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Original Article

The study of individuals' preferences for smile aesthetics in frontal, oblique, and lateral view images

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KEYWORDS
Smile aesthetics;
Frontal view;
Oblique view;
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Orthodontics

Abstract *Background/purpose:* Smile aesthetics play a central role in facial attractiveness and often influence patients' expectations in orthodontic treatment. The study aimed to determine individuals' preferences for smile aesthetics in frontal, oblique, and lateral view images and to compare the preferences of general population (laypeople) and dentists.

Materials and methods: There were 19 variables of smile photographs were designed respectively in frontal view (8), oblique view (4), and lateral view (7). Each variable was created based on previous studies and standard deviation values using Adobe Photoshop (version CS6) to produce five images, resulting in 95 images in total. Taiwanese laypeople, general dentists, and orthodontists completed an online questionnaire evaluating these images. Statistical analysis included Pearson chi-square tests and logistic regression.

Results: This study included 773 participants, comprising 412 women and 361 men. The participants' mean age was 20–40 years. The sample comprised 351 laypeople, 188 general dentists, and 63 orthodontists. Their preferences for the smile aesthetics were strongly influenced by identity, age, and gender, with identity having the greatest influence. The chi-square test revealed differences in preferences between gender and identity subgroups. Preferences for arc ratio, posterior tooth visibility, and maxillary and mandibular tooth exposure varied among the frontal, oblique, and lateral view images. A customized smile chart was designed based on the participants' preferences for smile aesthetics to provide a reference for orthodontic diagnosis and treatment planning.

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Conclusion: Identity, gender, and age strongly influenced smile perceptions, with identity having the strongest impact. Accordingly, we propose that the most beautiful smile is one that achieves the greatest consensus in terms of individuals' preferences for smile aesthetics while maintaining normal physiological function and form.

Introduction

The aesthetic appearance of an individual's smile after orthodontic treatment influences their satisfaction with the treatment. Janzen reported that the primary objective of orthodontic treatment is to produce a well-balanced functional occlusion.[1]

An equally crucial objective is to create a well-balanced smile. This has thus stimulated research on the achievement of smile harmony in orthodontic treatment; smile harmony refers to the existence of a pleasing visual balance and alignment between the dentition and the surrounding soft tissues, including the lips and gums. For example, a study presented a Smile arc index by analyzing the concept of smile harmony.[2] Other studies have also conducted smile analyses to determine factors contributing to desirable smile aesthetics.[3–7]

Despite studies on factors contributing to desirable smile aesthetics, an absolute standard for the smile has yet to be established. Smile preferences may vary across different backgrounds and are influenced by race, gender,[7] and age.[8,9] In 1999, Kokich Jr et al. were the first to compare dentists' and non-dentists' perceptions of dental aesthetics.[10] Subsequently, numerous studies have further explored how a professional background influences smile perceptions.[11–14] Many study conducted in recent years summarized smile preferences in Korea and China, highlighting the influence of regional culture on smile aesthetics.[15–17] These findings indicate variable objective criteria and subjective personal and cultural perceptions influence smile aesthetics.

Studies on smile perceptions have mostly focused on aesthetics from the frontal view. Few studies have focused on aesthetics from the oblique view. The oblique view enables clinicians to detect features not visible in the frontal view, such as the skeletal pattern of the palatal plane and dental compensation.[18,19] A recent study indicated that smile preferences can vary depending on the observer's viewing angle; distinct preferences were noted for smiles observed from the frontal, oblique, and lateral views.[20] Moreover, smile preferences are influenced by different types of malocclusions, particularly in the lateral and oblique views.[21] Accordingly, the objective of the present study was to determine Taiwanese individuals' preferences for smile aesthetics in frontal, oblique, and lateral view images and to compare the preferences of individuals from the general population (laypeople) and dental professionals. The study findings can serve as a reference for orthodontic diagnosis and treatment planning.

Materials and methods

Ethical approval for this study was obtained from the Institutional Review Board of (Protocol No. N201803029).

Questionnaire design

This cross-sectional study used a two-part online questionnaire. The first part comprised eight questions designed to collect demographic information, including identity (individual, general dentist, and orthodontist), gender, age group, orthodontic treatment experience, and income. The second part comprised 19 randomly arranged multiple-choice questions based on smile images for assessing smile aesthetics.

The smile images were captured from five randomly selected patients who were aged 20 to 25 years and had undergone orthodontic treatment; one of these patients was selected as the standard model owing to their aesthetic appeal. The smile images were captured from the frontal, oblique, and lateral views by using a Canon 700D DSLR camera at a fixed distance of 150 cm. In accordance with procedures described in previous studies,[20–23] a total of 19 variables for assessing smile aesthetics were derived on the basis of the frontal (8), oblique (4), and lateral (7) view images. Subsequently, Adobe Photoshop (version CS6) and standard deviation values were used to generate five images for each variable, resulting in a total of 95 images. The images were then incorporated into 19 randomized questions in the second part of the questionnaire; the questions were presented to participants on a computer screen during the survey. A detailed description of each variable is presented in Table 1.

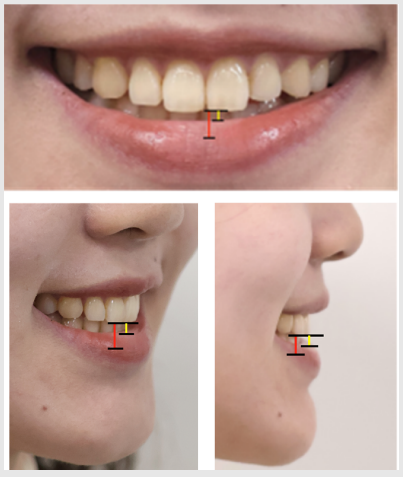
Survey methods

Survey participants were divided into three groups: individuals from the general population (i.e., laypeople, hereafter denoted as LP group), general dentists (hereafter denoted as GD group), and orthodontists (hereafter denoted as Ortho group). Participants in the LP group were randomly recruited from public areas in Taiwan, and those in the GD and Ortho groups were recruited from professional conferences. All participants were aged ≥20 years and willingly joined the study. Before they filled out the questionnaire, the participants received a brief explanation of the study. The questionnaire was administered privately by the researchers. The participants were instructed to

Table 1 Definitions of variables for smile aesthetics.

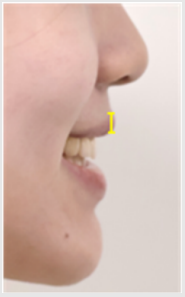
Smile variable	Range of values	Definition	Figure
AR[a] (123[b])	1, 0.5, 0, −0.5, −1	The perpendicular distance from the incisal edge of the right maxillary central incisor to a line connecting the cusp tips of the maxillary canine divided by the distance between a tangent line of the upper border of the lower lip and the maxillary intercanine line (0 indicates parallel, whereas the other values represent variations in terms of standard deviations)	
BC[a] (1[b])	0 %, 5 %, 10 %, 15 %, 20 %	The sum of the width of the bilateral dark space divided by the total smile width	
UDM[a] (1[b])	0, 1, 2, 3, 4 mm	The maxillary dental midline (measured between the central incisors) compared with the facial midline (a line representing the midline of the face as defined by the center of the philtrum and nasal tip)	
MxTE[a] (123[b])	50 %, 75 %, 100 %, 125 %, 150 %	The height of the visible maxillary central incisor on smiling divided by the actual height of the maxillary central incisor	

Table 1 (*continued*)

Smile variable	Range of values	Definition	Figure
MPMTV[a] (123[b])	3,4,5,6,7	The most posterior maxillary tooth exposed on both sides when smiling	
MGD[a] (1[b])	0, 1, 2, 3, and 4 mm	The height of the visible gingiva between the lower border of the upper lip and gingival zenith of the maxillary central incisors	
MdTE[a] (123[b])	0 %, 25 %, 50 %, 75 %, 100 %	The proportion of the lower front tooth that is visible when smiling compared with its full height measured from the top edge of the upper teeth to the gum line of the lower teeth.	
Cant[a] (1[b])	0°, 3°, 6°, 9°, 12°	The degree of rotation of the maxillary teeth from the horizontal plane through the middle of the maxillary central incisors	

(*continued on next page*)

Table 1 (*continued*)

Smile variable	Range of values	Definition	Figure
ULT[a] (3[b])	4, 5, 6, 7, 8 mm	The vertical distance from the most superior point of the cupid's bow to the most inferior portion of the tubercle of the upper lip	
MA[a] (3[b])	20°, 25°, 30°, 35°, 40°	The angle formed by the most inferior border of the upper lip and the most superior border of the lower lip on smiling	
NA[a] (3[b])	70°, 80°, 90°, 100°, 110°	The angle between columella of the nose and anterior surface of the upper lip	

[a] Abbreviation: AR, arc ratio; BC, buccal corridor; MPMTV, most posterior maxillary teeth visible; MGD, maxillary gingival display; MxTE, maxillary tooth exposure; MdTE, mandibular tooth exposure; MA, mouth angle; NA, nasolabial angle.
[b] 1: variables based on frontal view images. 2: variables based on oblique view images. 3: variables based on lateral view images.

rate the most appealing image from each set of five images representing distinct smile variables. The participants' data were collected through the online questionnaire.

To assess the test–retest reliability of the questionnaire, a test was conducted with 10 participants from each group and was repeated after 7 days. Reliability was assessed by estimating the reliability coefficient. In addition, intraclass correlation coefficients were calculated to measure consistency.

Statistical analysis

The collected data were analyzed and categorized. Descriptive statistics were derived to determine the distribution of the participants' demographic characteristics and the participants' preferences for smile aesthetics. The Pearson chi-square test was applied to assess differences in smile preferences according to demographic characteristics. Multivariate logistic regression was employed to determine the influence of each demographic characteristic on the participants' preferences for the smiles in the images captured from the three views. All statistical analyses were performed using the SPSS statistical software package (version 19; IBM, Chicago, IL, USA), and significance was set at $P < 0.05$.

Results

This cross-sectional study included 773 participants, consisting of 412 women and 361 men. The majority of the

Table 2 Distribution of demographic characteristics of participants.

Characteristic	Sample (%)			
	All sample	LP[a]	GD[a]	Ortho[a]
	N = 773	n = 522	n = 188	n = 63
Gender				
Men	361 (46.7 %)	225 (43.1 %)	104 (55.3 %)	32 (50.8 %)
Women	412 (53.3 %)	297 (56.9 %)	84 (44.7 %)	31 (49.2 %)
Age				
20–30 y	448 (58.0 %)	361 (69.2 %)	84 (43.1 %)	6 (9.52 %)
31–40 y	241 (31.2 %)	107 (20.5 %)	93 (49.5 %)	41 (65.1 %)
>40 y	84 (10.9 %)	54 (10.3 %)	14 (7.45 %)	16 (25.4 %)
Treatment				
w/o T	351 (45.4 %)	351 (67.2 %)	–	–
T (LP)	171 (22.1 %)	171 (32.8 %)	–	–
T (Dentist)	251 (32.5 %)		188 (100 %)	63 (100 %)
Income				
<20,000	197 (25.5 %)	197 (37.7 %)	–	–
20,000–40,000	148 (19.1 %)	148 (28.4 %)	–	–
40,000–60,000	95 (12.3 %)	95 (18.2 %)	–	–
60,000–80,000	36 (4.66 %)	36 (6.9 %)	–	–
>80,000	46 (5.95 %)	46 (8.81 %)	–	–
>80,000	251 (32.5 %)		188 (100 %)	63 (100 %)
Identity				
Laypeople	522 (67.5 %)	522 (100 %)	–	–
General dentists	188 (24.3 %)	–	188 (100 %)	–
Orthodontists	63 (8.15 %)	–	–	63 (100 %)

[a] LP: laypeople, GD: general dentists, Ortho: orthodontists, w/o T: without treatment, T: with treatment.

participants were aged between 20 and 40 years. The LP group comprised 522 participants, of whom 351 had not undergone orthodontic treatment and 171 had. Additionally, the GD group contained 188 participants, and the Ortho group contained 63 participants. The distribution of the participants' demographic characteristics is detailed in Table 2.

In Table 3, the results revealed that the participants' preferences for the same smile aesthetic varied with the views. 52.4 % of the participants preferred an arc ratio of 0 in the frontal view images; however, 91.8 % and 30.8 % of the participants preferred a ratio of 1 in the oblique and lateral view images, respectively. The participants' preferences for maxillary tooth exposure (MxTE) and mandibular tooth exposure (MdTE) varied with the views. 69.5 % and 65.9 % of the participants preferred an MxTE rate of 100 % in the frontal and lateral view images, respectively, and 67.8 % of the participants preferred an MxTE rate of 125 % in the oblique view images. Moreover, 68.0 % of the participants preferred an MdTE rate of 0 % in the frontal view images, 63.5 % preferred an MdTE rate of 50 % in the oblique view images, and 65.9 % preferred an MdTE rate of 25 % in the lateral view images.

Demographic characteristics, including identity, gender, age, and orthodontic treatment experience, significantly influenced perceptions of the various smile aesthetics in Table 4. Identity exerted a strong influence on the participants' perceptions of most of the smile aesthetics in the images captured from the three views; nevertheless, it did not strongly influence their perceptions of MdTE in the lateral and oblique view images and upper lip thickness in the lateral view images. Regarding gender, the results revealed significant differences between male and female participants' perceptions of the arc ratio, most posterior maxillary tooth visible (MPMTV), and MdTE in the oblique view images. Age was another influential factor for perceptions of MxTE and nasolabial angle (NA), particularly in the frontal and lateral view images.

As indicated in Tables 5 and 6, gender exerted more negative effects on the participants' perceptions of arc ratio (AR) in the frontal and oblique view images than in the lateral view images. By contrast, age, particularly the >40-year age group, influenced the participants' perceptions of AR in the images captured from the three views. Moreover, identity exerted a stronger influence on the participants' perceptions of MxTE in the frontal view images than in the images from the other views, and gender significantly affected MdTE perceptions in the oblique view images. These findings demonstrate that images captured from all three views must be considered to comprehensively determine how demographic factors influence differences in participants' preferences for smile aesthetics.

This study designed a smile chart on the basis of the participants' most common preferences for the 19 smile variables, as illustrated in Fig. 1. This chart can serve as a reference for orthodontic diagnosis and treatment planning.

Discussion

The findings of this study and those in the literature indicate cross-cultural differences in preferences for smile

Table 3 Distribution of smile preferences in frontal, oblique, and lateral view images.

Frontal view smile					
AR[a]					
	1	0.5	0	−0.5	−1
	46 (5.95 %)	264 (34.2 %)	405 (52.4 %)	30 (3.88 %)	28 (3.625 %)
BC[a]					
	0 %	5 %	10 %	15 %	20 %
	204 (26.4 %)	359 (46.4 %)	130 (16.8 %)	54 (6.99 %)	26 (3.36 %)
UDM[a]					
	0 mm	1 mm	2 mm	3 mm	4 mm
	495 (64.0 %)	175 (22.6 %)	23 (2.98 %)	52 (6.72 %)	28 (3.62 %)
MxTE[a]					
	50 %	75 %	100 %	125 %	150 %
	28 (3.62 %)	98 (12.7 %)	86 (11.1 %)	500 (64.7 %)	61 (7.89 %)
MPMTV[a]					
	Canine	First premolar	Second premolar	First molar	Second molar
	90 (11.6 %)	124 (16.0 %)	258 (33.4 %)	165 (21.3 %)	136 (17.6 %)
MGD[a]					
	0 mm	1 mm	2 mm	3 mm	4 mm
	526 (68.0 %)	159 (20.6 %)	36 (4.66 %)	30 (3.88 %)	22 (2.85 %)
MdTE[a]					
	0 %,	25 %	50 %	75 %	100 %
	131 (16.9 %)	90 (11.6 %)	458 (59.2 %)	59 (7.63 %)	35 (4.53 %)
Cant[a]					
	0°	3°	6°	9°	12°
	570 (73.7 %)	176 (22.8 %)	21 (2.72 %)	1 (0.13 %)	5 (0.65 %)
Oblique view smile					
AC[a]					
	1	0.5	0	−0.5	−1
	71 (91.8 %)	164 (21.2 %)	324 (41.9 %)	142 (18.4 %)	72 (9.31 %)
MxTE[a]					
	50 %	75 %	100 %	125 %	150 %
	30 (3.88 %)	149 (19.3 %)	243 (31.4 %)	313 (40.5 %)	38 (4.92 %)
MPMTV[a]					
	Canine	First premolar	Second premolar	First molar	Second molar
	175 (22.6 %)	116 (15.0 %)	259 (33.5 %)	170 (22.0 %)	53 (6.86 %)
MdTE[a]					
	0 %	25 %	50 %	75 %	100 %
	228 (29.5 %)	336 (43.5 %)	114 (14.7 %)	67 (8.67 %)	28 (3.62 %)
Lateral view smile					
AR[a]					
	1	0.5	0	−0.5	−1
	238 (30.8 %)	215 (27.8 %)	222 (28.7 %)	47 (6.08 %)	51 (6.60 %)
MxTE[a]					
	50 %	75 %	100 %	125 %	150 %
	29 (3.75 %)	121 (15.7 %)	406 (52.5 %)	164 (21.2 %)	53 (6.86 %)
MPMTV[a]					
	Canine	First premolar	Second premolar	First molar	Second molar
	34 (4.40 %)	97 (12.5 %)	156 (20.2 %)	275 (35.6 %)	211 (27.3 %)
MdTE[a]					
	0 %	25 %	50 %	75 %	100 %
	87 (11.3 %)	363 (47.0 %)	206 (26.6 %)	89 (11.5 %)	28 (3.62 %)
ULT[a]					
	4 mm	5 mm	6 mm	7 mm	8 mm
	132 (17.1 %)	198 (25.6 %)	176 (22.8 %)	162 (21.0 %)	105 (13.6 %)

Table 3 (*continued*)

Frontal view smile					
MA[a]					
	20°	25°	30°	35°	40°
	165 (21.3 %)	73 (9.44 %)	206 (26.4 %)	61 (7.89 %)	270 (34.9 %)
NA[a]					
	70°	80°	90°	100°	110°
	201 (26.0 %)	224 (29.0 %)	77 (9.96 %)	211 (27.3 %)	60 (7.76 %)

[a] Abbreviation: AR, arc ratio; BC, buccal corridor; MPMTV, most posterior maxillary teeth visible; MGD, maxillary gingival display; MxTE, maxillary tooth exposure; MdTE, mandibular tooth exposure; NA, nasolabial angle.

Table 4 Chi-square test (X^2, Power) of differences in demographic characteristics and smile variables.

Frontal view								
	AR[a]	BC[a]	UDM[a]	MxTE[a]	MPMTV[a]	MGD[a]	MdTE[a]	Cant[a]
Gender	(5.11, 0.4)	(9.33, 0.68*)	(1.78, 0.16)	(5.86, 0.46)	(11.7, 0.89*)	(19.3, 0.96*)	(12.8, 0.83*)	(2.52, 0.21)
Age	(23.5, 0.96*)	(12.7, 0.71)	(12.4, 0.70)	(21.7, 0.94)	(57.3, 1.00*)	(7.24, 0.43)	(7.46, 0.44)	(12.1, 0.69)
Treatment	(4.93, 0.39)	(3.56, 0.29)	(15.5, 0.90*)	(4.9, 0.39)	(10.3, 0.7**)	(2.65, 0.22)	(4.06, 0.32)	(19, 0.95*)
Income	(22.4, 0.87)	(14.6, 0.65)	(12.4, 0.55)	(22.2, 0.87)	(17.3, 0.74)	(5.34, 0.23)	(10.6, 0.48)	(17.2, 0.74)
Identity	(89.2, 1.00*)	(26.4, 0.98*)	(44.8, 1.00*)	(64.7,1.00*)	(116, 1.00**)	(24.9, 0.97*)	(19.7, 0.91*)	(52.9, 1.00*)

Oblique view				
	AR[a]	MxTE[a]	MPMTV[a]	MdTE[a]
Gender	(13.2, 0.84*)	(4.35, 0.35)	(6.52, 0.51)	(21.5, 0.97*)
Age	(5.48, 0.33)	(21.2, 0.93*)	(11.5, 0.66)	(5.03, 0.3)
Treatment	(2.94, 0.24)	(10.5, 0.74*)	(1.26, 0.12)	(9.14, 0.67)
Income	(17.6, 0.75)	(21.3, 0.85)	(17.8, 0.76)	(9.9, 0.44)
Identity	(48, 1.00*)	(54.3, 1.00*)	(28.5, 0.99*)	(10.8, 0.63)

Lateral view							
	AR[a]	MxTE[a]	MPMTV[a]	MdTE[a]	ULT[a]	MA[a]	NA[a]
Gender	(10.3, 0.73*)	(2.36, 0.2)	(3.91, 0.31)	(13, 0.84*)	(2.63, 0.22)	(16.1, 0.91*)	(2.88, 0.24)
Age	(10.1, 0.59)	(4.48, 0.27)	(15.6, 0.82*)	(11.2, 0.65)	(2.97, 0.18)	(10.7, 0.63)	(17.6, 0.87*)
Treatment	(4.96, 0.39)	(9.81, 0.71*)	(7.32, 0.56)	(3.02, 0.25)	(4.08, 0.33)	(3.8, 0.3)	(8.54, 0.64)
Income	(8.7, 0.38)	(20.1, 0.82)	(23.2, 0.88)	(18.4, 0.78)	(7.8, 0.34)	(15, 0.66)	(16, 0.70)
Identity	(33.2, 0.99*)	(69.3, 1.00*)	(35.8, 1.00*)	(13.9, 0.76)	(11.5, 0.66)	(28.5, 0.98*)	(57, 1.00*)

*$P < 0.05$.
**$P<0.01$.
[a] Abbreviation: AR, arc ratio; BC, buccal corridor; MPMTV, most posterior maxillary teeth visible; MGD, maxillary gingival display; MxTE, maxillary tooth exposure; MdTE, mandibular tooth exposure; NA, nasolabial angle.

aesthetics. This study revealed that 52.4 % of the participants preferred a parallel smile arc in the frontal view and that 34.2 % favored a flat arc. By contrast, previous research has reported that most raters from Western countries preferred a parallel arc (84.8 %).[24–26,28] Similar to the present study, a previous study observed variability in Thai raters' preference for the smile arc, with orthodontists tending to prefer a curved arc (59 %) and laypeople favoring a flat arc (48.4 %).[20] A Korean study conducted in 1992 reported that 60 % of the participants preferred a parallel arc.[27] These findings demonstrate that not all individuals favor a perfect smile arc and that preferences vary significantly between populations from Eastern and Western countries. Furthermore, the present study revealed that the participants displayed the lowest preference for an ideal arc, with 34.2 % even favoring a flat arc. This finding suggests that the Taiwanese participants exhibited variability in their preferences for the smile arc, indicating cultural variations in smile aesthetics and a lack of standard criteria for smile aesthetics.

In addition to the aforementioned differences in individuals' preferences for the smile arc, differences in individuals' preferences for the buccal corridor (BC) have been noted among populations from different countries. Hideki et al. reported that Japanese and Korean orthodontists preferred a narrow or medium BC.[27] These preferences are consistent with those of Taiwanese orthodontists (5 %). By contrast, both Western (2 %) and Thai (0 %) raters exhibited a strong preference for a narrow

Table 5 Multivariate logistic regression of association between demographics and all smile variables in frontal, oblique, and lateral view images.

Issue	Gender		Age			Identity		
	Men	Women	20-30 y	31-40 y	>40 y	Layperson	General dentist	Orthodontist
AR[a]								
Frontal		−0.09		0.08	−0.22		0.06	0.04
Oblique		−0.39**		−0.11	−0.66*		−0.11	−0.14
Lateral		0.07		−0.10	0.09		−0.11**	−0.04**
MxTE[a]								
Frontal		−0.20*		−0.16	−0.11		0.25**	0.37**
Oblique		−0.31*		−0.01	−0.29		0.25**	0.37**
Lateral		−0.15		0.11	0.20		−0.5**	0.11**
MPMTV[a]								
Frontal		0.16		−0.24	−0.45		−0.20*	−0.11
Oblique		0.03		−0.08	0.17		0.06	0.04
Lateral		0.08		−0.01	0.13		−0.27*	0.07**
MdTE[a]								
Frontal		−0.18		0.01	0.01		0.06	0.04
Oblique		−0.18*		−0.15	−0.15		−0.2*	−0.11
Lateral		−0.23*		0.16	0.16		0.00	−0.03
UDM[a]								
Frontal		−0.02		−0.15	−0.34		−0.11	−0.14
BC[a]								
Frontal		0.09		0.07	−0.56*		−0.20*	−0.11
MGD[a]								
Frontal		−0.24		−0.19	−0.10		0.25**	0.37**
Cant[a]								
Frontal		0.16**		0.11	−0.01		−0.11***	−0.14***
ULT[a]								
Lateral		0.12		−0.16	0.04		0.20	−0.08
MA[a]								
Lateral		−0.28**		−0.30	−0.14		0.15**	0.04**
NA[a]								
Lateral		−0.07		−0.11*	0.01		0.74**	0.17**

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

[a] Abbreviation: AR, arc ratio; BC, buccal corridor; MxTE, maxillary tooth exposure; MPMTV, most posterior maxillary teeth visible; MGD, maxillary gingival display; MdTE, mandibular tooth exposure; NA, nasolabial angle.

BC.[18] Overall, the findings indicate that the Taiwanese participants had a broader acceptance range for the BC compared with Thai and Western raters, who had stricter preferences for a narrower BC.

In addition, tooth visibility also reflects cultural and aesthetic differences. The present study determined that for MPMTV, 67.8 % of the participants preferred the second premolar to be visible in frontal and oblique view images and that 63.5 % favored the first molar to be visible in the lateral view images. Moreover, a previous study reported that Thai individuals preferred a smile with the first or second premolars as the innermost teeth in images from all views.[20] A Korean study also indicated that orthodontists preferred the second premolar to be the last visible tooth in a smile.[29] By contrast, a study indicated that Western raters preferred the first premolar to be visible in images from all views, indicating a preference for a less pronounced smile arc.[24–26] The findings suggest that the Taiwanese participants preferred a broader, more expressive smile with the visibility of the second premolar.

Regarding MxTE, the present study observed that the participants preferred 125 % exposure in the frontal and oblique view images, indicating a preference for some percentage of gingival display. Similarly, a previous study reported that 56 % of Korean participants preferred smiles with 0 %–25 % gingival display.[29] By contrast, both Thai and Western raters preferred no gingival display at all, with the raters favoring 100 % MxTE.[20,24–26] These findings thus indicate the existence of cultural variation in MxTE preferences. The Taiwanese participants preferred a brighter, more radiant smile, and showing a bit of gingiva is acceptable.[17]

The present study also revealed that the participants favored an MdTE rate of 25 %–50 %. By contrast, Western raters preferred a rate of 17 %,[24–26] and Thai raters preferred minimal MdTE values. The study involving Thai raters demonstrated that an MdTE rate of 25 % in the frontal view images was considered the most attractive by the participants. Preferences varied with views. Thai participants favored an MdTE rate of 0 % in the oblique view images and a tooth height of 50 % in the lateral view

Table 6 Multivariate logistic regression of association between various demographic factors and all smile variables in frontal, oblique, and lateral view images.

	Treatment		Income				
	w/o T	T	<20T	20–40T	40–60T	60–80T	>80T
AR[a]							
Frontal		−0.09		0.16	0.11	0.43*	0.25
Oblique		0.09		−0.14	−0.24	0	0.14
Lateral		0.20*		0.1	−0.33*	−0.19	0.01
MxTE[a]							
Frontal		−0.26*		−0.11	−0.15	0.21	−0.15
Oblique		0.23		0.02	0.23	0.25	0.18
Lateral		0.02		−0.04	−0.18	0.14	−0.08
MPMTV[a]							
Frontal		−0.13		0.21	0.19	0.40	0.55*
Oblique		−0.05		−0.08	0.13	−0.61*	0.04
Lateral		−0.35*		0.09	0.24	0.32	−0.21
MdTE[a]							
Frontal		−0.16		0.16	0.39*	0.27	0.19
Oblique		0.08		−0.26*	−0.03	0.15	−0.23
Lateral		−0.06		0.087	−0.14	0	0.13
UDM[a]							
Frontal		−0.20*		−0.34*	−0.33*	0.01	−0.09
BC[a]							
Frontal		0.14		−0.01	−0.29	0.07	0.07
MGD[a]							
Frontal		−0.12		−0.13	−0.08	0.01	−0.16
Cant[a]							
Frontal		−0.14		0	0.15	−0.15	−0.13
ULT[a]							
Lateral		0.10		−0.13	0.06	−0.47*	−0.23
MA[a]							
Lateral		−0.10		−0.07	0.05	−0.15	0.14
NA[a]							
Lateral		−0.22*		−0.12	0.13	−0.16	−0.01

*$P < 0.05$.
[a] Abbreviation: AR, arc ratio; BC, buccal corridor; MTE, maxillary tooth exposure; MPMTV, most posterior maxillary teeth visible; MGD, maxillary gingival display; MxTE, maxillary tooth exposure; MdTE, mandibular tooth exposure; NA, nasolabial angle.

images.[20] These findings thus indicate that the Taiwanese participants demonstrated a higher tolerance for MdTE compared with Western and Thai participants, who mostly preferred minimal exposure across images captured from different views.

Overall, according to the results obtained for various smile variables, the Taiwanese participants preferred broader and more expressive smiles. Recent five-year Asian studies also support cultural variability in smile perception. Musa et al. showed that Chinese raters were more sensitive to upper midline deviations, consistent with our finding that identity influences aesthetic thresholds; however, their work focused on a single feature, whereas our study assessed multiple variables across three views.[16] Lee et al. reported that Korean adults preferred minimal gingival display and stricter smile-arc standards, aligning with our observation that professionals tend to apply higher aesthetic demands; in contrast, Taiwanese participants tolerated greater posterior tooth visibility and wider buccal corridors, indicating subtle cultural differences within East Asia.[17] These findings suggest that while certain aesthetic patterns are shared across East Asian populations, Taiwanese participants display a comparatively broader acceptance range. No universal standard exists for the "perfect" smile; rather, the ideal smile reflects broad consensus within normal oral–facial form and function.

Most research on smile aesthetics has focused on frontal views,[20,21] despite smiles often being observed from lateral or oblique angles. Relying solely on frontal views risks missing malocclusion details, such as crossbites in Class III cases, which are more evident in lateral views. Incorporating multiple views improves orthodontic diagnosis, treatment planning, and patient communication, reducing misdiagnosis risks.

This study included lateral and oblique view images to better reflect real-life observations, providing more practical references for orthodontic diagnosis and treatment planning. In this study, 52.4 % preferred an AC of 0, favoring a parallel smile arc. For oblique and lateral views, 91.8 %

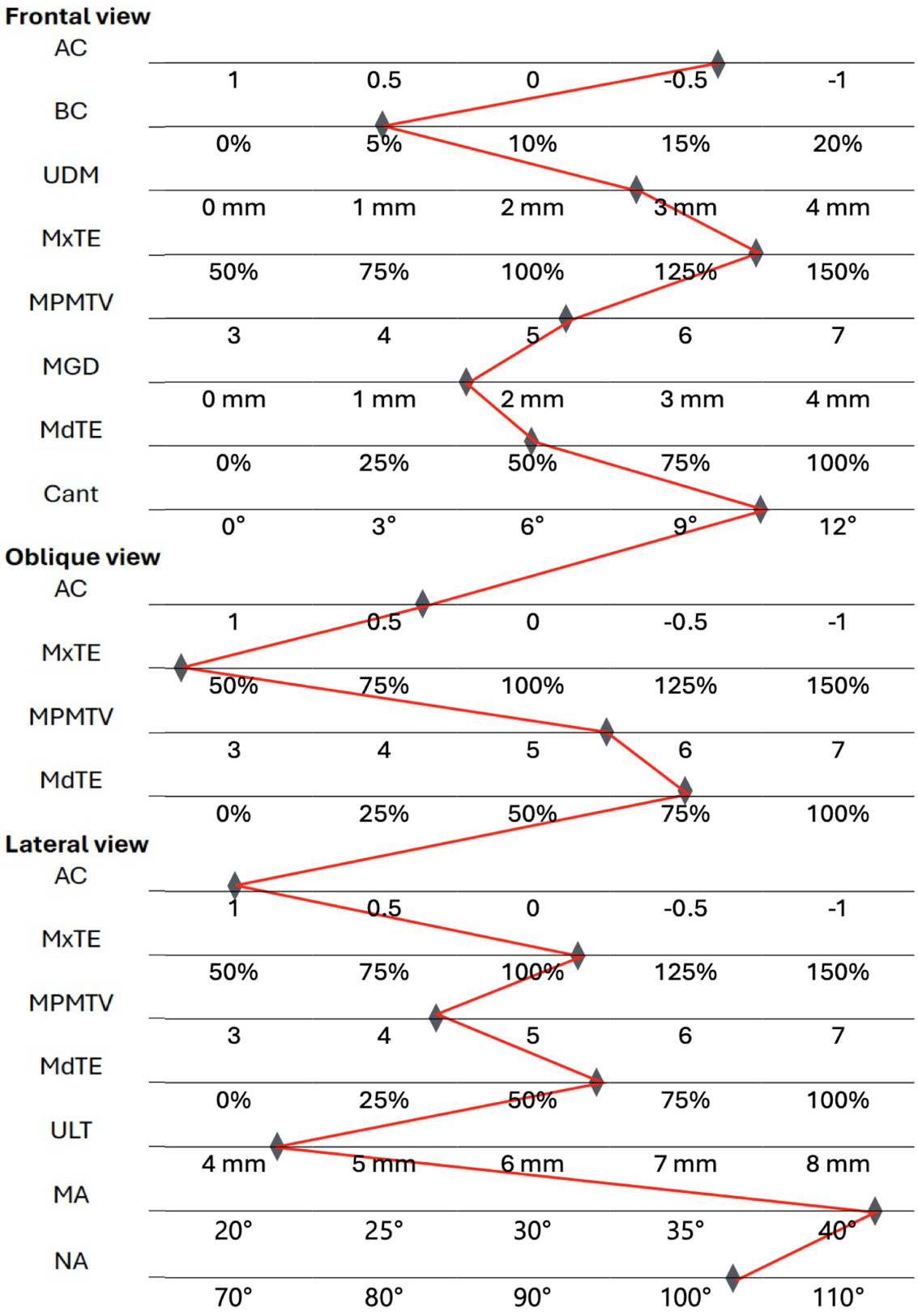


Figure 1 Smile chart based on participants' preferences for the smile aesthetics.

and 30.8 % preferred an AC of 1, indicating a preference for a more curved smile in these views.

Participants consistently preferred 125 % MxTE for a fuller upper tooth display, though this decreased to 100 % in lateral views, showing variation across views. A 0 % MGD was the dominant choice, reflecting a strong preference for minimal gingival exposure. Overall, Taiwanese individuals prioritize clean, full-tooth smiles with minimal gum

visibility. Participants preferred an MdTE rate of 50 % in oblique views, 25 % in lateral views, and 0 % in frontal views, indicating no visible lower teeth from the front. Preferences for lower tooth exposure vary by view.

This study has limitations to address in future research. First, using two-dimensional images may not fully reflect real smiles; incorporating dynamic videos can improve realism. Second, the sample distribution was uneven, with most participants being in the 20—30-year age group (LP) and the 31—40-year age group (Ortho), limiting generalizability. Future studies should include a broader age range and integrate subjective and objective smile factors. Additionally, cross-national research should use multi-view smile images for a comprehensive understanding of cultural differences in smile aesthetics.

In conclusion, smile aesthetics vary significantly across frontal, oblique, and lateral views, influenced by identity, gender, age, region, and culture. To assist orthodontists in diagnosis and treatment planning, we developed a customized smile chart. We propose that the most beautiful smile is one that achieves the greatest consensus in terms of individuals' preferences for smile aesthetics while maintaining normal physiological function and form. Future research should incorporate diverse perspectives to improve patients' satisfaction with their smile after orthodontic treatment.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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