknologi MARA (UiTM) [Reference Number 600-TNCPI (5/1/6)]. One hundred and three samples were required based on the effect size determined by Lima et al. (2019) with a power of 95% and a significance level of 0.05.

Construction of photographic booklet

A close-up, smiling colour photograph of an 18-year-old female was selected as the subject. The dentitions were well-aligned, without crowding, rotations, nor spacing. Adobe© Photoshop© version 20.0.0 was used to digitally manipulate the gingival show to create displays ranging from +4 mm to -4 mm, each with a 2 mm incremental change and produce a total of 5 photographs (Figures 1–5). One of the photographs was duplicated to allow for Intra-class Coefficient measurements. The photographs were printed in A4 size, laminated, and mounted, in no particular sequence, in a booklet. Between each photograph, a laminated A4 sized picture of a waterfall was inserted. Photographs of a waterfall were shown to the subjects in between each smile photograph to reduce visual fatigue.

Construction of the questionnaire and cross-cultural translation

A 2-part questionnaire was constructed in English, of which the first part consisted of the subject's demographic data and the second part consisted of a 10-point Likert scale to assist in rating the attractiveness of each photograph. The Likert scale used a numerical rating from one to ten, with the

"least attractive" and "most attractive" labelled on the left end and the right end, respectively. A Malay version was created by an expert panel using a forward and backward cross-cultural translation method from the English questionnaire.

Questionnaire construction

Content validity was carried out as outlined by Rodrigues et al.[20] The questionnaire and photographs were validated by an expert panel of five orthodontists each with more than ten years of experience. The instructions, the overall suitability of photographs to test objectives, and different gingival exposure levels and lip positions were assessed based on their relevance, clarity, and necessity. All items were deemed necessary by the panel with a Content Validity Ratio (CVR) of 1.00. All items were also deemed relevant and clear as each item scored excellent on the Item-level Content Validity Index (I-CVI).

Face validity is a test conducted on simulators to determine if a questionnaire subjectively appears to measure the variable or construct that it is intended to measure. It was conducted by recruiting subjects to answer the questionnaire which was followed by a semi-structured interview. Based on the pilot results, no adjustment of the questionnaire was necessary. Subsequently, test-retest reliability was conducted by having the 10 subjects answer the same questionnaire again after 2-4 weeks. The intraclass correlation coefficient (ICC) for the test-retest reliability was 0.71 suggesting moderate reliability.[21] The ICC of the duplicated photos was 0.70 for the 10 subjects. After validation and reliability testing, the questionnaires with the three photograph booklets were accordingly adjusted and printed to distribute to each centre.

Data collection

Based on the inclusion and exclusion criteria, the participants were conveniently selected from patients who sought dental treatment in the primary dental care units of UKM KL Campus, UM, and UiTM. All participants were given a study information sheet and were asked to sign an informed consent letter.

The participants were offered the questionnaire in either English or the Malay language and requested to fill in their demographic information.



Figure 3. Smile with 0 mm gingival display.

Subsequently, the image booklet was provided and each subject asked to appraise each individual smile, for up to 1 minute, and then rate the smile by circling the most appropriate number on the Likert scale. A comparison between photographs was not allowed.[14] The participants received little information about the study design and were asked to judge the photographs based purely on their perception of attractiveness.

Inclusion criteria

The subjects recruited were older than 18 years of age. To be categorised under either Malay, Chinese or Indian, each subject must have descended from at least two generations of either Malay, Chinese or Indian pure parentage. If these two conditions were not met, for example, the subject was of another ethnicity other than the three main ethnicities in Malaysia, or if the subject did not have at least two generations of pure parentage of the three main ethnicities, the subject was classified into an "Others" category.



Figure 4. Smile with +2 mm gingival display.



Figure 5. Smile with +4 mm gingival display.

Exclusion criteria

Non-Malaysian citizens, dental students, dental professionals, and patients younger than 18 years of age were excluded. The study design targeted Malaysian laypeople, and deviations from these criteria would likely yield data that would not accurately represent the target group. Young subjects (those less than 18 years of age) were also excluded due to their inability to consent for their own treatment, as the results of the study were to aid in treatment planning. In addition, prostheses that involve gingival and smile aesthetics e.g., implants and crowns, are usually recommended after the gingiva has fully matured, which is usually after 18 years old.

Table I. Demographic distribution of the subjects

Demographic	Category	Frequency (n = 117)	Percentage
Gender	Male	47	40.1
	Female	70	59.9
Age	18–30 years old	32	27.4
	31–49 years old	55	47.0
	≥ 50 years old	30	25.6
Ethnicity	Malay	81	69.2
	Chinese	21	17.9
	Indian	12	10.3
	Others	3	2.6

Table II. Median scores for each level of gingival display for all the subjects

Gingival display	Median
-4 mm	4.0
-2 mm	6.0
0 mm	5.0
+2 mm	5.0
+4 mm	5.0
P value	<0.001*

Friedman test between levels of gingival display.

*Statistically significant differences.

Statistical analysis

The data were reported descriptively with tables as a median of the scores. The scores for different levels of gingival display were found to be not normally distributed using the Kolmogorov–Smirnov test. Therefore, non-parametric tests were applied. The Kruskal–Wallis test was used for intergroup comparisons between genders, the age groups and ethnicities. The Friedman test was used for overall and intragroup comparisons between the levels of gingival display. All tests were performed at a 0.05 significance level. To assess intra-rater agreement, the scores for the duplicated photographs were analysed using the ICC. All statistical tests were conducted using IBM SPSS© version 26.

Results

Table I summarises the demographic distribution of the subjects. A total of 117 subjects were recruited from the three treatment centres. The interclass correlation coefficient from all participant groups was 0.73, suggesting moderate reliability.[21]

Table II summarises the median score for each level of gingival display assessed by all of the subjects. The -2 mm gingival display was rated as the most aesthetic, while the -4 mm gingival display was rated as the least aesthetic by all of the subjects. Statistically significant differences were observed between the various gingival displays.

Table III summarises the median scores for each gingival display between different genders. Statistically significant differences were observed within both genders and between genders for

Table III. Median of the scores considering different genders and levels of gingival display

Gingival display	Male	Female	P-value
-4 mm	5.0	4.0	0.017*
-2 mm	6.0	5.0	0.088
0 mm	5.0	5.0	0.027*
+2 mm	6.0	5.0	0.006*
+4 mm	5.0	5.0	0.383
P value	<0.001†	<0.001†	

Kruskal–Wallis test between genders, Friedman test between levels of gingival displays within each gender group; P < 0.05.

*Statistically significant differences between genders.

†Statistically significant differences between levels of gingival display.

gingival displays of -4 mm, 0 mm and +2 mm. Male subjects regarded smiles with gingival displays of -2 mm and +2 mm the most aesthetic, while smiles showing gingival displays of -4 mm, 0 mm, and +4 mm were the least aesthetic. Females regarded all gingival displays to be pleasant except -4 mm, which was rated slightly lower.

A comparison between the scores of different age groups for each level of gingival display is summarised in Table IV. Subjects from the youngest age group regarded smiles with gingival displays of -2 mm, 0 mm, and +2 mm as the most aesthetic, and smiles with -4 mm and +4 mm gingival displays were the least aesthetic. Subjects aged 31 – 49 years old rated the most aesthetic gingival display was at -2 mm while the least aesthetic gingival display was at -4 mm. Subjects aged 50 or above preferred a gingival display of +2 mm and regarded gingival displays of -4 mm, 0 mm, and +4 mm as the least aesthetic. Statistically, significant differences were noted between the age groups for the +2 mm gingival display. Additionally, age groups of 18- to 30-year old and 31- to 49-year old had statistically significant differences between the various levels of gingival display.

Table V summarises the comparison between the ethnicity of the subjects and their median scores on different levels of gingival display. Malay subjects rated smiles with -2 mm gingival display to be the most pleasant, while smiles with -4 mm gingival display were the least pleasant. Chinese subjects regarded all gingival displays to be aesthetic. Subjects from the Indian ethnic group preferred smiles with +2 mm gingival display and regarded smiles with -4 mm, -2 mm, and +4 mm gingival displays to be the least aesthetic. Subjects belonging to the "Others" group preferred all gingival displays except +4 mm. Statistically significant differences were found between different gingival displays for the ethnic groups of Malay, Chinese and Others.

Discussion

Multiple characteristics contribute to an aesthetic smile, of which the gingival display is an important component.[3,4] The perception of the most aesthetic level of gingival display varies between people from different demographic backgrounds.[1,4,7,8] This implies that an ideal smile identified in studies conducted outside Malaysia may not be perceived as the most attractive by Malaysian adults.

Moreover, multiple studies have shown that clinicians perceive smiles differently compared to laypeople, thus, emphasising the need to comprehend the patients' perspective and opinion regarding their smile before embarking on any treatment.[4,22] Little is known about the perception of gingival display among the Malaysian population, and more specifically, those who seek dental treatment.

The present study aimed to determine the influence of gingival display on smile perception among Malaysian adults who sought dental treatment. Therefore, subjects

Table IV. Median of the scores considering different age groups and levels of gingival display

Gingival display	18 – 30	31 – 49	≥ 50	P value
-4 mm	5.00	4.00	5.00	0.087
-2 mm	6.00	6.00	5.50	0.256
0 mm	6.00	5.00	5.00	0.119
+2 mm	6.00	5.00	6.00	0.037*
+4 mm	5.00	5.00	5.00	0.220
P value	0.011†	<0.001†	0.204	

Kruskal–Wallis test between age groups, Friedman test between levels of gingival displays within age groups; *P* < 0.05.

*Statistically significant differences between age groups.

†Statistically significant differences between levels of gingival display.

Table V. Median of the scores considering different ethnicity groups and levels of gingival display

Gingival display	Malay	Chinese	Indian	Others	*P*-value
-4 mm	4.00	6.00	4.50	4.00	0.245
-2 mm	6.00	6.00	4.50	4.00	0.039*
0 mm	5.00	6.00	5.00	4.00	0.257
+2 mm	5.00	6.00	5.50	4.00	0.316
+4 mm	5.00	6.00	4.50	3.00	0.072
P value	<0.001†	0.018†	0.661	0.034†	

Kruskal–Wallis test between ethnic groups, Friedman test between levels of gingival displays within ethnic groups; $P < 0.05$.

*Statistically significant differences between ethnicity.

†Statistically significant differences between levels of gingival display.

were recruited from primary care dental clinics and were divided based on gender, age, and ethnicity.

There were slightly more females (59.8%) compared to males (40.2%). This was possibly due to females being more concerned about their dental health and had more frequent dental attendance compared to males.[23–25] The ratio of the four different ethnic groups of the recruited subjects closely reflected the ethnic composition of Malaysian citizens with 67.4% of Malay, 24.6% of Chinese, 7.3% of Indians, and 0.7% of "Others" ethnic groups.[26]

The present study was designed to simulate the social perception of laypeople towards different smiles revealing different levels of gingival exposure. To replicate the "first impression" on the attractiveness of a smile, the images were presented to the subjects for a brief period (less than 60 seconds). Photographs of a waterfall were shown to the subjects in between each smile photograph to reduce visual fatigue.

The present study evaluated smile perception based on a close-up image of a smile with the aim to investigate the sole influence of gingival display on smile aesthetics and to eliminate other confounding factors such as facial characteristics (e.g. long vs balanced facial type).[7] Flores-Mir et al. found that gingival exposure had a greater impact on the judgment of smile aesthetics when the examiner was presented with a close-up image of a smile compared to an image of an entire face, while other studies found no difference between the two.[9,11] A Malaysian study reported that facial type (brachyfacial, mesofacial and dolichofacial) had no influence on the perception regarding the aesthetics of varying levels of gummy smiles (+2 mm to +5 mm) when subjects were presented with an image of the entire face.[27]

Based on the overall median scores for each of the images, the most attractive smile among Malaysian adults was the smile revealing -2.0 mm of gingival display. Similarly, a study on the Turkish population using a Likert scale reported that laypeople rated the smiles showing -2.0 mm gingival display to be the most attractive.[4] An additional study conducted in Japan also reported similar results among dental students, with the most attractive gingival exposure noted at -2.0 mm, although the study used a VAS scale instead of a Likert scale.[1] Further studies had mixed results regarding the most attractive level of gingival display, and ranged from +0 mm to +4 mm.[11–14] These studies were conducted in multiple countries and of subjects from different demographic backgrounds, indicating that smile perception might depend heavily on ethnicity and culture.

The least attractive smile showed -4.0 mm of gingival display. There were similar findings demonstrated in studies from Indonesia,[16] Thailand[8] and Germany.[10] In contrast to the literature in which most subjects rated gummy smiles poorly,[4,8,10,12] the subjects in the present study did not rate gummy smiles as unattractive. This is supported by Norman et al. who determined that Malaysians may be more accepting of gummy smiles.[27] However, in contrast, the present study focused on smile perception without the influence of facial types, over a wider range of gingival exposures including underexposed gingivae.

Gender

There was a statistically significant difference in smile perception between male and female participants.

Female participants regarded -2 mm, 0 mm, +2 mm, and +4 mm as most aesthetic, and -4 mm as the least aesthetic display. Females therefore found all levels of gingival display aesthetic but extreme coverage of the teeth intolerable. Males, however, preferred gingival displays of -2 mm and 2 mm over gingival displays of -4 mm, 0 mm, and +4 mm, demonstrating that they do not have a consistent preference pattern. Similar findings were demonstrated by Bolas–Colvee et al.,[28] in which males were found to be less critical in their perception of gingival display, although alternative studies[1,29,30] reported no gender difference. These findings might be related to ethnic, cultural, or social differences in smile preference. That the male participants had an inconsistent pattern may also be attributed to the lower intra-rater agreement measured using the ICC (0.643) compared to female participants (0.771). As previous literature did not report the ICC values of the genders, no comparison could be made.

Age

The present study also indicated that the age of a person influenced smile perception. The youngest age group regarded smiles with the smile line closer to the gingival zenith (-2 mm, 0 mm, +2 mm) to be the most aesthetic, whereas smiles with gingival underexposure (-4 mm) and overexposure (+4 mm) were regarded as the least aesthetic. Accordingly, Pausch and Katsoulis found that subjects aged between 22 and 35 years old were less tolerant of smiles with over- or under-exposed gingiva.[10] Similarly, Sriphadungporn and Chamnannidiadha reported that subjects aged between 15 and 29 years of age rated smiles with -4 mm and +6 mm of gingival display to be the least attractive.[8] It was also suggested that excessive lip coverage was unfavourable among young subjects as it is a feature associated with ageing.

The middle age group preferred smiles with -2 mm gingival display but disliked smiles with -4 mm gingival display. This is in agreement with Sriphadungporn and Chamnannidiadha who revealed that subjects aged 36 to 50 years old perceived smiles with -2 mm smile line to be attractive.[8] However, the study reported smiles showing a +6 mm smile line to be the least attractive among the middle age group.

The oldest age group deemed the smile with +2 mm gingival display to be the most attractive, and the smile with -4 mm, 0 mm and +4 mm gingival display as the least attractive smiles. This finding is in contrast to Sriphadungporn and Chamnannidiadha,[8] in which it was found that the older age groups were more accepting of incisal coverage, as it was likely to occur at their age. Interestingly, the oldest age group in the present study had the lowest ICC of 0.576 of all the age groups, reflecting that the elderly might find it difficult to differentiate between smiles of different gingival exposures. There were also no significant differences between the different gingival exposures in this age group. This could explain the inconsistency of the findings between the present study and the existing literature. Nevertheless, the difficulty in differentiating smiles with varying gingival displays among the elderly could be attributed to their increased satisfaction with their dental appearance compared to younger people, as demonstrated by Alkhatib, Holt and Bedi.[31] This unique finding should be considered during orthodontic treatment of the elderly, when more attention could be directed to other more important parts of the elderly smile.

Ethnicity

The present study also showed that smile perception was influenced by ethnicity. This is in concordance with Nimbalkar et al., who demonstrated that Malaysia's three main ethnic groups (Malay, Chinese and Indian) perceived smiles differently.[32]

Malay participants regarded a gingival exposure of -2 mm as the most aesthetic and -4 mm as the least aesthetic. These findings were consistent with a study conducted of Indonesian laypersons.[16] An additional study conducted among dental students in Indonesia found that the most aesthetic smile was when the smile line covered the gingival zenith and only allowed visibility of the gingival embrasure.[33] However, participants in the study rated the smile with excessive gingival exposure as the least aesthetic and the smile line covering the gingival zenith and embrasure as the second least aesthetic. A direct comparison between the past study and the present could not be made as no measurement of the gingival display was conducted in millimeters.

Chinese subjects were the most tolerant towards smiles displaying all types of gingival exposure as they rated all smiles (-4 mm, -2 mm, 0 mm, +2 mm, +4 mm) the same score in the present study. A study

conducted in China indicated that Chinese laypeople preferred smiles with the smile line revealing less than 75% to 100% of the maxillary anterior teeth and interproximal gingiva, over smiles with the gingival display revealing 100% of the maxillary anterior teeth and a contiguous band of gingiva.[17] In the present study, subjects from the Chinese ethnic group had no intra-rater reliability as the value of the reported ICC was 0, suggesting that Chinese subjects were not able to differentiate between the various gingival displays.

In the present study, no significant differences were found between gingival exposures within the Indian ethnic group. A gingival display of +2 mm was regarded as the most aesthetic and smiles with a gingival display of -4 mm, -2 mm and +4 mm to be the least aesthetic. Studies conducted in India reported the most aesthetic gingival display to be -2 mm[18] and 0 mm.[15]

Subjects who were outside of the three main ethnic groups in Malaysia (Malay, Chinese and Indian) were classified into the "Others" category which consisted of a heterogeneous group of indigenous tribes in Malaysia, for example, Dayak, Iban, Kadazan and Orang Asli. People from the "Others" group favoured all smiles except gingival overexposure (+4 mm). The present study was the first to investigate smile perception in the minority ethnic group in Malaysia.

Overall, when comparing the different ethnic groups, Malays seem to be the most specific when evaluating smiles, as they only had a single most and least aesthetic gingival display value. Additionally, their ICC was the highest of the four groups, at 0.881, which suggested that they were critical in differentiating smiles of various gingival displays. However, Chinese subjects were accepting of all the smiles, as the difference in various levels of gingival display may be largely imperceptible to them. Subjects from the "Others" group disliked gummy smiles.

The discrepancies between the findings of the current study and past literature about the perception of smile aesthetics between different ethnic groups could be attributed to the cultural differences, varying lifestyles, and environmental factors between Malaysia and other countries. Furthermore, due to Malaysia's multi-ethnic nature, smile perception differences exist between the different ethnicities within Malaysia and must be considered during treatment planning.

Limitations

As subjects in the present study were recruited from patients attending primary care units in the three institutions, these subjects may not represent the whole Malaysian population. However, data can be assumed as homogenous as they were sampled from an area of mixed population. The sample size calculation was carried out to achieve the minimum sample size except for the different ethnicities. Therefore, the findings for each ethnic group should be interpreted with caution. Future studies are required with a larger sample size to better determine the effect of ethnicity on the perception of smile aesthetics in the Malaysian population.

An additional limitation of this study was that the assessment of smile perception was only on a female smile and not a male smile. As smiles of different gender may be evaluated differently,[14] future studies on the smile perception in both male and female subjects appear to be warranted. The present study investigated the effect of varying gingival display only on a relaxed smile. Since the shape of the lips and visibility of teeth might affect smile perception, the authors recommend future studies to assess the effect of a broad, full smile compared to a relaxed smile.

Conclusions

1. Lip position and gingival display influence the smile perception of Malaysian adult patients seeking dental treatment.
2. In all subjects, the most aesthetic gingival display was at -2 mm, while the least aesthetic gingival display was -4 mm.
3. Malaysians seem to tolerate gummy smiles, which differs from previous literature.
4. Smile perception is influenced by gender, age, and ethnicity, resulting in varying perception between each group.

Conflict of interest

The authors declare that there is no conflict of interest.

Source of funding

This work has been supported by UKM Grant Code DDD-2020-005.

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Acknowledgements

The authors would like to express their gratitude to the dental officers at UKM KL Campus (Klinik Ratawan Utama), UM (Bahagian Rawatan Utama) and UiTM (Klinik Rawatan Primer) for their generous support.

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