Original Research Paper

Volume - 16 | Issue - 01 | January - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

ANATOMY

A STUDY OF LIP INDEX AMONGST CHILDREN WITH CONGENITAL HEARING IMPAIRMENT AND NORMAL CHILDREN FROM AN URBAN AREA MUMBAI

Dr. Motiram Ramji Khandode* Associate Professor, Department of Anatomy MGM Medical College Nerul *Corresponding Author

Dr. Sumedh Ganpat Sonavane Additional Professor, Department of Anatomy TNMC & BYL Nair Mumbai

Dr. Pranjali Rathod Assistant Professor, Department of Anatomy Vasantrao Naik Government Medical College Yavatmal

ABSTRACT

Background: The lips are a central feature in the lower third of the face, playing an important role in the evaluation of the craniofacial complex and the perception of facial beauty and attractiveness. Anthropometric (morphometric) measurements are of significant importance in forensic medicine, plastic surgery, and facial reconstruction surgery. This study was prompted by the scarcity of lip data in the Indian population. The primary aim was to create a lip morphometric database and determine the differences in the lip index (LIx) between children with congenital hearing impairment (who are known to have hyper-nasal voice) and normal children of 5 to 15 years from an urban area. The study sought to quantify and statistically prove the changing facial patterns that occur as age advances. **Material and Methods:** The study was conducted over 24 months. The total number of subjects was 1600, consisting of 400 males and 400 females in each of the two primary age groups: 5 to 10 years and 10 to 15 years. Subjects were divided equally into those with congenital hearing impairment (HI) and normal control (N) children. Measurements were projective (shortest distance between two points) and taken using a Calibrated Digital Point Vernier Calliper. The relevant labial surface landmarks marked were Labial superior (ls), Labial inferior (li), and Cheilion (ch). Two external lip measurements were taken: Length of Labial Fissure (LF) (ch-R to ch-L) and Height of Integumental Lip (LH) (Ls to Li). The Lip Index (LIx) was calculated using the formula: (Height of Integumental Lips (LH) / Length of Labial Fissure (LF)) X 100. Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS) Version 16.0, employing the unpaired t-test to compare variables.

Results: Statistically significant differences were observed in the mean LIx across various comparisons ($p \leq 0.002$).

- 5 to 10 Years Comparison: The mean LIx for Control males (36.51) and HI males (45.42) showed a statistically significant difference ($p=0.000$). A statistically significant difference ($p=0.000$) was also noted between Control males (36.51) and Control females (25.78).
- 10 to 15 Years Comparison: In the control group, the mean LIx for males (38.14) and females (37.28) showed no statistically significant difference ($p=0.739$). However, a statistically significant difference ($p=0.000$) was found between Control group males (38.14) and HI group males (37.02).
- Age Group Comparison (Control): There was a statistically significant difference in LIx for Control males between the 5 to 10 years group (36.51) and the 10 to 15 years group (42.76) ($p=0.002$). Control females also showed a statistically significant difference ($p=0.000$) between the 5 to 10 years group (25.78) and the 10 to 15 years group (38.26).
- General Observation: In both the Control and Hearing Impaired groups, the majority of males possessed a wider mouth compared to their female counterparts.

Conclusion: The study established a database of lip index measurements. The data gathered from this study on lip morphometric measurements can be beneficial for future studies concerning lip index in different age groups, populations, and ethnicities.

KEYWORDS : Lip Index, Length of Labial Fissure, Labial Superior, Labial Inferior, Height of Integumental Lip, Cheilion, Facial Reconstruction Surgery, Forensic Medicine

INTRODUCTION

The lips play an important role in evaluating and recognizing the craniofacial complex and our perception of facial beauty and attractiveness, impart a sense of youth and health [1]. Lips are the central feature in the lower third of the face [2]. The lips or labia oris are two fleshy folds which surround the orifice of the mouth, are formed externally by skin and internally of mucous membrane, between which are found orbicularis oris muscle, labial vessels, some nerves, loose areolar tissue, fat numerous small labial glands. The inner surface of each lip is connected in the middle line to the corresponding gum by a fold of mucous membrane known as frenulum. The surface of the lip is comprised of four zones: 1. Hairy skin, 2. Vermilion border, 3. Vermilion, 4. Oral mucosa. The normal shape of the lips varies with age, and is influenced by ethnicity. Vermilion is the red part of the lips. Vermilion border is present at mucoctaneous junction over the lips surface [3].

Forensic facial approximation is the process by which an individual's face is reconstructed from the skull. Various guidelines are used to determine certain characteristics of facial features such as the width and position of the mouth [4].

Thus, the significance of various facial anthropometric (morphometric) measurements in facial reconstruction surgery, plastic surgery and in forensic medicine is beyond doubt.

Physical anthropologist have in recent years become increasingly concerned with the dimensions, proportions and shape of man's immediate physical environment. They have made significant contributions in formulating standard sizes for various equipment used in defence services as well as production of industrial goods, anaesthetic and dental equipment etc.[5]

Since the concept of beauty and normal facial proportions has changed with time. It is apparent that what is considered beautiful and acceptable for one culture may differ for another culture.[6,7]

Inherently, the notion of a single aesthetic standard and beauty is grossly inadequate. Thus, a new model of aesthetic standards and beauty unique to a particular ethnic group is required. With the substantial increase in the number of cosmetic surgeries performed for patients of every ethnic group, it has become a great responsibility for surgeons to maintain core ethnic features while to achieve cosmetic enhancement.[8,9]

Scarcity of data on lip in Indian population prompted this study and is an attempt to have lip morphometric database to find the differences of lip index in children with congenital hearing impairment and its comparison with normal children of 05 to15 years from an urban area.

MATERIALAND METHODS

The present study conducted for duration of 24 months. The age groups for the present study were subjects were divided into two age groups viz. i) 5 -10 years and ii) 10 - 15 years.

Subjects for the study were selected by random sampling from schools of children with congenital hearing impairment as well as normal children as a control group from schools of an urban area.

The field work was carried out at respective schools for hearing impaired children and schools for normal children.

The subjects consist of 400 males and 400 females of each age group with total number of subjects were 1600, distributed as follows:

i) Children with congenital hearing impairment = 400 subjects (200 males and 200 females of age group 5 to 10 years)
ii) Normal Children = 400 subjects (200 males and 200 females of age group 5 to 10 years)
iii) Children with congenital hearing impairment = 400 subjects (200 males and 200 females of age group 10 to 15 years)
iv) Normal Children = 400 subjects (200 males and 200 females of age group 10 to 15 years)

External lip measurements were taken after approval of institutional and university Ethical Committees. Written informed consent were obtained from parent of subjects since all the subjects were minor however in addition ascent was also obtained from the subjects between 7 to 15 years prior to the measurements.[10]

Material used in the study as follows:

1. Calibrated Digital Point Vernier Calliper
2. Micro-pore Pen with Removable Ink
3. Digital Camera

Methods

➢ Criteria for selection of Age groups:

Size and shape of the face markedly altered with the growth of paranasal air sinuses. Paranasal air sinuses are rudimentary at birth but they enlarge appreciably during eruption of permanent teeth and after puberty.[11] As far as face is concerned, Schiltz (1955), Silomen (1955) and Montacer-Kuhssary (1955) found that, major growth bouts occurred between 6-8 years and then 11-15 years.[12,13,14]

Based on this information the age groups were selected from 05 to 10 years and 10 to 15 years from both the gender. School registers which had the record, date of birth of subjects was taken as the reliable reference for the age.

➢ Other criteria for selection:

1. The subject should not have any obvious facial and nasal deformity.
2. The subjects should not have undergone any facial and nasal surgical procedures.
3. The subject should not have any history of facial and nasal trauma.
4. The subject should hail originally from that particular urban area over at least three generations.

Following Three Relevant Labial Surface Landmarks Were Selected.[11]

1. Labile superior (ls)
2. Labile inferior (li)
3. Cheilion (ch): Left (ch-L) and Right (ch-R)

Above points were marked with removable ink with the help of micro pore pen on the subject's face.

To improve the consistency and to decrease the error in measurements great care were taken to locate and mark the landmarks.

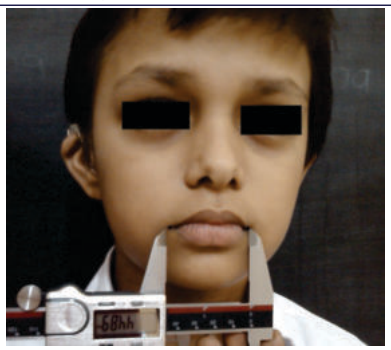
1. Labial Superior (ls): The midpoint of the upper vermillion line[11]
2. Labial Inferior (li):midpoint of the lower vermillion line[11]
3. Cheilion (ch): The point located each labile commissure

The following projective measurements (i.e. shortest distance was taken with calibrated point vernier calliper).

The data obtained in millimeters were converted to centimeters.

1. Length of Labial fissure (LF): (ch-R to ch-L) [Photograph No.1]
2. Height of Integumental Lip (LH): (Ls to Li) [Photograph No.2]

The lip index was calculated in different age groups and both genders of above mentioned subjects.



Photograph No. 1 Showing Length of Labile Fissure (LF) Length of Labile Fissure = Shortest Distance between Cheilion - Right to Cheilion – Left

Photograph No. 2 Showing Height of Integumental Lip (LH) Shortest distance between Labile Superior (ls) and Labile inferior (li)

Lip Index (LIx) = Height of Integumental Lips (LH) / Length of Labial Fissure (LF) X100.

Standard abbreviations were used in present study as mentioned by Farkas Leslie. The measurements were projective (i.e. the shortest distance between two points)

The head position varied according to the measurement to be taken. The most frequently head position was used the rest position, which was determined by the subject's own feeling of natural head balance.

Length of Labial fissure (LF): (ch-R to ch-L) The shortest distance between Cheilion-Right to Cheilion-Left.

Height of Integumental Lip (LH): (Ls to Li) The shortest distance between Labile superior to Labile inferior.

All measurements were taken only by the author. An average of the three readings was taken for every measurement to minimize the error.

Statistical Analysis

The following parameters were measured in each subject viz. Length of Labile Fissure (LF), Height of Integumental Lip (LH)

The data obtained was analysed statistically with the help of Statistical Package for Social Sciences (SPSS) Version 16.0 Window.

To compare between two independent groups (In between Age Groups and gender and for comparison between Hearing Impaired with control group) unpaired t test was used to compare variables viz. Lip Index (Lix).

Bar diagrams were plotted to show comparison between gender as well as hearing impaired with control group in the age groups of 5 to 10 years and 10 to 15 years.

OBSERVATION AND RESULTS

The statistical analysis used in this research was computer program SPSS version 16.0, T test was performed as comparison test, differences to examine the between the groups. P-value of <0.005 was

considered to indicate significance and P value of equal or less than 0.001 regarded as highly significant. The general characteristics of the study group included in this study were explored using mean and SD.

Table No. 1. Descriptive statistics: Age Group 5 to 10 years control Males and control Female

Parameter	Gender	No.	Mean	Std. Dev.	Std. Error	95% Confidences Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Lip Index	5 to 10 N Male	200	36.51	1.96	0.13	35.25	35.76	24.18	46.24
	5 to 10 N Female	200	25.78	2.69	0.19	25.40	26.15	15.05	36.57

Lip Index: 95% of males show lip index 35.25 to 35.76 and females show lip index 25.40 to 26.15

Table No. 2. Descriptive statistics: Age Group 5 to 10 years Hearing Impaired males and females

Parameter	Gender	No.	Mean	Std. Dev.	Std. Error	95% Confidences Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Lip Index	HI Male	200	45.42	3.08	0.21	45.00	45.83	43.90	46.94
	HI Female	200	43.90	2.84	0.20	43.50	44.29	42.38	45.42

Lip Index: 95% of males show lip index 45.00 to 45.83 and 95% of females show lip index 43.50 to 44.29

Table No. 3. Descriptive statistics: Age Group 10 to 15 years control group males and females

Parameter	Gender	No.	Mean	Std. Dev.	Std. Error	95% Confidences Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Lip Index	10 to 15 N Males	200	38.14	1.71	1.71	34.78	41.49	37.28	39.00
	10 to 15 N Females	200	37.28	1.89	1.89	33.53	40.98	36.42	38.14

Lip Index: 95% males lip index 34.38 to 41.49 and females have lip index 33.53 to 40.98

Table No. 4. Descriptive statistics: Age Group 10 to 15 years Hearing Impaired males and females

Nasal Parameter	Gender	No.	Mean	Std. Dev.	Std. Error	95% Confidences Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Lip Index	10 to 15 HI Males	200	37.02	2.73	.019	36.34	37.39	30.19	43.85
	10 to 15 HI females	200	30.18	1.56	0.11	29.96	33.39	23.35	37.01

Lip Index: 95% males lip index 36.34 to 37.39 and females have lip index 29.96 to 33.39

Group Statistics: Comparison between 5 to 10 years and 10 to 15 years age groups Control/Normal (N) males

Lip Index: The mean Lip Index in 5 to 10 years control group males have 36.51 whereas in 10 to 15 years control group males have 42.76 showing statistically significant difference (p = 0.002).

Group Statistics: Comparison between 5 to 10 years and 10 to 15 years Hearing Impaired (HI) Males

Lip Index: The mean Lip Index in 5 to 10 years Hearing Impaired males have 45.43 whereas in 10 to 15 years Hearing Impaired males have 37.02 showing statistically no significant difference (p = 0.296).

Group Statists: Comparison Between 5 to 10 Years and 10 to 15 Years Age Groups Control/Normal (N) Females

Lip Index: The mean Lip Index in 5 to 10 years control group females have 25.78 whereas in 10 to 15 years control group females have 38.26 showing statistically significant difference (p = 0.000).

Group Statists: Comparison between 5 to 10 Years Age Group and 10 to 15 Years Hearing Impaired (HI) Females

Lip Index: The mean Lip Index in 5 to 10 years control females have 43.90 whereas in 10 to 15 years females have 30.18 showing statistically significant difference (p = 0.000).

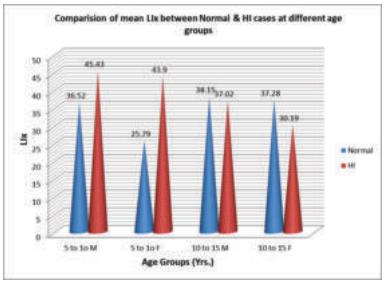


Chart No. 1. Comparison of Mean Lip Index (LIx) in Control/ Normal (N) and Hearing Impaired (HI) Subjects at 5 to 10 Years and 10 to 15 Years Age Groups

DISCUSSION

The purpose of present study is aimed at throwing light on changing lip parameters as the age advances by comparing them in different age groups and both the genders from congenital hearing impaired children with their control group counterpart (normal subjects).

The present study was conducted in two different age groups (5 to 10 years and 10 to 15 years) in which there is maximum growth spurt occurs in all facial and nasal parameters in addition among the two groups congenital hearing impaired subjects are known to have hyper nasal voice which may have due to facial and nasal growth pattern so this need to be quantified and statistically proved.

The present study evaluated the lip index (LIx) in children aged 5 -15 years, comparing normal-hearing and congenital hearing-impaired (HI) individuals across two age groups (5–10 and 10–15 years) and between genders. The findings indicate distinct patterns in LIx distribution, with noticeable differences based on age, gender, and congenital hearing status.

In the 5–10 years male group, the mean LIx was significantly higher in hearing-impaired children (45.43) compared to their normal-hearing counterparts (36.52), suggesting that HI males in this age group may exhibit increased vertical lip proportions. This trend was also observed in females of the same age group, where HI females showed a markedly higher LIx (43.90) than normal-hearing females (25.79). These results suggest that younger hearing-impaired children, regardless of sex, tend to have a significantly greater lip index compared to normal peers. This could be attributed to craniofacial developmental variations possibly influenced by underlying syndromic factors or altered orofacial muscle use in congenital hearing-impaired individuals.

However, the pattern changes in the older 10–15 years age group. Among males, the LIx values between normal (38.15) and congenital hearing-impaired (37.02) participants were nearly equal, suggesting that the differences observed in the younger group may diminish with age. In females aged 10–15 years, the LIx was again higher in normal children (37.28) compared to congenital hearing-impaired children (30.19), reversing the earlier trend.

Sexual dimorphism was also evident. Normal-hearing males had a consistently higher LIx than females in both age groups, reflecting known patterns of facial growth where males tend to exhibit greater vertical facial dimensions during development. However, among congenital hearing-impaired children, this trend was reversed in the 5–10 years group, where females had a slightly lower LIx than males, and the difference was more pronounced.

The high lip index in younger HI children may be associated with abnormal or compensatory orofacial muscle activity due to speech and auditory impairments. Additionally, syndromic or developmental conditions often coexisting with hearing impairment could contribute to these variations.

These findings emphasize the need for early identification of craniofacial growth deviations in congenital hearing-impaired children, which could impact orthodontic treatment planning, speech therapy, and surgical interventions. The age-related normalization of LIx in older HI males also highlights the potential for growth compensation over time.

Comparative Studies:
Several studies have explored craniofacial and orofacial morphology in hearng impaired individuals, supporting the current findings:

- Shibasaki et al. [14] found that children with sensorineural hearing loss had significant differences in craniofacial structure, including longer lower facial height and increased vertical proportions consistent with a higher Lip Index.
- Zhao et al. [15] reported altered lip posture and muscle activity in Hearing Impaired children, particularly in those who did not use hearing aids or cochlear implants early, which may affect lip dimensions.
- In contrast, Liu et al.[16] found no significant differences in facial morphology between Hearing I and normal children after the age of 12, supporting the current finding ofmpaired age-related normalization in Lip Index values.
- Singh et al. [17] emphasized the importance of early intervention (hearing aids/cochlear implants) in minimizing craniofacial deviations, reinforcing the notion that early auditory stimulation can influence orofacial development trajectories.

These comparative studies underscore the role of auditory feedback in orofacial development, and the potential for early therapeutic intervention to reduce structural anomalies.

Clinical Implications:
The findings suggest that early identification of altered lip proportions and craniofacial deviations in HI children is crucial. These structural differences can impact oral function, speech articulation, and aesthetic appearance, all of which are critical for psychosocial development. Early intervention, including speech therapy, myofunctional therapy, and where necessary, orthodontic or surgical intervention, may help manage these differences more effectively.

Moreover, recognizing age- and sex-related trends in LIx development can aid clinicians in timing interventions optimally, potentially taking advantage of natural growth compensation phases during adolescence.

Limitations
The study is cross-sectional in nature and may not capture growth trends longitudinally. Moreover, the sample size and potential variability in measurement techniques could influence the results. Future research should include larger samples, detailed analysis of facial types, and longitudinal tracking to assess how these differences evolve with growth.

v) Lip Index:
In control as well as Hearing Impaired groups majority of males have wider mouth as compared to their female counterpart.

In hearing impaired group majority of males have wider mouth as compared to the males of control group however the control group majority of females showed wider mouths as compared to females belonging from hearing impaired group.

Present study database of lip index will be useful for further study of lip anthropometric measurements and lip index in other age groups population and ethnicity. Lip index data will be helpful for facial plastic surgery, orthodontic surgery, cosmetic surgery, medical equipment's, facial masks, Anthropologist and Forensic experts for medico legal significance. Clinicians working in these fields by using these data will be able to estimate the normal and abnormal growth, planning and evaluating surgical treatment.

CONCLUSION:

I. Age Group 5 to 10 Years:

- Control group males and females shows wider mouth than Hearing Impaired group males and females

II. Age Group 10 to 15 Years:

- Hearing Impaired males and females shows wider mouth than their control group counterpart males and females

From the observations of present study, following conclusions are drawn:

- By virtue of this study, the design industry will be benefited to provide better and more comfortable face masks, nebulizer mask etc.
- Lip morphometric database of this study will also be useful for forensic experts in reconstruction of face from the skull in medico - legal cases,
- Facial plastic surgery, cosmetic surgery, medical equipment's industry will also get befitted by this study

Summary
Lip parameters and lip index serve as valuable tools in aesthetic medicine, forensic identification, and cosmetic surgery. They provide objective measurements for enhancing facial harmony, personal identification, and planning or evaluating surgical outcomes.

CONCLUSION
There is notable age, gender, and hearing-status-related variations in the lip index among children. These findings highlight the importance of early anthropometric assessment, especially in congenital hearing-impaired children, to support clinical interventions in orthodontics and speech-related therapies.

REFERENCES

1. Farkas LG, Kolar JC. Anthropometrics and art in the aesthetics of women's faces. Clin Plast Surg. 1987;14(4):599-616.
2. Farkas LG. Anthropometry of the Head and Face. 2nd ed. New York: Raven Press; 1994.
3. Burket LW, Greenberg MS, Glick M. Burket's Oral Medicine. 11th ed. Hamilton: BC Decker; 2008. p. 9–12.
4. Wilkinson C. Forensic facial reconstruction. In: Thompson T, Black S, editors. Forensic Human Identification. Boca Raton: CRC Press; 2006. p. 231-57.
5. Montagu A. An Introduction to Physical Anthropology. 3rd ed. Springfield: Charles C. Thomas; 1974.
6. Rhodes G. The evolutionary psychology of facial beauty. Annu Rev Psychol. 2006;57:199-226.
7. Little AC, Jones BC, DeBruine LM. Facial attractiveness: evolutionary based research. Philos Trans R Soc Lond B Biol Sci. 2011;366(1571):1638-59.
8. Rohrich RJ, Ghavami A. The African-American rhinoplasty. Plast Reconstr Surg. 2009;124(1):36e-48e.
9. Wong JY, Oh AK, Ohta E, Hunt AT, Rogers GF, Mulliken JB, et al. Validating three-dimensional photogrammetry in craniofacial surgical planning. Plast Reconstr Surg. 2008;121(1):87-93.
10. Standring S, editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. London: Elsevier; 2021. p. 707–710.
11. Schiltz R. Growth of the paranasal sinuses in childhood. Am J Orthod. 1955;41:XYZ–XYZ. As cited in: Enlow DH. Facial Growth. 3rd ed. Philadelphia: WB Saunders; 1990. p. 140–145.
12. Silomen RL. Developmental changes in paranasal sinuses. Angle Orthod. 1955;25:XYZ–XYZ. As cited in: Scott JH, Symons NBB. Introduction to Dental Anatomy. 9th ed. Edinburgh: Churchill Livingstone; 1982. p. 220–223.
13. Montacer-Kuhssary M. Growth pattern of facial sinuses during childhood and adolescence. J Anat. 1955;89:XYZ–XYZ. As cited in: Williams PL, Bannister LH, Berry MM, et al. Gray's Anatomy. 38th ed. Edinburgh: Churchill Livingstone; 1995. p. 1641–1644.
14. Shibasaki Y, Tsuji Y, Nishimura M, Ohno K. Craniofacial morphology in children with sensorineural hearing loss. Cleft Palate Craniofac J. 2011;48(2):155–60. doi:10.1597/08-120
15. Zhao Y, Wang S, Jiang T, Zhang Y. Orofacial muscle activity and lip posture in children with congenital hearing impairment. J Oral Rehabil. 2017;44(9):696–703. doi:10.1111/joor.12535
16. Liu H, Chen X, Lin H, Tan Y. Comparison of facial morphology between hearing-impaired and normal-hearing children after the age of 12. Int J Pediatr Otorhinolaryngol. 2019;119:180–5. doi:10.1016/j.ijporl.2019.01.033
17. Singh R, Batra P, Kaur M. The role of early auditory intervention in preventing craniofacial anomalies in children with congenital hearing loss. Int J Pediatr Otorhinolaryngol. 2020;134:110016. doi:10.1016/j.ijporl.2020.110016