ORIGINAL RESEARCH REPORT

Are the Gingival Display and the Smile Arc in Males and Females Different?

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ABSTRACT

Background: An aesthetic smile is part of a person's attraction and affects their level of psychosocial well-being. Gingival display and smile arc belong to smile components that enhance the aesthetic value of a person's smile. **Objective:** To determine the differences in gingival display and smile arc in social smiles between males and females. **Material and method**: This analytical observational study was conducted with a cross-sectional design. A total of 110 photographs (55 males and 55 females) of study subjects who fulfilled the inclusion criteria were taken directly by Canon EOS-600D while performing social smile poses. The CorelDraw Graphic Suite 2022 measured gingival appearance and smile curves. The Chi-square test was performed to analyze the differences in gingival display and smile arc between males and females. **Result:** Based on gingival display, social smiles between genders were categorized into moderate (56.4% males and 58.2% females), low (30.9% males and 20% females), high (9.1% males and 18.2% females), and very high (3.6% males and females) smile lines. Social smiles based on smile arc were categorized into consonant (85.5% males and 96.4% females), straight (10.9% males and 3.6% females), and inverted (3.6% men and 0% women) smiles. No statistical differences were found in gingival display (p=0.397) or smile arc (p=0.113). **Conclusion:** There were no significant differences in gingival display or smile arc between males and females. Females, on the other hand, had an increased gingival show while smiling and no inverted smile arc.

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Highlights

1. Gingival display and smile arc enhance the aesthetic value of a person's smile and may be influenced through dental treatment.
2. The individual profile photographs taken during social smiles can be used to evaluate dental treatment plans.

BACKGROUND

Humans are social creatures who spend most of their time interacting verbally and nonverbally with others around them. Verbal communication involves spoken words, while nonverbal communication is conveyed through body movements or facial expressions. Facial expressions are a way of expressing a purpose, intention, or idea. Variations in facial expressions can be formed from a variety of contractions of 42 facial muscles that are coordinated and reflect changes in a person's emotions (Kuramoto, et al., 2019; Anggraini, 2020).

The changes in facial expression may affect a person's success in social interactions because they may predict their feelings, emotions, and circumstances (Smith & Rossit, 2018). A smile is a positive facial expression usually triggered by feelings of happiness and joy and is the second most crucial factor, easily visible after the eyes. It is produced through a slight upward movement of the lips (Pithon, et al., 2014).

Anatomically, a smile is a form of facial expression resulting from contractions of the facial muscles surrounding the mouth. This contraction lengthens the midline of the lips laterally, pulls the mouth corner superiorly, and folds the sulcus nasolabialis to become more prominent. When a person smiles, the eye slits become narrowed, and wrinkles appear at the outer corners of the eyes. The mouth also usually opens slightly to reveal the anterior teeth (Abdurachman, 2018). The primary muscle that plays a role in forming a smile is the m. zygomaticus major. This muscle functions to lift the mouth corner superiorly and laterally, create the lip curve, and generate a smile (Anggraini, 2020). In addition, m. zygomaticus minor, m. levator anguli oris, m. risorius, and m. buccinator also contribute to generating a smile (Abdurachman, 2018).

Smile aesthetics impact a person's attractiveness and become an essential factor affecting a person's psychosocial health. A person with an attractive smile is seen as more thoughtful and valuable because he or she exhibits behaviors that others prefer in social interactions (Wang, et al., 2018; Alexandra, et al., 2023). A previous study by Pithon, et al., (2014), which conducted observations of groups working to recruit employees, supports this statement. They stated that a person with an attractive smile is more likely to get a job because that person looks more intelligent.

Several factors, such as tooth arrangement and position framed by the lips, gingiva contours, and the number of spaces and gaps while smiling, may affect the smile's aesthetics (Rambe, 2016). More precisely, the harmony and symmetry of the smile are influenced by the height and width of the visible gingival surface, the smile arch, the proportion and color of the teeth, changes in tooth position, and the buccal corridor formed while smiling (Armalaite, et al., 2018). Therefore, dentists must clearly understand the aesthetic standards and have diagnostic guidelines for arranging dental treatment plans with smile aesthetics in mind (Wang, et al., 2018).

Smiles are categorized into two types: non-Duchenne and Duchenne smiles. The non-Duchenne smile is also known as the social smile because it is widely used when interacting with others and taking profile pictures. In contrast, the Duchenne smile is associated with involuntary emotions of happiness and pleasure (Gunnery & Ruben, 2016; Patankar & Khatri, 2021).

Eight main components can be assessed from a person's smile, and dentists can use them to arrange a patient's dental treatment. Those components are the lip line, the smile arch, the upper lip curvature, the buccal corridor, the smile symmetry, the occlusal frontal plane, the dental components, the gingival components, or the gingival display. However, the components of gingival display and smile arch significantly impact generating an aesthetic smile (Ioi, et al., 2009; Abdurachman, 2018).

In dentistry, one of the parameters that must be considered to create an aesthetic and attractive smile is the gingival display (Akyalcin, et al., 2014). This includes the color, contour, shape, texture, and height of the gingival surface that is present while smiling. A slight appearance of the gingiva surface while smiling makes a person look younger (Sapkota, et al., 2017). The previous study by Sriphadungporn & Chamnannidiadha (2017) stated that an attractive smile reveals 0-2 mm of gingival surface. Moderate smile lines were reported, equally distributed among males and females (Mahn, et al., 2020). However, another previous study by Arifağaoğlu & Yılmaz (2021) reported that moderate smile lines were primarily present in males, whereas females had high smile lines.

Another parameter that may affect the aesthetic value of a smile is the smile arc (Seixas & Câmara, 2021). It is defined as the relationship between the curved line formed by the incisal edges of the maxillary anterior teeth and the curved line formed by the inner lower lip while smiling (Sabri, 1965; Munjal & Chhabra, 2017). A consonant smile is considered the ideal smile arc because it makes a

person look younger and more attractive (Wang, et al., 2018; Chandran, et al., 2019). The consonant smile was distributed equally among males and females (Lubis & Kevin, 2018). In contrast, Hadi et al., (2020) stated that most females have a consonant smile while males have a straight smile.

OBJECTIVE

This study aimed to determine the differences between males and females in gingival display and smile arc in social smiles.

MATERIAL AND METHOD

Observational analytical research using a cross-sectional design was conducted at the Laboratory of the Faculty of Dentistry, Universitas Trisakti, from October to December 2022. The Research Ethics Committee of the Faculty of Dentistry, Universitas Trisakti, approved all procedures in this study under number 021/S3/KEPK/FKG/6/2022. From the total population, there were 110 participants (55 males and 55 females) ranging in age from 17 to 24 years who agreed to provide informed consent and met the inclusion criteria, such as having at least complete upper anterior teeth in the right and left regions and healthy periodontal tissue. Participants were excluded if they have a history of conditions that cause changes in facial shape, such as Bell's palsy, facial trauma that affects muscle activity, take corticosteroids that may cause moon face conditions, are undergoing or have undergone orthodontic treatment, have dental restorations in the maxillary anterior teeth, have undergone cosmetic procedures such as Botox or lip fillers, or (in males) have mustaches that interfere with the measurement process.

Photographs capture

The same operator took all participants' profile photos under natural sunlight using a Canon EOS-600D with an 18-megapixel resolution, ISO 100-6400, and an 18-135 mm lens. The camera was positioned on a tripod placed 30 cm in front of the participant. The photographed parts of the face included the top of the forehead, both ears, and the lower edge of the chin. During taking the photographs, the participant was asked to remove facial makeup. The participant's head was positioned in the neutral position (NHP) by instructing him or her to sit upright, with the head straight forward and the eyes looking straight at a point on the wall in front of him or her. Glasses equipped with a water pass were also placed on the participant's head to keep his or her head in a neutral position. In addition, the elbow ruler was also equipped with a water pass to help the operator confirm that the position was parallel to the floor. This technique was introduced by Maniyar, et al., (2018).

Participants were also instructed to say "cheese" to generate a social smile. An elbow ruler was used as a measurement reference and placed on the right side of the participant's head during the profile photograph (Figure 1).

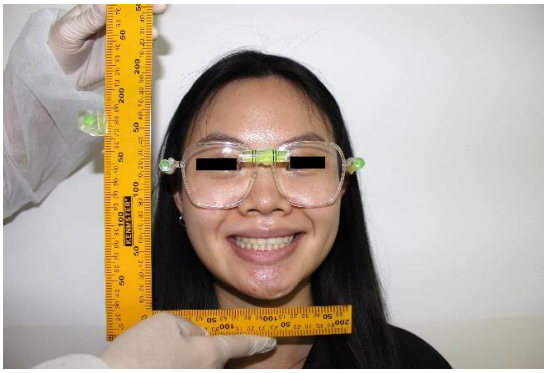

Figure 1. Profile photographs were captured during a social smile using an elbow ruler and glasses with a water pass on the participant's right side.

Photograph assessment

The photos were measured by two calibrated healthy and emotionally stable raters using the parallel dimension and connector tools in CorelDraw Graphic Suite 2022. The evaluated smile components included:

Gingiva display is defined as the amount of gingival surface visible while smiling and measured by the distance between the crest of the marginal gingiva of the maxillary central incisor and the inferior border of the upper lip while doing a social smile. Initially, a 1 cm straight line was created using the parallel dimension tools and calibrated with an elbow ruler as the reference. Then, the distance obtained was categorized into very high smile line, high smile line, medium smile line, and low smile line. In the very high smile line category, the visible gingival surface is more than 2 mm from the marginal gingiva. In the high smile line category, the visible gingival surface is 0–2 mm from the marginal gingiva. If only the gingival embrasure is visible while smiling, it is categorized as a medium smile line. Meanwhile, it is classified as a low smile line if it does not display the gingival embrasure and the cementoenamel junction (CEJ) of the maxillary central incisor (Sapkota, et al., 2017; Sriphadungporn & Chamnannidiadha, 2017; Alexandra, et al., 2023).

Smile arc is measured by connecting the cusp tips of the right and left upper canine teeth with an imaginary line using the connector tool feature. The evaluation results were then categorized into consonant smile, straight smile, and inverted smile, depending on the position of the incisal edges of the upper central incisor teeth against the imaginary line (Machado, 2014; Lubis & Kevin, 2018). If the incisal edges of the maxillary central incisor teeth are below the imaginary line, it is categorized as a consonant smile. However, if the incisal edges of the maxillary central incisor teeth are parallel to the line, it belongs to a straight smile. Lastly, an inverted smile is described when the incisal edges of the maxillary central incisor teeth are above the line, forming a concave impression.

Statistical Analysis

The Chi-Square test and IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, N.Y., USA) were used to analyze the relationship between gender and these two smile components, gingival display and smile arc (Masturoh, 2018).

RESULT

This study was conducted with a total of 110 participants, comprising 55 males and 55 females. Profile photographs were captured while doing a social smile, and a 20 x 30 cm elbow ruler was used as a measurement reference.

Interrater reliability

The Cohen's Kappa test for gingival display showed that the interrater agreement was very good, with a value of 0.967. Similarly, the kappa value of 1.00 for the strength of agreement on the smile arc also showed that the strength of agreement between the measurers is very good.

Gingiva display

The majority of all participants had moderate smile lines, with a percentage of 56.4% (31 individuals) of males and 58.2% (32 individuals) of females. This was followed by low smile lines with 30.9% (17 individuals) of males and 20% (11 individuals) of females and very high smile lines with 3.6% (2 individuals) of both genders. (Figures 2 and 3; Table 1)

The Chi-square test showed a significance value of 0.397 ($p > 0.05$), indicating no significant difference in gingival display in social smiles among genders.

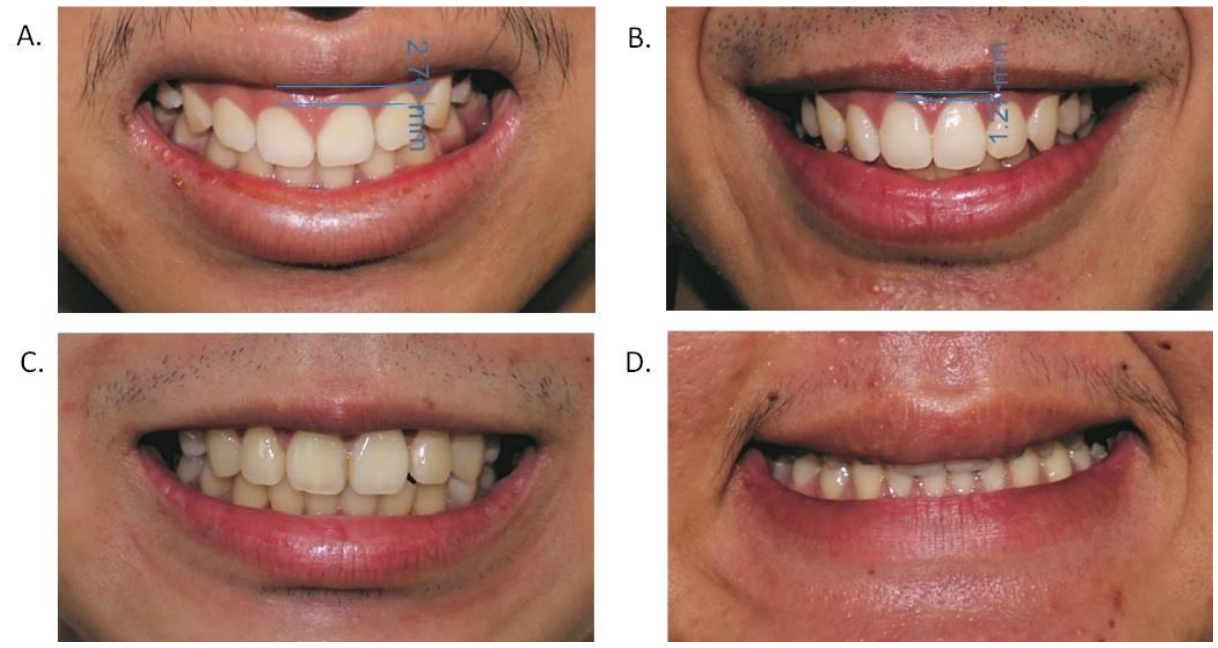

Figure 2. Results on the gingival display component in males during a social smile: A) Very high smile line (x >2 mm); B) High smile line (0<x<2 mm); C) Moderate smile line (only gingival embrasure visible); D) Low smile line (no gingival embrasure and CEJ of the central upper incisor visible).

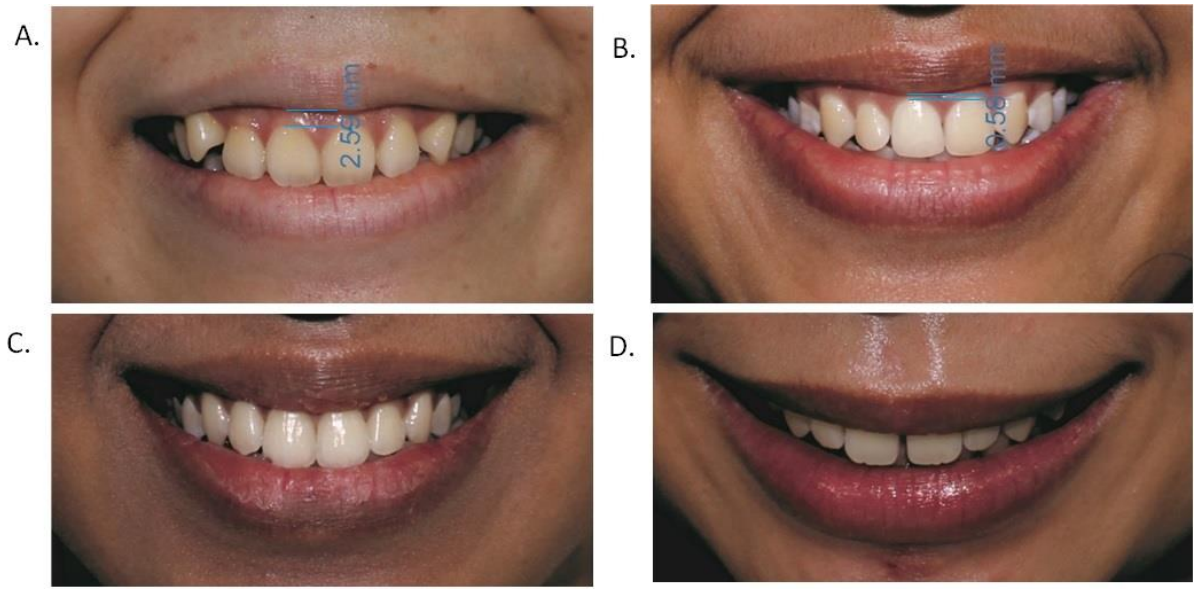

Figure 3. Results on the gingival display component in females during a social smile: A) Very high smile line (x>2 mm); B) High smile line (0<x<2 mm); C) Moderate smile line (only gingival embrasure visible); D) Low smile line (no gingival embrasure and CEJ of the central upper incisor visible).

Table 1. Frequency distribution and Chi-Square test of social smiles based on gingival display and smile arc components.

Smile components	Categories	Gender		p
		Males (%)	Females (%)	
Gingiva display	Very high smile line	3.6	3.6	0.397
	High smile line	9.1	18.2	
	Moderate smile line	56.4	58.2	
	Low smile line	30.9	20	
Smile arc	Consonant smile	85.5	96.4	0.113
	Straight smile	10.9	3.6	
	Inverted smile	3.6	0	

*Significantly different ($p<0.05$)

Smile arc

The consonant smile was the most common smile arc observed in males, with 85.5% (47 individuals) exhibiting this type. Straight smiles were the second most common, at 10.9% (6 individuals), followed by inverted smiles at 3.6% (2 individuals). Like male participants, most female participants also had a consonant smile, with 96.4% (53 individuals) exhibiting this type, followed by a straight smile of 3.6% (2 individuals). However, no female participant showed the inverted smiles. (Figures 4 and 5; Table 1)

According to the Chi-squared test, there was no significant difference in smile arc between genders while showing social smiles, as the significance value was 0.113 ($p >0.05$).

Figure 4. Results on the smile arc component in males during a social smile: A) Consonant smile; B) Straight smile; C) Inverted smile

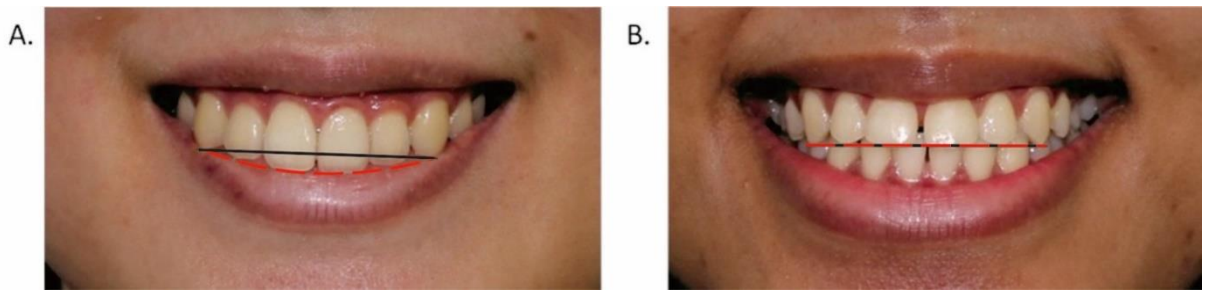

Figure 5. Results on the smile arc component in females during a social smile: A) Consonant smile; B) Straight smile.

DISCUSSION

An aesthetic smile is crucial for a person's attractiveness and well-being. Smiling positively affects social interaction (Alexandra, et al., 2023). Eight components can be assessed in a smile: the gingival display and the smile arc. The harmony of these components may improve the appearance (Wang, et al., 2018)

Data analysis began with assessing the inter-rater reliability of the two calibrated raters. The Cohen's Kappa test values for the gingival display and the smile arc components were 1.00 and 0.967, respectively. This indicated that the interrater agreement was very good. Therefore, the results can be trusted, and there was no bias when conclusions were reached.

Our findings on gingival display by gender showed a similar pattern, with the majority of participants exhibiting a moderate smile line (56.4% males and 58.2% females), followed by a low smile line (30.9% males and 20% females), a high smile line (9.1% males and 18.2% females), and lastly, a very high smile line with a percentage of 3.6% in both. (Table 1) These findings are consistent with a previous study by Mahn, et al., (2020) that also found moderate smile lines to be most common in males (52.9%) and females (54.6%) while doing a social smile. In contrast, very high smile lines were the least visible gingival display (0.6% males and 7.9% females). However, we did not find any differences in gingival display among genders.

Corresponding to previous studies by Liébart, et al., (2004), we also found no difference in gingival display between males and females. However, there was a difference in gingival display between males and females while doing a social smile, which was reported by Arifağaoğlu & Yılmaz, (2021). The method used to capture the profile photographs may have caused this difference in the results.

Furthermore, we observed that female participants exhibited a higher smile line than males while doing a social smile. This finding was consistent with a previous study by Arifağaoğlu & Yılmaz, (2021), which found that females exhibited more gingival surface (medium to high smile line categories) during social smiles. In contrast, males showed less gingival surface (low to medium smile line categories). The difference in the upper lip length between males and females might have caused this phenomenon. The upper lip length of females at rest is 20 mm, while that of males is 23 mm. Thus, when smiling, women will reveal more dental crowns and gingival tissue (Abdurachman, 2018).

A slightly visible gingiva surface while making a social smile makes a person look younger (Sapkota, et al., 2017). However, the excessive gingiva appearance (>3 mm) may reduce the aesthetic value of the smile (Al-Hazmi, 2018). This condition might be triggered by multiple factors, such as (1) delayed tooth eruption causing the improper position of the gingival margin at the CEJ; (2) gingival enlargement due to inflammation, hereditary fibromatosis, hormonal changes, or medication; and (3) hypermobility of the upper lip muscles. Therefore, dentists must be able to assess and determine the condition's cause to decide on the appropriate treatment plan (Al-Hazmi, 2018; Nasution & Nasution, 2020).

Our smile arc data revealed that most participants (85.5% males and 96.4% females) exhibited a consonant smile, while the second most common type was a straight smile, with 10.9% of males and 3.6% of females exhibiting this smile (Table 1). The previous study by Cruz, et al., (2015) reported that consonant smile was primarily found in most participants (94.4%). In this study, 53 females exhibited a consonant smile, while only 47 males did, and no female displayed an inverted smile. This finding was in line with previous studies by Hadi, et al., (2020) and Lubis & Kevin, (2018), which

also found that more females have a consonant smile, and fewer have an inverted smile. Therefore, it can be concluded that female smiles are more attractive (Krishnan, et al., 2008).

A person's smile arc can be influenced by orthodontic and restorative treatment. When the incisal edge of the incisor teeth is lower than the cusp tip of the canine teeth on the incisal plane, the anterior dental arch becomes more curved or convex (Seixas & Câmara, 2021). A consonant smile is considered an aesthetic smile because it makes the individual appear younger and more confident. On the other hand, a straight smile is considered less attractive and makes a person look older (Lubis & Kevin, 2018).

The shape of an individual's jaw arch impacts his or her smile arc. When the jaw arch is more expansive, the dental arch of the anterior teeth becomes flatter, reducing the aesthetic value of the smile (Krishnan, et al., 2008). Therefore, dentists must consider and ensure that the dental treatment does not change the curvature of the anterior dental arch in a consonant smile (Lubis & Kevin, 2018).

Similar to previous studies by Lubis & Kevin, (2018) and Hadi, et al., (2020), we found no difference in smile arc among genders for social smiles. In contrast, a previous study by Maulik & Nanda, (2007) found a difference in smile arc among genders for social smiles. The more significant number of female participants than males might be one of the reasons for this difference. Another reason that may occur when capturing the photograph's participant is that the operator's perception influences the curvature of the anterior teeth. When the participant's head position is lower (not in the NHP plane), the smile arc appears more convex (Seixas & Câmara, 2021). Therefore, we used glasses with a water pass to keep the participant's head in the NHP to avoid this.

Strength and limitations

The result of this study presented the goal standard of the smile component that the dentist should consider when arranging dental care for young adult patients. The aging process was known to decrease the strength and contraction of the facial muscles, leading to a change in the height of the lip line. Thus, further research is needed in various age groups, such as young adulthood, adulthood, and the elderly. This study demonstrated that individual profile photographs while doing a social smile can be used to evaluate dental treatment plans for young adults.

CONCLUSION

There was no statistical difference in gingival display or smile arc between males and females. Most males and females exhibited a gingival surface with a moderate smile line. However, females had a higher gingival surface (high smile line) than males. In the smile arc, a consonant smile arc was primarily found in both genders, and an inverted smile was not found in females.

Future studies are expected to include a broad range of populations and ages. In addition, more focused research on the possible relationship between the two components, the smile arc and gingival display, or with other elements of the smile, can be conducted to advance the field of smile aesthetics science.

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Conflict of Interest

All authors have no conflicts of interest.

Ethic Consideration

All procedures in this study were approved by the Research Ethics Committee of the Faculty of Dentistry, Universitas Trisakti, under number 021/S3/KEPK/FKG/6/2022 on 03-06-2022.

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This study did not receive any funding.

Author Contribution

WA and APA: conceptualization and design. WA, APA, IS, and SA: provision of study materials. APA, IS, and SA: collection and assembly of data. APA, IS, and SA: analysis and interpretation of the data. APA: statistical expertise. WA: Obtaining funding and administrative, technical, and logistic support. WA and APA: drafting of the article. APA and IS critical revision of the article for important intellectual content. APA: final approval of the article. All the authors have read and approved the manuscript for publication.

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