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Assessment of Lip Morphometry and Sexual Dimorphism Among Medical Students of Gujarat

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ABSTRACT

Background: Lips play a crucial role in facial expression, speech, mastication and overall facial esthetics. The morphology of the lips significantly influences the appearance of the lower third of the face and contributes to social perception and attractiveness. Sexual dimorphism in lip morphology has been documented in different populations, highlighting the need for population-specific normative data as it is helpful in many aspects of forensic, esthetic facial and clinical practice.

Aim:The present study aimed to establish standard reference values for lip morphometry and to compare these parameters between male and female Gujarati students.

Methods:A cross-sectional study was conducted on 250 Gujarati medical students (125 males and 125 females). Facial measurements were obtained using a Digital Vernier caliper with the head positioned in the Frankfurt plane. Parameters measured included lip width, upper lip height, upper vermillion height, lower lip height and lower vermillion height.

Results:In females, the mean cutaneous upper lip height was 17.30 ± 2.07 mm and exceeded the upper vermillion height (8.00 ± 1.47 mm). The lower vermillion height was 9.52 ± 1.48 mm, while the mean lower lip height was 14.91 ± 2.14 mm. Lip width recorded the highest mean value (46.72 ± 3.62 mm). In males, the mean upper lip height was 19.03 ± 2.35 mm. The upper vermillion height measured 9.30 ± 1.74 mm, the lower lip height was 16.59 ± 2.34 mm, and the lower vermillion height was 10.30 ± 1.67 mm. Mouth width showed the highest mean value (49.73 ± 5.08 mm). Overall mouth width exhibited the greatest variability, whereas vermillion height parameters showed lower dispersion. All parameters demonstrated statistically highly significant sexual dimorphism ($p < 0.001$), with males showing consistently higher mean values than females.

Conclusion:The study establishes normative lip morphometric data for the Gujarati population and demonstrates clear sexual dimorphism. These findings may be useful in plastic and reconstructive surgery, forensic science, anthropology and aesthetic facial procedures

Keywords: Lip morphometry; Sexual dimorphism; Gujarati population; Lip measurements; Vermillion height; Mouth width; Facial anthropometry; Facial esthetics; Digital Vernier caliper; Normative data

INTRODUCTION

Lips are important for facial expression, speech, smiling, eating and for aesthetic purpose (1). The physical appearance is closely related to an individual's own personality as well as its social acceptance and facial appearance plays important role in it (2). Facial form is a simple method to distinguish between people (2).

Face is divided into three parts via. upper, middle and lower thirds. The lips comprise the key esthetic feature of the lower third, with the upper lip essentially having a significant effect on the esthetic judgment of the face (3). The size and curvature of the exposed red lip surface is subject to considerable individual, gender and ethnic variation (4). These measurements alter

with age as well, although to a very small extent. Lips and their relationship with the position of anterior teeth considerably affect a person's smile and facial esthetics in general (5). Lips thin as people age and the wet line moves caudally; in addition, oral commissure begins to downturn as the age advances (6).

The lips are the key features of the lower third of the face and are discrete from the surrounding skin (7). The anthropometry of Lip- Nose complex at different ages provides measurements which serve as guidelines for 3-6 reconstruction of various deformities of these structures (8-11). Although various methods have been used to assess lip size for reconstructive or esthetic surgeries however these methods either require softwares or sophisticated medical gadgets, therefore a database of lip size (lip area and lip volume) can be of great help to reconstructive and esthetic surgeons (12).

MATERIAL AND METHODS:

A descriptive cross-sectional study was performed among 250 Gujarati medical students aged 17–26 years at Parul Sevashram Hospital, Parul Institute of Medical Sciences & Research (PIMSR) Limda, Waghodia, Vadodara, Gujarat.

Method of sampling- Cross-sectional study of descriptive type was carried out. Selection of samples was done by simple random sampling method.

As per **inclusive criteria** and the criteria for selection of subjects were as follows:

1. Pleasing profile with competent lips (13).

2. No history of prior surgical or orthodontic treatment (13).

3. Class I occlusion with near normal dental arches (13).

4. Normal overjet and overbite (13).

5. Devoid of any obvious defect or deformity (13).

6. Each subject should originally belong to the local area of Gujarat region (caste of each participant was mentioned).

7. Subjects should belong to 17-26 years of the age group. (out of 250 - 125 males and 125 female participants were part of the present study).

8. Only Gujarati medical students were the selected participant in the present study.

Exclusion criteria - Subjects with scarring, craniofacial trauma, amputated limbs, visible tumours, facial oedema, pregnant women as well as any physical signs of endocrine disorders such as dwarfism and gigantism were excluded from the present study.

The measuring procedure was explained to each participant clearly to eliminate the participant's anxiety and consent form filled by each participant as well as the caste of each participant was mentioned in each form.

Participants were asked to sit in a chair comfortably with the head lying according to Frankfurt's plane. Landmark was accurately marked using a skin marking pencil; then, the measurements was taken using a digital vernier caliper. All measurements were recorded twice by single investigator to minimize measurement error. Measurements were taken in millimeters. The data was analyzed by using SPSS 23.0 version. All the data was compiled and entered in Microsoft excel worksheet as master chart. The data was analyzed in the form of descriptive tables and charts. An independent Student's t-test was used to compare means between two groups (to determine the difference in mean between males and females); p value <0.05 was considered to be statistically significant.

TOOLS USED FOR THE STUDY:

- Digital Vernier Caliper
- Skin marking pencil

Specification

- Device name: Digital Vernier Caliper
- Manufacturer: Freeman's FDC200

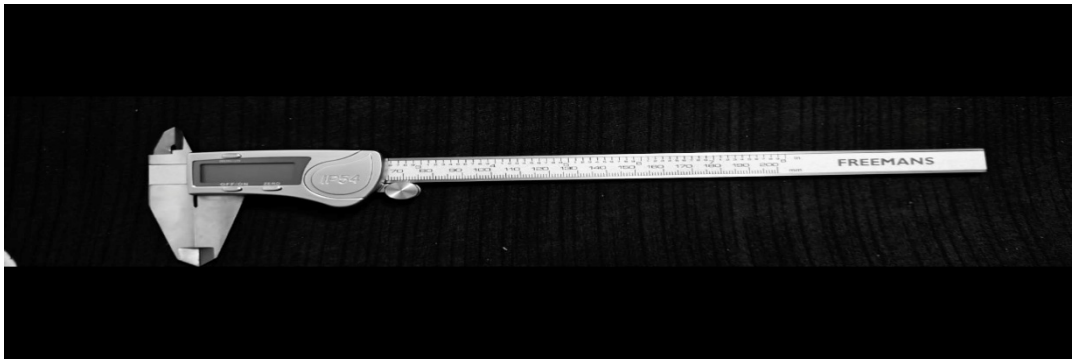


Figure 1: Digital Vernier Caliper used in anthropometric measurements for lips (Freeman's FDC-200).

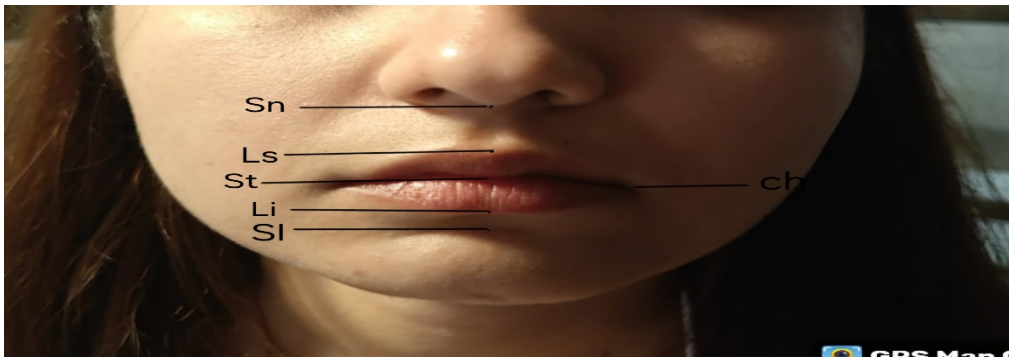


Figure 2. Linear measurements of the lips and mouth: upper lip height (sn–sto), upper vermilion height (ls–sto), lower lip height (sto–sl), lower vermilion height (sto–li), and mouth width (ch–ch).

Various landmarks marked on lips:

1. **Sn: Subnasale -** the point at which the nasal septum merges in the midsagittal plane, with the upper lip.
2. **Sto/ st: Stomion -** median point of the oral slit when the lips are closed.
3. **Ch: Chelion -** the most lateral point of the labial fissure.
4. **Ls: Labiale superius -** midline point of the vermillion border of the upper lip, at the base of the philtrum.
5. **Li: Labiale inferius -** midline point of the vermillion border of the lower lip.
6. **Sl: sublabiale -** the midpoint of the mentolabial sulcus.

RESULT AND DISCUSSION:

Table 1: Mean and standard deviation of anthropometric measurements of various parameters of lips in males.

S. No	Parameters	Mean	St. Deviation	Max	Min
1.	Sn-sto	19.02896	2.348902	26.100	11.090
2.	Ls-sto	9.29856	1.736246	13.600	4.670
3.	Sto-sl	16.59192	2.336942	22.560	8.560
4.	Sto-li	10.29672	1.669252	14.480	6.020
5.	Ch-ch	49.72704	5.081207	59.0	33.440

The anthropometric measurements of the lips in male participants were summarized in the table 1, showing the mean,

standard deviation, maximum and minimum values for each parameter.

- **Lip width (Ch–Ch):** Lip width was the largest measurement recorded, with a mean value of 49.73 mm and a standard deviation of 5.08 mm. It also exhibited the greatest variability among all parameters, indicating considerable individual variation in lip width within the study population.
- **Upper lip and upper vermillion heights:** The mean height of the cutaneous upper lip (Sn–Sto) was 19.03 mm with a standard deviation of 2.35 mm, which was greater than the mean height of the upper vermillion lip (Ls–Sto), measured at 9.30 mm with a standard deviation of 1.74 mm. This indicates that the cutaneous portion of the upper lip contributes more to total upper lip height.
- **Lower lip and lower vermillion height (least variable):** The lower vermillion lip height (Sto–Li) showed the least variability, with a mean value of 10.30 mm and a standard deviation of 1.67 mm. In contrast, the lower lip height (Sto–Sl) had a higher mean of 16.59 mm with a standard deviation of 2.34 mm, indicating greater variation compared to the lower vermillion height.

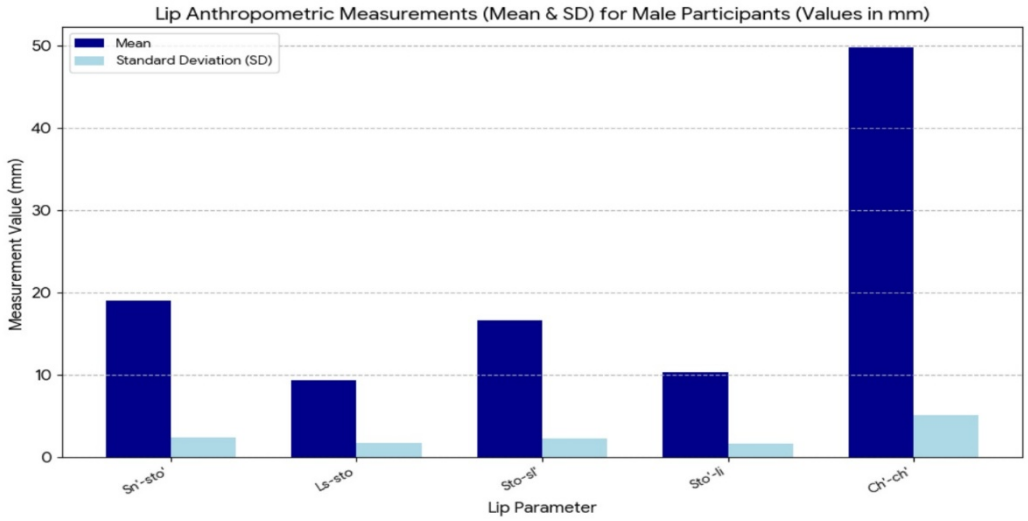


Figure 3: Depicting Mean and standard deviation of anthropometric measurements of various parameters of lips in male participants

Table 2: Mean and standard deviation of anthropometric measurements of various parameters of lips in females.

S.No	Parameters	Mean	St. Deviation	Max	Min
1.	Sn-sto	17.30472	2.066882	23.250	11.640
2.	Ls-sto	7.99960	1.466172	12.000	4.810
3.	Sto-sl	14.90624	2.140237	20.870	7.210
4.	Sto-li	9.52328	1.483198	12.400	5.270
5.	Ch-ch	46.71808	3.617063	61.570	34.000

- **Lip width (Ch–Ch):** Lip width was the largest and most variable parameter, with a mean value of 46.72 mm and a standard deviation of 3.62 mm. This indicates considerable inter-individual variation in lip width among the female participants.
- **Upper lip and upper vermillion heights:** The mean height of the cutaneous upper lip (Sn–Sto) was 17.30 mm with a standard deviation of 2.07 mm, which was greater than the mean height of the upper vermillion lip (Ls–Sto), measured at 8.00 mm with a standard deviation of 1.47 mm.
- **Lower lip and lower vermillion height (least variable):** The lower vermillion lip height (Sto–Li) demonstrated

the low variability, with a mean of 9.52 mm and a standard deviation of 1.48 mm, indicating high measurement consistency. In comparison, the lower lip height (Sto–Sl) showed a higher mean value of 14.91 mm with a standard deviation of 2.14 mm, reflecting greater variability.

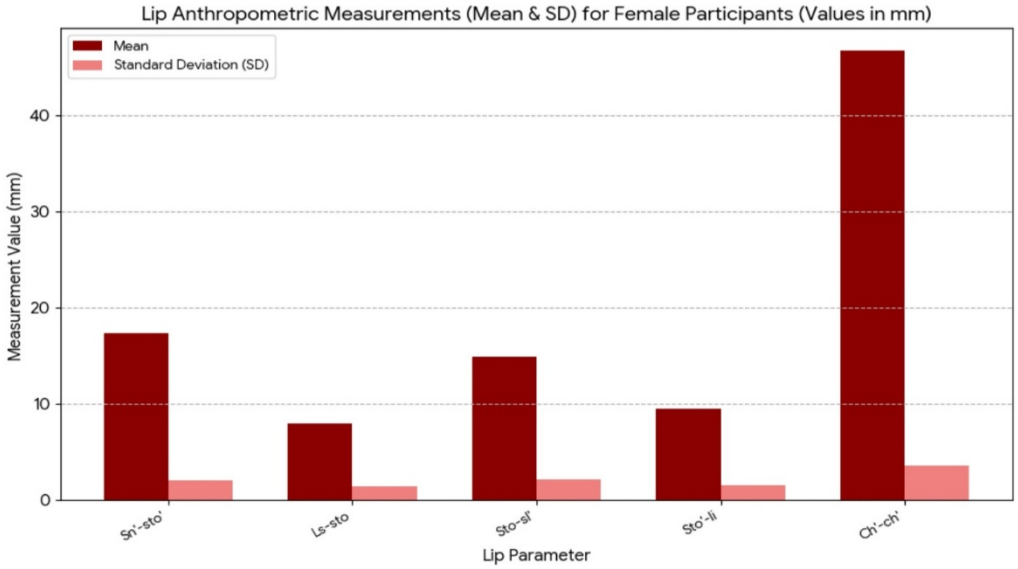
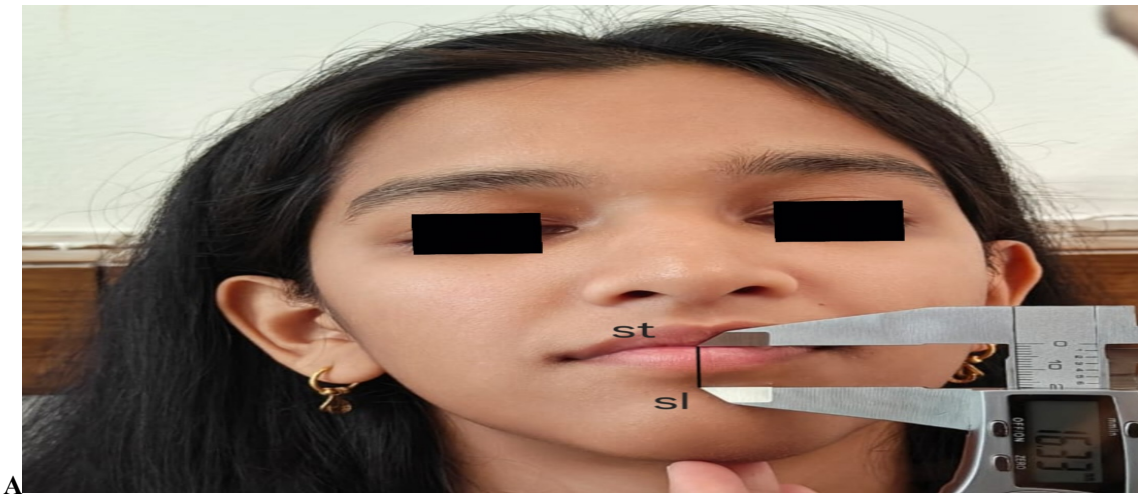


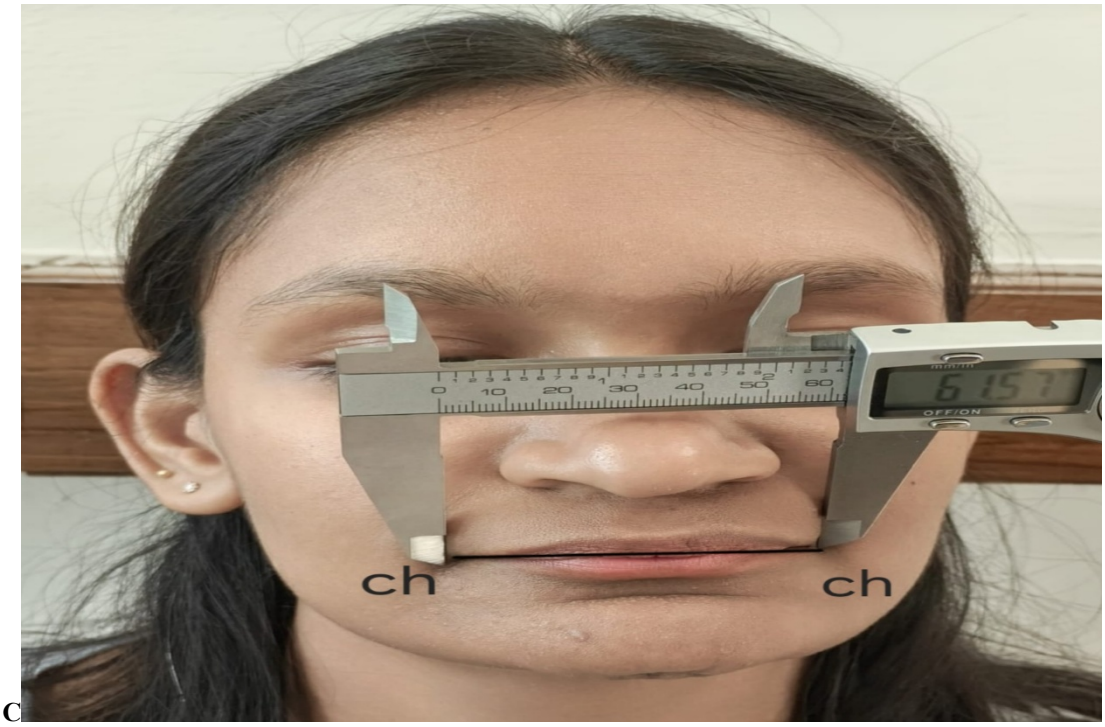
Figure 4: Depicting mean and standard deviation of anthropometric measurements of various parameters of lips in female participants



A

B

Figure 5: Anthropometric measurements of (A) Height of lower lip (B) Height of upper lip (C) Mouth width (D) Height of vermillion of upper lip (E) Height of vermillion of lower lip.



C

D E

Table 3: Association of gender with anthropometric parameters of lips of study participants.

S.No		Group	N	Mean	Standard Deviation	p value	t test
1.	Sn-sto	Males	**125**	19.02896	2.348902	**.001**	**6.161**
		Females	**125**	17.30472	2.066882		
		Total	**250**	18.166	2.370918		
2.	Ls-sto	Males	**125**	9.29856	1.736246	**.001**	**6.391**
		Females	**125**	7.99960	1.466172		
		Total	**250**	8.64908	1.730680		
3.	Sto-sl	Males	**125**	16.59192	2.336942	**.001**	**5.947**
		Females	**125**	14.90624	2.140237		
		Total	**250**	15.74908	2.390402		
4.	Sto-li	Males	**125**	10.29672	1.669252	**.001**	**3.873**
		Females	**125**	9.52328	1.483198		
		Total	**250**	9.91000	1.622738		
5.	Ch-ch	Males	**125**	49.72704	5.081207	**.001**	**5.394**
		Females	**125**	46.71808	3.617063		
		Total	**250**	48.22256	4.652455		

For all five parameters, statistically highly significant differences between gender were observed (p value <0.001). The mean values of all lip anthropometric measurements were higher in males as compared to females. This indicates that males have consistently larger lip dimensions in this study population. All parts of the lips do not grow with a fixed pattern at all ages, rather some sections grow more and some section grow less (14). Growth and development of the lips isn't a maturation process and it happens gradual and for many years (15). This phenomenon requires different changes but in tune with the lip and on the other hand it is related to age (15).

- The mean values of upper lip height (Sn-sto) were significantly longer in males (19.03 mm) than in females (17.30 mm). As age increases, the height of the lip significantly goes higher, and the younger, the total height of lips is lower, but the connection is poor (15).
- Similarly, the mean values of height of the vermillion of the upper lip (Ls-sto) in males (9.3mm) was statistically significant as compared to females (8.00mm). The shape and size of the lips are different in ethnic groups and have a lot of diversity. Thin lips are seen at European Caucasian, thick or very thick lips are seen in black people and combinational lips are usually seen in Orientals. The middle lips are the most common type with average size of 8-10 mm (16). So, as compared to our studies measurements, middle lips are the most common type.
- The mean values of height of the vermillion of the lower lip (Sto-li) in males (10.30mm) were significantly larger as compared to females (9.52mm). The upper lip height was higher when compared to lower lip height. The mean value of vermillion height of the lower lip was higher as compared to mean value of vermillion height of the upper lip. These data will be helpful in cosmetics purpose, lip reconstructive surgery like labiaplasty, lip enhancement surgeries and orthodontic treatment (1).
- The mean total lower lip height (Sto-sl) was significantly longer in males (16.59 mm) than in females (14.91 mm). Perhaps the younger age groups show lower sizes and the age of sexual maturity, sexual secretions and the development of male testis has influence on this difference (15).
- The mean width of the mouth (Ch-ch) was significantly wider in males (49.73 mm) than in females (46.72 mm). Accordingly, it seems that the average mouth width of the Persian cases was more similar and closer to men from Northern India, which may be due to impact of racial, nutritional, economic and cultural factors (15).

The present study demonstrates marked sexual dimorphism in the anthropometric dimensions of the lips. All measured

parameters showed statistically highly significant differences between males and females ($p < 0.001$), with males consistently exhibiting higher mean values. Vertical lip dimensions—including upper lip height, upper and lower vermillion heights and total lower lip height—were significantly greater in males, indicating a consistent pattern of increased lip height compared with females. Similarly, the horizontal dimension of mouth width was also significantly larger in males. The relatively greater dimensions observed in males may be associated with hormonal influences and sexual maturation. These normative data are clinically relevant and may be useful in forensic identification, orthodontic diagnosis, maxillofacial surgery, cosmetic and reconstructive procedures, and anthropological studies. Overall, the study confirms that lip morphology exhibits significant gender-based variation in the studied population.

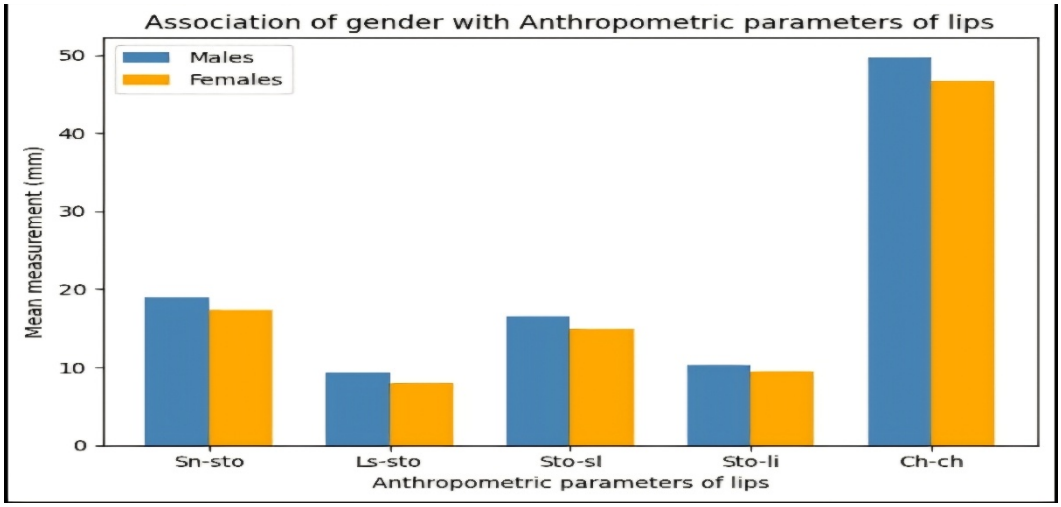


Figure 6: Depicting the association of gender with anthropometric parameters of lips

Table 4: Comparison of anthropometric measurements of lips with previous studies.

Parameters	Hasibuan LY etal (19)		Husein OF etal(20)		Heidari Z etal (18)		Kibadi AK etal (21)	Goel A (17)		Present Study	
Population	Indonesian males	Indonesian females	Indian American woman's	North American woman's	Baluch	Sistani	Negroid	North Indian males	North Indian females	Males	Females
Sn'-sto'	22.40±2.	20.78±2.96	18.6±3.2	20.1±2.0	18.9±1.1	18.9±1.4	11.7±1.1	20.51±2.25	18.72±2.05	19.02±2.3	17.3±2.07
Ls-sto	5.60±1.60	6.59±1.39	8.3±1.0	8.7±1.3	13.4±2.3	13.9±2.6		8.85±1.51	8.06±1.12	9.2985±1.7	7.9996±1.5
Sto-sl'	16.44±1.33	15.71±1.10			20.8±4.8	21.7±7.1	17.7±1.1	16.01±2.27	14.57±1.78	16.6±2.3	14.9±2.1
Sto'-li	10.51±2.09	10.02±1.38	10.1±1.3	9.4±1.5				9.7±1.63	9.15±1.32	10.3±1.7	9.5±1.5
Ch'-ch'	48.17±6.26	49.24±6.06	51.1±5.2	50.2±3.5	47.7±2.7	49.0±2.1	66.6±3.3	47.18±3.49	44.28±3.22	49.7±5.1	46.7±3.6

The function and aesthetic roles of the lips have been widely recognized in facial analysis. The physical appearance is closely related to an individual's own personality as well as its social acceptance and facial appearance plays important role in it. Facial form is a simple method to distinguish between people [2]. The lips comprise the key esthetic feature of the lower third of the face [3].

Lip measurements, in particular, show marked variations based on sex and ethnicity. The present study evaluated lip anthropometric parameters and compared them with previously published studies across different populations.

Upper lip height (Sn–sto)

In this study, the mean upper lip height (Sn–sto) was observed to be 19.02 ± 2.3 mm in males and 17.3 ± 2.07 mm in females, indicating pronounced sexual dimorphism. Comparable measurements have been documented in North Indian populations by Goel A (17). Similar observations were also reported among Baloch and Sistani groups by Heidari Z et al (18) In contrast, greater values were recorded in Indonesian males and females by Hasibuan LY et al. (19) whereas slightly reduced measurements were noted in our study as compared to American populations by Hussein OF et al. (20). These differences may reflect the influence of ethnic and genetic factors on soft-tissue facial morphology.

Upper vermilion height (Ls–sto)

The average upper vermillion height in the present study measured 9.30 ± 1.7 mm in males and 7.99 ± 1.5 mm in females. These values were consistent with findings reported in North Indian populations by Goel A (17). However, increased measurements were observed in Baloch and Sistani populations by Heidari Z et al. (18) while lower values were reported among Indonesian subjects by Hasibuan LY et al. (19). Such variations emphasize the role of ethnic diversity in determining vermillion dimensions.

Lower lip height (Sto–sl)

In the present study, the mean lower lip height measured 16.6 ± 2.3 mm in males and 14.9 ± 2.1 mm in females. These values closely correspond with findings reported in Indonesian populations by Hasibuan LY et al. (19) as well as North Indian data documented by Goel A. (17). Conversely, greater lower lip height measurements have been reported in Baloch and Sistani populations (18) indicating the presence of racial and ethnic variation in facial soft-tissue proportions.

In a study done by Sharma RL et al. (1), the lower lip height was higher when compared to upper lip height. The vermillion height of the lower lip was higher in compared to vermillion height of the upper lip.

Lower vermilion height (Sto–li)

The lower vermillion height observed in this study was 10.3 ± 1.7 mm in males and 9.5 ± 1.5 mm in females. These results were in agreement with observations reported by Hasibuan LY et al. (19) and Hussein OF et al. in Indian American women (20) as well as findings from North Indian populations reported by Goel A (17).

Mouth width (Ch–ch)

The mean mouth width was greater in males (49.7 ± 5.1 mm) than in females (46.7 ± 3.6 mm) in the present study. These measurements were comparable to those reported in Indonesian and Indian American populations (19,20). In contrast, smaller mouth width values were documented by Goel A. (17) suggesting intra-population variability. Additionally, markedly larger mouth width measurements reported in Negroid populations (21) emphasize substantial ethnic differences in transverse facial dimensions.

All parameters assessed in the present study exhibited sexual dimorphism, with males showing higher mean values than females. This trend is consistent with the previous studies across various ethnic groups [19, 20, 17]. Differences observed between the present study and previous reports emphasize the role of ethnicity, genetics, and environmental factors in determining facial soft-tissue characteristics.

CLINICAL AND FORENSIC RELEVANCE:

The normative data generated in the present study are valuable for forensic facial reconstruction, orthodontic diagnosis, and aesthetic treatment planning within the studied population. Comparisons with previous studies reinforce the necessity of utilizing population-specific anthropometric standards rather than universal norms, as supported by earlier authors [19, 17, 18].

The orolabial region frequently undergoes significant changes following trauma, orthognathic surgery orthodontics (1). Ethnicity, age and gender specific normative data are needed during the planning phase before surgical interventions in this region [22]. Fuller lips have been reported as a hallmark of beauty and fertility [3, 23]. The lip region has also been the subject of various rejuvenation procedures including augmentation cheiloplasty, soft tissue fillers, laser assisted and chemical peeling [24, 25].

CONCLUSION:

Comparison with previously published studies across diverse ethnic groups reveals both similarities and variations in lip dimensions, emphasizing the influence of ethnicity, genetic background, and environmental factors on facial soft-tissue morphology. The observations were in agreement with North Indian and Indonesian populations, whereas different when comparing some parameters of Baloch, Sistani and other ethnic groups, highlights population-specific variations in lip measurements.

Furthermore, the study confirms that upper lip and lower vermillion heights are generally greater than their counterparts, supporting existing literature and reinforcing their relevance in clinical evaluation. The data generated in this study can serve as a valuable reference in many aspects like forensic identification, orthodontic diagnosis, maxillofacial and reconstructive surgery, aesthetic planning and anthropological research. Overall, the findings contribute meaningful insight into gender and population-based variations in lip morphology and underscore the importance of population-specific anthropometric standards.

Conflict of interest- The author does not have any conflict of interest to declare.

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