

CORRELATION BETWEEN MAXILLARY ANTERIOR TOOTH SIZE RATIO AND SMILE ESTHETICS INDEX IN ORTHODONTIC PATIENTS: A CROSS-SECTIONAL ANALYSIS

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ABSTRACT

Introduction: Smile aesthetics is a crucial aspect of physical appearance that significantly influences self-confidence. The proportion of maxillary anterior teeth size plays an essential role in forming a harmonious smile. The Smile Esthetics Index serves as a parameter to measure smile characteristics from the frontal dimension. **Aim:** To determine the relationship between the maxillary anterior teeth size ratio and Smile Esthetics Index in orthodontic patients at the FKG UB Clinical Laboratory. **Methods:** This cross-sectional analytical study utilized 32 samples of study models and photometry from orthodontic patients aged 17-30 years who met the inclusion criteria. The anterior teeth size ratio (central incisor, lateral incisor, and canine) was measured using calipers on study models by dividing mesiodistal width by cervicoincisal height. The Smile Esthetics Index was measured through frontal photometry by dividing intercommissural width by interlabial distance during smiling. Data were analyzed using the Spearman correlation test and simple linear regression with a 95% confidence level. **Results:** The mean size ratio was 0.88 ± 0.02 for central incisor, 0.87 ± 0.02 for lateral incisor, 0.93 ± 0.02 for canine, and 6.98 ± 0.25 for Smile Esthetics Index. There was no significant difference between right and left anterior teeth size ratios ($p > 0.05$). Correlation tests showed no significant relationship between central incisor size ratio and Smile Esthetics Index ($r = -0.083$; $p = 0.651$), lateral incisor ($r = 0.033$; $p = 0.858$), or canine ($r = -0.079$; $p = 0.667$). Overall, the anterior teeth size ratio showed no significant relationship with Smile Esthetics Index ($p = 0.908$). **Conclusion:** There is no relationship between the maxillary anterior teeth size ratio and Smile Esthetics Index in orthodontic patients. Anterior teeth do not show a significant relationship either individually or collectively with Smile Esthetics Index values. This finding suggests that smile aesthetics could be influenced by multiple factors beyond tooth dimensions alone, including soft tissue characteristics and facial proportions.

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INTRODUCTION

Due to dental aesthetics being a major contributing factor, malocclusion and irregularities in anterior teeth have been reported to negatively affect self-confidence, social behavior, and quality of life, especially among adolescents and young adults.^{1,2} Dissatisfaction with dental appearance has been shown to negatively influence psychosocial well-being, potentially leading to anxiety, social withdrawal, and decreased self-esteem.^{1,2}

Smile aesthetics is influenced by various dental and soft tissue components, including tooth size, shape, alignment, gingival display, and lip dynamics.^{3,17,22} Among these components, the maxillary anterior teeth are considered dominant elements within the aesthetic zone because they are the most visible during smiling and speaking.^{3,22} Disproportionate dimensions of anterior teeth may disrupt smile harmony and reduce facial attractiveness, making tooth proportion an important consideration in aesthetic evaluation and orthodontic treatment planning.^{3,6}

One objective parameter used to assess smile characteristics in the frontal dimension is the Smile Esthetics Index, which was introduced by Ackerman and Ackerman.⁸ The Smile Esthetics Index is defined as the ratio between inter-commissural width and inter-labial distance during smiling, providing a quantitative description of smile proportions.^{8,17} Although anterior tooth dimensions and Smile Esthetics Index are both associated with smile aesthetics, previous studies have reported inconsistent findings regarding their relationship.^{3,7} Therefore, this study aimed to investigate the

association between maxillary anterior teeth size ratio and Smile Esthetics Index in orthodontic patients.

METHODS

Study Design and Sample

This analytical study employed a cross-sectional design conducted at the Clinical Laboratory of the Faculty of Dentistry, Universitas Brawijaya, in August 2025. The study utilized study models and photometry from orthodontic patients. The sample size was calculated using the correlation test formula with a significance level of 5% and power of 90%, resulting in a minimum of 32 samples. Samples were collected using consecutive non-probability sampling technique. All measurements were performed by a single calibrated operator. Each measurement was repeated twice, and the average of the two measurements was used for statistical analysis.

Inclusion and Exclusion Criteria

Inclusion criteria included study models and photometry from FKG UB clinic patients aged 17-30 years, study models with complete and fully erupted anterior teeth for measurement, and frontal patient photometry during posed smile with teeth visible. Exclusion criteria included damaged study models and photometry, study models from orthodontic treatment patients who underwent interproximal reduction on anterior teeth, study models with anterior teeth having caries, restorations, crowding, diastema, prostheses, attrition, abrasion, or fractures, study models with anomalous anterior tooth shapes (such as peg-shaped), and

photometry not conforming to posed smile standards.

Measurement Procedures

Anterior Teeth Size Ratio Measurement: The mesiodistal and cervicoincisal dimensions of six maxillary anterior teeth were measured using calipers on study models, starting from the zero point for each tooth measurement. Mesiodistal width was measured between proximal contact points from mesial to distal at the widest area. Cervicoincisal height was measured from the apical peak of the gingival margin to the incisal edge of the crown. The width-to-height ratio was obtained by dividing the mesiodistal measurement by the cervicoincisal measurement. This measurement procedure was repeated for right and left central incisor, lateral incisor, and canine.



Figure 1. Smile Esthetics Index measurement on frontal smile photograph. The horizontal line represents the intercommissural width, while the vertical line represents the interlabial distance used to calculate the Smile Esthetics Index. (Sarver & Ackerman, 2003)

Smile Esthetics Index Measurement: Measurements were performed using ImageJ software on frontal patient photometry during smiling. Inter-commissural width was measured by creating an imaginary line from the outermost commissure on the right to the left side. Interlabial distance was measured by creating a

perpendicular imaginary line from the upper and lower lips during patient smiling, taking the largest distance formed. The Smile Esthetics Index value in photometry was obtained by dividing the intercommissural width measurement by the interlabial distance during smile formation (Figure 1).

Data Analysis

Data were processed and analyzed using SPSS Statistics 21 software. The first analysis performed was the normality test using the Shapiro-Wilk test, because the sample size was less than 50. Data were considered normally distributed if the significance value was greater than 0.05 ($p > 5\%$). Homogeneity testing was performed using the Levene test. Comparative testing used the non-parametric Mann-Whitney U test for unpaired and non-normally distributed data. Correlation testing used the Spearman non-parametric correlation test due to non-normally distributed data. Simple linear regression analysis was performed to assess the overall relationship between anterior teeth size ratio and Smile Esthetics Index.

Ethical Approval

This study received ethical approval from the Health Research Ethics Committee (KEPK) of the Faculty of Dentistry, Universitas Brawijaya.

RESULTS

Descriptive analysis showed that the mean size ratio of maxillary central incisor was 0.88 ± 0.02 , lateral incisor 0.87 ± 0.02 , and canine 0.93 ± 0.02 .

Table 1. Measurement result

Variable	n	Min	Max	Mean $\pm$ SD.
Width-to-height central incisor ratio	32	0.58	1.10	0.8323 $\pm$ 0.01590
Width-to-height lateral incisor ratio	32	0.53	1.08	0.8173 $\pm$ 0.01326
Width-to-height canine ratio	32	0.76	1.13	0.9253 $\pm$ 0.01359
Smile Esthetics Index	32	4.70	10.25	6.9373 $\pm$ 0.45103

The mean Smile Esthetics Index among subjects was 6.98 ± 0.25 , which falls within the range considered aesthetically acceptable. Normality and homogeneity tests indicated that the data were suitable for non-parametric analysis. No statistically significant differences were found between right and left anterior teeth size ratios ($p > 0.05$). Spearman correlation analysis demonstrated no significant association between the size ratio of central incisor and Smile Esthetics Index ($r = -0.083$; $p = 0.651$), lateral incisor and Smile Esthetics Index ($r = 0.033$; $p = 0.858$), or canine and Smile Esthetics Index ($r = -0.079$; $p = 0.667$). Simple linear regression analysis also confirmed that maxillary anterior teeth size ratio did not significantly predict Smile Esthetics Index values ($p = 0.908$).

DISCUSSION

Anterior Teeth Size Ratio Findings

The mean anterior teeth size ratios obtained in this study (central incisor: 0.88 ± 0.02 , lateral incisor: 0.87 ± 0.02 , canine: 0.93 ± 0.02) are consistent with previous research conducted in Indonesia⁹ and Spain.¹⁰ A study at Universitas Indonesia with 92 subjects found mean ratios of 0.84 for central incisor, 0.81 for lateral incisor, and 0.84 for canine.⁹ Similarly, research in Spain with 384 subjects reported ratios of 0.92, 0.87,

and 0.89 for central incisor, lateral incisor, and canine, respectively.¹⁰ According to Wilson's Aesthetic Dentistry textbook, the proportional tooth size for good aesthetics ranges from 0.75 to 0.80 based on the Chicago population, with variations across different races.¹¹ Ratios less than 0.75 tend to produce tall and narrow crown appearances, while ratios greater than 0.80 tend to produce short and wide crown appearances.⁹

The diversity in anterior teeth size is influenced by various factors. Genetics is the primary determinant of tooth size.¹² Several studies have also demonstrated differences in tooth size based on gender, race, environment, and age.¹⁰ Genetic factors and gender have the greatest influence on tooth dimension variation, while age and functional habits can cause vertical crown changes over time.¹³

Smile Esthetics Index Findings

The mean Smile Esthetics Index obtained in this study was 6.98 ± 0.25 , which closely aligns with research conducted in the United States showing a mean Smile Esthetics Index of 6.73 for adults.¹⁴ Similar research in the United Arab Emirates found a mean Smile Esthetics Index of 7.16 for adults aged 17-25 years.¹⁵ According to Sabbah, aesthetically pleasing smiles demonstrate Smile Esthetics Index values greater than 5.0 and less than 7.5. Smile Esthetics Index values greater than 7.5 indicate smiles found in older individuals, characterized by wider inter-commissural width with narrow inter-labial distance.¹⁶ Smile Esthetics Index value variation is influenced by various factors including lip shape and mobility, vertical facial length, anterior teeth exposure, buccal corridors, age

factors, and the type of smile used during photo capture.¹⁷ In this study, the smile type used was the posed smile or social smile, which is a smile performed consciously (voluntarily) and not caused or accompanied by specific emotions.⁸

Symmetry of Right and Left Anterior Teeth

The comparative analysis revealed no significant differences between right and left anterior teeth size ratios, indicating relatively symmetrical proportional distribution (Table 2). This finding is consistent with research by Alqahtani et al. and Sah et al., which stated that there are no significant differences between right and left anterior teeth sizes in terms of mesiodistal width or cervicoincisal height.^{18,19} According to Naini, anterior teeth size symmetry is one of the key factors determining smile aesthetics. Balanced tooth proportions between right and left sides provide a harmonious smile appearance because incisal edge alignment and tooth midline become visual focal points when smiling.¹²

Table 2. Comparison test of right and left anterior tooth size ratios ($p < 0.05$)

Variable	Mann-Whitney U Statistic	Sig.
Width-to-height ratio of central incisor (left vs. right)	486.000	0.727
Width-to-height ratio of lateral incisor (left vs. right)	458.000	0.468
Width-to-height ratio of canine (left vs. right)	478.000	0.648

Although differences between sides may occur, such variations are considered within normal limits. Research by Charruel et al. demonstrated asymmetry between left and right body sides, indicating that perfect body symmetry in humans does not naturally exist completely.²⁰ Genetic factors, individual anatomical variations, and environmental

influences such as oral habits and occlusal pressure can affect crown tooth size. Altemus stated that genetic factors are the primary determinant of tooth size variation among individuals, while secondary factors such as abrasion, attrition, or restorative procedures can cause minor changes to natural tooth proportions.¹² However, these variations are generally not statistically significant and do not meaningfully affect overall smile aesthetic perception.

Table 3. Spearman correlation test of anterior tooth size ratio on smile esthetics index with 95% confidence level ($p < 0.05$)

Width-to-height ratio	Smile Esthetics Index
Width-to-height central incisor ratio	$r = -0.083$ $p = 0.651$ $n = 32$
Width-to-height lateral incisor ratio	$r = 0.033$ $p = 0.858$ $n = 32$
Width-to-height canine ratio	$r = -0.079$ $p = 0.667$ $n = 32$

Relationship Between Anterior Teeth Size Ratio and Smile Esthetics Index

The main finding of this study is the absence of a significant relationship between maxillary anterior teeth size ratio and Smile Esthetics Index, both individually, central incisor tooth ratio with Smile Esthetics Index, lateral incisor tooth ratio with Smile Esthetics Index and canine tooth ratio with Smile Esthetics Index, (table 3) or collectively, anterior tooth ratio with Smile Esthetics Index (Table 4)

Table 4. Simple linear regression of anterior tooth size ratio on Smile Esthetics Index ($p < 0.05$)

Independent Variable	Dependent variable	R Square	P-Value/Sig.
Width-to-height anterior teeth ratio	Smile Esthetics Index	0.019	0.908

This finding suggests that anterior teeth dimensions alone do not directly determine the Smile Esthetics Index value. According to Machado, anterior teeth size proportions, particularly the relationship between anterior teeth mesiodistal widths, are important components in smile harmony formation.³ However, as stated by Mayun, this balance refers to the regularity of anterior teeth size proportions visible from the frontal direction and is used to create visual harmony in smiles.²¹ This indicates that anterior teeth do not directly influence formed smiles, but their continuous proportions between teeth affect the displayed smile impression.³

One concept used to evaluate these proportions is the Golden Proportion theory, which states that lateral incisor width should ideally be 62% of central incisor width, and canine width 62% of lateral incisor width. This pattern forms harmonious and proportional anterior teeth arrangement and becomes the basis for aesthetic smile design planning.²¹ The research findings also align with Davis's statement that anterior teeth anatomy plays an important role in natural appearance as well as uniqueness and character of a smile.²² Another factor that can explain this relationship is the morphological character of each tooth. Lateral incisor, for example, are known to have high variation in size and shape among individuals.²³ Shape variation diversity is also found in canine teeth. Research by Magat and Uzun on the Turkish population stated high diversity of anatomical variation in canine teeth.²⁴ Morphological diversity in each tooth causes tooth proportions and shapes to vary widely

among individuals, thus not forming consistent size patterns. This irregularity may explain why tooth size ratios showed no significant relationship with Smile Esthetics Index values. Smile Esthetics Index values are not limited to anterior teeth dimension relationships alone but also involve soft tissue elements and facial characteristics that play roles in determining smile balance. According to Zawawi, lip mobility, upper lip height, and lip line shape influence the extent of teeth exposure during smiling. Upper lip length greatly determines how much anterior teeth are visible when smiling. Shorter upper lips tend to show more teeth and gingiva, increasing anterior and gingival exposure potentially causing gummy smile appearance. Conversely, longer upper lips limit tooth exposure, making smiles appear less open.²⁵ Identifying smile appearance involves not only teeth but many supporting structures in the oral cavity, such as muscles, bones, joints, gingival tissue, and occlusion.²² The presence of soft tissue supporting factors significantly influences smile appearance. Research by Desai found that muscle activity and function involved in smiling decrease with age, and loss of skin elasticity can contribute to wrinkles at the commissure or corner of the lips. These factors can determine transversal and vertical smile appearance.¹⁴

According to Tjan, smile arc shapes that are parallel or slightly follow the lower lip contour are considered most aesthetic because they provide harmonious proportion impressions.²⁶ Sarver and Ackerman also explained that smile dynamics, including lip movement and facial muscle activity, can

influence vertical and horizontal smile proportions without directly depending on tooth size.¹⁷ The diverse smile-forming factors make Smile Esthetics Index a complex interaction result between tooth structure, soft tissues, and facial expressions that together form smile aesthetic balance.

Study Limitations

This study has several limitations that should be considered when interpreting the results. First, although the sample size was adequate for statistical analysis, it was relatively limited. Second, this study only included orthodontic patients from a single institution, which may limit the generalizability of the findings to broader populations. Third, although all measurements were performed twice by a single calibrated operator and the average values were used for analysis, formal intra-operator reliability testing was not performed, which may have introduced measurement variability. Fourth, the study did not control for all variables that might influence smile aesthetics, such as lip thickness, facial muscle tone, gingival display, facial proportions, and smile arc characteristics. Future studies with larger sample sizes, more diverse populations, formal assessment of measurement reliability, and a more comprehensive evaluation of smile aesthetic components are recommended.

CONCLUSION

This study concludes that there is no significant relationship between maxillary anterior teeth size ratio and Smile Esthetics Index in orthodontic patients at the FKG UB Clinical

Laboratory. The mean anterior teeth size ratios were 0.88 ± 0.02 for central incisor, 0.87 ± 0.02 for lateral incisor, and 0.93 ± 0.02 for canine, with a mean Smile Esthetics Index of 6.98 ± 0.25 . No significant differences were found between right and left anterior teeth size ratios, indicating symmetrical tooth dimensions. Individual correlation analysis showed no significant relationships between central incisor ($r = -0.083$, $p = 0.651$), lateral incisor ($r = 0.033$, $p = 0.858$), or canine ($r = -0.079$, $p = 0.667$) size ratios and Smile Esthetics Index. Overall regression analysis confirmed the absence of a significant relationship ($p = 0.908$, $R^2 = 0.019$). These findings suggest that smile aesthetics, as measured by Smile Esthetics Index, is influenced by multiple factors beyond anterior teeth dimensions alone, including soft tissue characteristics, lip dynamics, facial proportions, and smile arc configuration. Understanding this complexity is essential for comprehensive orthodontic treatment planning aimed at achieving optimal smile aesthetics.

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