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Evaluation and establishment of norms for facial index in Kerala population-a cross sectional study

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Abstract
The norms for facial index will help in clinical diagnosis and treatment planning in orthodontics. The established norms will assist orthodontist in determining the optimal amount, duration and timing of treatment. The norms will also be of value to maxillofacial and plastic surgeon in their treatment planning for patients from Kerala. Facial pattern indicates the direction of growth of craniofacial complex. Accurate facial analysis such as facial height, facial width and facial index is essential for diagnosis of genetic and acquired anomalies, for the study of normal and abnormal growth and for morphometric investigation. Kerala is a state with varied ethnicity, genetic influence, traditions, nutrition, environment and climate which influence the variation in facial morphology. No reports are available on the studies relating to face and facial dimensions of Kerala population so it is important to establish norms for facial index in Kerala population.
The main aim of this study is to evaluate and establish norms for facial index in Kerala population and to find out dominant facial type in Kerala population. And also to find out dominant facial type based on sexual dimorphism.

Keywords: Facial index, facial form, facial norms, facial height, facial width, anthropometry, Kerala population

Introduction
Variation in facial shape in a population is determined by facial anthropometry. It characterise the distinctive feature of a face in a particular population [1]. Face allows to differentiate one person from another, and also helps to distinguish between races, sexes, ethnic group and members of same family [2]. The measurable characters are never alike for two individual. Even genetically identical twins differ in some aspects. These characteristics undergo changes in varying degree under the influence of ecological, geographical, biological, racial, gender and age factor.
Comparing the change in facial index between parent offspring and sibling give the clue to genetic transmission of inherited characteristics [3, 4]. Anthropometry expresses quantitatively the form of the body and the sexual dimorphism, which refer to phenotypic character that differ in male and female [5, 6]. Anthropometric characteristics have direct relation with sex, shape and form of an individual and are manifestation of the internal structure and tissue components, which is influenced by environmental and genetic factor [7]. Ethnicity, genetic influence, traditions, nutrition, certain pathology conditions, environment and climate influences the type of head and face [8]. To evaluate these variation facial forms should be established in a particular population.
The most distinguishable feature in an individual is face. Face is anterior part of head which lies transversely between the ears and longitudinally from chin to the hairline which includes forehead, eyes, nose, mouth and chin [9]. The facial dimensions have got special interest in different fields including anatomy, forensic science, dentistry, reconstructive and cosmetic surgery. The measurements are essentially used in the treatment of reconstructive and plastic surgery due to congenital and post traumatic deformity. The first step in cosmetic and reconstructive surgery of face is facial analysis. In facial analysis, facial width, facial height and facial index is assessed.

Facial height will be measured from Nasion (point on the root of the nose where the midsagital plane cuts the nasofrontal sutures) to Menton (lowest point on the mandible where the lower margin of the lower jaw is intersected by the midsagital plane) with the help of sliding caliper

Facial width will be measured between the zygion (most laterally placed point on the zygomatic arch) of each side with the help of spreading caliper.

Facial index is calculated using formula

$$\text{Facial Index} = \frac{\text{Facial height}}{\text{Facial width}} \times 100$$

Based on this index, the facial shape and type will be categorised according to Banister's classification.

Classification of facial index determined on the basis of International Descriptions [10].

Facial Shape	Range of Facial Index	Type of face
Hypereuryprosopic	< 79.9	Very broad face
Euryprosopic	80-84.9	Broad face
Mesoprosopic	85-89.9	Round face
Leptoprosopic	90-94.9	Long face
Hyperleptoprosopic	> 95	Very long face

Facial form helps in diagnosis of genetic and acquired anomalies for the study of normal and abnormal growth and for morphometric investigations. Facial forms play an important role in orthodontic diagnosis, treatment planning and prognosis. The facial form is related to pharyngeal airspace [11], anatomy of masticatory muscles [12, 13], dentoalveolar anatomy [14] and occlusion type [15, 16]. The direction of growth of craniofacial complex is influenced by facial forms [17, 18], this helps to systemise the biomechanics used to treat orthodontic cases [19]. Postural relation of head, jaw and tongue are established during birth, and it alters as necessary to maintain airway [20]. There exist a link between respiration and malocclusion which could be due to soft tissue pressure against dentition that affect dental arch form, face morphology and direction of maxillary and mandibular growth. An alteration in jaw posture and head posture such as head extension will lead to stretching of facial musculature, which ultimately affects facial form. Occlusion and facial morphology are inter related, as there is strong evidence that such relationship is genetically determined. For this reason, it is important to identify how the face behaves in case of malocclusion, regardless of patient's age, since facial morphology is established at an early age. The spatial relationship established between mandible and maxilla tends to remain unchanged throughout the growth period, even though it has not achieved its final dimension at that point. This trend also applies to the sagittal relationship established between dental arches, with dental and facial patterns being determined at an early age [17]. Clinical facial analysis reveals the spatial arrangement of basal bones, maxilla and mandible, and is capable of identifying facial balance or skeletal discrepancy [21]. Facial index is also important factor in diagnosis and treatment of obstructive sleep apnea as euryprosopic face favours nasal breathing [4]. Hence facial index, facial height and facial width parameter should be given importance in orthodontics and more research should be done in this field.

Kerala is a state with varied ethnicity, genetic influence, traditions, nutrition, environment and climate which influence the variation in facial morphology. The present study is aimed to determine the morphometric facial types and their predominance in Kerala population. No reports are available on the studies relating to face and facial dimensions of Kerala population so it is relevant to establish norms for facial index in Kerala population.

Methods

The present study was cross sectional descriptive study to evaluate and establish norms for facial index in Kerala population. The protocol for the study was reviewed and approved by the Institutional Ethic Committee (IEC) of PMS College of Dental Science and Research, Vattappara, Trivandrum. (PMS/IEC/2017/07)

Volunteers from six Dental Colleges in Kerala geographically located on South, Central and North Kerala were selected. The following dental colleges were selected.

1. PMS College of Dental Science and Research Thiruvananthpuram.
2. Government Dental College, Thiruvananthpuram.
3. Government Dental College, Kottayam.
4. Amrita School of Dentistry, Ernakulam.
5. Pariyaram Dental College, Kannur.
6. KMCT Dental College, Kozhikode.

Sample size was calculated using the formula

$$SS = \frac{Z^2 \times p \times (1-p)}{C^2}$$

Total population of Kerala within the age group of 18 to 23 years is 305130759. Accordingly the sample size is determined with the following inputs.

The confidence level is 95%, level of significance is 5%, Z value is 1.96, confidence interval is 6%.

sample size based on the above formula is 270.

To increase the validity of the study the sample size was increased to 276 (138 males and 138 females) Volunteers from six dental colleges were slected which was divided into North zone, central zone and south zone.

North zone consisted of volunteers from

1. Pariyaram Dental College, Kannur
2. KMCT Dental College, Kozhikode

Central zone consisted of Volunteers from

1. Amritha School of Dentistry, Ernakulam
2. Government Dental College Kottayam.

South Zone consisted of volunteers from

1. PMS Dental College, Thiruvananthapuram.
2. Government Dental College, Thiruvananthapuram.

From each college 46 volunteers were selected, 23 males and 23 females.

Inclusion Criteria

1. People within the age group of 18 to 23 years.
2. People who are healthy without any obvious craniofacial abnormalities like congenital, developmental or acquired through any form of trauma.

3. People who are completely willing for this study and who will give a written consent.

Exclusion Criteria

1. People with any history of plastic or reconstructive surgery.
2. People with any congenital or developmental anomalies.

Methodology

Volunteers from six Dental Colleges in Kerala geographically located on South, Central and North Kerala, and who are native to those places respectively were selected. Study population was grouped into southern zone, central zone and northern zone based on the location of dental colleges. From each representative college 46 Volunteers, 23 males and 23 females were selected. Volunteers were selected by Simple Random Sampling. A proforma for nativity proof was distributed and obtained from volunteers. A permission letter was obtained from the principal of respective dental colleges where study will be conducted explaining the aim, characterstics, and importance of study.

The volunteers were asked to sit in a chair in relaxed position keeping the mouth closed and teeth in central occluded position and head in anatomical position. All the measurements will be carried out after locating anatomical landmarks and measurements will be taken to the nearest 1mm. Measurements will be recorded 2-3 times, average of the measurements will be taken.

Facial height was measured from Nasion (point on the root of the nose where the midsagital plane cuts the nasofrontal sutures) to Menton (lowest point on the mandible where the lower margin of the lower jaw is intersected by the midsagital plane) with the help of sliding caliper and Facial width will be measured between the zygion (most laterally placed point on the zygomatic arch) of each side with the help of spreading caliper.

Facial index was calculated using the following formula.

$$\text{Facial Index} = \frac{\text{Facial height}}{\text{Facial width}} \times 100$$

Based on this index, the facial shape and type will be categorised according to Banister's classification.

Classification of facial index determined on the basis of International Descriptions10.

Facial Shape	Range of Facial Index	Type of face
Hypereuryprosopic	< 79.9	Very broad face
Euryprosopic	80-84.9	Broad face
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Leptoprosopic	90-94.9	Long face
Hyperleptoprosopic	> 95	Very long face

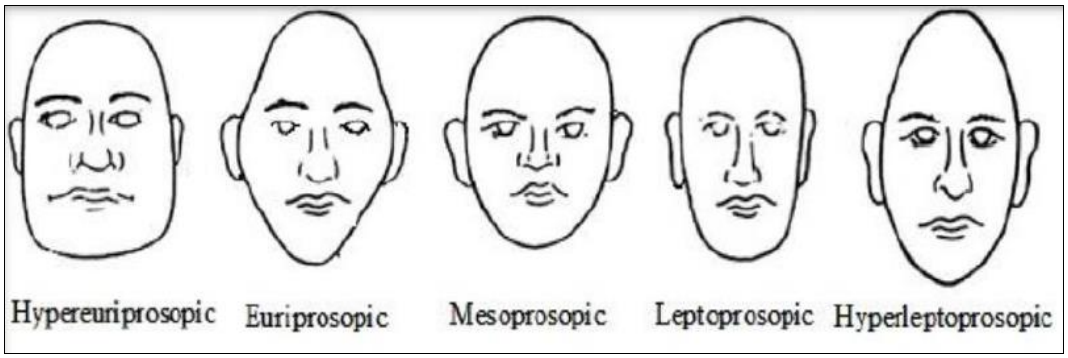


Fig 1: Morphological classification of facial form

Fig 2: Sliding caliper for measuring facial height

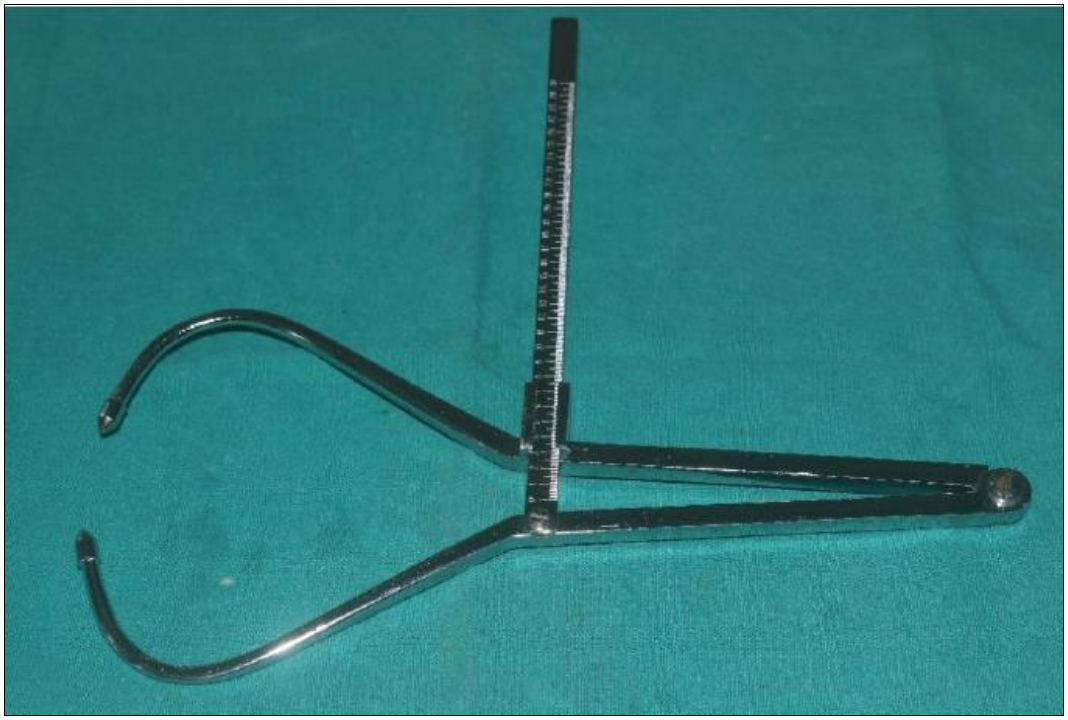


Fig 3: Spreading caliper for measuring Facial width.

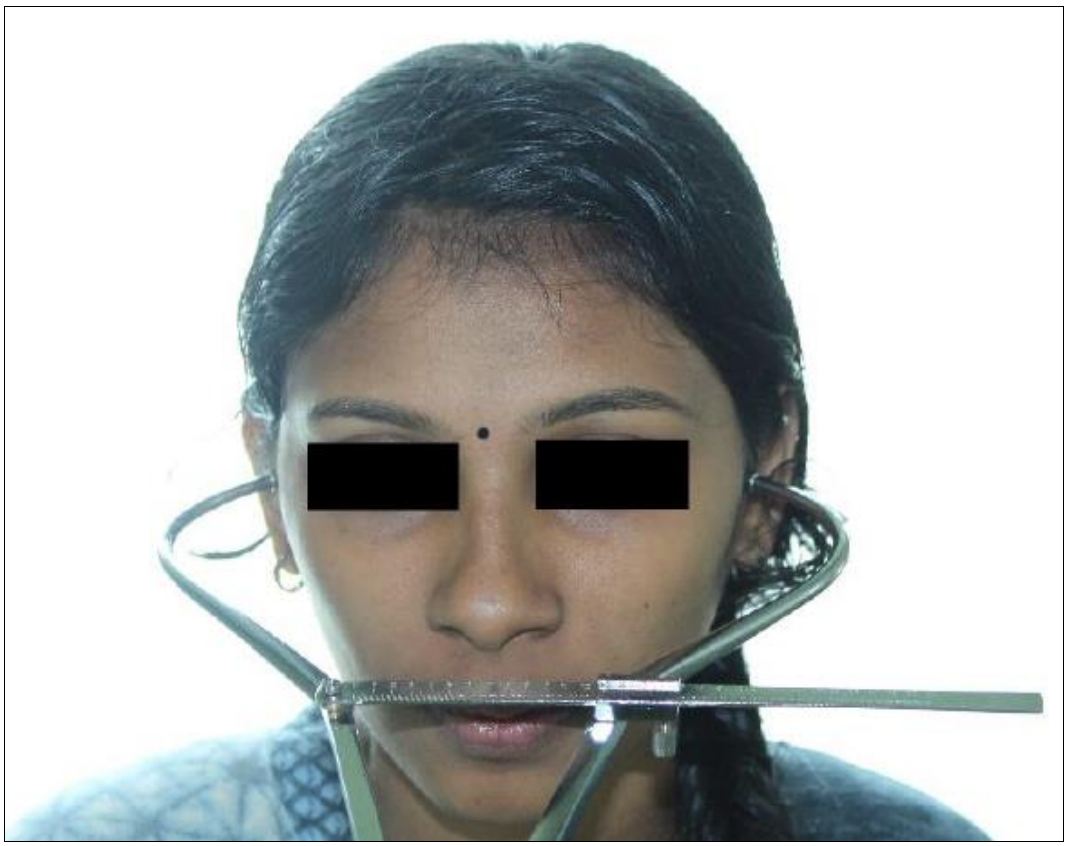


Fig 4: Showing Measurement of facial width.

Fig 5: Showing Measurement of facial height

Results

The present study was conducted for the evaluation and establishment of norms for facial index in Kerala population and to find out prevalent facial type based on sexual dimorphism. Study sample consisted of 276 subjects (138 males and 138 females) of age group 18- 23 years selected from 6 Dental colleges in Kerala, 46 subjects (23 males & 23 females) from PMS College of Dental Science and Research, Trivandrum, 46 subjects (23 males & 23 females) from Government Dental College, Trivandrum, 46 subjects (23 males & 23 females) from Government Dental College, Kottayam, 46 subjects (23 males & 23 females) from Amrita School of Dentistry, Ernakulam, K.M.C.T Dental College, Kozhikode and 46 (23 males & 23 females) samples from Pariyaram Dental College, Kannur.

Data was entered into Microsoft excel data sheet and was analyzed using SPSS for Windows (Statistical Presentation System Software, SPSS Inc.) version 17.0.

Continuous data was represented as mean and standard deviation. Student t test and chi square test was used.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram and Pie diagram.

p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel, SPSS version 17.0 was used to analyze data.

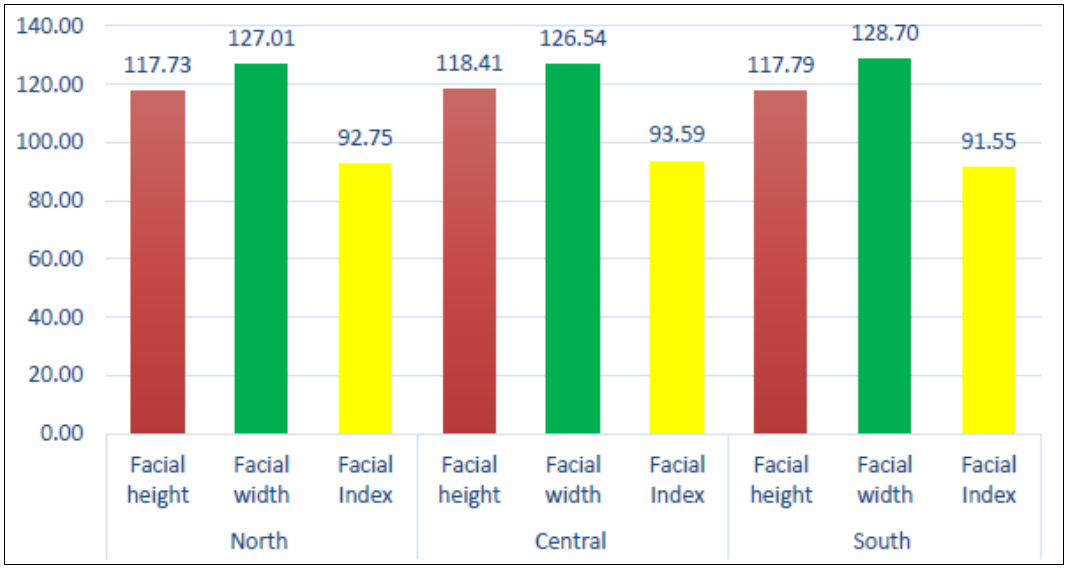
Table 1, table 2 and table 3 shows data for facial height, facial width and facial index from North, Central and South zones respectively. Facial height and facial width were measured in millimeters.

Descriptive details of Facial height, Facial width and Facial Index in North Zone, Central zone and South Zone

Table 4 and graph 1 shows mean facial height, facial width and facial index of each zone. In north zone the mean facial height of 117.72±5.45 mm, facial width of 127.00±5.33 mm and facial index of 92.74±3.66, In central zone the mean facial height of 118.40±5.71 mm, facial width of 126.54±5.54 mm and facial index of 93.59±2.77. In south zone the mean facial height of 117.78±5.73 mm, facial width of 128.70±4.53 mm and facial index of 91.55±3.99. Mean facial height, facial width and facial index of 3 zones is 117.97±5.62, 127.41±5.22, 92.63±3.6 respectively.

Table 4: Descriptive detail of facial height, facial width and facial index in North zone, Central zone and South zone

Zones	Group	N	Minimum	Maximum	Mean	Std. Deviation
North	Facial height	92	104.60	128.00	117.7293	5.45585
	Facial width	92	115.00	138.00	127.0087	5.33682
	Facial Index	92	81.72	98.40	92.7488	3.66336
Central	Facial height	92	104.90	131.00	118.4076	5.71595
	Facial width	92	114.00	143.00	126.5435	5.54994
	Facial Index	92	87.10	98.34	93.5918	2.77985
South	Facial height	92	104.00	128.00	117.7880	5.73194
	Facial width	92	119.00	139.00	128.7043	4.53686
	Facial Index	92	82.31	99.19	91.5530	3.99378
Total	Facial height	276	104.00	131.00	117.9750	5.62388
	Facial width	276	114.00	143.00	127.4188	5.22437
	Facial Index	276	81.72	99.19	92.6312	3.60255



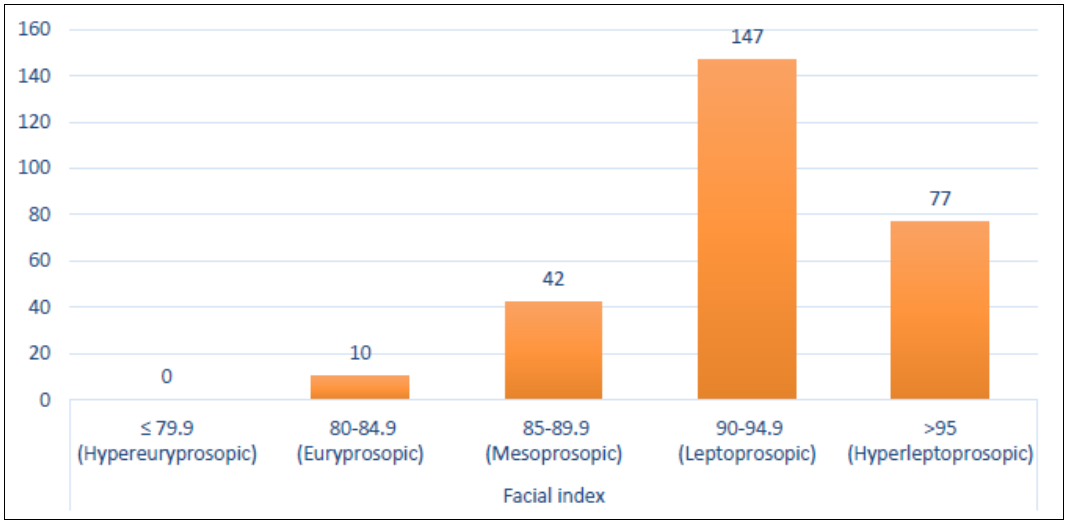
Graph 1: Descriptive detail of facial height, facial width and facial index in North zone, Central zone and South zone

Distribution of face type in Kerala Population

Table 5 shows distribution of facial type in Kerala population with 53.3% leptoprosopic facial form which is the most dominant facial form, 27.9% hyperleptoprosopic facial form, 15.2% mesoprosopic facial form, 3.6% euryprosopic facial form.

Table 5: Distribution of face type in Kerala population

		Frequency	Percent
Gender	Male	138	50.0
	Female	138	50.0
Facial index	< 79.9 (Hypereuryprosopic)	0	0
	80-84.9 (Euryprosopic)	10	3.6
	85-89.9 (Mesoprosopic)	42	15.2
	90-94.9 (Leptoprosopic)	147	53.3
	> 95 (Hyperleptoprosopic)	77	27.9



Graph 3: Distribution of face of type in Kerala population

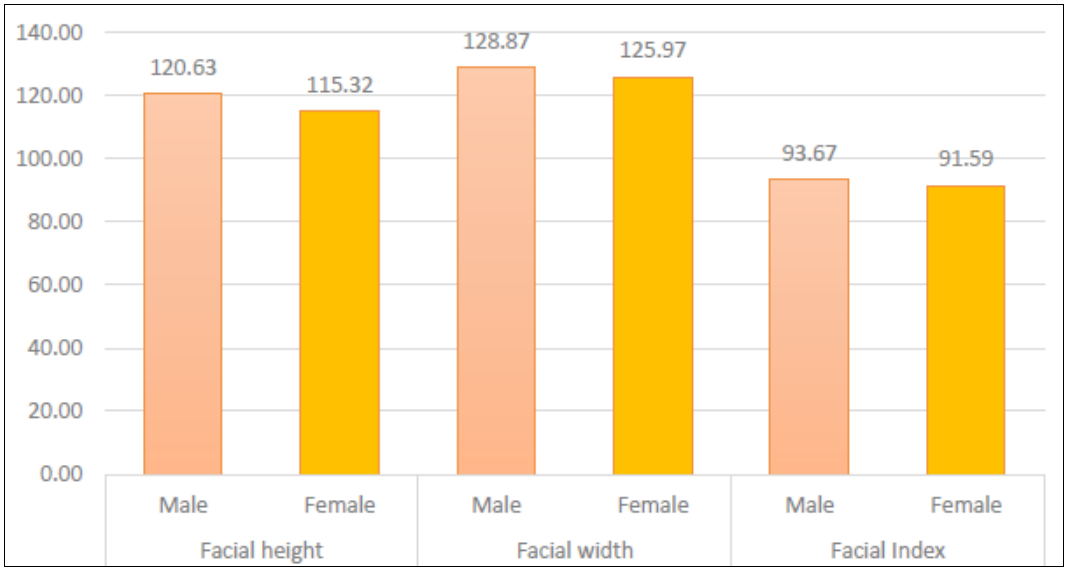
Comparison of Gender among the variables

Table 6 and graph 4 shows comparison of facial height, facial width and facial index between males and females and it was statistically significant with p value = 0.001. The mean facial height in females is 115.31±5.5 mm, facial width is 125.97±5.14 mm, facial index is 91.59±3.74. The mean facial height in males is 120.63±4.33 mm, facial width is 128.86±4.9mm and facial index is 93.67±3.14. The facial height, facial width and facial index was more in males than in females.

Table 6: Comparison of gender among the variables

Days	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
Facial	Male	138	120.6333	4.33942	.36940	0.001*
height	Female	138	115.3167	5.51540	46950	
Facial	Male	138	128.8674	4.90796	41779	0.001*
width	Female	138	125.9703	5.14510	.43798	
Facial	Male	138	93,6701	3.14320	26757	0.001*
Index	Female	138	91,5924	3.74133	31848	

* Significant at the 0.05 level.



Graph 4: Comparison of gender among the variables

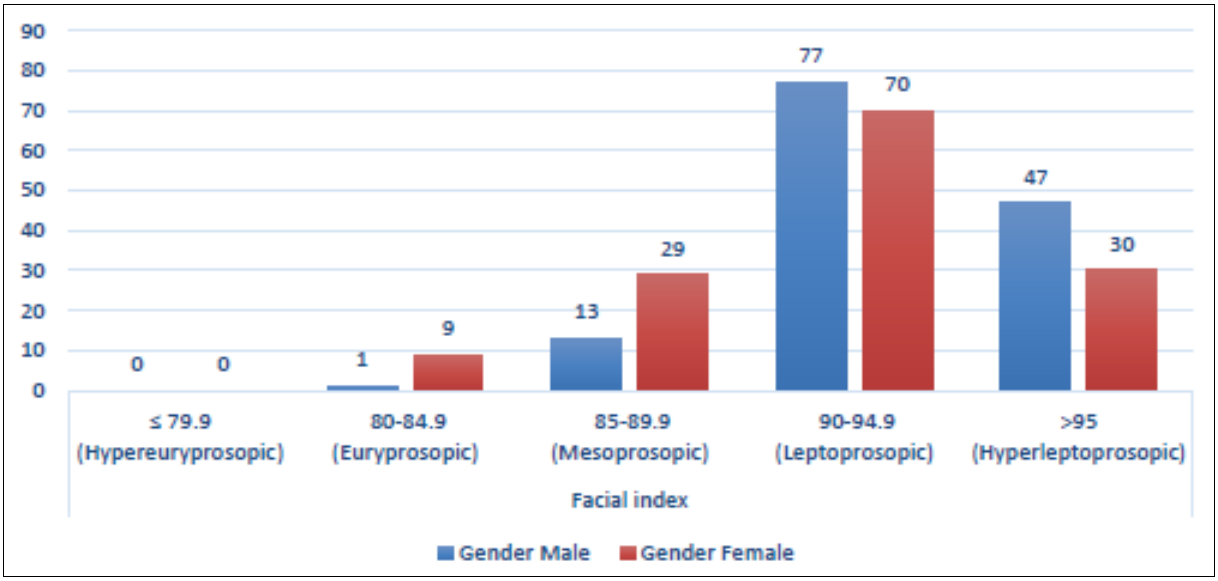
4. Comparison of Gender among facial index

Table 7 and graph 5 shows comparison of gender among facial index which shows in Kerala population males are 0.7% euryprosopic, 9.4% mesoprosopic, 55.8% leptoprosopic, 34.1% hyperleptoprosopic, and females are 6.5% euryprosopic, 21.0% mesoprosopic, 50.7% leptoprosopic, 21.7% hyperleptoprosopic.

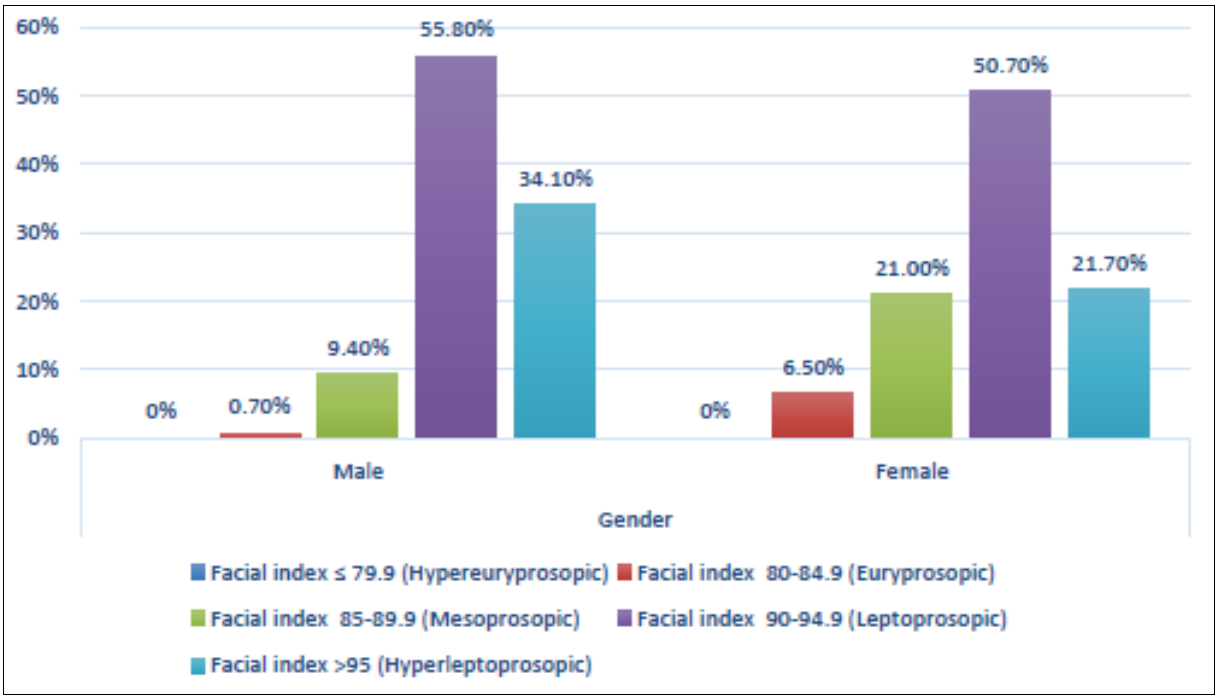
Table 7: Comparison of gender among the facial index

			Gender		Total
			Male	Female	
Facial index	< 79.9 (Hypereuryprosopic)	Count	0	0	0
		%	0	0	0
	80-84.9 (Euryprosopic)	Count	1	9	10
		%	0.7%	6.5%	3.6%
	85-89.9 (Mesoprosopic)	Count	13	29	42
		%	9.4%	21.0%	15.2%
	90-94.9 (Leptoprosopic)	Count	77	70	147
		%	55.8%	50.7%	53.3%
	>95 (Hyperleptoprosopic)	Count	47	30	77
		%	34.1%	21.7%	27.9%
Total		Count	138	138	276
		%	100.0%	100.0%	100.0%
P=0.001*					

* Significant at the 0.05 level.



Graph 5: Comparison of gender among the facial index



Graph 6: Morphological variation of facial index in males and females

Discussion

Analysis of the face is a preliminary and important step in the approach to the patient who presents for facial plastic and reconstructive surgery [22]. Previous studies have shown specific dentofacial characteristics in each ethnic group, leading professionals to consider these differences in orthodontic and surgical diagnosis and treatment planning [23]. The present study reported the anthropometrical variations in facial index of students by measuring morphological facial height, facial width and calculating facial index. All measurements were expressed in millimeters. The facial dimensions were expressed by facial index which is ratio of facial length to facial breadth and multiplied by 100. The present study revealed that the norm for facial index in Kerala population is 92.63±3.60, facial height is 117.97±5.62 mm and facial width is 127.41±5.22 mm. In north zone the mean facial height of 117.72±5.45 mm, facial width of 127.00±5.33 mm and facial index of 92.74±3.66, In central zone the mean facial height of 118.40±5.71 mm, facial width of 126.54±5.54 mm and facial index of 93.59±2.77. In south zone the mean facial height of 117.78±5.73 mm, facial width of 128.70±4.53 mm and facial index of 91.55±3.99. The mean facial index of males in Kerala population is 93.67±3.14 and the mean facial index of females in Kerala population is 91.59±3.74. The difference of facial index between males and females was statistically significant.

Shetti V reported the mean facial index for males and females as 87.19 and 86.75 respectively in medical students of Manipal Medical College, Manipal. The minimum facial indexes in both sexes were 75.75 and maximum facial index of males and females were 96.66 and 100 respectively. The difference that was observed between two groups was statistically significant (p=0.018). The dominant face type in Malaysian males were euriproscopic and female belonged to mesoproscopic. In the present study only 0.7% males were

euryprosopic and 21% females were mesoprosopic. The dominant facial type of male was leptoprosopic and the dominant facial type of female was leptoproscopic [25].

Study conducted by Sandip *et al*. on normal undergraduate medical students of Nepalese origin from BP Koirala Institute of Health Sciences (BPKIHS), Nepal found that the face form of males were mesoproscopic and of females were leptoproscopic. In the present study also the females were leptoprosopic. They showed the comparison of all measured parameters with geographical differences. In present study also the students included were from different ethnic and geographical variations and the measurements are affected by ecological, biological, geographical, racial,gender, age related and nutritional factors [37].

D. Jeremić *et al*. conducted anthropometric study of the facial index in the population of Central Serbia The research was conducted on 700 persons (360 males and 340 females), aged 18-65 years, selected randomly. The measured parameterswere morphological facial height and breadth. There were significant differences in the facial parameters of male compared to female subjects in all observed parameters. The mean value of the morphological facial height in the study population was 116.8mm±7.28, maximum facial breadth 124.12 mm±8.44, while the mean value of the total facial index was 93.68±6.86 which was close to the facial index in the present study which was 93.67±3.14. The dominant phenotype in the studied population was leptoprosopic which was similar to the facial type in the present study [30].

Mar Mar Wai *et al*. done nasofacial anthropometric study among university students of three races in Malaysia. The study was aimed to observe the variations of length and width of face and nose among university students of three races in Malaysia. A cross-sectional study was done on 200 college students aged between 18 and 21 years, using convenient sampling method. The mean facial index of Malay subjects showed 88.82±6.63, showing dominance of the leptoprosopic face type which was similar to the present study where dominant facial type was leptoprosopic [38].

Kanan U *et al*. studied the variation in facial index of Gujarati males. The study results showed that dominant type of male face was euriproscopic and rare type of face was leptoproscopic and hyperleptoproscopic which was opposite to the findings of present study as in Kerala Population dominant face type was leptoprosopic and the rare face type was Euryprosopic [29].

Jeyaseelann *et al*. studied facial index among the ethnic races of Malaysian Population. A total number of 565 students between the ages of 20 – 25 years, 179 Malays, 215 Chinese and 171 Indians were used in the present study. Facial index calculated from the measurements made. There was statistically significant difference in facial index among males and females of Indian race (p=0.032). Indian race, where males have a higher facial index than females. In the present study also males had higher facial index than males [41]. Raymond *et al*. (2019) studied on facial types and morphology among Sisaala and Dagaaba adult population in the Upper West Region, Ghana. In the study, a total of 387 healthy individuals (202 females and 185 males), be- tween 18 and 60 years of age were recruited. In the study main finding was that, the males had higher facialheight and breadth than females and the prominent facial type was leptoprosopic the findings were close to the present study [45]. In this study 53.3% are leptoprosopic, 27.9% are hyperleptoprosopic, 15.2% are mesoprosopic, 3.6% are euryprosopic, 0% hypereuryprosopic. Hence the commonest facial type in Kerala population is leptoprosopic second most common is hyper leptoprosopic third most common is mesoprosopic and least common is euryprosopic and hyper euryprosopic. In Kerala population males are 0.7% euryprosopic, 9.4% mesoprosopic, 55.8% leptoprosopic, 34.1% hyperleptoprosopic, and females are 6.5% euryprosopic, 21.0% mesoprosopic, 50.7% leptoprosopic, 21.7% hyperleptoprosopic which shows dominant facial type in males and females in Kerala is leptoprosopic.

This study had been conducted on 276 students in Kerala which is the limitation of this study. Hence, in future similar studies with larger sample size is recommended. The findings of study will be useful to orthodontists, plastic surgeons, anatomists, maxillo-facial surgeons and anthropologists. This study will serve as base line information for future facial studies on Kerala population.

Conclusion

Facial index is crucial for diagnosis and treatment planning in orthodontics [7]. Facial pattern indicates the direction of growth of craniofacial complex. Facial index influences the anchorage system, growth prediction of maxillofacial structures on orthodontic treatment outcome. Facial index also have influence on bite force and masticatory function [8]. In Kerala population 53.3% are leptoprosopic, 27.9% are hyperleptoprosopic, 15.2% are mesoprosopic, 3.6% are euryprosopic, 0% hypereuryprosopic. Hence the commonest facial type in Kerala population is leptoprosopic, second most common is hyper leptoprosopic, third most common is mesoprosopic and least common is euryprosopic and hyper euryprosopic. In Kerala population males are 0.7% euryprosopic, 9.4% mesoprosopic, 55.8% leptoprosopic, 34.1% hyperleptoprosopic, and females are 6.5% euryprosopic, 21.0% mesoprosopic, 50.7% leptoprosopic, 21.7% hyperleptoprosopic which shows dominant facial type in males and females in Kerala is leptoprosopic. In this study significant differences were found in the facial measurements and facial index of males and females with values being higher in males. Based on this study the most common type of face form in Kerala population is leptoprosopic. Both males and females are leptoprosopic. The facial measurements obtained in this study were quite different from the findings in other populations. Thus it supports the notion that there appears to be substantial variability in facial morphology under the influence of ecological, geographical, biological, racial, gender and age factor.

Conflict of Interest
Not available

Financial Support
Not available

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