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SMILE ESTHETICS IN DIFFERENT VERTICAL SKELETAL PATTERNS IN AN EGYPTIAN SAMPLE (A CROSS SECTIONAL OBSERVATIONAL STUDY)

Maiada M. Alhakeem[1], Ahmed R. ElKalza[2], Nadia M. ElHarouni[3]

Abstract

Objective: *To assess smile esthetics in different skeletal patterns in an Egyptian sample.*

Materials and Methods: *A total of 120 participants in the age group 15-30 years were selected and divided into three groups: horizontal, average, and vertical skeletal patterns, using the following three cephalometric parameters: SN-MP, FMA, and Jarabak ratio. Two photographic records one taken during smile and the other at rest were obtained, and measurements were analyzed at rest, including upper lip length, and on smiling including maxillary incisal display, interlabial gap, inter commissure width, maxillary intercanine width, and buccal corridors. Upper lip elevation (IULL) was calculated.*

Results: buccal corridor measurements were wider in the vertical skeletal pattern compared with both the average and the horizontal skeletal pattern. Upper lip length, upper lip elevation on smiling, the intercanine width and outer inter commissure width and interlabial gap showed no statistically significant difference between the studied groups.

Conclusion: Different skeletal patterns show different smile characteristics. Vertical skeletal patterns exhibit wider buccal corridors. Upper lip length was not responsible for the increased incisal show during smiling.

Key words*: smile esthetics, vertical dimension, skeletal patterns.*

INTRODUCTION

The smile is one of the most characterizing features of the face and is essential for expressing joy, pleasure, mood, and gratitude. Face attractiveness is considered one of the important social issues in every culture. An attractive smile in modern society has a great influence in interviews, work setting and even social interactions [1]. Improvement in facial esthetics is also one of the powerful motivations for seeking Orthodontic treatment [2]. Therefore, Orthodontists must take special care to the facial appearance and smile particularly of their patients.

The final orthodontic treatment success can be measured by many objective measurements. However, the patient and / or parent determines the success of treatment by the final esthetic

1. Department of Orthodontics, Faculty of Dentistry, Alexandria University, Egypt
email: Maiada.alhakeem.dent@alex.edu.eg
2.Assistant Professor, Department of Orthodontics, Faculty of Dentistry, Alexandria University, Egypt
email: akalza@yahoo.co.uk
3.Professor, Department of Orthodontics, Faculty of Dentistry, Alexandria University, Egypt
email: nadia.moustafa@alexu.edu.eg
Corresponding author
Name: Maiada alhakeem
Email: Maiada.alhakeem.dent@alex.edu.eg
Address: 5 Hussein Kamel Mahmoud, Al-Ibrahimeyah, Alexandria
Phone number: +201012738665

results [3], which can be quite subjective to judge. Many studies were done to determine the subjective factors that influence the pleasing smile.

In the past, the diagnosis was dependant on the cephalometric analysis and patient's profile photograph. The smile analysis was underemphasized. The trend now is directed towards the dental aesthetic and the pleasing smile is the key outcome of the orthodontic treatment. Consequently, the orthodontists around the world give a special attention to the soft tissue paradigm. This shifted the focus on the clinical examination of soft tissue function and aesthetics. [4].

Ackreman et al [5] classified smiles into either posed or spontaneous, where the posed (international) smile is static, voluntary, reproducible and does not need to elect by emotion. On the other hand, spontaneous (unposed) smile is involuntary and induced by emotions; it is dynamic but not sustained. In orthodontic smile analysis, the posed smile is used to evaluate the incisal show and gingival display and the transverse dimensions of the smile.

It is preferable for the elevation of the lip in a posed smile to end at the gingival borders of the upper incisors for a more harmonious and appealing smile.; nevertheless, some gingival display indicates a more youthful and aesthetic smile, especially in females. In contrast, a complete lack of gingiva in the smile is less appealing than than one with all of the incisors showing or even partial gingival display. As that reduced maxillary teeth length at rest or while smiling represents an aging characteristic, orthodontists should not overuse incisor intrusion in adult patients not to give them an older look [6].

In prosthetic literature, the transverse dimension of smile was first introduced by Frush and Fisher [7], they referred the term (smile broadness) and buccal corridors to describe the transverse smile characteristic. Lack of buccal corridors known as denture smile was described as unesthetic and unrealistic. The orthodontist must have his or her own judgment of the number of buccal corridors appropriate size. Moore et al [8] studied smile attractiveness when judged by laypersons, and they concluded that minimal buccal corridors are more easthetic in both women and men. The study suggested that large buccal corridors should be mentioned in the problem list during early stages of orthodontic diagnosis and treatment planning. Tikku et al [9] studied the relation between buccal corridors and underlying hard tissues and no influence was found. Mild to moderate inverse correlation was found with intercanine and intermolar width.

The vertical components of the smile are the maxillary anterior tooth show (Morley ratio), upper lip drape, and gingival display. In a youthful smile, 75–100 % of the maxillary central incisors should fall below the inter commissure line (a line connecting the corners of the mouth) [10]. These components are contributed to skeletal and dental factors.

AIM OF THE STUDY

To assess smile esthetics in different vertical skeletal patterns.

MATERIALS AND METHODS

Prior to treatment, this study involved 120 volunteers who were chosen from among the patients at the Alexandria University Dental Faculty's Department of Orthodontics. The selected age range was 15-30 years with skeletal class I malocclusion. Exclusion criteria included gross facial asymmetry, previous orthodontic treatment, history of facial trauma, plastic surgery, and orthognathic surgery.

Standardized lateral cephalograms were obtained for all participants. A single operator has traced the lateral cephalometric graphs. After making sure that the participants were class I skeletally, they were then categorized into (average, horizontal and vertical) skeletal patterns, using these parameters: SN-MP, FMA and Jarabak ratio. The sample grouping was done according to Bishara and Augspurge [11] and Zaher et al [12], who found that it is not accurate to rely on just one cephalometric parameter to identify the face type. At least two of the three cephalometric parameters have to be satisfied in order to be selected in a specific vertical skeletal group. The parameters used to classify subjects' growth patterns in different groups are shown in (Table 1).

Table (1): Parameters used for classification of growth pattern for Egyptian population [13].

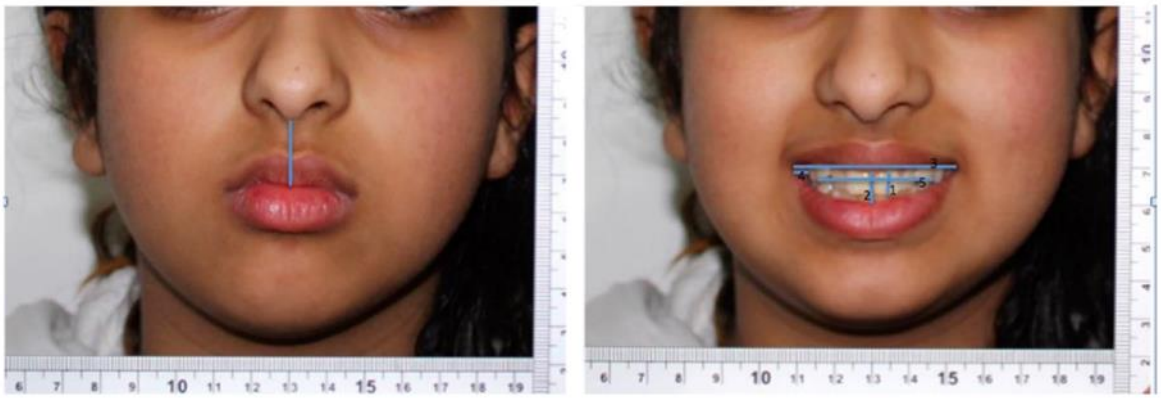
S.no.	*Parameters*	*Average*	*Vertical*	*Horizontal*
1	Jarabak's ratio	66± 1.5 %	<61 %	>71 %
2	SN-MP	32°± 1.5°	>37°	<27°
3	FMA	25± 3°	>28°	< 22°

The following four cephalometric measurements were noted: anterior maxillary vertical height (N-ANS), vertical skeletal facial height (N-Me), incisal inclination, and vertical distance between the incial edge of the upper incisor of the maxilla (U1-PP). After cephalometric tracings have been made, the following cephalometric landmarks and planes were used in the study (Figure 1).

For the photographs, two millimeter-marked rulers were fixed parallel to the participant's face at right angles to one another in order to allow real-life-size measurements. The participants were asked to look at the level of the eye to achieve a natural head position. In order to achieve an equal magnification each time, the camera (Canon EOS 700D) was placed 3 feet from the participant.

Measurements were taken directly from the photographs. The upper lip length (ULL) was taken from the rest position photograph, and the following six measurements were taken from the posed smile photograph: maxillary incisal display (MID), interlabial gap (ILG), intercanine width (CW), buccal corridors, outer inter commissure width, and the upper lip length at smiling. And the difference between lip length at rest and while smiling was calculated and called upper lip elevation (ΔULL) (Figure 2).

The measurements were taken by the same operator two times, with a time interval of two weeks. An intra-examiner reliability test was done.



(a) (b)

Figure (1): (a) Measurement taken at rest: upper lip length at rest. (b) Measurements are taken at smile photograph: (1) maxillary incisal display, (2) interlabial gap, (3) outer intercommissural width (4) buccal corridors (5) intercanine width.

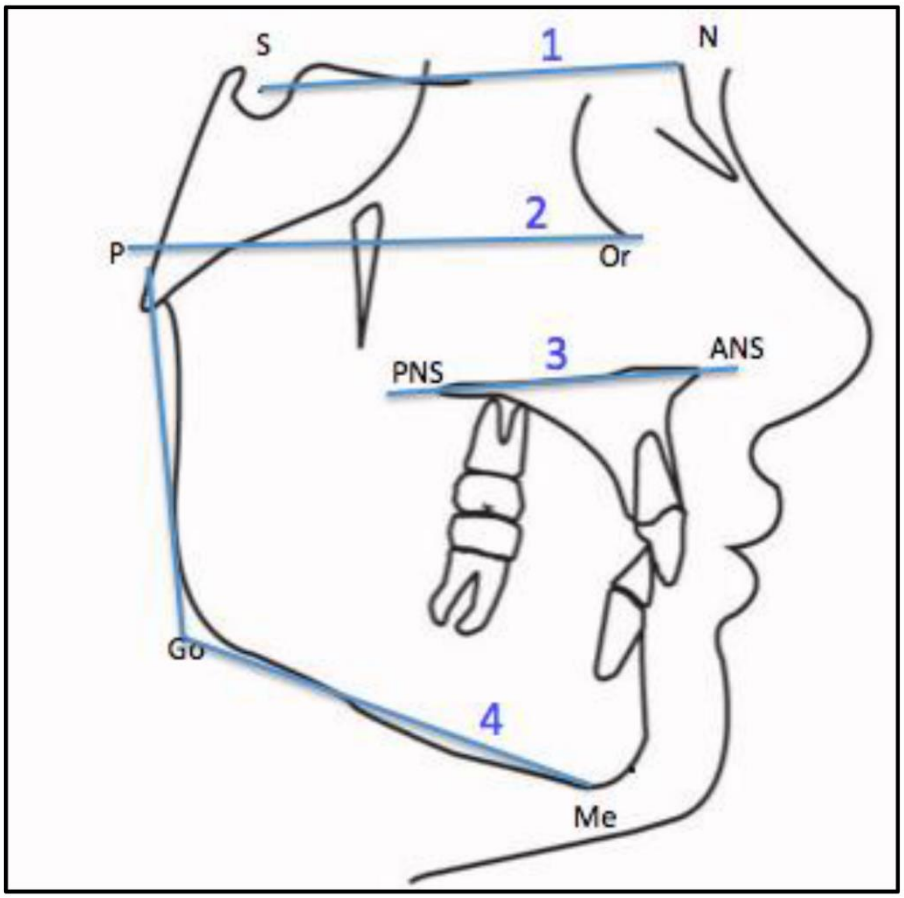


Figure (2): Cephalometric planes and Cephalometric points used in the study (angular and linear): (1) SN. (2) Frankfort plane. (3) Palatal plane. (4) Mandibular plane. (5) N-ANS. (6) N-Mn. (7) U1 to palatal plane.

Sample size estimation

In order to evaluate dynamic smile in diverse skeletal patterns and associate vertical characteristics with underlying causative causes, the smallest sample size estimated based on the prior study conducted by Siddiqui et al [14] was used. By adopting a power of 80% to detect the difference in vertical parameters 0.376 (a small-sized standardized effect size), and a level of significance of 95 % (a - 0.05), 110 patients were indicated to be the bare minimum needed sample size. It is not necessary to increase the sample size to account for attrition (withdrawal) bias. Consecutive sampling was employed until the appropriate sample size is reached.

Software: The sample size was calculated using G*Power version 3,1.9.2**.**

Statistical analysis of the data

Non-parametric statistics were used since the bulk of the variables' distributions were significant according to the results of the Kolmogorov-Smirnov test for normality [15]. Minimum, maximum, median, 95% CI of the median, and the 25th to 75th percentile were used to describe the data. In order to describe categorical variables, frequency and percentage were used. The Kruskal-Wallis test was used to compare data from more than two independent, non-normally distributed subgroups [16]. Dunn-Sidak test for multiple comparisons was used for post-hoc pair-wise comparisons after Kruskal-Wallis test results were significant [17].

RESULTS

The Intra-examiner reliability test values for UUL, MID, ILG, ICW, BC and ΔULL were 0.926,0.960, 0.984,0.994, 0.995, 0.949 and 0.982 respectively (Table 2).

There was no significant difference in the age nor gender distribution between the three studied groups (Table 3).

For the vertical smile parameters, post hoc tests (Table 4) revealed no significant difference was found for ULL, ΔULL, MID, ILG, UII, and U1_PP.

As for the transverse smile measurement, Post hoc test (Table 5) showed that the BC was significantly increased in the vertical pattern when compared with the average and horizontal pattern ($p \leq 0.05$).

Table (2): Intra class Correlation coefficient for measurements (n=40)

Intra class examiner	ICC coefficient	95% C.I (LL–UL)	p
ULL	0.926	0.822 – 0.970	<0.001*
MID	0.960	0.902 – 0.984	<0.001*
ILG	0.984	0.961 – 0.994	<0.001*
ICW	0.994	0.986 – 0.998	<0.001*
CW	0.995	0.987 – 0.998	<0.001*
BC	0.949	0.876 – 0.979	<0.001*
ΔULL	0.982	0.955 – 0.993	<0.001*

CI: Confidence interval
LL: Lower limit
UL: Upper Limit
*: Statistically significant at $p \leq 0.05$

By Koo and Li (2016) [18]

Value of ICC	Strength of agreement#
Below 0.50	Poor
0.50 and <0.75	Moderate
0.75 and 0.90	Good
Above 0.90	Excellent

(3): Demographic data of the three studied groups

	Skeletal pattern			Test of significance *p*-value
	Average (n = 42)	Vertical (n = 40)	Horizontal (n = 38)	
Age (years)				
- **Min-Max**	15.00-27.00	15.00-28.00	15.00-29.00	$H_{(df=2)} = 2.704$
- **Median**	19.00	20.00	18.50	*p*=.259 NS
- **95% CI for median**	17.00-20.00	20.00-21.00	17.00-20.00	
- **25th percentile-75th percentile**	16.00-21.00	17.00-22.00	17.00-21.00	
Gender				
- **Male (n=30) (25.00%)**	10 (23.81%)	10 (25.00%)	10 (26.32%)	$c^2_{(df=2)} = 0.067$
- **Female (n=90) (75.00%)**	32 (76.19%)	30 (75.00%)	28 (73.68%)	*p*=.967 NS

n : Number of patients
Min-Max: Minimum – Maximum
CI: Confidence interval
df: degree of freedom
H: Kruskal-Wallis H
c^2 : Pearson Chi-Square
NS: Statistically not significant ($p \geq 0.05$)

Table (4): Comparison of vertical smile parameters among the three studied groups

	Skeletal pattern			Test of significance *p*-value
	Average (n = 42)	Vertical (n = 40)	Horizontal (n = 38)	
Upper Lip Length (At rest) (cm)				
- Min-Max	1.30-2.40	1.30-2.80	1.60-2.70	$H_{(df=2)} = 2.952$
- Median	2.10	2.10	2.00	*p*=.229 NS
- 95% CI for median	2.10-2.30	2.00-2.20	2.00-2.20	
- 25th percentile-75th percentile	1.90-2.20	1.90-2.25	1.70-2.20	
Upper Lip Elevation (cm)				
- Min-Max	0.10-1.00	0.20-1.00	0.20-0.90	$H_{(df=2)} = 2.787$
- Median	0.50	0.50	0.40	*p*=.248 NS
- 95% CI for median	0.40-0.60	0.40-0.70	0.40-0.60	
- 25th percentile-75th percentile	0.30-0.60	0.40-0.70	0.30-0.60	
Maxillary Incisal Display (cm)				
- Min-Max	0.40-1.10	0.60-1.10	0.50-1.10	$H_{(df=2)} = 3.609$
- Median	0.80	0.80	0.90	*p*=.165 NS
- 95% CI for median	0.80-0.90	0.80-0.90	0.90-1.00	
- 25th percentile-75th percentile	0.70-1.00	0.75-0.90	0.80-1.00	
Inter Labial Gap (cm)				
- Min-Max	0.70-2.00	0.80-2.10	0.60-1.60	$H_{(df=2)} = 3.507$
- Median	1.00	1.20	1.20	*p*=.173 NS
- 95% CI for median	0.90-1.30	1.20-1.40	1.10-1.40	
25th percentile-75th percentile	0.80-1.30	1.00-1.30	0.90-1.40	
Upper Incisial Inclination (◦)				
- Min-Max	96.00-143.00	95.00-140.00	102.00-145.00	$H_{(df=2)} = 2.776$
- Median	117.00	117.50	121.00	*p*=.250 NS
- 95% CI for median	117.00-124.00	114.00-122.00	119.00-128.00	
- 25th percentile-75th percentile	112.00-118.00	112.50-122.50	113.00-128.00	
U1 to PP (mm)				
- Min-Max	20.00-35.00	21.00-35.00	24.00-32.00	$H_{(df=2)} = 10.548$
- Median	27.00[a,b,c]	27.50[a,b]	27.00[a,c]	*p*=.005*
- 95% CI for median	26.00-28.00	27.00-30.00	27.00-32.00	
25th percentile-75th percentile	25.00-28.00	27.00-31.00	25.00-27.00	

n : Number of patients Min-Max: Minimum – Maximum CI: Confidence interval
df: degree of freedom H: Kruskal-Wallis H
*: Statistically significant ($p<.05$) NS: Statistically not significant ($p\geq0.05$)

Post-hoc pair-wise comparisons (using Dunn-Sidak test)

Each group was assigned a letter in sequence, i.e. Average group was assigned letter (a), Vertical group 2 was assigned letter (b), Horizontal Group was assigned letter (c). ***If the group median is labeled with a letter assigned to another group, this means that there is no statistically significant difference between these two groups***.

Table (5): Comparison of horizontal measurements among the three studied groups

	Skeletal pattern			Test of significance *p*-value
	Average (n = 42)	**Vertical (n = 40)**	**Horizontal (n = 38)**	
Inter Commissure Width (cm)				
- **Min-Max**	4.70-6.90	5.00-7.20	4.90-6.90	$H_{(df=2)} = 3.200$
- **Median**	5.90	5.75	6.10	p=.202 NS
- **95% CI for median**	5.50-6.40	5.60-5.90	5.90-6.30	
- **25th percentile-75th percentile**	5.30-6.40	5.45-5.95	5.50-6.50	
Canine Width (cm)				
- **Min-Max**	3.30-4.90	3.00-4.40	3.10-4.60	$H_{(df=2)} = 4.124$
- **Median**	3.80	3.80	3.90	p=.127 NS
- **95% CI for median**	3.60-4.00	3.80-3.90	3.70-4.00	
- **25th percentile-75th percentile**	3.50-4.00	3.50-3.85	3.50-4.10	
Buccal Corridor (BC) (cm)				
- **Min-Max**	5.00-11.00	8.00-16.00	4.50-9.00	$H_{(df=2)} = 50.957$
- **Median**	8.50[a,c]	10.00[b]	8.00[a,c]	p<.001*
- **95% CI for median**	8.50-10.00	10.00-11.00	7.50-8.50	
- **25th percentile-75th percentile**	7.50-9.00	9.50-11.00	6.00-9.00	
Buccal Corridor ratio				
- **Min-Max**	1.30-1.77	1.31-1.80	1.38-1.77	$H_{(df=2)} = 6.776$
- **Median**	1.51	1.57	1.55	p=.034*
- **95% CI for median**	1.46-1.60	1.55-1.63	1.53-1.60	
25th percentile-75th percentile	1.44-1.60	1.49-1.67	1.50-1.70	

n : Number of patients Min-Max: Minimum – Maximum CI: Confidence interval
df: degree of freedom H: Kruskal-Wallis H
*: Statistically significant (p<.05) NS: Statistically not significant ($p \geq 0.05$)

Post-hoc pair-wise comparisons (using Dunn-Sidak test)

Each group was assigned a letter in sequence, i.e. Average group was assigned letter (a), Vertical group 2 was assigned letter (b), Horizontal Group was assigned letter (c). ***If the group median is labeled with a letter assigned to another group, this means that there is no statistically significant difference between these two groups****.*

DISCUSSION

The smile is an interactive relation between the perioral and underlying skeletal and dental components. In order to exclude the age-related factors, the age group in the present study was chosen between 15 and 30 years old. Every effort was made to equalize the three groups.

The outer inter commissure width showed no statistically significant difference among the studied groups. Contrary to this, Siddique et al, [16] and Grover et al [19] found that the ICW is higher in the horizontal group compared to the vertical group. The canine width showed no statistically significant difference in the current study. Contrary to this, Grover et al [18] and Grippaudo et al [20] found that the CW was lowest in the vertical group when compared to the average and horizontal groups.

The BC is one of the main components that affect the smile esthetics, as Sabry [6] mentioned. In the current study, the three study groups differed statistically significantly from one another, with the vertical group having a wider buccal corridor than both the average and horizontal groups. It can be said that an increase in the skeletal vertical dimension will increase the negative posterior space as the maxillary complex gets more constricted. This finding was contradictory to what Yang et al., [21] who found a significant negative correlation between the vertical skeletal patterns (FMA and LAFH) and the buccal corridor width. Another factor related to increased BC in the literature was a retrusive maxilla. Sarver and Ackerman [22] found that a patient with a retrusive maxilla could have large buccal corridors even if the maxilla is average in width, as the wider portion of the maxillary arch is positioned posteriorly. Surgical advancement of the maxilla may improve the negative space by placing the wider portion of the maxilla forward and filling the buccal corridor space [23,24]. The pursuit of a wider smile has increased recently in order to give a broader smile. In order to make that happen, orthodontists tend to widen the arch. This may significantly improve the transverse smile dimension and reduce buccal corridors in patients with collapsed arch. One should use this technique wisely, as it may lead to undesired side effects. The complete absence of posterior negative space should be avoided, as it gives a fake smile appearance. Another side effect of arch widening is decreasing the prominence of the incisors relative to the canines.

The upper incisal inclination showed no statistically significant difference among the different skeletal groups. A similar observation was found by Bou Assi et al.; [25] the study concluded that maxillary compensation was only found in the sagittal discrepancies, while in vertical discrepancies there was no difference between the hypodivergent, normodivergent, and hyperdivergent groups. Controversial observations were made by Chirivella et al. [26], who found that different vertical patterns exhibit different maxillary incisor inclination.

There was no statistically significant difference in ULL (at rest) or upper lip elevation on smiling ΔULL and the different studied groups. It can be stated that the ULL is not related to the skeletal type of the face. The current study

findings and Peck's et al.,[10] findings were similar, they examined 115 participants and discovered no difference between the gingival smile group and the control group in terms of upper lip length.

Controversial results were found in the literature: Siddiqui et al.,[14] Blanchette et al.,[25] Feres et al. [28] and Lai et al. [29] found that the longer the face, the longer the lip, and vice versa. In other words, soft tissues follow the underlying skeletal pattern to create lip competence. This may be due to the differences between the ethnic groups.

In the current study, there was no statistically significant difference in the interlabial gap among the three studied groups. Controversial results were reported by Grover et al., [19] who found that the interlabial gap was highest in the vertical group, followed by the average, then the horizontal group.

CONCLUSIONS

- Different skeletal patterns show different smile characteristics. The vertical skeletal pattern exhibited increased posterior buccal corridors and buccal corridor ratios when compared to both average and horizontal skeletal patterns.
- Upper lip length and upper lip elevation on smiling showed no statistically significant difference between the studied groups. The current study suggests that increased incisal show while smiling is not related to lip length.
- The intercanine width and outer inter commissure width showed no statistically significant difference between different vertical skeletal patterns.
- The interlabial gap showed no statistically significant difference between the studied groups.

List of abbreviations

ILG : Interlabial gap

ICW : Inter commissure width

UII : Upper incical inclination

ΔULL: Change in upper lip length

CW : Intercanine width

MID : Maxillary incisal display

ULL : Upper lip length

U1-PP: Perpendicular distance from the U1 tip to the palatal plane

N-Me : Vertical skeletal facial height

BC : Buccal corridors

Author's participating

MA performed the methodology, data collection, data analysis, wrote the original draft; AK, NH revised the paper and approved the final version for publication.

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Availability of data and materials

All data used and analyzed during the current study are available in the manuscript in the form of figures and tables.

Declarations

Ethics approval and consent to participate

The study was approved by the institutional review board at the Faculty of Dentistry, Alexandria University (IORG0008839). Written informed consents were received from respondents before participating in the study.

Consent of publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

REFERENCES

1. Stevenage SV. The effect of facial appearance on recruitment decisions. Br J Psychol 1999; 90:221-34.

2. Rashed R, Heravi F. Lip tooth relationships during smiling and speech: an evaluation of different malocclusion types. Aust J Orthod 2010; 26:159-65.

3. Işiksal E, Hazar S, Akyalçin S. Smile esthetics: perception and comparison of treated and untreated smiles. Am J Orthod Dentofacial Orthop 2006; 129:8-16.

4. Ackerman JL, Proffit WR, Sarver DM. The emerging soft tissue planning. Clin Orthod Res 1999; 2:49-52.

5. Ackerman JL, Ackerman MB, Brensinger CM, Landis JR. A morphometric analysis of the posed smile. Clin Orthod Res 1998;1:2-11.

6. Sabri R. Overview-the-eight-components-of-a-balanced-smile. J Clin Orthod 2005; 39:155-67.

7. Frush JO Fisher RD.The dysesthetic interpretation of the dentogenic concept. *J Prosthet Dent.* 1958; 8:558

8. Moore T, Southard KA, Casko JS, Qian F, Southard TE. Buccal corridors and smile esthetics. Am J Orthod Dentofacial Orthop. 2005;127:208-13.

9. Tikku T, Khanna R, Maurya RP, Ahmad N. Role of buccal corridor in smile esthetics and its correlation with underlying skeletal and dental structures. Indian J Dent Res. 2012;23:187-94.

10. Peck S, Peck L, Kataja M. The gingival smile line. Angle Orthod 1992;62:91-100.

11. Bishara SE, Augspurger EF. The role of the mandibular plane inclination in orthodontic diagnosis. Angle Orthod 1975; 45:273-81.

12. Zaher AR, Bishara SE, Jakobsen JR. Posttreatment changes in different facial types. Angle Orthod 1994; 64:425-36.

13. Aboul-Azm SF, Enany NM, Fahmy MA, Tamish NO, Abdallah HE. The Alexandria Analysis: Radiographic Cephalometric Standards for Egyptian Adults. Alex Dent J 1984;9:1-8.

14. Siddiqui N, Tandon P, Singh A, Haryani J. Dynamic smile evaluation in different skeletal patterns. Angle Orthod 2016; 86:1019-25

15. Field A. Discovering Statistics Using IBM SPSS Statistics. 4th ed. London, California, New Delhi: SAGE Publications Ltd; 2013.

16. Kruskal WH, Wallis WA. Use of ranks in one-criterion variance analysis. J. Am. Stat. Assoc 1952;47:583-621.

17. Dunn OJ. Multiple comparisons using rank sums. Technometrics 1964;6:241-52.

18. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. J Chiropr Med. 2016;15:155-63.

19. Grover N, Kapoor DN, Verma S, Bharadwaj P. Smile Analysis in Different Facial Patterns and Its Correlation with Underlying Hard Tissues. Prog Orthod 2015; 16:28.

20. Grippaudo C, Oliva B, Greco AL, Sferra S, Deli R. Relationship between vertical facial patterns and dental arch form in class II malocclusion. Prog Orthod 2013;14:43.

21. Yang IH, Nahm DS, Baek SH. Which hard and soft tissue factors relate with the amount of buccal corridor space during smiling? Angle Orthod 2008;78:5-11.

22. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: part 1. Evolution of the concept and dynamic records for smile capture. Am J Orthod Dentofacial Orthop 2003; 124:4-12.

23. Graber TM. Orthodontics principles and practice. 3rd ed. Philadelphia: W.B. Saunders Company; 1972.

24. Benson KJ, Laskin DM. Upper lip asymmetry in adults during smiling. J Oral Maxillofac Surg 2001;59:396-8.

25. Bou Assi S, Macari A, Hanna A, Tarabay R, Salameh Z. Cephalometric Evaluation of Maxillary Incisors Inclination, Facial, and Growth Axes in Different Vertical and Sagittal Patterns: An Original Study. J Int Soc Prev Community Dent 2020;10:292-9.

26. Chirivella P, Singaraju GS, Mandava P, Reddy VK, Neravati JK, George SA. Comparison of the effect of labiolingual inclination and anteroposterior position of maxillary incisors on esthetic profile in three different facial patterns. J Orthod Sci 2017;6:1-10.

27. Blanchette ME, Nanda RS, Currier GF, Ghosh J, Nanda SK. A longitudinal cephalometric study of the soft tissue profile of short- and long-face syndromes from 7 to 17 years. Am J Orthod Dentofacial Orthop. 1996; 109:116–131.

28. Lai J, Ghosh J, Nanda RS. Effect of orthodontic therapy on the facial profile in long and short vertical facial patterns. Am J Orthod Dentofacial Orthop. 2000; 118:505–513.

29. Feres MFN, Hitos SF, Paulo de Sousa HI, Matsumoto MAN. Comparison of soft tissue size between different facial patterns. Dental Press J Orthod 2010;15:84-93.