*Int. J. Morphol.*,
*43(2)*:502-510, 2025.

# Correlations of the Lateral Lip Morphology with Maxillofacial Hard Tissue Features Among Young Chinese Adults with Attractive Lateral Facial Appearances

## Correlaciones de la Morfología Lateral de los Labios con las Características del Tejido Duro Maxilofacial entre Jóvenes Adultos Chinos con Apariencias Faciales Laterales Atractivas

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**DENG, L.; FU, X.; DUAN, C.; LI, Y.; HAN, X. & DUAN, P.** Correlations of the lateral lip morphology with maxillofacial hard tissue features among young Chinese adults with attractive lateral facial appearances. *Int. J. Morphol., 43(2)*:502-510, 2024.

**SUMMARY:** Lips play an important part in facial aesthetic perception. The lateral lip morphology of young Chinese adults with attractive lateral facial appearances has not been well studied, and the relationship between the lateral lip morphology and the maxillofacial hard tissue features is not yet clear. This study aimed to obtain referable data of the lateral lip morphological characteristics among young Chinese adults with attractive lateral facial appearances and discover potential correlations between lateral lip appearances and hard tissue parameters. Final subjects of 48 males and 56 females were included according to the inclusion and exclusion criteria and the results of visual analogue scale (VAS) evaluation. The lateral morphological characteristics of lips and hard tissue features were characterized through the cephalometric radiographs. Sex differences of each soft tissue item were evaluated, and Pearson correlation coefficients were computed for the correlation analysis between lateral lip characteristics and hard tissue parameters. Sex differences were mainly discovered in the nasolabial angle. The lateral lip appearances of females were more closely related with the hard tissue morphology than that of males, and the lower lip-chin profile, the nasolabial angle, the upper lip inclination, UL-EP, and LL-EP showed moderate correlations with several hard tissue parameters respectively. Our results promoted the reference values of lateral lip morphology parameters for young Chinese adults. The correlation analysis provided insights into the soft tissue considerations in treatment planning and into the predictions of the soft tissue change during orthodontic, orthognathic, and prosthodontics procedures.

**KEY WORDS: Lip; Facial bones; Cephalometry; Correlation of data.**

## INTRODUCTION

Lips play an important part in facial aesthetic perception. The profile and sagittal position of lips is vital to the aesthetic evaluation of the facial profile, and enhancing lip profiles ranks among the primary requests from patients seeking orthodontic treatment (Naini *et al.*, 2015).

Nevertheless, there remains a paucity of reference literature regarding normative values for soft tissue morphology of the lips. Additionally, variations in the anatomical features and aesthetic preferences across different ethnic groups limit the applicability of findings derived from various regions (Wu *et al*., 2019). This study delineates the lateral lip morphological characteristics of Chinese young adults possessing aesthetically pleasing lateral facial appearances and examines the correlations between lip characteristics and the factors including incisor inclinations, anteroposterior maxillomandibular relationships, and vertical skeletal patterns, as these factors are crucial considerations in the diagnosis and treatment of orthodontic conditions. The findings aim to provide a reference for establishing the norm for the lateral lip soft tissue morphology in Chinese young adults and offer insights into the influence factors of the lateral lip appearances.

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FUNDING: This study was supported by the Ministry of Science and Technology of the People's Republic of China (2018FY101003), Sichuan Science and Technology Program (2024NSFSC1593), and West China Hospital of Stomatology Interdisciplinary curriculum (WCHSIC-23-17).

Received: 2024-10-26 Accepted: 2025-01-15

## MATERIAL AND METHOD

This cross-sectional research was approved by the ethics and research committee of West China School of Stomatology, Sichuan University (Approval No: WCHSIRB-D-2018-14). The volunteers of this study were recruited according to the following inclusion and exclusion criteria: 1) aged between 18 and 35 years; 2) of Chinese Han population; 3) with individual normal occlusion; 4) without craniofacial anomalies, trauma, or history of facial plastic surgery or orthodontic/prosthodontic treatment; 5) without defect of dentition or anterior teeth defect. The preliminarily involved volunteers were taken the lateral facial photographs of resting lip positions for the visual analogue scale (VAS) assessment (rated on a scale of 0-10 from "least attractive" to "most attractive") (McNamara *et al*., 2008).

The VAS evaluators were composed of 10 laypeople and 10 specialists of either orthodontics, prosthodontics, or endodontics with at least 5 years of clinical experience. Finally, 104 volunteers with top 25 % total scores of the lateral facial appearances were involved as the final participants, who were from 26 out of 34 provincial-level administrative regions all cross China. They then had their lateral cephalometric radiographs taken. All the participants have signed the informed consent forms.

The lateral morphological characteristics of lips, the incisor inclinations, the overjet, the anteroposterior maxillomandibular relationships, and the vertical skeletal patterns were characterized through the cephalometric radiographs (Fig. 1 and Table I). The landmarks in radiographs were manually annotated by the same researcher, and the measurement of lengths and angles was performed using Dolphin Imaging (version 11.95, Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). 15 % of the items were measured again two weeks later, and the test-retest reliability was 0.9572.

Data analysis was conducted utilizing SPSS software (version 25.0; IBM, Armonk, NY). The mean value, standard deviation (SD), minimum value (Min.), and maximum value (Max.) of each item were categorized by *sex* for descriptive statistics. Independent samples t-tests were employed to compare measurements between males and females. Pearson correlation coefficients were computed for the correlation analysis. The significance level was established as a P value<0.05.

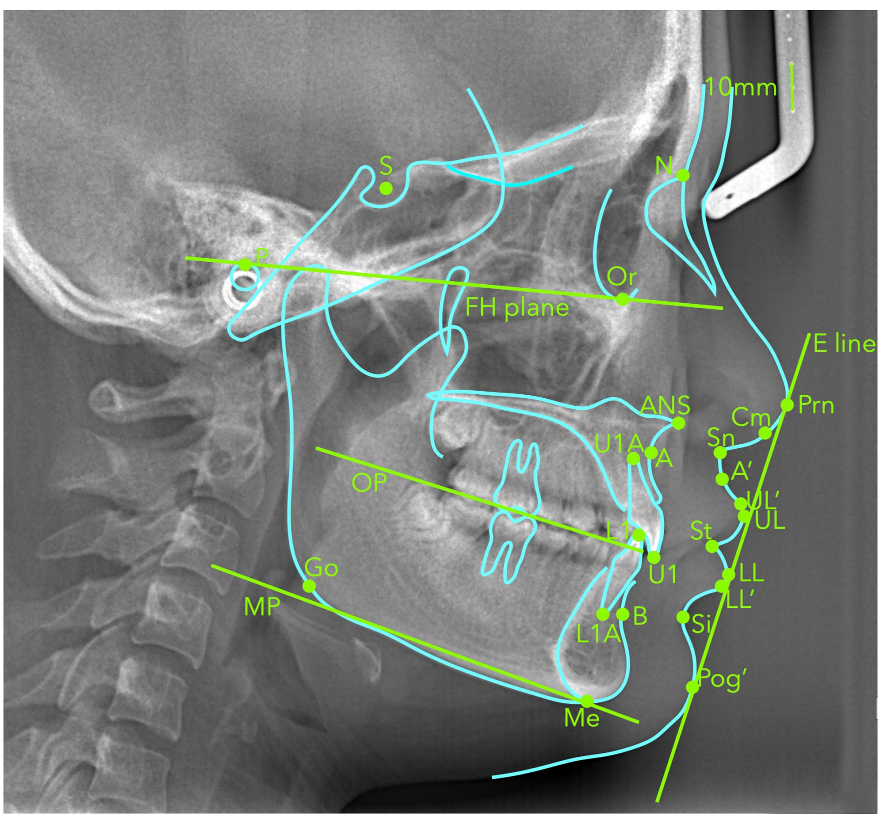


Fig. 1. The landmarks. The landmarks of the lateral cephalometric radiographs: S, sella; N, nasion; P, porion; Or, orbitale; A, subspinale; ANS, anterior nasal spine; B, supramental; Me, menton; Go, gonion; U1, upper incisor; U1A, upper incisor apex; L1, lower incisor; L1A, lower incisor apex; Prn, pronasale, the most prominent point of the nasal tip; Cm, columella, the most anterior point of the columella nasi; Sn, subnasale; the intersection point of the columella crest and the upper lip; A′, upper lip concave point; UL′, upper vermilion margin, UL, the most anterior point of the upper lip; St, stomion, the midpoint of the labial fissure; LL, the most anterior point of the lower lip; LL′, lower vermilion margin; Si, the most concave point of the mentolabial sulcus; Pog′, the most anterior point of the chin. Planes involved: FH plane, Frankfort horizontal plane, formed by the connecting line between P and Or; OP, occlusive plane, formed by the line that equally divides the occlusal contact points of the posterior teeth; MP, mandibular plane, the line passing Me and tangent to the lower margin of the mandibular angle; E line, the line joining Prn and Pog′.

Table I The definitions of the items involved.

| Items | Definition |
|---|---|
| **The lateral morphological characteristics of lips** | |
| Nasolabial angle (Cm-Sn-UL') (°) | The angle of Cm-Sn-UL' |
| Inferior angle of the nasolabial angle (SnUL'-FH) (°) | The anteroinferior angle formed by Sn-UL' line and FH plane |
| Upper lip inclination (A'UL'-FH) (°) | The anteroinferior angle formed by A'-UL' line and FH plane |
| Lateral upper lip curvature (Sn-A'-UL') (°) | The angle of Sn-A'-UL' |
| Lower lip inclination (SiLL'-FH) (°) | The anterosuperior angle formed by Si-LL' line and FH plane |
| Mentolabial angle (LL'-Si-Pog') (°) | The angle of LL'-Si-Pog' |
| Inferior angle of the mentolabial angle (SiPog'-FH) (°) | The anteroinferior angle formed by Si-Pog' line and FH plane |
| The sum of upper and lower lip inclination (°) | The sum of the upper lip inclination (A'UL'-FH) and the lower lip inclination (SiLL'-FH) |
| UL-St-LL (°) | The angle of UL-St-LL |
| UL-EP (mm) | The perpendicular distance from UL to E line. If UL is superior to E line, the value is designated as positive, and vice versa. |
| LL-EP (mm) | The perpendicular distance from LL to E line. If LL is superior to E line, the value is designated as positive, and vice versa. |
| UL-EP minus LL-EP (mm) | The value of UL-EP (mm) minus LL-EP (mm) |
| **Cephalometric hard tissue parameters involved** | |
| U1-SN (°) | The posteroinferior angle formed by U1-U1A line and S-N line |
| U1-NA (mm) | The distance from U1 to N-A line |
| FMIA (L1-FH) (°) | The anterosuperior angle formed by L1-L1A line and FH plane |
| IMPA (L1-MP) (°) | The posterosuperior angle formed by L1-L1A line and MP plane |
| L1-NB (mm) | The distance from L1 to N-B line |
| U1-L1 (°) | The posterior crossing angle formed by U1-U1A line and L1-L1A line |
| Overjet (mm) | The projected distance of U1 and L1 on the occlusal plane |
| ANB (°) | The angle of A-N-B |
| Wits (mm) | The projected distance of A and B on the occlusal plane |
| FMA (FH-MP) (°) | The angle formed by the mandibular plane and FH plane |
| MP-SN (°) | The angle formed by the mandibular plane and S-N line |
| ANS-Me/N-Me (%) | The ratio of the distance between ANS and Me to the distance between N and Me |
| S-Go/N-Me (%) | The ratio of the distance between S and Go to the distance between N and Me |

## RESULTS

Table II shows the lateral morphological characteristics of lips. The angles formed along the lip profile from Sn to Pog' were all measured. Except for the nasolabial angle, no significant *sex* differences were found in the lateral lip morphological characteristics.

Table III displays the Pearson correlation coefficients and P values of the Pearson correlation analysis of the lateral lip morphological characteristics with the hard tissue parameters.

## DISCUSSION

Firstly, the nasolabial angle has been proved to be a significant factor influencing the lateral facial aesthetics in numerous studies (Armijo *et al*., 2012; Xu *et al*., 2015). The mean Nasolabial angle in our study was 91.56°±10.73° for males and 98.14°±9.81° for females, quite close to the previous values investigated among Chinese young attractive or normal adults (Lew *et al*., 1992; Cheung *et al*., 2011), which varied from 95° to proximately 100°. Inferior angle of the nasolabial angle reflected the inclination of upper cutaneous lip, and was thought to be ideal from 79° to 85° and unattractive outside the range of 67°-94°, according to Naini *et al*. (2015), study of the Caucasian male profile. However, few studies involved the evaluation of the inferior angle of the nasolabial angle among Chinese groups. Our investigations showed that the upper lips with appropriate inclinations (nearly 70° for SnUL'-FH and 59° for A'UL'-FH) and appropriate lateral lip curvature (around 159° for Sn-A'-UL') were inclined to be attractive.

According to our results, in females, Nasolabial angle, Inferior angle of the nasolabial angle and Upper lip inclination all correlated with the upper incisor inclinations (characterized by U1-SN and U1-NA) and ANB, with the most obvious correlation found in the comparison of Nasolabial angle (r=-0.4824) and SnUL'-FH (r=-0.4585) with

Table II. The lateral morphological characteristics of lips.

| | Male (*n*=48) | | | | Female (*n*=56) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Min. | Max. | Mean | SD | Min. | Max. | *P*-value |
| Nasolabial angle (Cm-Sn-UL') (°) | 91.56 | 10.73 | 68.78 | 111.38 | 98.14 | 9.81 | 79.87 | 121.08 | *0.0015*** |
| Inferior angle of the nasolabial angle (SnUL'-FH) (°) | 70.10 | 8.74 | 54.62 | 86.31 | 71.64 | 7.09 | 56.17 | 82.98 | *0.3244* |
| Upper lip inclination (A'UL'-FH) (°) | 58.46 | 9.88 | 38.02 | 80.39 | 59.74 | 7.82 | 41.70 | 74.89 | *0.4642* |
| Lateral upper lip curvature (Sn-A'-UL') (°) | 159.29 | 8.41 | 141.64 | 175.59 | 159.06 | 9.15 | 134.86 | 175.76 | *0.8948* |
| Lower lip inclination (SiLL'-FH) (°) | 42.88 | 12.01 | 20.35 | 75.21 | 43.44 | 10.33 | 18.20 | 61.82 | *0.7979* |
| Mentolabial angle (LL'-Si-Pog') (°) | 129.50 | 13.55 | 99.27 | 155.83 | 131.81 | 12.48 | 105.16 | 156.41 | *0.3679* |
| Inferior angle of the mentolabial angle (SiPog'FH) (°) | 86.65 | 7.09 | 71.16 | 101.98 | 88.29 | 8.56 | 71.30 | 110.95 | *0.2935* |
| The sum of upper and lower lip inclination (°) | 101.34 | 17.15 | 64.53 | 135.80 | 103.18 | 12.78 | 71.79 | 128.47 | *0.5333* |
| UL-St-LL (°) | 109.93 | 10.51 | 86.79 | 133.75 | 112.53 | 9.52 | 95.20 | 138.11 | *0.1876* |
| UL-EP (mm) | -1.43 | 1.87 | -5.60 | 2.65 | -0.88 | 1.96 | -4.59 | 4.28 | *0.1502* |
| LL-EP (mm) | -0.21 | 2.32 | -5.30 | 4.81 | 0.30 | 2.07 | -3.56 | 5.03 | *0.2375* |
| UL-EP minus LL-EP (mm) | -1.22 | 1.70 | -4.68 | 2.28 | -1.18 | 1.14 | -3.71 | 1.10 | *0.8996* |

Note: *, P<0.05; **, P<0.01; ***, P<0.001; ****, P<0.0001.

U1-SN. However, in males, no significant correlation existed between these parameters and the upper incisor inclinations. As a contrast, SnUL'-FH and A'UL'-FH displayed weak associations with the inclination of lower incisors.

To investigate the potential causes of the differences in the correlative factors of lateral upper lip appearances between males and females, we reviewed existing literature and hypothesized that the *sex* differences of the upper lip thickness may be the contributing factors. Guan *et al*. (2019), had pointed out that the upper lip thickness of Chinese adult males was significantly greater than that of adult female, and there were negative correlations between the thickness of upper lip and the ratio of the variation in the maxillary incisor protrusion to the variation in the upper lip protrusion following orthodontic treatment. Similarly, Paranhos *et al*. (2013), noted that males presented increased soft tissue thickness and weaker correlations between the incisor movement and the soft tissue retraction during orthodontic treatment compared to females. These results indicated that the upper lip protrusion degree of males who characterized by thicker upper lips exhibited greater resistance to variations in incisor positioning, which partially accounted for the lack of significant correlation of Nasolabial angle, Upper lip inclination, and A'UL'-FH with upper incisor inclinations for males in our study. These results underscored the complexity of the prediction of soft tissue changes after orthodontic treatment (Konstantonis *et al*., 2018), and suggested that in future studies, *sex* influences need to be taken into account when discussing the soft tissue changes relative to hard tissue changes.

The lower lip-chin curve constitutes a significant aesthetic component of the lower third face. The mentolabial angle should be appropriate, not too deep or flat to attain good aesthetics. Naini *et al*. (2017), pointed out that for Caucasian males, a mentolabial angle of 107°-118° was most attractive, and a mentolabial angle below to 98° or higher than 162° was deemed the least attractive. In our study, the values of Mentolabial angle was 129.50°±13.55° for males and 131.81 °±12.48° for females, which were approximate to Wamalwa *et al*. (2011)´s results derived from Chinese young adults.

For females' Mentolabial angle, Overjet (r= -0.5731) was the most significant correlative factor, and Wits (r=-0.3856), FMA (r=0.3145), and ANS-Me/N-Me (r=0.3152) exhibited weaker correlations. For males' Mentolabial angle, the most significant correlative factor was ANS-Me/N-Me (r=0.5223), followed by Wits (r=-0.4375) and Overjet (r=-0.3134), with ANB (r=-0.2854) exhibiting a weaker correlation. It can be inferred that a low-angle patient with class II division 1 malocclusion is prone to show a very low mentolabial angle, while a high-angle patient with class III skeletal relationship tends to have excessively mentolabial angle. The study conducted by Mobarak *et al*. (2001), has confirmed our speculation and discovered that within the Class II group, the low-angle patients displayed more pronounced mentolabial fold and attained larger increase of the mentolabial angle after the mandibular advancement surgery than the high-angle or moderate-angle Class II patients. Möhlhenrich *et al*. (2021), compared the soft tissue changes of different treatment methods (extraction or

Table III. The results of Pearson correlation analysis of the lateral lip morphological characteristics with the hard tissue parameters.

| | | | Nasolabial angle (°) | SnUL'-FH (°) | A'UL'-FH (°) | Sn-A'-UL' (°) | SiLL'-FH (°) | Mentolabial angle (°) | SiPog'-FH (°) | The sum of upper and lower lip inclination (°) | UL-St-LL (°) | UL-EP (mm) | LL-EP (mm) | UL-EP minus LL-EP (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1-SN (°) | Male | r | -0.3205 | -0.2656 | -0.1328 | 0.1881 | 0.1691 | 0.2767 | 0.2382 | 0.0419 | -0.0622 | -0.1854 | 0.2310 | -0.5182 |
| | | P | 0.0263* | 0.0681 | 0.3680 | 0.2005 | 0.2505 | 0.0570 | 0.1030 | 0.7775 | 0.6744 | 0.2070 | 0.1143 | 0.0002*** |
| | Female | r | -0.4824 | -0.4585 | -0.3232 | 0.1792 | 0.3304 | 0.2224 | -0.0780 | 0.0694 | 0.1952 | -0.0659 | 0.1104 | -0.3153 |
| | | P | 0.0002*** | 0.0004*** | 0.0151* | 0.1863 | 0.0129* | 0.0994 | 0.5676 | 0.6112 | 0.1495 | 0.6292 | 0.4180 | 0.0179* |
| U1-NA (mm) | Male | r | -0.2606 | -0.0042 | 0.1112 | 0.2283 | 0.0030 | 0.2027 | 0.3766 | 0.0662 | -0.1536 | -0.2244 | 0.2616 | -0.6028 |
| | | P | 0.0736 | 0.9771 | 0.4517 | 0.1185 | 0.9836 | 0.1670 | 0.0083** | 0.6548 | 0.2971 | 0.1251 | 0.0724 | <0.0001**** |
| | Female | r | -0.4025 | -0.3831 | -0.3147 | 0.0952 | 0.3147 | 0.1285 | -0.1897 | 0.0619 | 0.0649 | -0.1894 | 0.0084 | -0.3424 |
| | | P | 0.0021** | 0.0036** | 0.0182* | 0.4853 | 0.0182* | 0.3452 | 0.1614 | 0.6504 | 0.6346 | 0.1621 | 0.9508 | 0.0098** |
| FMIA (L1-FH) (°) | Male | r | -0.2777 | -0.4481 | -0.3755 | -0.0376 | 0.3894 | 0.0467 | -0.5695 | 0.0563 | -0.0779 | -0.2448 | -0.4365 | 0.3256 |
| | | P | 0.0560 | 0.0014** | 0.0085** | 0.7997 | 0.0062** | 0.7524 | <0.0001**** | 0.7038 | 0.5989 | 0.0936 | 0.0019** | 0.0239* |
| | Female | r | -0.0390 | -0.2018 | -0.1281 | 0.1123 | 0.5100 | -0.0136 | -0.6315 | 0.3340 | -0.1409 | -0.5126 | -0.5529 | 0.1242 |
| | | P | 0.7755 | 0.1357 | 0.3469 | 0.4100 | <0.0001**** | 0.9210 | <0.0001**** | 0.0119* | 0.3002 | <0.0001**** | <0.0001**** | 0.3617 |
| IMPA (L1-MP) (°) | Male | r | 0.2709 | 0.3671 | 0.2963 | -0.0015 | -0.3057 | -0.1369 | 0.2565 | -0.0434 | 0.1351 | 0.1933 | 0.2812 | -0.1707 |
| | | P | 0.0626 | 0.0103* | 0.0409* | 0.9920 | 0.0346* | 0.3533 | 0.0784 | 0.7697 | 0.3600 | 0.1881 | 0.0529 | 0.2460 |
| | Female | r | 0.0119 | 0.0691 | 0.0284 | -0.0948 | -0.5389 | -0.2079 | 0.3409 | -0.4184 | 0.2183 | 0.4644 | 0.4081 | 0.0569 |
| | | P | 0.9306 | 0.6127 | 0.8355 | 0.4872 | <0.0001**** | 0.1241 | 0.0102* | 0.0013** | 0.1061 | 0.0003*** | 0.0018** | 0.6772 |
| L1-NB (mm) | Male | r | 0.2267 | 0.3028 | 0.2370 | 0.0316 | -0.2233 | 0.1067 | 0.5812 | -0.0198 | 0.1143 | 0.2750 | 0.5283 | -0.4174 |
| | | P | 0.1213 | 0.0364* | 0.1048 | 0.8312 | 0.1272 | 0.4703 | <0.0001**** | 0.8940 | 0.4390 | 0.0585 | 0.0001*** | 0.0032** |
| | Female | r | -0.0870 | 0.0578 | 0.0740 | 0.0093 | -0.3750 | 0.1322 | 0.6384 | -0.2580 | 0.2062 | 0.5151 | 0.5994 | -0.2049 |
| | | P | 0.5236 | 0.6724 | 0.5880 | 0.9457 | 0.0044** | 0.3315 | <0.0001**** | 0.0549 | 0.1274 | <0.0001**** | <0.0001**** | 0.1299 |
| U1-L1 (°) | Male | r | -0.0284 | -0.2317 | -0.2358 | -0.1288 | 0.2061 | -0.1497 | -0.6307 | 0.0084 | -0.0247 | -0.1051 | -0.5334 | 0.6110 |
| | | P | 0.8482 | 0.1131 | 0.1066 | 0.3831 | 0.1599 | 0.3100 | <0.0001**** | 0.9547 | 0.8677 | 0.4770 | <0.0001**** | <0.0001**** |
| | Female | r | 0.3175 | 0.2033 | 0.1575 | -0.0528 | 0.1080 | -0.1554 | -0.3543 | 0.1837 | -0.2059 | -0.2766 | -0.4621 | 0.3658 |
| | | P | 0.0171* | 0.1329 | 0.2464 | 0.6992 | 0.4283 | 0.2527 | 0.0074** | 0.1753 | 0.1278 | 0.039* | 0.0003*** | 0.0056** |
| Overjet (mm) | Male | r | -0.2865 | -0.2347 | -0.0772 | 0.2500 | -0.2768 | -0.3134 | -0.1319 | -0.2383 | 0.1372 | 0.1838 | -0.0187 | 0.2273 |
| | | P | 0.0483* | 0.1084 | 0.6018 | 0.0866 | 0.0568 | 0.0301* | 0.3715 | 0.1029 | 0.3525 | 0.2112 | 0.8995 | 0.1202 |
| | Female | r | 0.0273 | -0.0809 | -0.0241 | 0.0198 | -0.5250 | -0.5731 | -0.2045 | -0.4393 | 0.2853 | 0.2287 | 0.0527 | 0.2986 |
| | | P | 0.8416 | 0.5536 | 0.8600 | 0.8847 | <0.0001**** | <0.0001**** | 0.1306 | 0.0007*** | 0.0330* | 0.0900 | 0.6997 | 0.0254* |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANB (°) | Male | r | 0.2864 | 0.2224 | 0.0636 | -0.2217 | -0.3647 | -0.2854 | 0.0720 | -0.2187 | 0.2851 | 0.4135 | 0.1349 | 0.2704 |
| | | P | 0.0484* | 0.1287 | 0.6678 | 0.1300 | 0.0108* | 0.0493* | 0.6266 | 0.1353 | 0.0495* | 0.0035** | 0.3606 | 0.0630 |
| | Female | r | 0.3286 | 0.3598 | 0.2686 | -0.1378 | -0.5795 | -0.1459 | 0.4838 | -0.3043 | 0.0873 | 0.4769 | 0.3301 | 0.2207 |
| | | P | 0.0134* | 0.0065** | 0.0453* | 0.3113 | <0.0001**** | 0.2832 | 0.0002*** | 0.0226* | 0.5222 | 0.0002*** | 0.0130* | 0.1022 |
| Wits (mm) | Male | r | 0.1448 | 0.1585 | 0.0085 | -0.2785 | -0.3617 | -0.4375 | -0.2296 | -0.2483 | 0.2568 | 0.1282 | -0.1522 | 0.3480 |
| | | P | 0.3262 | 0.2821 | 0.9543 | 0.0553 | 0.0115* | 0.0019** | 0.1165 | 0.0888 | 0.0781 | 0.3853 | 0.3017 | 0.0154* |
| | Female | r | 0.2513 | 0.2642 | 0.1706 | -0.1502 | -0.6442 | -0.3856 | 0.2132 | -0.4165 | 0.1512 | 0.3774 | 0.2116 | 0.2651 |
| | | P | 0.0617 | 0.0491* | 0.2087 | 0.2693 | <0.0001**** | 0.0033** | 0.1147 | 0.0014** | 0.2661 | 0.0041** | 0.1174 | 0.0483* |
| FMA (FH-MP) (°) | Male | r | 0.0665 | 0.2041 | 0.1868 | 0.0619 | -0.1959 | 0.1149 | 0.5497 | -0.0296 | -0.0628 | 0.1218 | 0.3048 | -0.2813 |
| | | P | 0.6535 | 0.1642 | 0.2037 | 0.6762 | 0.1820 | 0.4366 | <0.0001**** | 0.8419 | 0.6716 | 0.4095 | 0.0352* | 0.0528 |
| | Female | r | 0.0453 | 0.2235 | 0.1638 | -0.0448 | -0.0511 | 0.3145 | 0.5233 | 0.0589 | -0.0837 | 0.1602 | 0.3036 | -0.2776 |
| | | P | 0.7402 | 0.0977 | 0.2278 | 0.7430 | 0.7082 | 0.0182* | <0.0001**** | 0.6665 | 0.5396 | 0.2382 | 0.0229* | 0.0383* |
| MP-SN (°) | Male | r | 0.0994 | 0.2882 | 0.2192 | 0.0028 | -0.1959 | 0.1185 | 0.5547 | -0.0109 | -0.0610 | 0.1801 | 0.3374 | -0.2616 |
| | | P | 0.5013 | 0.047* | 0.1344 | 0.9851 | 0.1820 | 0.4225 | <0.0001**** | 0.9415 | 0.6804 | 0.2206 | 0.019* | 0.0724 |
| | Female | r | 0.2011 | 0.3047 | 0.2143 | -0.0809 | -0.0631 | 0.1926 | 0.3665 | 0.0801 | -0.2271 | 0.0321 | 0.1613 | -0.2390 |
| | | P | 0.1373 | 0.0224* | 0.1127 | 0.5536 | 0.6439 | 0.1550 | 0.0055** | 0.5573 | 0.0924 | 0.8142 | 0.2349 | 0.0761 |
| ANS-Me/N-Me (%) | Male | r | 0.0397 | -0.0909 | -0.0174 | 0.1820 | 0.3970 | 0.5223 | 0.3279 | 0.2679 | -0.2034 | 0.0504 | 0.2344 | -0.2639 |
| | | P | 0.7890 | 0.5390 | 0.9068 | 0.2158 | 0.0052** | 0.0001*** | 0.0229* | 0.0656 | 0.1655 | 0.7339 | 0.1088 | 0.0699 |
| | Female | r | -0.1828 | -0.2027 | -0.0995 | 0.1204 | 0.1862 | 0.3312 | 0.2580 | 0.0897 | 0.0770 | 0.1725 | 0.3108 | -0.2694 |
| | | P | 0.1775 | 0.1341 | 0.4659 | 0.3766 | 0.1693 | 0.0127* | 0.0549 | 0.5107 | 0.5725 | 0.2035 | 0.0197* | 0.0447* |
| S-Go/N-Me (%) | Male | r | -0.0803 | -0.1915 | -0.1431 | 0.0050 | 0.2010 | -0.0996 | -0.5273 | 0.0583 | -0.0297 | -0.2193 | -0.3451 | 0.2292 |
| | | P | 0.5873 | 0.1922 | 0.3319 | 0.9734 | 0.1706 | 0.5007 | 0.0001*** | 0.6938 | 0.8413 | 0.1343 | 0.0163* | 0.1171 |
| | Female | r | -0.1826 | -0.3181 | -0.2304 | 0.0666 | 0.0812 | -0.1433 | -0.3166 | -0.0753 | 0.2690 | 0.0429 | -0.0732 | 0.2077 |
| | | P | 0.1779 | 0.0169* | 0.0875 | 0.6258 | 0.5517 | 0.2922 | 0.0174* | 0.5810 | 0.045* | 0.7534 | 0.5917 | 0.1245 |

Note: * , P<0.05; **, P<0.01; ***, P<0.001; ****, P<0.0001.

surgery) in moderate skeletal Class II cases and exhibited that the mandible advancement group obtained more mentolabial angle increase than the maxillary extraction group, providing soft tissue considerations for Class II treatment planning. They also pointed out that in the moderate skeletal Class III cases, the decrease of the mentolabial angle was less significant in the mandibular extraction group than the single-maxillary advancement group, suggesting that maintaining the normal inclinations of lower incisors for class III patients may be more beneficial to the mentolabial sulcus formation. However, the mandibular setback surgery only resulted in limited reduction of the mentolabial angle due to thickening of soft tissue (Kim *et al*., 2010; Möhlhenrich *et al*., 2021).

Furthermore, the magnitude of Lower lip inclination and Inferior angle of the mentolabial angle, both of which constitute the mentolabial angle, are also critical factors of the lateral lip morphology. It was often observed in clinic that patients with an excessive overjet were accompanied by the exposure of the upper incisors at rest and the interposition and eversion of the lower lip (Bittencourt *et al*., 2012), and an overjet exceeding 7mm tends to result in a " trapped" lower lip (Otuyemi, 1993). Lew (1991) also pointed out that in Class II division 1 malocclusion subjects, the patients with the presence of the complete lip trap had more retroclined lower incisors and the larger overjet than the partial lip trap group. These previous studies were in line with our results that in females, led by Wits (r=-0.6442) and ANB (r=-0.5795), IMPA (r=-0.5389), Overjet (r=-0.5250) and FMIA (r=0.5100) also exhibited a moderate correlation with Lower lip inclination. For males, the lower incisor inclinations, ANB, Wits and ANS-Me/N-Me all weakly correlated with Lower lip inclination. This suggested that for the orthodontic camouflage treatment of Class II division 1 patients, reducing the overjet is the key to the recovery of a normal lower lip inclination.

Inferior angle of the mentolabial angle describes the convexity of the chin. An excessive small or large one would hinder the aesthetic assessment of facial profile (Naini *et al*., 2019). The average Inferior angle of the mentolabial angle of Chinese young adults with attractive lateral facial appearances was almost perpendicular to the FH plane with a slight anteroinferior slope (86.65°±7.09° for males and 88.29°±8.56° for females). Inferior angle of the mentolabial angle strongly correlated with Po-NB (mm) in males (data not in tables, r=-0.7292 for males and -0.5697 for females) but seemed to show the closest relevance with L1-NB (r= 0.6384) and FMIA (r=-0.6315) in females. Inferior angle of the mentolabial angle also displayed significant correlations with FMA (r=0.5233), ANB (r=0.4838), MP-SN (r=0.3665), U1-L1 (r=-0.3543) and S-Go/N-Me (r=-0.3166) in females. The vertical skeletal pattern (MP-SN (r=0.5547), FMA (r= 0.5497) and ANS-Me/N-Me (r=0.3279)) had stronger correlations with Inferior angle of the mentolabial angle in males than in females, and U1-L1 (r=-0.6307), FMIA (r=-0.5695) and L1-NB (r=0.5812) also showed moderate correlations with males' Inferior angle of the mentolabial angle.

These many correlative factors indicated that in addition to the convexity of the bony chin, the mentalis muscle tension may also have an obvious influence on Inferior angle of the mentolabial angle. It can be inferred that a high-angle patient with protrusive incisors would show a large inferior angle of the mentolabial angle due to the elevated tension of the mentalis muscle induced by the difficulty in lip closure. Enhancing the chin profile is a common concern among many orthodontic patients. de Souza *et al*. (2008), mentioned that the Class II division 1 patients were often accompanied by elongated lower facial third, incomplete lip seal and mentalis muscle hyperfunction, and they found that even after the removal of lip trap and the attainment of lip seal during swallowing was realized following tooth extraction, a quite part of the Class II division 1 patients did not correct the habitual open-lip posture at rest, suggesting that these patients might need additional upper lip muscle training or upper lip lengthening to relieve the mentalis muscle tension. Nicolet *et al*. (2012), discovered that in severe skeletal Class III patients, the mentalis muscle electromyography (EMG) activity in "contact" and "apart" lip position was significantly greater than that of "lip competent" individuals. Besides, the difference of EMG mentalis muscle activity between the contact lip position and the apart lip position was eliminated after the orthognathic surgery of sagittal split osteotomy, LeFort I and genioplasty, implying the normalization of the mentalis muscle function of severe skeletal Class III patients after orthognathic surgery. Besides, the chin augmentation and injection of OnabotulinumtoxinA have been proved to be beneficial to the patients with hyperactive mentalis muscle or a retruded chin (Oranges *et al*., 2023).

As for the position of the upper and lower lips relative to the E line, the average position in this study was slightly behind or on the E line (UL-EP: -1.43mm±0.87mm for males and -0.88mm±1.96mm for females; LL-EP: -0.21mm±2.32mm for males and 0.30mm±2.07mm for females), which was approximate to the normative value for Chinese young normal adults (Wu *et al*., 2021). For females' UL-EP, the most significant correlative factors were the lower incisor inclinations (r=-0.5126 for FMIA, 0.4644 for IMPA, and 0.5151 for L1-NB), followed by ANB (r=0.4769) and Wits (r=0.3774); for females' LL-EP, in addition to the inclinations of the lower incisor (r=-0.5529 for FMIA, 0.4081 for IMPA, and 0.5994 for L1-NB), U1-L1 (r=-0.4621) was also a moderate correlative factor, along with ANB, FMA and ANS-Me/N-Me showing weaker correlations. However, except for ANB (r=0.4769), no more correlation was found between any hard tissue parameters and males' UL-EP, and males' LL-EP was moderately correlated with U1-L1 (r=-0.5334), L1-NB (r=0.5283), and FMIA (r=-0.4365), along with FMA, MP-SN and S-Go/N-Me exhibiting a weak correlation. In summary, the lower incisor inclination had a significant effect on the lip positions other than the upper incisor inclination, and the lower lip position was more strongly influenced by the lower incisor inclinations than the upper lip position, with LL-EP also affected by the vertical growth patterns. This finding resonated with the discoveries of Shamlan & Aldrees (2015). In addition, Guo *et al*. (2014), investigated among the Class II division 1 patients with favorable facial and occlusal outcomes after orthodontic treatment and summarized that those who had four first premolar extracted exhibited more reclined lower incisors, more protrusive lower lips, and higher prevalence of the vertical growth patterns before treatment than those who only had only maxillary first premolars removed, suggesting that for enhancing the soft tissue profile of Class II division 1 patients with greater lip protrusion, it is essential to achieve the upright positioning of lower incisors through removing mandibular first premolars.

## CONCLUSION

1. This study surveyed among the Chinese young adults with attractive lateral facial appearances and evaluated their lateral lip morphological characteristics and maxillofacial hard tissue features. *Sex* difference of the lateral lip morphology was mainly discovered in the nasolabial angle.

2. In Chinese young adults with attractive lateral facial appearances, the lateral lip appearances of females were more closely related with the hard tissue morphology than that of males. In females, the lower incisor inclinations, sagittal skeletal relationship, and overjet were significantly correlated with the lower lip-chin profile. The nasolabial angle and upper lip inclination were moderately correlated with the upper incisor inclinations. For males, only the inferior angle of the mentolabial angle showed moderate correlations with the hard tissue parameters of lower incisor inclinations, vertical skeletal patterns, and U1-L1.

3. For the upper and lower lip position relative to E line, UL-EP and LL-EP were moderately correlated with the lower incisor inclinations in both males and females in our study.

**DENG, L.; FU, X.; DUAN, C.; LI, Y.; HAN, X. y DUAN, P.** Correlaciones de la morfología lateral de los labios con las características del tejido duro maxilofacial entre adultos chinos jóvenes con apariencias faciales laterales atractivas. *Int. J. Morphol., 43(2)*:502-510, 2024.

**RESUMEN:** Los labios juegan un papel importante en la percepción estética facial. La morfología lateral de los labios de los jóvenes adultos chinos con apariencias faciales laterales atractivas no ha sido bien estudiada, y la relación entre la morfología del labio y las características del tejido duro maxilofacial aún no está clara. Este estudio tuvo como objetivo obtener datos referenciables de las características morfológicas lateral de los labios entre jóvenes adultos chinos con apariencias faciales laterales atractivas y descubrir correlaciones potenciales entre las apariencias lateral de los labios y los parámetros del tejido duro. Fueron incluidos 48 hombres y 56 mujeres de acuerdo con los criterios de inclusión y exclusión y los resultados de la evaluación de la escala analógica visual (EAV). Las características morfológicas laterales de los labios y las características de los tejidos duros se caracterizaron a través de radiografías cefalométricas. Se evaluaron las diferencias de sexo de cada elemento de tejido blando y se calcularon los coeficientes de correlación de Pearson para el análisis de correlación entre las características laterales de los labios y los parámetros de los tejidos duros. Las diferencias del sexo se descubrieron principalmente en el ángulo nasolabial. Las apariencias laterales de los labios de las mujeres estaban más estrechamente relacionadas con la morfología del tejido duro que las de los hombres, y el perfil del labio inferior y el mentón, el ángulo nasolabial, la inclinación del labio superior, UL-EP y LL-EP mostraron correlaciones moderadas con varios parámetros de los tejidos duros respectivamente. Nuestros resultados promovieron los valores de referencia de los parámetros de la morfología lateral de los labios para jóvenes adultos chinos. El análisis de correlación proporcionó información sobre las consideraciones de los tejidos blandos en la planificación del tratamiento y sobre las predicciones del cambio de los tejidos blandos durante los procedimientos de ortodoncia, ortognática y protésica.

**PALABRAS CLAVE: Labio; Huesos faciales; Cefalometría; Correlación de datos.**

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