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Research Article

Morphometric Evaluation of Lips in Iraqi Subjects with its Possible Esthetic Benefits

Sinan Subhi Farhan*[1], Ahmed Al-Imam[2,3], Ali Mohammed Hatem Al-Sabti[4], Yosor Harith Ali Al-Shahrabi[4], Mustafa Eyad Murayati[4]

[1]*Department of Anesthesia, Al-Rafidain University College, Baghdad, Iraq;* [2]*Alumni Ambassador, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, London E1 2AD, United Kingdom;* [3]*Department of Anatomy, College of Medicine, University of Baghdad, Baghdad, Iraq;* [4]*College of Medicine, University of Baghdad, Baghdad, Iraq*

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Abstract

Background: Various facial landmarks are considered valuable tools for surgeons to evaluate and achieve optimal esthetic repair and facial reconstruction. ***Objectives***: to assess the normal range of different lip parameters with gender differences and its role in esthetic procedures for Iraqi people. ***Methods***: Direct lip measurements were performed with a closed lip position using a digital vernier caliper in 132 young Iraqi subjects (89 female and 43 male). ***Results***: Lip measurements showed sexual dimorphism with higher values in men than women in six parameters. Cutaneous height of the upper lip was higher in both sexes. The mustache area in males was longer in males compared to females. Also, it was noticed that upper lip vertical thickness had a higher value, especially in subjects with cosmetic procedures. In addition to that, vertical upper lip thickness showed a higher rise in values of mid-line upper lip parameters than those of lower lips. ***Conclusions***: Lip parameters had established a base level for Iraqi subjects that had a variation from other populations with gender variance and the possible role of these parameters to be kept in mind during different surgical procedures (plastic surgeons, orthodontists, and forensic odontologists).

Keywords: Esthetic, Lip surgery, Lower lip, Morphometry, Upper lip.

التقييم المورفومتري للشفاه لدى الأشخاص العراقيين وفوائدها الجمالية المحتملة

الخلاصة

الخلفية: تعتبر معالم الوجه المختلفة أدوات قيمة للجراحين لتقييم وتحقيق الإصلاح الجمالي الأمثل وإعادة بناء الوجه. **الأهداف**: تقييم النطاق الطبيعي لمعايير الشفاه المختلفة مع الفروق بين الجنسين ودورها في الإجراءات التجميلية للشعب العراقي. **أساليب**: تم إجراء قياسات الشفاه المباشرة بوضع شفة مغلقة باستخدام الفرجار الورني الرقمي في 132 شابا عراقيا (89 أنثى و 43 ذكرا). **النتائج**: أظهرت قياسات الشفاه إزدواج الشكل الجنسي بقيم أعلى عند الرجال مقارنة بالنساء في ستة معلمات. كان الارتفاع الجلدي للشفة العليا أعلى في كلا الجنسين. كانت منطقة الشارب عند الذكور أطول عند الذكور مقارنة بالإناث. أيضا ، لوحظ أن السماكة الرأسية للشفة العليا لها قيمة أعلى ، خاصة في الأشخاص الذين خضعوا لإجراءات تجميلية. بالإضافة إلى ذلك ، أظهر سمك الشفة العليا العمودية ارتفاعا أعلى في قيم معلمات الشفة العليا في منتصف الخط مقارنة بتلك الموجودة في الشفاه السفلية. **الأستنتاجات**: أنشأت معلمات الشفاه مستوى أساسيا للأشخاص العراقيين التي كان لها اختلاف عن المجموعات السكانية الأخرى ذات التباين بين الجنسين والدور المحتمل لهذه المعلمات يجب أن يؤخذ في الاعتبار أثناء العمليات الجراحية المختلفة (جراحو التجميل وأخصائيو تقويم الأسنان وأطباء الأسنان الشرعيون).

* ***Corresponding author***: Sinan S. Farhan, Department of Anesthesia, Al-Rafidain University College, Baghdad, Iraq; Email: sinan.subhi4@ruc.edu.iq

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INTRODUCTION

Various facial landmarks are considered beneficial tools for evaluation by surgeons for esthetic repair and facial reconstruction to gain optimal facial beautiful appearance [1,2]. Assessment of the relationships among structures of the face gives us the best results in the diagnosis and/or treatment of subjects. Lip appearance is considered one of the necessary features for a face look. In addition to that, its shape is affected by other factors like ethnic background [3]. The aging process and gender especially affect lip parameters like thickness and vermilion dimensions, the distance between the nose and vermilion border of the upper lip, and oral width [4,5]. Due to the importance of lip morphology in appearance and any possible changes of lips that might occur due to accidents or injuries that have importance in forensics and esthetic aspects, this study was performed to

establish a baseline, especially since it is considered the first one according to our knowledge of the normal range in lip parameters of young adult Iraqi subjects.

METHODS

Study design and setting

This study was conducted over 132 subjects (89 female and 43 male) aged from 18 to 22 years, students at a certain university-affiliated college in Baghdad, for the period January to April 2024. Subjects excluded from our study once had facial trauma or congenital malformation. Ethical approvals for the committee were gained. Data collected from participants was recorded in a special data sheet in addition to the consent from all participants. The study was performed after an explanation to participants, and informed consent was taken from each participant. The landmarks were located on subjects carefully and marked using blue liquid eyeliner. In this study, 9 parameters of the lips were measured using a digital vernier caliper. The lip dimensions were evaluated according to parameters performed by Sadacharan 2016 [6], as seen in Figure 1. This study also assessed the body mass index (BMI).

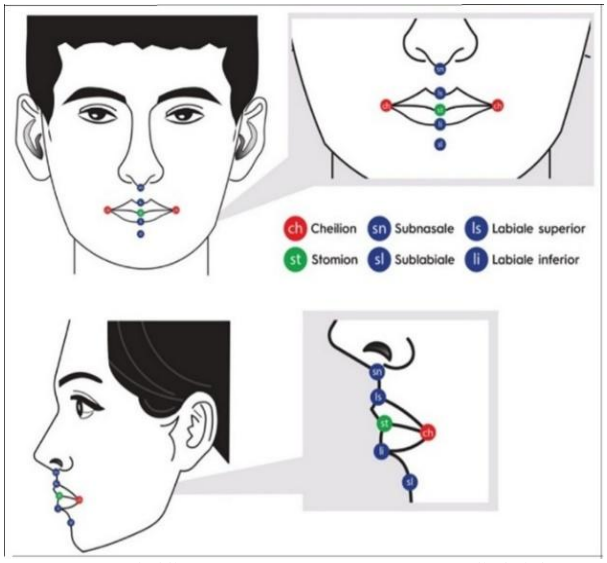

Figure 1: revealed lip measurements. Cutaneous upper-lip height (sn–ls); height of upper lip vermilion (ls-st); height of upper lip (sn-st); cutaneous lower lip height (li-sl); height of the lower lip vermilion (st-li); height of lower lip (st-sl); total height of vermilion (ls-li); total height of lips (sn-sl); intercommisural width (ch-ch).

Landmarks and ratios

sn subnasale: midpoint at the junction of the upper lip and lower margin of the nasal septum. **ls** labiale superius: mid-point of upper lip vermilion line. **st** stomion: mid-point of transverse labial fissure. **li** labiale inferioris: midpoint of lower lip vermilion line. **sl** sublabiale: midline of nasolabial sulcus. ch cheilion: labial angle. Cutaneous superior lip total height index (**sn-ls/sn-st**). Vermilion superior lip total height index (**ls-st/sn-st**). Vermilion superior lip cutaneous height index (**ls-st/sn-ls**). Vermilion height index (**ls-st/st-li**). Cutaneous Inferior lip total height index (**li-sl/st-sl**). Vermilion Inferior lip total height index (**st-li/st-sl**). Vermilion-cutaneous height Inferior lip index (**st-li/li-sl**). The ratio of vertical to horizontal parameters: Superior lip height/mouth width index (**sn-st/ch-ch**). Inferior lip height/mouth width index (**st-sl/ch-ch**).

Position of the subjects

Subjects should be in a standing relaxed position with erect heads, and both arms aside of trunk to evaluate face landmarks [7].

Direct manual anthropometric measurements

The measurements were performed with 0.5 mm accuracy using a digital caliper [8]. With LCD screen. Measurements were performed twice by a single observer. An obvious discrepancy is the only indication for the third reading.

Statistical analysis

The SPSS software is used for data analysis. The lip parameters were demonstrated as mean, standard deviation, range, percentile, Spearman's correlation, Mann-Whitney U test, and frequency for a total sample comparing gender on one hand and cosmetic procedures on the other hand. Significance level was considered with p-value < 0.05.

RESULTS

The sample was 132 medical students, with a female majority (67.4%) and a male minority (32.6%). Only seven females (5.3%) had undergone cosmetic procedures. Most students had a normal BMI (82 students, 62.1%), while around one-third were overweight (43 students, 32.6%), and a few were underweight (7 students, 5.3%) (Figure 2).

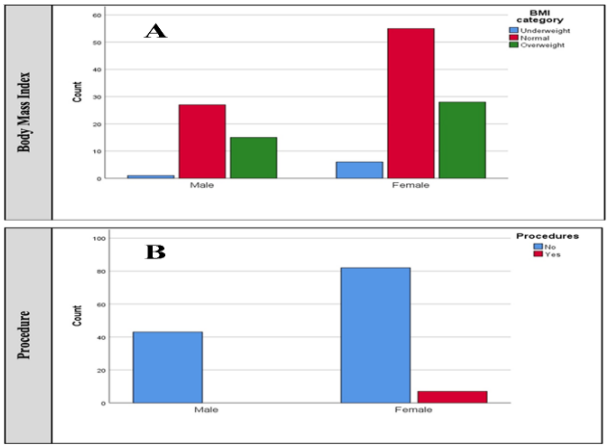

Figure 2: Frequency distribution of BMI (A) and cosmetic procedures (B) based on gender.

The mean±SD was calculated using demographic and morphometric parameters. The median and interquartile range (median [IQR]) were reported for statistical inference concerning those who did and did not undergo cosmetic procedures and for evaluating the effects of gender and BMI on the examined morphometric parameters. Most students were in their early twenties (20.5±0.2) with an average BMI (24±0.4). The morphometric parameters were computed as follows: Sn-ls (12.4±0.2), Ls-st (6.9±0.1), Sn-st (19.2±0.2), Li-sl (7.1±0.2), St-li (10±0.1), St-sl (17±0.2), Ls-li (17.4±0.3), Sn-sl (37±0.4), and Ch-ch (51.3±0.3) (Tables 1 and 2). Some morphometric parameters appeared larger (longer) in individuals with cosmetic procedures, while most were measured to be higher among males. However, these findings require confirmation through reliable hypothesis testing and statistical analysis. Spearman's correlation was evaluated to assess associations between age, weight, height, BMI, and morphometric parameters.

Table 1: Descriptive statistics of demographics and morphometrics of the sample (n=132)

Parameters	Range	Result
Age	18-33	20.5±2.6
Weight	42-120	66.2±15.3
Height	150-190	165.7±9.7
BMI	15.6-37.6	24.0±4.3
Sn-ls	6-19.2	12.4±2.2
Ls-st	3.2-12	6.9±1.6
Sn-st	14.5-24.9	19.2±2.0
Li-sl	2.9-13.8	7.1±2.2
St-li	6.3-14.7	10.0±1.7
St-sl	10.6-22.8	17.0±2.5
Ls-li	8.6-34.1	17.4±3.2
Sn-sl	24.9-46.2	37.0±4.3
Ch-ch	42.8-58.9	51.3±3.7

Values are expressed as mean±SD.

Significant bivariate correlations were found; most had weak to moderate effect sizes, while a few exhibited strong correlation coefficients (Table 3).

Table 2: Quartile distribution (25th, 50th, and 75th percentiles) of the sample

		Age	BMI	Sn-ls	Ls-st	Sn-st	Li-sl	St-li	St-sl	Ls-li	Sn-sl	Ch-ch
Percentiles	25th	19.0	20.8	11.0	5.9	17.7	5.6	8.9	15.0	15.7	33.8	48.7
	50th	20.0	23.2	12.1	6.9	19.2	6.8	10.0	16.9	17.2	37.0	50.5
	75th	21.8	26.9	13.8	7.8	20.6	8.5	11.1	18.7	18.9	39.9	53.5

Table 3: Spearman's correlation of demographics and morphometrics (n=132)

		Age	BMI	Sn-ls	Ls-st	Sn-st	Li-sl	St-li	St-sl	Ls-li	Sn-sl
BMI	*r*	0.128									
	p	0.143									
Sn-ls	*r*	0.243	0.080								
	p	**0.005**	0.360								
Ls-st	*r*	-0.020	-0.023	-0.306							
	p	0.823	0.795	**<0.001**							
Sn-st	*r*	0.218	0.164	0.671	0.221						
	p	**0.012**	0.061	**<0.001**	**0.011**						
Li-sl	*r*	-0.092	-0.064	0.227	-0.138	0.183					
	p	0.292	0.469	**0.009**	0.113	**0.036**					
St-li	*r*	0.045	0.003	0.013	0.297	0.167	-0.265				
	p	0.612	0.972	0.885	**0.001**	0.056	**0.002**				
St-sl	*r*	-0.013	0.035	0.219	0.083	0.312	0.674	0.336			
	p	0.882	0.688	**0.012**	0.344	**<0.001**	**<0.001**	**<0.001**			
Ls-li	*r*	-0.023	-0.021	-0.225	0.659	0.191	-0.302	0.747	0.194		
	p	0.789	0.812	**0.009**	**<0.001**	**0.028**	**<0.001**	**<0.001**	**0.026**		
Sn-sl	*r*	0.136	0.114	0.417	0.208	0.629	0.469	0.383	0.779	0.0326	
	p	0.121	0.194	**<0.001**	**0.017**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	
Ch-ch	*r*	-0.088	0.117	0.115	-0.007	0.115	0.230	0.139	0.323	-0.003	0.326
	p	0.315	0.183	0.190	0.936	0.190	**0.008**	0.112	**<0.001**	0.970	**<0.001**

The strongest correlations existed between St-ls and Sn-ls (Spearman's r=0.779, p< 0.001), St-li and Ls-li (r= 0.747, p< 0.001), Li-sl and St-sl (r= 0.674, p< 0.001), Ls-st and Ls-li (r= 0.659, p< 0.001), Sn-st and Sn-sl (rho= 0.629, p< 0.001), height and Ch-ch (r= 0.599, p< 0.001), and weight and Ch-ch (r= 0.440, p< 0.001). Similar correlations were observed when stratifying the sample based on cosmetic procedure and sex. Concerning cosmetic procedures, the Mann-Whitney U Test (Table 4) suggested a significant difference (p= 0.042) for Ls-st (median= 8.9, IQR= 6.6 to 10.6) compared to those without the procedure (median= 6.8, IQR= 5.8 to 7.8). At the 90% confidence interval, two other parameters showed trends towards significance, including Sn-ls (p= 0.093) and Ls-li (p= 0.099), that favored individuals who had undergone the procedure (Figure 3). Accordingly, only the midline distance from the labial superior to the station was significantly longer in medical students who underwent the cosmetic procedure. On the other hand, the two morphometric parameters were equivocal, could only be significant at the 90% confidence level—and these included the midline distance from the subnasale to labiale superior and the midline distance from the labiale superior to labiale inferior. Therefore, cosmetic procedures mainly targeted the upper lip's vertical thickness rather than the lower lip among Iraqi medical students.

Table 4: Summary of hypothesis tests on cosmetic procedures

	Null Hypothesis	Test	*p*-value
1	The distribution of age is the same across categories of procedures.	Independent-Samples Mann-Whitney U Test	0.760
2	The distribution of BMI is the same across categories of procedures.		0.074
3	The distribution of Sn-ls is the same across categories of procedures.		0.093
4	The distribution of Ls-st is the same across categories of procedures.		**0.042**
5	The distribution of Sn-st is the same across categories of procedures.		0.262
6	The distribution of Li-sl is the same across categories of procedures.		0.212
7	The distribution of St-li is the same across categories of procedures.		0.923
8	The distribution of St-sl is the same across categories of procedures.		0.984
9	The distribution of Ls-li is the same across categories of procedures.		0.099
10	The distribution of Sn-sl is the same across categories of procedures.		0.566
11	The distribution of Ch-ch is the same across categories of procedures.		0.101

Regarding demographics, significant sexual dimorphism was observed for several parameters (Table 5). Males had higher values for Sn-ls (13.4 [12.3 to 14.9] *vs*. 11.7 [10.9 to 13], $p<0.001$), Sn-st (19.8 [19.1 to 21] *vs*. 18.7 [17.3 to 20.1], $p=0.001$), Li-sl (8 [5.8 to 9.7] *vs*. 6.7 [5.5 to 7.9], $p=0.022$), St-sl (18.7 [16.2 to 20] *vs*. 16.4 [14.9 to 17.8], $p<0.001$), Sn-sl (39.6 [36.8 to 42.4] *vs*. 36.2 [33.2 to 38.2], $p<0.001$), and Ch-ch (55.4 [52.4 to 57.1] *vs*. 49.5 [48.1 to 50.9], $p<0.001$). On another note, the BMI had no significance on any morphometric parameter.

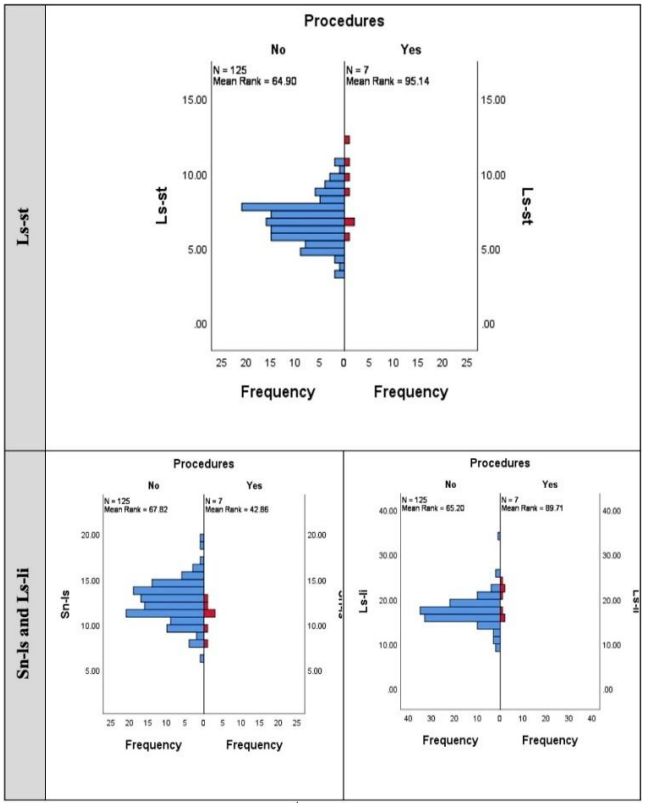

Figure 3: Mann-Whitney U test for cosmetic procedures.

Accordingly, males scored higher on six morphometric parameters: the midline distances from the subnasale to the labiale superior, subnasale to the stomion, labiale inferior to sublabiale, stomion to sublabiale, subnasale to sublabiale, and the distance between the mouth angles (Cheilion).

Table 5: Summary of hypothesis tests on gender

	Null Hypothesis	Test	*p*-value
1	The distribution of age is the same across categories of gender.	Independent-Samples Mann-Whitney U Test	0.814
2	The distribution of BMI is the same across categories of gender.		0.692
3	The distribution of Sn-ls is the same across categories of gender.		**<0.001**
4	The distribution of Ls-st is the same across categories of gender.		0.180
5	The distribution of Sn-st is the same across categories of gender.		**0.001**
6	The distribution of Li-sl is the same across categories of gender.		**0.022**
7	The distribution of St-li is the same across categories of gender.		0.636
8	The distribution of St-sl is the same across categories of gender.		**<0.001**
9	The distribution of Ls-li is the same across categories of gender.		0.169
10	The distribution of Sn-sl is the same across categories of gender.		**<0.001**
11	The distribution of Ch-ch is the same across categories of gender.		**<0.001**

Iraqi male medical students have a longer midline distance above the upper lip (the mustache area) and a longer transverse length of the mouth. In summary, only the upper lip vermilion height (the midline distance from labiale superior to stomion) was significantly longer in medical students who had undergone cosmetic procedures, suggesting these procedures primarily targeted the upper lip's vertical thickness. On the other hand, Iraqi male medical students displayed a greater cutaneous height of the upper lip (midline distance above the upper lip) and a wider inter-commissural width (the transverse length of the mouth). Notably, the body mass index did not significantly influence any of the morphometric parameters examined.

DISCUSSION

The human face, in general, is partitioned into three transverse segments. The upper part extends from the glabella below to the hairline above. The second third extends from the subnasale to the glabella, while the lower third encompasses the area from Menton to the subnasale. The size of these facial thirds is usually variable. In individuals of Caucasian descent, the mid-face was smaller than the upper third. Moreover, the lower third was larger than both the upper and middle thirds. East Asians typically had a larger middle third compared to the upper third, while the middle third is approximately equal in size to the lower third. Additionally, the upper third tends to be smaller than the lower third. The lower third of the face is further

subdivided into three thirds, which correspond to the upper lip, lower lip, and chin [9]. The lips have a crucial role in maintaining harmony and aesthetic value of the face. Anthropometric studies have demonstrated that individuals with fuller and broader lips in proportion to the width of their face, as well as larger vermilion height, were considered more aesthetically pleasing [10]. Therefore, it was crucial to have a comprehensive definition of normative dimensions of facial features in various ethnic groups, age categories, and genders. This was essential for accurately restoring the overall facial look in esthetic or forensic reconstructions (such as estimating facial aging or reconstructing a face from skeletal remnants) as well as in medical procedures for patients (such as lip fillers, dental prostheses, orthodontics, or surgery) [10,11]. Particularly, it is important to preserve or repair the correct balance of the vermilion with the surrounding cutaneous part of the lips. This can be achieved through dental procedures [10,12] or artificial reconstructions [13-15]. In a study conducted by Sforza *et al*. [4], it was observed that various parts of the lip exhibit varying levels of growth. It signifies that the growth of different parts of the lips does not follow a consistent pattern across all ages. Instead, certain areas have more growth while others experience less growth. Gonzalez-Ulloa [16] documented the alterations that occur in the lip because of aging, which include a decrement in vermilion exposure and a noticeable decrease in vermilion bulk. These findings have also been reported in the literature [4,16,17]. Most metrics exhibit a trend to decrease after the age of 50 or 60 [18]. Akgül and Toygar [17] observed in their study that during the third decade of age, the lips had decreased in thickness and shifted downwards. The changes in facial dimensions that happened during aging could be attributed to both macroscopic factors, like gravity and obesity, as well as microscopic factors, including effects of cutis or changes in subcutaneous fat and/or muscle weakness [19]. Furthermore, it is important to consider the impact of menopause on hormonal changes in women [20]. The current study participants had an age range of 18-33 years, with a mean of 20.5 years, representing a young population, as before age-related lip alterations could occur. The shape and size of lips vary significantly among different ethnic groups, exhibiting a wide range of diversity [18]. European Caucasians often have thin lips, while dark-skinned individuals tend to have thick or very thick lips. Orientals commonly have combinational lips. Ethnic diversity significantly influences anthropometric data and the domains where it might be applied. Consequently, many countries have exerted significant endeavors to establish and develop a database for different demographics. Ideal lips had certain characteristics that were reported in an article by Kar *et al*. [21]. It mentions that when looking at the front of the face, the upper lip vermilion should be shorter than the lower lip vermilion, and the upper lip should project out about 2 mm more than the lower lip when viewed from the side [22]. Throughout recorded history, large lips have consistently been linked to qualities such as beauty, youth, and even voluptuousness in the vast majority of females [23]. Previously, there has been a rush in the popularity of cosmetic procedures aimed at enhancing the appearance of the lips to augment facial attractiveness. Out of the participants in the current study, only seven individuals of the female gender, accounting for 5.3% of the total, had undergone cosmetic procedures. The findings indicated that the significant difference between participants who had undergone cosmetic surgery and those who had not was the increased length of the midline distance from the labiale superior to the mouth stomion (Ls-St) (height of upper vermilion). However, two more morphometric parameters were inconclusive and could only be considered significant at the 90% confidence level. These parameters are the midline distance from the subnasale to labiale superior (Sn-Ls) (medial vertical height of upper lip) and the midline distance from the labiale superior to labiale inferior (Ls-Li) (height of integumental lips). Therefore, cosmetic procedures mainly targeted the augmentation of the vertical thickness of the upper lip rather than the lower lip among Iraqi medical student participants. One of the primary objectives of this work is to evaluate gender dimorphism using lip morphometrics and to compare these findings with previously published global data, despite the limited availability of regional data. The current study examined nine morphometrics of the lips, which is perhaps the most comprehensive range described in the literature yet. Following a comprehensive literature analysis, the findings from each study were retrieved and compared to the results of this study. While the majority agreed with the findings, there were some disagreements, possibly due to the influence of genetic, racial, ethnic, nutritional, economic, environmental, and cultural factors [24-26]. Genetic variation between individuals and races may explain the observed physical disparities among populations [25]. In addition, a thorough analysis conducted by Chouery *et al*. [27] revealed notable variations in short tandem repeat (STR) loci between the Mediterranean region populations, including samples from Lebanon, Egypt, Iraq, and Syria, when compared to a European Caucasian population. Therefore, the data obtained from studies conducted on European Caucasians or even other ethnic groups cannot be applied to the Iraqi population. Additionally, it is inappropriate to generalize about people in the Mediterranean basin unless genetic mapping is used to identify their similarities and differences. Existing morphometric studies on the orolabial region were focused on Caucasian, East Asian, and African populations. There was limited research on Mediterranean populations, and according to our knowledge, none on the Iraqi population. Farkas *et al*. [28] performed benchmark studies depending on Caucasians in North America by direct anthropometry. The findings from these studies were considered as

references for facial soft tissue norms. Regarding participants demographics in the current study, significant sexual dimorphism was observed for several parameters. Male individuals exhibited greater measurements for Sn-Ls (medial vertical height of cutaneous upper lip), Sn-St (height of upper lip), Li-Sl (medial vertical height of cutaneous lower lip), St-Sl (height of lower lip), Sn-Sl (vertical measurement from the base of the nose to the upper chin—or total lip length), and Ch-Ch (mouth width) than females. These findings were harmonic with reported results in multiple studies [4,7,10,26,29-41]. Few studies have looked for the correlation between various lip morphometrics, and as far as we know, none of them have revealed the correlations among linear labial measurements. Al-Khatib *et al*. observed significant correlations among the horizontal labial dimensions, whereas they found a weak correlation between the horizontal and vertical measurements [37]. The associations between age, weight, height, BMI, and morphometric characteristics in the current study were also deduced. We observed noteworthy bivariate correlations, with the majority displaying weak to moderate effect sizes, while a few demonstrated strong correlation coefficients. The labial morphometrics analysis revealed that the most significant association was seen between St-Ls (height of upper vermilion) and Sn-Ls (medial vertical height of cutaneous upper lip). Individuals with a longer upper vermilion may also have a correspondingly longer cutaneous upper lip, although this is not an absolute rule as there might be differences among individuals. These two dimensions can be associated because they both contribute to the total vertical height of the upper lip and are impacted by genetic, developmental, and environmental variables, as well as changes that occur with age. This correlation across people can fluctuate due to variations in lip shape, size, and general facial morphology. Furthermore, there were correlations between St-Li (height of lower vermilion) and Ls-Li (height of the integumental lip). Although specific studies that directly correlate St-Li and Ls-Li might be scarce. The correlation between these parameters arises from their joint influence on the overall aesthetics and symmetry of the lips. Based on the returns of the current study and previous literature, it can be deduced that lower vermilion height is greater than upper vermilion height. Thus, the height of the integumental lip is mostly determined by the length of the lower vermilion height rather than the upper vermilion height. Additionally, there were correlations between Li-Sl (vertical height of cutaneous lower lip) and St-Sl (height of lower lip). Both measurements pertain to the vertical aspect of the lower lip. The total height of the lower lip is primarily determined by the height of the lower lip vermilion and, to a lesser extent, by the height of the cutaneous lower lip. However, there could be a correlation between the dimensions of Li-Sl and St-Sl, meaning that changes in one dimension may affect the other. Correlations were also observed between the height of the upper vermilion (Ls-St) and the height of the integumental lip (Ls-Li). Both measurements pertain to the vertical dimensions of the upper and lower lips. The prominence of the upper lip vermilion (Ls-St) could influence the perceived height of the integumental lip (Ls-Li) due to the overall shape and volume of the lips. Furthermore, there were correlations observed between Sn-St (height of upper lip) and Sn-Sl (vertical measurement from the base of the nose to the upper chin, also known as total lip height). Sn-St measures the height of the upper lip, while Sn-Sl measures the vertical distance from the base of the nose to the upper chin, considering the height of the upper lip as well. Therefore, there is a direct relationship where Sn-St is a component of Sn-Sl. Changes in the Sn-St proportion can impact the Sn-Sl proportion if the proportions between the upper and lower parts of the face are in balance, as both proportions are influenced by the overall vertical dimension of the face. From an aesthetic perspective, comprehending this correlation provides advantages for assessing facial proportions and attaining aesthetic harmony. An important aspect of facial aesthetics is maintaining a harmonic balance between the height of the upper lip and the overall vertical dimensions of the face. Precise measurement of these parameters is essential for cosmetic and reconstructive procedures to guarantee accurate alignment and proportion. Furthermore, there were correlations observed between an individual's height and their Ch-Ch (mouth width); however, the strength of these correlations may not be very high. In general, those who are taller tend to have face characteristics that are larger in proportion, such as a wider mouth. This correlation is influenced by the concept of allometric growth, which refers to the differential growth rates of distinct body parts relative to each other. The magnitude of the correlation may vary based on genetic characteristics, ethnicity, and other variables. Additional research using larger sample sizes and diverse populations is necessary to accurately measure and comprehend this correlation. Moreover, there was a correlation between an individual's body weight and Ch-Ch (mouth width). Although there may appear to be a relationship between body weight and mouth width, the association is generally less obvious when compared to that of height. Body weight is determined by various factors such as body fat, muscular mass, and overall body composition. However, these characteristics may not have a clear correlation with mouth width. Some studies indicate a possible weak correlation between body weight and face morphometrics, including mouth width [35]. Nevertheless, the extent of this link might significantly range among individuals because of variations in body composition and genetics. Furthermore, the Body Mass Index (BMI) did not demonstrate any statistical significance on any of the morphometrics studied in the current study. Facial morphometrics are predominantly determined by genetic factors, and there may be variations between facial parameters and the BMI [25]. On the contrary, a

study conducted on healthy adults in Lebanon observed a correlation between higher individual BMI and bigger linear lip measurements [35]. They explained their findings by the assumption that increased BMI is associated with lip soft-tissue expansion, leading to variations in some linear dimensions, rather than structural variations of lips. These observed effects seem to resemble those observed in the aging of lips. Research has demonstrated that lip aging does not lead to a decrease in the volume of the lips, but rather a redistribution of its dimensions. This redistribution was noticed by a reduction in the height of the vermilion and an increase in the mouth width [42]. However, due to the exploratory nature of our data and the number of underweight and overweight individuals in our sample, future studies must validate our findings before generalization is made. The findings of this study on lip morphometrics were compared to existing data on various populations, including Northern Indians, North Americans, Malays, Indians (Malaysian and Western), Caucasians, Northern White Italians, Sudanese, African Americans, Angolans, Egyptians, Zulus, Kenyan Africans, Lebanese, Turks, individuals from the United Kingdom, Koreans, Spaniards, Croatians, and Slovaks [4,7,10,26,29-41]. These studies can only be partially compared to the current study because not all the morphometrics used in the current study have been reported in the literature. Indeed, even if all the metrics were described in the literature for some studies, they varied due to technical factors, such as the use of different data collection methods and age ranges included in the studies. Moreover, biological diversity also had a significant impact on results from different populations. The previous research conducted by Ferrario *et al*. [43] and Sforza *et al*. [4,44] used 3D computerized electromagnetic digitizer devices for data acquisition. Despite the data measured by stereophotogrammetry, they were reported to be comparable to those obtained using direct anthropometry [10]. Another variant of the data acquisition method is a photographic dataset collected from a Turkish study conducted by Ozdemir *et al*. [36]. Similarly, previous studies on Caucasian [32] relied on photographic methods. However, the current study used direct measurements, which are considered more reliable, despite being time-consuming. Regarding the upper lip metrics, (Sn-Ls) and (Sn-St) were significantly higher in males for this study (13.4 mm and 20 mm, respectively). Consistent with other studies [10,26,29-31,35-37], it was observed that males have longer cutaneous upper lip and total upper lip height. In addition, Sn-St is greater than Sn-Ls, except in a Turkish study [36] that demonstrated a higher cutaneous upper lip height (with a mean of 24.4 mm and 22.4 mm for males and females, respectively) compared to the overall upper lip height (with values of 21.6 mm and 19.3 mm in males and females, respectively). Probably explained by their genetic and ethnic uniqueness. The findings of our study were more closely aligned with research conducted in Northern India and Malaysia [26,29]. However, in the current study, (Ls-St) was higher in females (7.1 mm), but this difference was not statistically significant (p= 0.180). Furthermore, several studies have shown that the mean values for the upper lip vermilion (Ls-St) were higher in females [4,32,35,39,40]. However, in Slovakia [41], the average values for the upper lip vermilion were similar in both males and females, with a mean of 6.9 mm. Furthermore, regarding this parameter, Italian women exhibited the closest approximation to the current study results [4]. The Western Indian [31], North White Americans, Lebanese [35], and Turkish [36] studies have documented the highest measurements for the upper lip in males. This may be attributed to the fact that Western Indians and North White Americans are more closely related to the Australoid race [45]. However, the Lebanese and Turkish studies had remarkably higher values, perhaps due to variations in the measurement methods employed by these researchers. Notably, the African Americans had the largest upper vermilion height among both males and females in the literature, with mean measurements of 13.6 mm and 13.3 mm, respectively. However, the absence of additional morphometric data made it rather challenging to make comparisons with other parameters. In this study, the mean male parameters for the upper lip were comparatively smaller. This discrepancy may be attributed to hereditary variables and developmental influences, as well as variations in the measuring methods employed across different studies. Environmental factors have barely any effect on the difference in sizes of upper lip characteristics among these populations [18]. However, racial disparities should be considered when a comparison is made. Regarding lower lip metrics, the mean values of these metrics likewise exhibit sexual differences. The mean values were found to be higher in males, and there was a statistically significant difference between different sexes, except for the height of the lower vermilion (St-Li). The observed difference in the cutaneous lower lip (Li-Sl) and the height of the lower lip (St-Sl) between males and females aligns with findings from several studies [26,32,35,36]. Nevertheless, several studies in the literature have found that the height of the lower lip vermilion is greater in females compared to males, as indicated by the findings of previous research [4,35,37,39,41]. These discrepancies may be attributed to racial disparities and maybe to variations in methods. Additionally, the current study revealed that the height of the lower lip vermilion was greater than that of the upper lip vermilion in both genders. Previous literature has shown similar findings, except for Sudanese [33] and Malays 2012 [37], who found a greater length of the top vermilion compared to the lower vermilion. In addition, the measurement of the height of the cutaneous upper lip (Sn-Ls) was found to be greater than the height of the lower lip (Li-Sl), which is consistent with the findings

reported in the literature [35,36]. In both genders, the upper lip had a greater total vertical height than the lower lip. This is consistent with prior research [26,32,35,36]. Remarkably, despite the absence of complete morphometric data on African Americans, they had the highest average lower vermilion measurements among both males and females, with a mean of 13.8 mm and 13.2 mm, respectively. Insufficient data for comparison was available for Malays, Malaysian Indians, Western Indians, Northern Italians, Sudanese, African Americans, Angolans, Egyptians, Zulu, Kenyan Africans, Koreans, Spain, and Croatia [7, 29-31,33,34,38-40]. Regarding the vertical height of both lips, the mean value of the integumental lip height (Ls-Li) was higher in females with a mean of 17.7 mm as compared to the male mean of 16.9 mm, but this difference was not statistically significant (p= 0.169). The findings were comparable to those of the studies conducted on White Italians, North Americans, and Lebanese populations [4,35]. However, unlike Northern Italians, Northern Indians, Sudanese, African Americans, the UK, and Malays, 2012 [10,26,33,37,46] studies found greater values among males. Meanwhile, the height of the integumental lips was the shortest among white Italians of both genders, with a mean value of 14.05 for males and 15 mm for females [4]. Furthermore, the Sudanese and African Americans exhibited the highest values for both males and females, with a mean of 20.7 mm and 19.7 mm for Sudanese males and females, respectively, and 27.4 mm and 26.5 mm for African American males and females, respectively [33]. These findings are primarily attributed to ethnic and genetic diversity among populations. Data on integumental lips metric was not obtainable for North Americans, Malays, Indians (Malaysian and Western), Caucasians, Angolans, Egyptians, Zulu, Kenyan Africans, Turkish, Korean, Spanish, and Croatian individuals for comparison [7,29-32,34,36,38-40]. Consequently, no comparison can be made regarding these studies. The mean vertical measurement from the base of the nose to the upper chin, which is also referred to as total lip length (Sn-Sl), was highly significantly larger in males (with a mean of 39.1 mm) compared to females (with a mean of 35.9 mm). This finding is consistent with several other studies that have reported comparable results [4,10,33,35]. However, the remaining literature does not provide sufficient data for comparison [35,40-45,48,49]; hence, no deductions can be made. Regarding mouth width (Ch-Ch), the mean values of 54.6 mm in males and 49.7 mm in females likewise exhibit sexual dimorphism, with notably larger values observed in males. The mean mouth width dimensions for Turkish individuals were 47.1 mm for males and 44 mm for females [36], which represent the smallest metrics regarding mouth width in the literature. On the other hand, the Zulu individuals reported the widest mouth width, with a mean of 56.2 mm for males and 52.2 mm for females [7]. Moreover, it was reported by Farahvash *et al*. [47] that the mean mouth width of Iranian men was 45.9 mm. In 2013, Amol *et al*. [48] conducted a study on the mouth width of 51 males and 117 females. The individuals were chosen from the Arab populations of Middle Eastern countries, including Bahrain, Kuwait, and Saudi Arabia. The mean width of the mouth measured 52.9 mm among all male samples. The mean measurement was recorded as 53.6 mm in Bahraini males, 52.6 mm in Saudi males, and 52.5 mm in Kuwaiti men. As seen with these results, the countries in the Arabian Gulf vicinity have close mean values of mouth width to the current study findings in the Iraqi population in males (54.6 mm), probably explained by the mutual descent in origin and even proximity and ethnicity of the Arab populations. Emelike *et al*. [49] conducted a study in 2012, examining a group of 200 subjects (100 males and 100 females) of the Igbo population in Maiduguri. The study revealed that the mean mouth width among males residing in Igbo is 53.7 mm, which is also close to the result of the current study. In 2005, Khandekar *et al*. [31] reported the mean width of the mouth in adult men and women from different ethnic groups. They found that the average mouth width was 33 mm for men in China, 33 mm for Caucasian men, and 38 mm for dark-skinned men. In females, the mean values were 34 mm in China (larger than the male value), 35 mm in Caucasians (larger than the male value), and 30 mm in dark-skinned women. It is evident from the available literature and data that the orolabial morphometrics of Iraqi adults differ from the established norms for white individuals and other populations and therefore cannot be generalized to each other. Thus, these findings indicate that gathering population data from one population to guide cosmetic surgery may be improper, as various populations require particular norms

Study limitations

The impact of age on lip morphometrics remains uncertain in this study due to the inclusion of a specific age group consisting solely of young adults. It is recommended to do further investigations into different age groups, with a particular focus on changes in the lips after the age of 40. The manual utilization of the vernier caliper remains susceptible to operator-dependent human errors when localizing anatomical locations for measurement, particularly in males with dense mustaches. This is especially crucial for accurately identifying the top vermilion point of the Ls. Indeed, this limitation is present in most portable devices. The BMI values should be classified into three distinct categories: underweight, normal, and overweight, instead of being shown as continuous numerical values. This categorization is likely to facilitate the establishment of correlations concerning BMI. The sample covered in the current study is restricted to a specific population group, being medical students. Iraq exhibits a diverse range of ethnicities that vary from the northern to the southern regions, resulting in notable disparities in culture,

customs, and environment. All these factors could potentially have an impact on labial morphometrics. Therefore, it is necessary to do additional research in other parts of Iraq to encompass the whole range of ethnic variety in the country before making any generalizations about the Iraqi population. However, the current study will not be negatively impacted as our main objective is to produce preliminary data, which will yield valuable insights and facilitate further research. Further research considerations involve the necessity of establishing a standardized methodology for positioning patients during orolabial measurements. This includes determining whether the lips should be relaxed, closed, open, or display different levels of contraction. It has been demonstrated that these variations can lead to significant variability in the resulting linear measurements. The recent advancements in stereophotogrammetric technology have made it easier to use and should promote more research on additional groups. This will involve using a consistent data-gathering approach to enable meaningful comparisons between the populations being studied.

Conclusions

When comparing the total vertical heights of the upper and lower lips (Sn-St and St-Sl), the upper lip was greater in size in both males and females, with males having a longer length. Similarly, this is applied to the measurement of the length of the cutaneous upper lip (known as philtrum length) and the lower lip (Sn-Ls–Li-Sl). Conversely, the height of the lower vermilion (St-Li) was bigger than that of the upper vermilion (Ls-St), with females exhibiting a larger length in the upper vermilion with no significance. Nevertheless, not all these findings provide evidence for the existence of sexual dimorphism. Although most previous studies concurred with the findings of the current study, a few disagreements arose, potentially attributable to the impact of genetic, racial, ethnic, dietary, economic, environmental, and cultural variables. In addition, the current study observed that individuals who had undergone lip cosmetic procedures had a considerably greater midline distance from the labiale superior to the stomion (height of upper vermilion) compared to those who had not undergone the cosmetic procedure. Hence, the focus of cosmetic procedures was mostly on the vertical dimension of the upper lip rather than the lower lip in the current study participants. The literature and data demonstrate that the orolabial morphometrics of Iraqi adults deviate from the established norms of other populations, indicating that they cannot be generalized across various populations.

Conflict of interests

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Data sharing statement

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