

## Soft tissue growth changes from 8 to 16 years of age: A cross-sectional study

### ABSTRACT

**Objective:** The present cross-sectional study was conducted to evaluate and compare the soft tissue growth changes between males and females of two groups from 8 to 16 years.

**Materials and Methods:** One hundred sixty skeletal class I lateral head cephalograms were screened aged between 8 to 16 years-Subjects were divided into two groups. Group I (8 to 12 years) and Group II (12 to 16 years) and further these groups were subdivided into male and female subgroups. Total eight linear and four angular parameters were studied.

**Results:** All the parameters increased in their dimension while angle of total facial convexity including nose and Nasolabialangle decreases. Among the linear variables, Noseheight, Lip thickness at laberale inferious, Lip thickness at B point, Soft tissue chin thickness and Measurements of lips to E-plane were found significant for both subgroups. While rest of the linear variables like Upper lip height, Lower lip height, Nose depth and Sagittal depth also increased but this increase wasfound non-significant. Among the angular parameters angle of total facial convexity including nose and Nasolabialangle decreases and angle of facial convexity excluding nose, and Nose inclination increases with the age, and these changes were found non-significant.

**Conclusion:** In this study, we observed that males showed a greater value of all parameters in comparison to females, and with the advancement of age, all the parameters increased, except for angle of total facial convexity and nasolabial angle.

**Keywords:** 8–16 years age, cephalometric study, cross-sectional study, soft tissue growth changes

### INTRODUCTION

An understanding of craniofacial growth and development is essential in orthodontics to attain treatment objectives. Craniofacial growth of the skeleton and soft tissue influences the final configuration of occlusion and overall facial esthetics. The interrelationship of soft tissue components of the face, such as nose, lip, and chin, changes during growth as well as with orthodontic treatment. Thus, it becomes imperative for orthodontists to understand normal growth trends of skeletal tissues as well as soft tissues such as the nose, lip, and chin.

The changes in the soft tissues resulting from growth have been examined by various types of studies such as cross-sectional, semi-longitudinal, and longitudinal studies.

There are so many studies reported in literature by authors such as Subtelny<sup>[1]</sup> and Posen<sup>[2]</sup> as they concluded the growth of various soft tissue parameters with age. In their study, they concluded that after the age of 14 years, the nose did not grow forward to the same extent as did the nasal bones and the nose tip became more prominent within the total

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facial profile after 2–3 years of age. The aims and objectives of our study were:

1. To evaluate the soft tissue parameters from 8 to 16 years of age
2. To compare the soft tissue changes from 8 to 16 years of age.

### MATERIALS AND METHODS

The present cross-sectional study was conducted on 160 skeletal Class I lateral head cephalograms of growing subjects in the age ranging from 8 to 16 years with the following inclusion criteria:

- Skeletal Class I relationship on the basis of App-Bpp ( $5 \pm 2$  mm)
- Age range from 8 to 16 years
- No history of prior orthodontic treatment
- No history of bone deformities, or bone diseases, and major illness in the past
- No congenital abnormalities affecting growth and development.

Subjects were divided into two groups: Group I (8–12 years) and Group II (12–16 years) on the basis of chronological age, and further, these groups were subdivided into male and female subgroups [Table 1].

The lateral head cephalograms were traced on acetate tracing sheets. If the right and left structural outlines were lacking in superimposition on each other, then the average between the two was drawn by inspection and the cephalometric points were located in reference to the arbitrary line so obtained. The linear and angular measurements were made to the nearest 0.5 mm and  $0.5^\circ$ , respectively.

#### Reference plane

##### Pterygomaxillary vertical plane

It is drawn from the sphenothmoid point (se) to the pterygomaxillary point (ptm) Nanda et al.<sup>[3]</sup> and Meng et al.<sup>[4]</sup>

#### Cephalometric landmarks

All the hard and soft tissue landmarks used in this investigation were determined according to the definitions

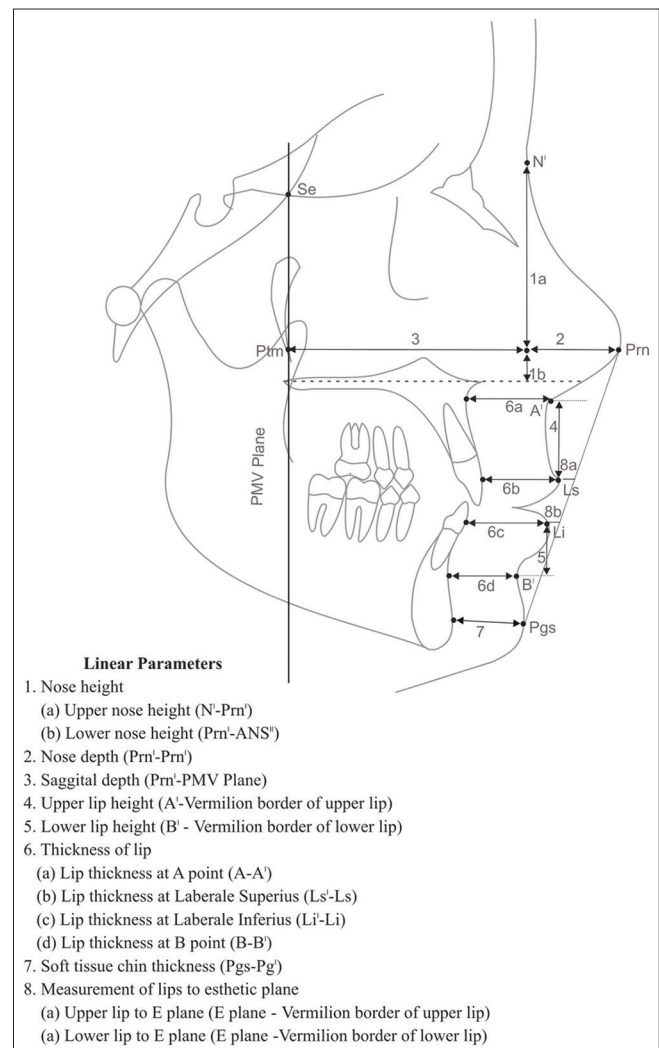
**Table 1: Distribution of skeletal Class I subjects into different groups and subgroups**

Total number of subjects (n)	Group I age 8-12 years (n=80)		Group II age 12-16 years (n=80)	
	Subgroup I (n)		Subgroup II (n)	
	Male	Female	Male	Female
160	40	40	40	40

of Nanda et al.,<sup>[3]</sup> Meng et al.,<sup>[4]</sup> Downs,<sup>[5]</sup> Broadbent,<sup>[6]</sup> Rakosi,<sup>[7]</sup> Bowker and Meredith,<sup>[8]</sup> Burstone,<sup>[9,10]</sup> and Steiner.<sup>[11]</sup>

Porion (Po), sella (S), sphenothmoidal point (se), nasion (n), orbitale (Or), pterygomaxillary point (ptm), anterior nasal spine (ans), point A (A), projected labrale superius (Ls'), projected labrale inferius (Li'), point-B (B), projected soft tissue pogonion (Pgs'), projected pogonion (Pg'), soft tissue glabella (Gl'), projected point nasion (n'), pronasale (prn), anterior nasal spine projected to soft tissue (ans'), columella (cm), projected A-point (A'), subnasale (Sn), superior labial sulcus (SLs), labrale superius (Ls), stomion (St), labrale inferius (Li), projected supramentale point (B'), soft tissue pogonion (Pgs), chin tangent point (Ct), projected pronasale (prn'), projected anterior nasal spine (ans'').

A total of 12 parameters were used in the study, of which eight were linear and four were angular, and these parameters are tabulated in Table 2 and shown in Figures 1 and 2.



**Figure 1: Linear parameters used in the study**

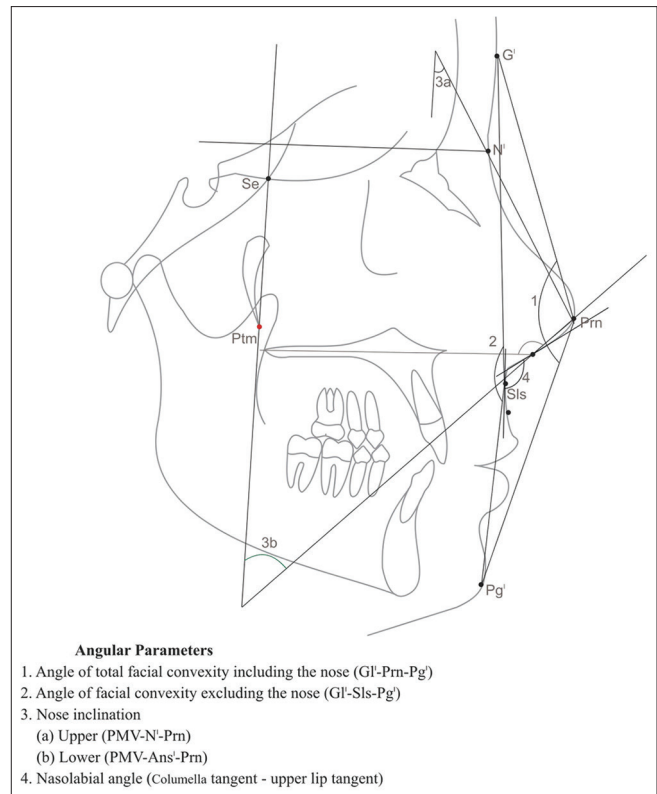
**Table 2: Parameters used in the study**

Linear parameters	
<b>Nose height</b>	
Upper nose height:	Measured from projected nasion (n') to a line connecting the projected pronasale (prn')
Lower nose height:	Measured from projected pronasale (prn') to a line connecting projected anterior nasal spine (ans')
Nose depth:	Measured from projected pronasale (prn') to a line connecting pronasale (prn)
Sagittal depth:	Measured from PMV to a line connecting projected pronasale (prn')
Upper lip height:	Measured from soft tissue subnasale (Sn) and upper lip stomion (St)
Lower lip height:	Measured from lower lip stomion (St) to the soft tissue B point (B')
<b>Thickness of lip</b>	
Upper lip thickness at point A (A-A'):	Measured from projected A point (A') to a line connecting A point (A)
Lip thickness at labrale superius (Ls-Ls'):	Measured from projected labrale superius (Ls') to a line connecting labrale superius (Ls)
Lip thickness at labrale inferius (Li-Li'):	Measured from projected labrale inferius (Li') to a line connecting labrale inferius (Li)
Lip thickness at point B (B-B'):	Measured from projected B point (B') to a line connecting B point (B)
<b>Soft tissue chin thickness:</b> The soft tissue chin thickness at the chin point was measured along two points: Pg, the hard tissue pogonion and Pg', a point at the level of skeletal pogonion (Pg')	
<b>Measurement of lips to esthetic plane:</b> It is the distance of lips to Rickett's esthetic plane	
Upper lip to E-plane:	Distance of upper lip vermillion border to esthetic plane
Lower lip to E-plane:	Distance of lower lip vermillion border to esthetic plane
<b>Angular parameters</b>	
<b>Angle of total facial convexity including the nose:</b> Formed by the line soft tissue glabella (Gl') to pronasale (prn) connecting the line pronasale (prn) to soft tissue pogonion (Pgs)	
<b>Angle of facial convexity excluding the nose:</b> Formed by the line soft tissue glabella (Gl') to superior labial sulcus (SLs) connecting the line soft tissue point A (A') to soft tissue pogonion (Pgs)	
<b>Nose inclination</b>	
Upper nose inclination:	Formed by the line connecting PMV to projected nasion (n') and a line joining to it connecting projected nasion (n') to pronasale (prn)
Lower Nose inclination:	Formed by line connecting PMV to anterior nasal spine projected to soft tissue (ans') and a line joining to it connecting anterior nasal spine projected to soft tissue (ans') and pronasale (prn)
<b>Nasolabial angle:</b> Formed by line connecting columella point (cm) to subnasale (Sn) and a line joining to it connecting subnasale (Sn) to labrale superius (Ls)	

PMV: Pterygomaxillary vertical

### Statistical analysis

The data obtained were summarized as mean  $\pm$  standard deviation. The groups were compared by two-way ANOVA and the significance of mean difference within and between the groups was done by Tukey's *post hoc* test after ascertaining normality by Shapiro–Wilk test and homogeneity of variances by Levene's test. A two-tailed



**Figure 2: Angular parameters used in the study**

( $\alpha=2$ )  $P < 0.05$  was considered statistically significant. Analyses were performed on software (IBM company, Chicago, USA, PSAW, Windows Version 18.0).

## RESULTS

### Linear measurements

The linear measurements of male and female children of two different age groups are summarized in Table 3.

Among the linear variables, a significant increase from Group I to Group II for male subgroup was observed for upper nose height, lip thickness at labrale inferius, lip thickness at B-point, soft tissue chin thickness, upper lip to E-plane, and lower lip to E-plane, whereas upper nose height, lip thickness at B-point, soft tissue chin thickness, upper lip to E-plane, and lower lip to E-plane for female subgroup were increased significantly. When we compared the values of Group I males to Group I females, the lower nose height, lower lip height, upper lip to E-plane, and lower lip to E-plane were differed significantly, whereas on comparison of Group II males to Group II females, lower nose height, lower lip height, lip thickness at labrale superius, lip thickness at labrale inferius, upper lip to E-plane, and lower lip to E-plane were differed significantly while rest of the values did not differ significantly.

**Table 3: Linear measurements and angular measurements (mean±standard deviation) of males and females of two groups**

	Group	Male (n=40)	Female (n=40)	P
Linear measurements (mm)				
1a. Upper nose height	Group I	37.88±4.09	38.43±3.77	0.922
	Group II	42.15±4.22	40.68±3.45	0.327
	P	<0.001	0.048	-
1b. Lower nose height	Group I	15.08±1.83	13.55±2.89	0.014
	Group II	16.03±2.41	14.45±1.72	0.010
	P	0.238	0.284	-
2. Nose depth	Group I	24.93±5.14	24.35±4.31	0.914
	Group II	25.93±3.71	25.23±1.69	0.855
	P	0.665	0.751	-
3. Sagittal depth	Group I	45.83±3.55	44.85±3.03	0.691
	Group II	47.93±6.01	46.93±2.29	0.673
	P	0.084	0.090	-
4. Upper lip height	Group I	12.38±1.55	11.58±1.55	0.128
	Group II	13.15±1.73	12.23±1.72	0.056
	P	0.149	0.286	-
5. Lower lip height	Group I	15.05±1.69	13.55±2.72	0.005
	Group II	15.73±2.10	14.30±1.20	0.008
	P	0.435	0.339	-
6a. Lip thickness at A point	Group I	13.88±2.05	13.10±1.89	0.372
	Group II	15.08±2.27	14.15±2.36	0.218
	P	0.061	0.128	-
6b. Lip thickness at labrale superius	Group I	12.08±2.47	11.13±1.49	0.126
	Group II	12.70±2.14	11.35±1.46	0.010
	P	0.473	0.955	-
6c. Lip thickness at labrale inferius	Group I	13.33±1.93	12.78±1.80	0.473
	Group II	14.73±1.55	13.30±1.51	0.001
	P	0.001	0.514	-
6d. Lip thickness at B point	Group I	11.38±1.53	10.60±1.48	0.122
	Group II	12.53±1.71	11.88±1.56	0.250
	P	0.006	0.002	-
7. Soft tissue chin thickness	Group I	10.45±1.89	9.63±1.72	0.234
	Group II	11.73±2.16	11.60±2.02	0.992
	P	0.019	<0.001	-
8a. Upper lip to E-plane	Group I	0.20±2.03	-2.00±1.54	<0.001
	Group II	-1.60±2.02	-3.10±1.55	0.001
	P	<0.001	0.032	-
8b. Lower lip to E-plane	Group I	1.43±1.62	-0.19±1.70	0.001
	Group II	0.23±2.22	-1.85±1.92	<0.001
	P	0.022	<0.001	-
Angular measurements (°)				
1. Angle of total facial convexity including nose	Group I	142.23±3.89	141.98±4.31	0.991
	Group II	140.38±3.37	141.38±3.26	0.627
	P	0.118	0.889	-
2. Angle of facial convexity excluding nose	Group I	164.43±4.45	164.65±5.02	0.997
	Group II	165.98±3.81	166.13±5.84	0.999
	P	0.479	0.523	-
3a. Upper nose inclination	Group I	32.00±4.77	31.73±5.45	0.993
	Group II	31.90±4.87	32.98±2.96	0.724
	P	1.000	0.618	-
3b. Lower nose inclination	Group I	35.15±5.56	36.18±7.45	0.873
	Group II	35.98±4.98	37.28±5.88	0.771
	P	0.929	0.848	-
4. Nasolabial angle	Group I	104.25±6.02	103.93±6.78	0.992
	Group II	101.90±4.67	101.05±1.96	0.884
	P	0.179	0.064	-

### Angular measurements

The angular measurements of male and female children of two different age groups are summarized in Table 3.

Among all the angular variables, angle of total facial convexity including nose, angle of facial convexity excluding nose, upper nose inclination, lower nose inclination, and nasolabial angle change on transition from Group I to Group II, but these changes were nonsignificant.

### DISCUSSION

In the present study, we used pterygomaxillary vertical (PMV) plane as the reference plane. Investigators such as Burstone,<sup>[9,10]</sup> Subtelny,<sup>[11]</sup> Sarnas,<sup>[12]</sup> and Vig and Cohen<sup>[13]</sup> had used palatal plane as a reference plane to orient vertical and sagittal measurements of the tissues while the authors such as Brodie,<sup>[14]</sup> Ricketts,<sup>[15]</sup> and Mamandras<sup>[16]</sup> noted that although the palatal plane has been shown to be fairly stable, its angulation may vary and the position of the plane may be altered by orthodontic treatment.

To study the changes in soft tissue profile, we need a stable and reproducible plane and both the pterygomaxillary (ptm) and sphenoethmoidal (se) points were regarded to be relatively stable during growth. Enlow<sup>[17]</sup> noted that PMV plane is approximately perpendicular to the line of vision and is consistent with anatomically neutral position of the head.

While large fluctuations in size of soft tissue measurements were to be anticipated and any change in posture and movement in the facial musculature, can affect the length and thickness of soft tissues particularly at the lips and chin. These findings, however provide consistency even with fairly large variance at each age and orientation of these measurements either with vertical plane parallel to PMV plane or along a plane perpendicular to PMV plane provide stability.

For these reasons, PMV plane was used in the present study because the use of this PMV plane also negates many of the adverse factors of stability and reproducibility associated with other skeletal and soft tissue planes.

### Nose height

The nose height was mainly divided into upper and lower nose height. We found that the nose height increased with age and the increment of upper nose height was found to be greater in males in comparison to females, and as we compared these increments from Group I to Group II, it was found significant for both male and female subgroups.

Lower nose height also increased with age and this increase was found to be more for female subgroup. This would be due to growth of the nasal bone as well as the overlying soft tissue, and as the age advances, the nasal growth changes in both size and form after the age of 13 years and the boys showed larger nasal bone component than females.

These findings were supported by Subtelny,<sup>[11]</sup> Posen,<sup>[2]</sup> Bishara *et al.*,<sup>[18]</sup> and Genecov *et al.*<sup>[19]</sup>

### Nose depth

Mean value of nose depth was nearly similar in males and females of Group I, and with age, it increases in both subgroups of Group II, while this increment was found nonsignificant.

### Sagittal depth

Sagittal depth was found greater in males when compared to females of Group I. With the advancement of age, increase in sagittal depth was noted. This is due to growth of the nasal bone as well as the overlying soft tissue in the vertical as well as in the anteroposterior direction; there was no sexual dimorphism observed for sagittal depth and nose depth. The study was supported by Meng *et al.*,<sup>[4]</sup> Nanda *et al.*,<sup>[3]</sup> and Genecov *et al.*<sup>[19]</sup>

### Lip height

Our study revealed that the upper lip height as well as lower lip height was found to be greater in Group I males, and with the transition from Group I to Group II, both upper and lower lip height increases in both the sexes.

According to Nanda *et al.*,<sup>[3]</sup> lip length and thickness were important elements of facial profile. Lip position is affected by the placement and inclination of the maxillary and mandibular incisors and hence is responsive to orthodontic treatment.

### Thickness of lip

Along with the lip length, the thickness of the lips adds another dimension to study the lip growth. In this study, we measured the upper and lower lip thickness at four different locations because variability in thickness of upper and lower lips can affect degree of facial convexity, and due to this variability of lip thickness at various points along the facial profiles, the upper and lower lip thickness were derived at four different locations.<sup>[3]</sup> Hence, in the present study, lip thickness is measured at four different positions

- a. Upper lip thickness at A-point
- b. Upper lip thickness at labrale superius
- c. Lower lip thickness at labrale inferius
- d. Lower lip thickness at B-point.

On evaluation, mean value for these parameters was higher in males as compared to females and lip thickness increased in both subgroups with age. We also found that this increase was greater at point A and point B than vermilion borders.

These changes can lead to thicker and longer lips for males. These findings were supported by Nanda *et al.*<sup>[3]</sup>

#### Soft tissue chin thickness

The soft tissue chin thickness increased from Group I to Group II, soft tissue chin thickness was higher in male as compared to female. This growth increment was found to be significant in both the males and females subgroups. The possible reason for this finding would be the growth changes that occur in hard tissue chin as well as the increase in the thickness soft tissue covering. This finding was supported by Subtelny,<sup>[1]</sup> Nanda *et al.*,<sup>[3]</sup> and Genecov *et al.*<sup>[19]</sup>

#### Measurements of lips to esthetic plane

The upper and lower lips were posterior to esthetic plane, the distances were expressed with a negative sign and when in an anterior position with a positive sign. In our study, we had measured the distance for both the upper and lower lip to the E-plane. On observing these values, we saw that both the upper and lower lips were placed forward to the esthetic plane, except for Group II male for upper lip, while in females, these were placed behind the esthetic plane in all the groups. When we compared the values between males and females of Group I and Group II, we found that both the upper and lower lip distances for Group II were found to be significant.

However, when we observed males and females of both groups, it was found that in both groups, the position of lips become more retruded with the advancement of age. While on comparison, we found that backward positioning of upper and lower lip was seemed significant for both the subgroups. Our findings were also supported by Nanda *et al.*,<sup>[3]</sup> who stated that the means for upper and lower lips relative to esthetic plane show an increased retrusion of lip and these changes can be accounted by increase in nasal depth and height accompanied by anteroposterior growth of the chin.

#### Angular parameters

##### Angle of total facial convexity including the nose

The mean value was higher in males related to females in Group I, and as the age advances, there is decrease in angle of total facial convexity including nose was observed for both male and female subgroups. This decrease was higher in males with age.

The angle of total facial convexity including the nose decreases with age because the tip of nose grows downward and forward with age and the growth at chin was not much when compared to growth at chin.

##### Angle of facial convexity excluding the nose

The mean values were nearly similar in both the males and females of Group I and Group II, and as the age progresses, value of angle of facial convexity excluding the nose increases, but this increment was found nonsignificant.

##### Nose inclination

The inclination of nose is divided into upper and lower nose inclination. The upper nose inclination was found nearly similar when comparison was made between male and female of Group I and Group II, and when compared between Group I and Group II, the upper nose inclination does not change in male group, but in female group, the increase in this value was noted. While lower nose inclination increased with age, this increase did not seem significant.

The angle of the dorsum of the nose to PMV plane depends on the sagittal growth of nose. These findings were supported by Meng *et al.*,<sup>[4]</sup> who noted that the increments in nose inclination are essentially complete in girls by 16 years of age while continuing to increase in males up to and beyond 18 years.

##### Nasolabial angle

In nasolabial angle, no significant difference was found on comparing the males and females of Group I and Group II, and as the age advances, the decrease in the nasolabial angle is observed when comparing male and female of Group I and Group II. These findings were also supported by Meng *et al.*<sup>[4]</sup> and Nanda *et al.*,<sup>[3]</sup> who in their study found that the females have greater value of nasolabial angle at 7 years of age and there is decrease in the nasolabial angle was observed.

We evaluated and compared soft tissue growth changes at different age groups in males and females, most of the soft tissue growth changes at the nose, lips, and chin suggest sexual dimorphism. Most of the measurements in terms of growth percentage had attained their adult size by the age of 15 years, while boys continue to grow beyond 15 years, the period of study covered only 8–16 years, so most of the soft tissue measurements in males could not be predicted. In addition, data included only subjects with Class I skeletal relationship on the basis of App-Bpp for homogenous subjects; therefore, further research can be done to determine growth changes in soft tissue in different skeletal pattern.

## CONCLUSION

1. Males showed a larger value of all the parameters in relation to females and all the parameters increased in their dimension with growth, except for angle of total facial convexity including the nose and nasolabial angle which decreased in their measurement
2. We also observed that the growth changes from Group I to Group II for both subgroups were found to be greater for males than for females in respect to all parameters
3. The upper and lower lips became significantly more retruded in relation to Ricketts esthetic plane with age
4. It is important for clinicians to be aware of these changes when planning the orthodontic treatment of still-growing adolescent patients because the changes might influence the extraction/nonextraction decision.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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