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STUDY OF THE LIP MORPHOLOGY IN YOUNG BULGARIANS

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Abstract

The aim of this study was to examine the morphology of the mouth and lips in young Bulgarian adults of both sexes and to perform a proportional analysis by calculating six anthropometric indices. The study included 95 Bulgarian subjects (46 males and 49 females) aged 21–30 years. Three-dimensional images were obtained using a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester, VT). Twelve landmarks were placed to measure the following distances (mm): mouth width (chr-chl), philtrum width (cphr-cphl), upper vermilion height (ls-sto), lower vermilion height (sto-li), upper lip height (sn-sto), lower lip height (sto-sl), zygomatic width (zyr-zyl), and lower facial height (sto-gn).

Based on these measurements, the following proportional indices were calculated: (chr-chl) × 100/(zyr-zyl); (cphr-cphl) × 100/(chr-chl); (sto-li) × 100/(sto-sl); (sto-li) × 100/(sto-gn); (ls-sto) × 100/(sn-sto), and (ls-sto) × 100/(sto-li). The results demonstrate that all dimensions were greater in males than in females, except for the upper vermilion height, which was equal in both sexes. Statistically significant sexual dimorphism ($p < 0.05$) was identified in mouth width, philtrum width, upper lip height, lower lip height, lower facial height, and zygomatic width. In contrast, significantly higher values were found in females for three of the studied indices (sto-li) × 100/(sto-sl), (ls-sto)

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$\times$ 100/(sn-sto), and (sto-li) $\times$ 100/(sto-gn) compared to males ($p < 0.05$). The results confirm the specific characteristics in the facial morphology of the studied Bulgarian males and females and the need for these data to achieve accurate outcomes in various clinical disciplines.

Key words: 3D laser scanning, Bulgarians, lip morphology

Introduction. In recent years, there has been a focus among dermatologists and plastic surgeons on achieving the ideal lip morphology. In the context of an increasing interest in facial harmony and the pursuit of balanced proportions, it is essential to consider the morphological variations among ethnic groups. For instance, the lip structure of Asian populations differs from that of Caucasian populations [1]. As indicated by Kar et al. [2], the optimal ratio between the upper and lower lips in young Caucasians is approximately 1:1.6. In the case of female subjects, fuller lips and a greater vermilion height are generally perceived as more attractive. Understanding population-specific facial features is crucial when planning aesthetic procedures for patients of different origins [3]. The lips, like other regions of the face, are subject to the effects of ageing. Substantial age-related changes become evident as people reach their forties. The process of ageing of the lips is characterized by an increase in skin part and a decrease in vermilion height and surface area [4]. Previous studies of young Bulgarian adults have measured basic dimensions such as mouth width and upper and lower vermilion height [5]. However, a detailed analysis of the proportions and relationships between these measurements is still needed. This data is crucial for obtaining optimal results in aesthetic procedures, orthodontic treatment, and reconstructive surgery.

The aim of this study was to examine the morphology of the mouth and lips in young Bulgarian males and females and to perform a proportional analysis of the orolabial region by calculating six anthropometric indices.

Materials and methods. The study included 95 clinically healthy individuals of Bulgarian origin (46 males and 49 females), aged between 21 and 30 years. Subjects of different ethnicities, with a history of facial injury, craniofacial anomalies, or mental disorders were excluded from the study. All participants have provided written informed consent in accordance with the Declaration of Helsinki (1964). The study was approved by the Ethics committee at the Medical University of Plovdiv (protocol No. 3/07.04.22). The study was conducted at the Department of Anatomy, Histology and Embryology of the Medical University of Plovdiv. Three-dimensional images were obtained using a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester VT). Twelve anthropometric landmarks were placed on each of the three-dimensional image: cheilion (chr,chl), crista philtri (cphr, cphl), labiale superius (ls), labiale inferius (li), stomion (sto), sublabiale (sl), zygion (zyr, zyl), subnasale (sn) and gnathion (gn) (Table 1). The procedure was performed by a single operator [6].

Table 1

Description of the landmarks

Landmarks	Description
Cheilion (chr, chl)	The points located at the right and left corner (commissure) of the mouth.
Crista philtri (cphr, cphl)	The points on the left and right elevated margins of the philtrum at the vermilion border.
Labiale superius (ls)	The midpoint of the upper vermilion border.
Labiale inferius (li)	The midpoint of the lower vermilion border.
Stomion (sto)	The point located at the medial aspect of the oral fissure.
Sublabiale (sl)	The point located in the middle of the mentolabial sulcus.
Zygion (zyr, zyl)	The most lateral point of the soft tissue contour is located on each of the zygomatic arches.
Subnasale (sn)	The point located in the middle of the nasolabial contour between the nasal septum and the superior lip.
Gnathion (gn)	The lowest point located at the middle of the lower border of the soft tissue contour of the chin.

Using these 3D landmarks, the following distances (mm) were measured: zygomatic width (zyr-zyl), lower facial height (sto-gn), mouth width (chr-chl), philtrum width (cphr-cphl), upper vermilion height (ls-sto), lower vermilion height (sto-li), upper lip height (sn-sto), and lower lip height (sto-sl) (Table 2). Based on these measurements, the following six indices were calculated: (chr-chl) $\times$ 100/(zyr-zyl), (cphr-cphl) $\times$ 100/(chr-chl), (sto-li) $\times$ 100/(sto-sl), (sto-li) $\times$ 100/(sto-gn), (ls-sto) $\times$ 100/(sn-sto), and (ls-sto) $\times$ 100/(sto-li) [7].

Table 2

Description of the measurements

Measurements	Description
Zygomatic width	The linear distance between the two zygion points (zyr-zyl).
Lower facial height	The linear distance from the stomion to the gnathion (sto-gn).
Mouth width	The linear distance between the two cheilion points (chr-chl).
Philtrum width	The linear distance between the two crista philtri points (cphr-cphl).
Upper vermilion height	The linear distance between the points labiale superius and stomion (ls-sto).
Lower vermilion height	The linear distance between the points labiale inferius and stomion (sto-li).
Upper lip height	The linear distance between the subnasale and stomion points (sn-sto).
Lower lip height	The linear distance between the stomion and sublabiale points (sto-sl).

Statistical analysis. Quantitative variables were summarized by mean and standard deviation (mean ± SD) or median (25th percentile; 75th percentile), based on the sample distribution. Qualitative variables are presented as numbers/totals (n). The Shapiro–Wilk test was applied to inform about the distribution of the participants sampled. Differences between groups were tested using the independent-samples t test as appropriate. A 2-sided p-value of <0.05 was considered statistically significant. Statistical analyses were performed using SPSS Statistics V26 software (IBM Corp., Chicago, IL, USA).

Results. All studied dimensions were greater in males than in females, with the notable exception of the upper vermilion height, which was the same for both sexes. Statistically significant sex differences ($p < 0.05$) were identified in mouth width, philtrum width, upper lip height, lower lip height, lower facial height, and zygomatic width. In contrast, no significant differences were observed between males and females regarding the vermilion height of the upper and lower lips ($p > 0.05$) (Table 3).

Table 3

Linear measurements of the mouth area and face

Dimensions (mm)	Males		Females		p
	Mean	SD	Mean	SD	
chr-chl	50.86	3.50	46.63	3.47	$p < 0.001$
cphr-cphl	12.84	1.62	11.60	1.58	$p < 0.001$
sn-sto	22.63	2.39	21.22	2.46	$p < 0.01$
ls-sto	6.09*	2.00**	6.09*	1.69**	$p > 0.05$
sto-sl	19.88*	3.26**	17.89*	2.77**	$p < 0.001$
sto-li	10.55	1.76	10.46	1.67	$p > 0.05$
sto-gn	48.41	4.82	44.08	4.15	$p < 0.001$
zyr-zyl	146.25*	11.24**	135.41*	7.16**	$p < 0.001$

* Median; ** Interquartile range

The calculated indices demonstrating the ratios of philtrum width to mouth width and mouth width to zygomatic width exhibited higher values in males than in females, though the differences were not statistically significant ($p > 0.05$). Three of the studied indices, representing the ratios of lower vermilion height to lower lip height, upper vermilion height to upper lip height, and lower vermilion height to lower face height, showed statistically significant higher values in females ($p < 0.05$). The ratio of upper vermilion height to lower vermilion height was higher in females as well, though this difference was not statistically significant ($p = 0.811$) (Table 4).

Table 4

Indices between dimensions of the mouth area and the face

Indices	Sex	N	Mean	SD	p
chr-chl × 100/zyr-zyl	Males	46	34.66	3.27	$p = 0.784$
	Females	49	34.49	2.76	
cphr-cphl × 100/chr-chl	Males	46	25.30	3.18	$p = 0.621$
	Females	49	24.96	3.49	
sto-li × 100/sto-sl	Males	46	53.63	11.56	$p = 0.040$
	Females	49	58.90	13.00	
sto-li × 100/sto-gn	Males	46	21.88	3.38	$p = 0.008$
	Females	49	23.76	3.32	
ls-sto × 100/sn-sto	Males	45	26.89	3.35	$p = 0.008$
	Females	45	28.70	3.12	
ls-sto × 100/sto-li	Males	46	61.22	22.61	$p = 0.811$
	Females	49	62.20	16.92	

Discussion. In the field of facial anthropometry, the widths of the mouth and philtrum have been widely studied. However, in recent years, the focus has been on the height of the vermilion and the lips following advancements in aesthetic dermatology and plastic surgery. In our study, the mouth width in Bulgarian males was 50.86 ± 3.50 mm. This is consistent with the dimensions reported for Spanish (51.11 ± 4.77 mm) [8], Italian (51.8 ± 3.8 mm) [9] and Albanian (51.99 ± 3.24 mm) [10] males, though slightly smaller. According to Zacharopoulos et al. [11], Greek males exhibited a wider mouth fissure (53.5 ± 2.9 mm), whereas narrower mouth widths were observed in Chinese males (49.70 ± 3.72 mm) [12] and Slovenian males (47.2 ± 3.2 mm) [13]. Regarding females, our findings (46.63 ± 3.47 mm) indicated a wider mouth fissure compared to the Chinese (45.18 ± 3.52 mm) and Slovenian females (45.4 ± 3.9 mm). In contrast, Albanian (49.06 ± 3.24 mm) and Turkish females (49.65 ± 4.22 mm) [14] exhibited significantly larger mouth widths. The widest mouth fissures recorded in the cited literature were found among males and females from Sudan [15] and Saudi Arabia [16].

The philtrum width in our male subjects (12.84 ± 1.62 mm) was very similar to data from the Italian males (12.4 ± 2.1 mm) and Chinese males (12.80 ± 1.83 mm). The Turkish males exhibited a wider philtrum (13.7 ± 2.25 mm), while the Spanish males demonstrated notably smaller values (10.62 ± 2.43 mm). For Bulgarian females, the philtrum width (11.60 ± 1.58 mm) showed strong similarities to Turkish (11.85 ± 2.00 mm) and Chinese (11.14 ± 1.34 mm) groups but was higher than those reported for Italian (10.7 ± 2.2 mm) and Spanish females (9.29 ± 1.95 mm).

The upper vermilion height in Bulgarian males (6.09 ± 2.00 mm) aligned closely with findings in Italian males (6.7 ± 2.3 mm). In contrast, notably higher

values were reported for the Greek (8.3 ± 1.6 mm) and Slovenian males (8.9 ± 1.8 mm), while Indonesian males exhibited lower heights (5.60 ± 1.60 mm). The highest recorded values were observed in Senegalese (11.00±2.45 mm) and Chinese males (10.20 ± 1.85 mm) [17,18]. The upper vermilion height in Bulgarian females in our study was identical to that of males (6.09±1.69 mm), suggesting an absence of sexual dimorphism for this linear measurement. This value was comparable to those obtained by Sforza et al. [9] in Italian females (6.8 ± 2.2 mm) and by Hasibuan et al. [17] in Indonesian females (6.59 ± 1.39 mm). Consistent with the male data, Greek (8.5±1.3 mm) and Slovenian females (8.2±1.1 mm) exhibited higher values, whereas the greatest upper vermilion heights were documented in Senegalese (10.10 ± 1.89 mm) and Sudanese females (10.5 ± 2.1 mm).

Regarding the lower vermilion height, our findings in males (10.55 ± 1.76 mm) were comparable to those reported for the Greek (10.2 ± 1.6 mm), Indonesian (10.51 ± 2.09 mm), and Sudanese (10.8 ± 2.3 mm) populations. In contrast, this dimension was smaller in Italian males (8.8 ± 3.0 mm) and substantially larger in Senegalese males (14.3 ± 1.75 mm). In females, the lower vermilion height (10.46 ± 1.67 mm) corresponded with data from Sudanese (10.3 ± 2.3 mm) and Indonesian (10.02 ± 1.38 mm) females. Smaller values were observed in Italian (9.1 ± 2.7 mm) and Slovenian (9.5 ± 1.7 mm) females, while significantly higher dimensions were documented in Senegalese female subjects (13.5 ± 1.63 mm). The results of the present study demonstrated that, in accordance with the data cited in the literature, the height of the lower vermilion was greater than that of the upper vermilion.

The upper lip height in our male subjects (22.63 ± 2.39 mm) was consistent with reports for Turkish (22.19 ± 3.52 mm) and Indonesian males (22.4 ± 2.84 mm). While Greek (24.5 ± 2.6 mm) and Chinese (23.39 ± 2.66 mm) males exhibited higher values, Slovenian males presented lower measurements (21.7 ± 2.4 mm). In the females, the mean measurements (21.22 ± 2.46 mm) demonstrated strong similarities to the Greek (21.7 ± 2.6 mm) and Chinese (21.50 ± 1.97 mm) groups. Although slightly higher values were found in Italian females (22.07 ± 2.19 mm), Bulgarian results were higher than those for Turkish (20.17 ± 3.40 mm) and Indonesian (20.78 ± 2.96 mm) females.

Data on lower lip height is relatively limited in recent anthropometric studies. The values for Bulgarian males (19.88 ± 3.26 mm) were highly comparable to those for Spanish (20.25 ± 3.20 mm) and Chinese (19.48 ± 2.61 mm) males but were significantly higher than the dimensions reported for Indonesian males (16.44 ± 1.33 mm). A similar trend was observed in the female subjects. The values recorded for the females (17.89 ± 2.77 mm) were consistent with the Chinese data (17.40 ± 1.96 mm) but were higher than those recorded for Indonesian females (15.71 ± 1.10 mm). Notably, Spanish females exhibited significantly greater lower lip heights (19.32 ± 3.69 mm). These results emphasize the importance of considering population-specific variation in linear measurements.

The concept of ideal lip volume and proportions varies significantly across different ethnic groups. In clinical planning for lip augmentation, it is imperative to consider the ratios between vermilion height, total lip height, philtrum width, and facial width, in addition to absolute dimensions [3].

Our results demonstrated that three of the calculated indices were statistically significantly higher in females than in males. Specifically, the lower vermilion height constituted a larger proportion of both the total lower lip height (sto-li $\times$ 100/sto-sl) and the lower facial height (sto-li $\times$ 100/sto-gn). In addition, the upper vermilion height accounted for a greater proportion of the total upper lip height (ls-sto $\times$ 100/sn-sto) in females. Bahşı et al. [19] identified statistically higher values in males regarding the ratios of upper cutaneous lip height to upper vermilion height (sn-ls/ls-sto), lower cutaneous lip height to lower vermilion height (li-sl/sto-li), and philtrum width to mouth width (cphr-cphl/chr-chl). Research by Hasibuan et al. [17] indicated that males had significantly higher values for the ratio between the cutaneous part and the vermilion of the upper lip (sn-ls/ls-sto). According to Winiarska et al. [20], a larger upper-to-lower vermilion ratio improved lip aesthetics. In the present study, the height of the upper lip in females was greater, while that of the lower lip was less than the values reported for attractive females by Farkas et al. [7]. This was not observed in the male subjects, where the height of the upper lip was comparable between the two groups. The height of the upper vermilion was higher in attractive males and females, in contrast to our results, where the height of the lower vermilion was larger. The calculated proportional indices demonstrated that, in both attractive males and females, the mouth width occupied a greater proportion of the facial width, and the upper vermilion height accounted for a larger proportion of the total height of the upper lip. The index representing the ratio of the lower vermilion to the total height of the lower lip was comparable in both female groups, but remained lower in attractive males than in our male participants.

Conclusion. The results obtained demonstrate significant sexual dimorphism in the dimensions of the orolabial region that was studied, with the exception of the vermilion height of both lips. In order to achieve results that approximate the ideal lip proportions in various procedures in the field of aesthetic and plastic-reconstructive medicine, it is necessary to consider the proportions between the measurements, as well as the relationship between them and other measurements of the face.

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