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Facial Anthropometric Analysis of a Representative Subset in an Average Kerala Population: A Pilot Study

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Abstract

Background The Neoclassical canons, originally framed based on the Renaissance artworks, vary across genders, races, and ages. This has been proved in multiple studies conducted on the Western population, but minimal studies exist on the Eastern population and lesser so on the Indian population. This study aims to define the standard Keralite face and assess its variation from the canons.

Methods A total of 250 people of Kerala origin aged 18 to 40 years were studied over a period of 1 year in our institute. Standardized frontal and profile photographs of the subjects were taken. Twenty anthropometric measurements were taken and analyzed for variation between genders, from published Indian standards and their conformity to the Neoclassical canons.

Results Compared to the Keralite men, there were significant differences in 14 of 19 measurements in Keralite women. The men had wider and longer faces than women. Five of 10 measurements in females and 6 of 10 measurements in males significantly differed from the published Indian norms. The average Keralite face was wider, longer, and rounder. None of the facial proportions fit the Neoclassical canons.

Conclusion The average Keralite face significantly differed from the Neoclassical canons and there were some significant variations between genders. This study highlights the need for a larger population-based study with more representation from various regions across India.

Keywords
- Keralite face
- neoclassical canons
- facial analysis
- South Indian face

Introduction

The face defines the individual. Loss or deformity of a art or the whole face or even the slightest change in detail can effect changes that are perceived dramatic.[1] Surgical reestablishment of facial harmony requires restoration of proportional facial structures and elimination of disproportionate relationships. The optimal relationships between facial structures are used to assess the face during aesthetic and reconstructive consultations. The analysis of these facial relations can be done by anthropometry and cephalometry.

The earliest record of facial proportional analysis is in the Greek Neoclassical canons (c. 450 BC).[2] Modern anthropometry originated in 19th century from the works of anthropologist-physician Hrdlicka and later in the works of plastic surgeon Dr. Leslie Farkas on North American White populations.[3,4] Later, Farkas demonstrated significant racial and regional differences in the facial proportions in his

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International Anthropometric studies.[5] The study of these variations helps us to accurately assess and correct facial features in keeping with their ethnicity. This regional and ethnic variation of the face has a greater significance in the Indian Subcontinent. Knowledge of these variations would help us align the facial corrective procedure such as in transgender aesthetic surgery, pediatric facial deformities, posttraumatic facial deformities, etc., to the accepted normal of a particular region.

There have been many studies assessing the facial proportions of various Western populations, but studies on Eastern populations are few[6] and fewer so on Indian faces. This study aims to identify the facial features in a subset of population in the South Indian state of Kerala and compare them with published Indian standards.

Methodology

A total of 250 people (144 females and 106 males) of Kerala origin aged 18 to 40 years were studied during a 1-year period. The study population included the patients admitted to our institution for surgeries other than that of the face, their available bystanders (relatives), and the residents of the institution. Individuals with past facial trauma or surgery, Norwood grade 3 or above alopecia, and any gross facial deformity or asymmetry were excluded. The study subjects were randomly chosen from the above population, filtered as per the inclusion and exclusion criteria and recruited after obtaining their written consent. The study was approved by the Institutional Review Board.

Demographic data such as age, sex, and place of birth were taken. Frontal and profile photographs of all the subjects were taken with a DSLR camera mounted on tripod at uniform standard settings (camera height to correspond the central focal point with the nasal tip, focal length of 70 mm, natural lighting, and no flash). The patient was seated 1.6 m away from the camera and 0.8 m in front of the background screen, with the Frankfurt horizonal kept parallel to the floor.

Photographs thus obtained were analyzed in MS Paint and GIMP 2.10.14 software using facial soft-tissue reference points (►**Figs. 1** and **2**). Twenty anthropometric measurements and their proportions in accordance to the Neoclassical canons were calculated. The various measurements in male and female faces are shown in ►**Figs. 3–5**.

The proportions as per the Neoclassical canons are as given in ►**Table 1**.

The measurements thus obtained were analyzed with respect to variations among male and female faces, variations from the Neoclassical canons, and variations from published data on Indian facial proportions.

The data was entered in Microsoft Excel and analyzed using IBM SPSS software version 24. The association between the various variables was assessed using appropriate Student's *t*-test and chi-squared test. A p value of <0.05 was considered statistically significant.

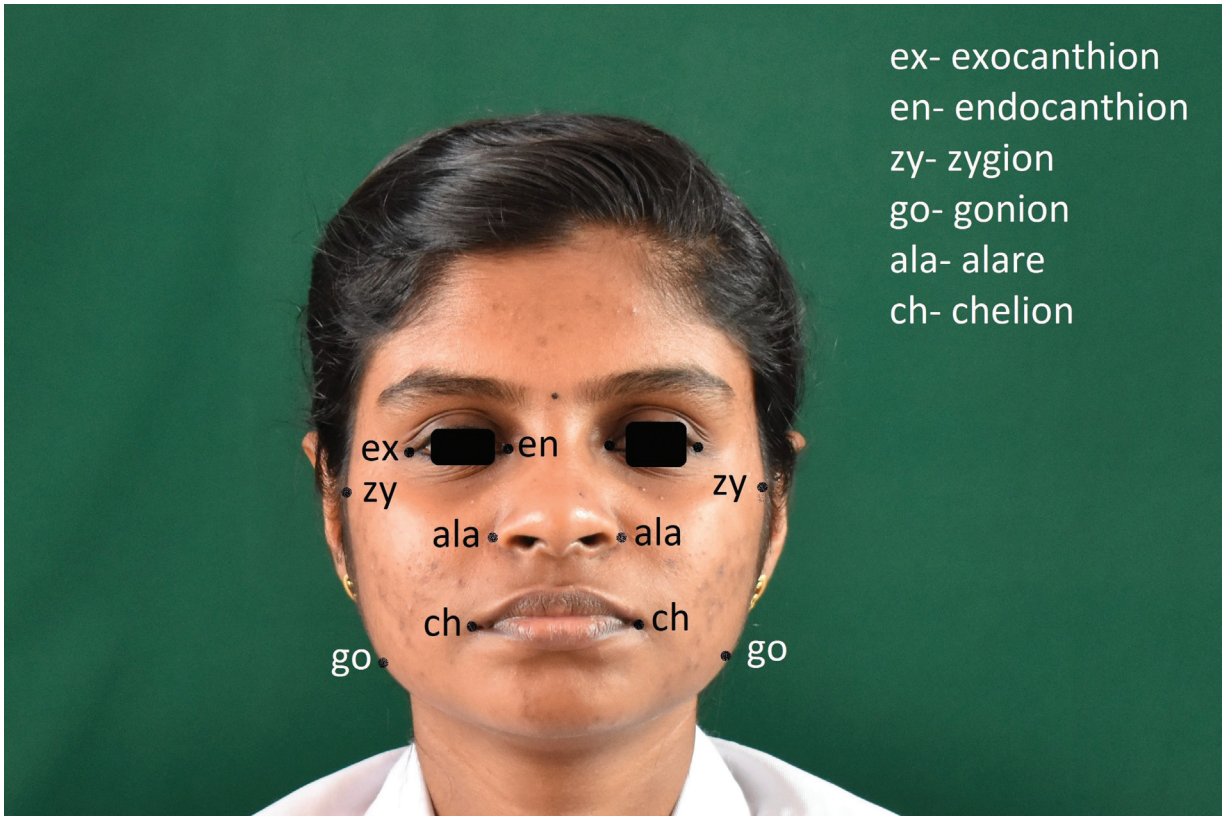

Fig. 1 Soft-tissue landmarks in frontal view.

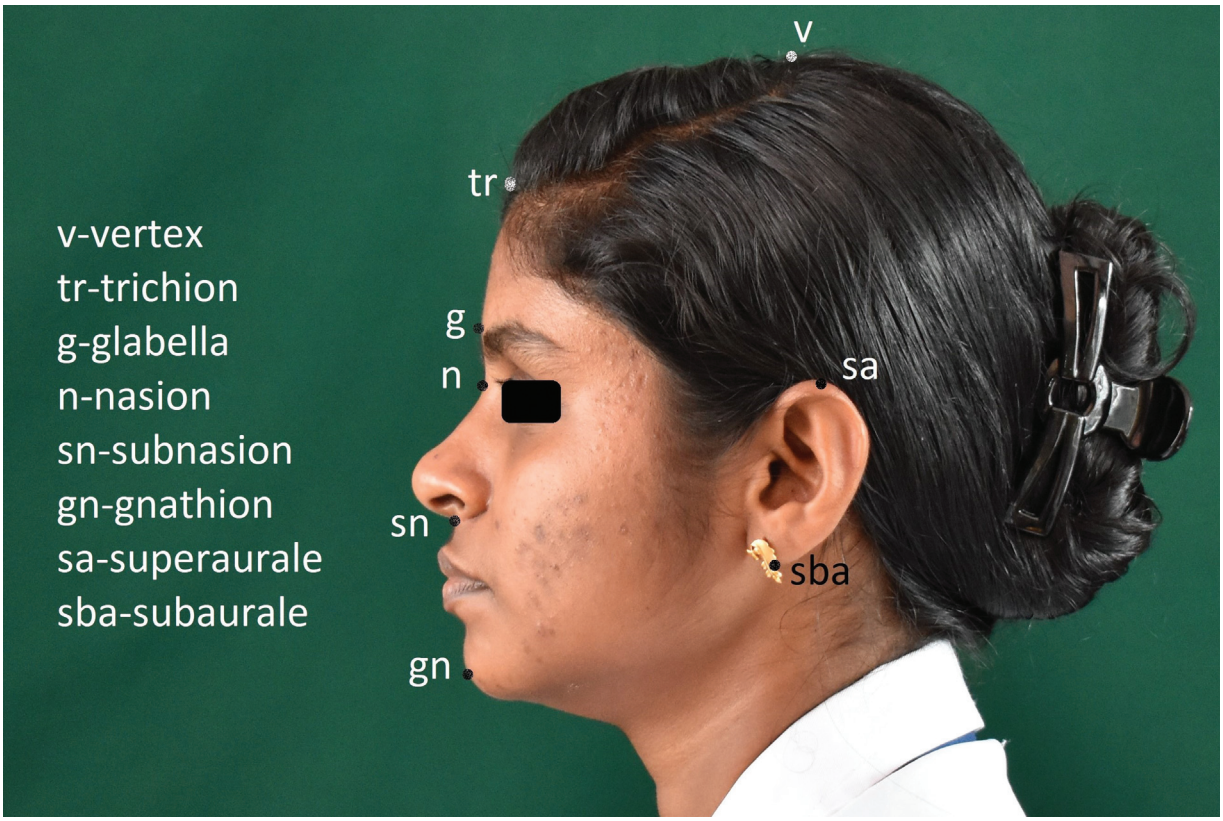

Fig. 2 Soft-tissue landmarks in profile view.

Results

A total of 250 subjects were studied. The study population consisted of 144 females (58%) and 106 males (42%) with an average age of 29.4 ± 6.7 years (range: 18–40 years). All the subjects belonged to Kerala with the majority coming from Central Kerala ($n = 168$ [67.2%]), and the rest from North ($n = 30$ [12%]) and South Kerala ($n = 52$ [20.8%]). A district-

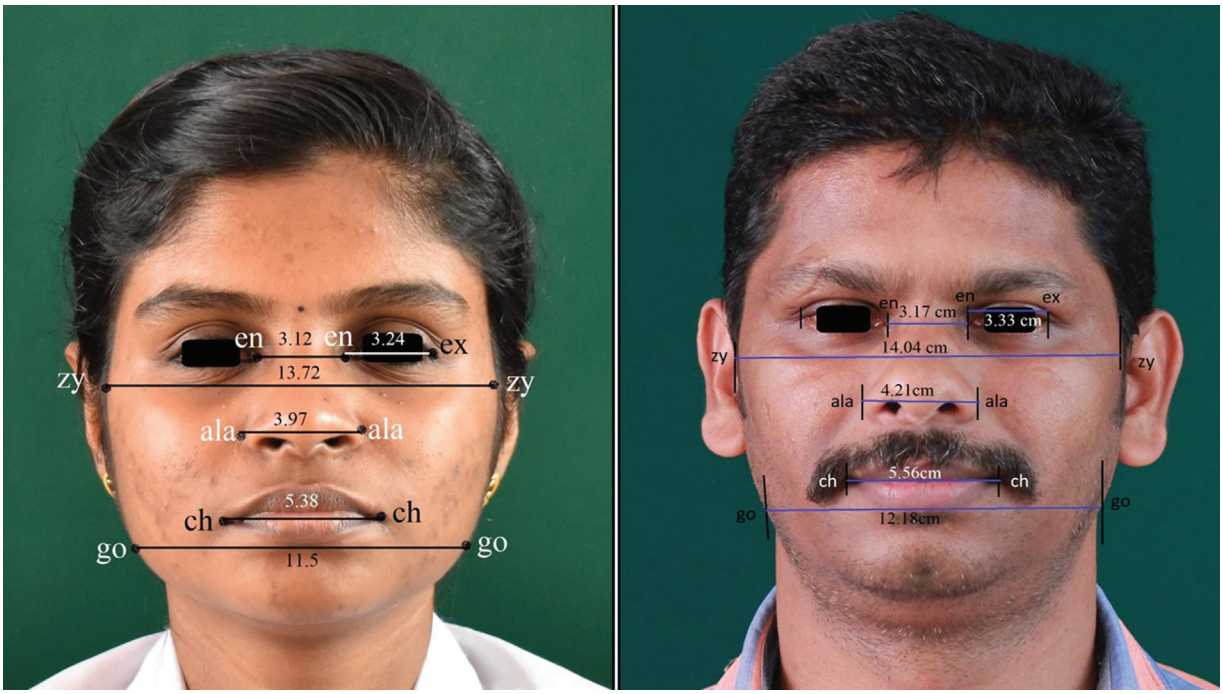

Fig. 3 Horizontal measurements: en-en = eye fissure length; zy-zy = upper facial width; go-go = lower facial; ala-ala = nasal width; and ch-ch = intercommissural width.

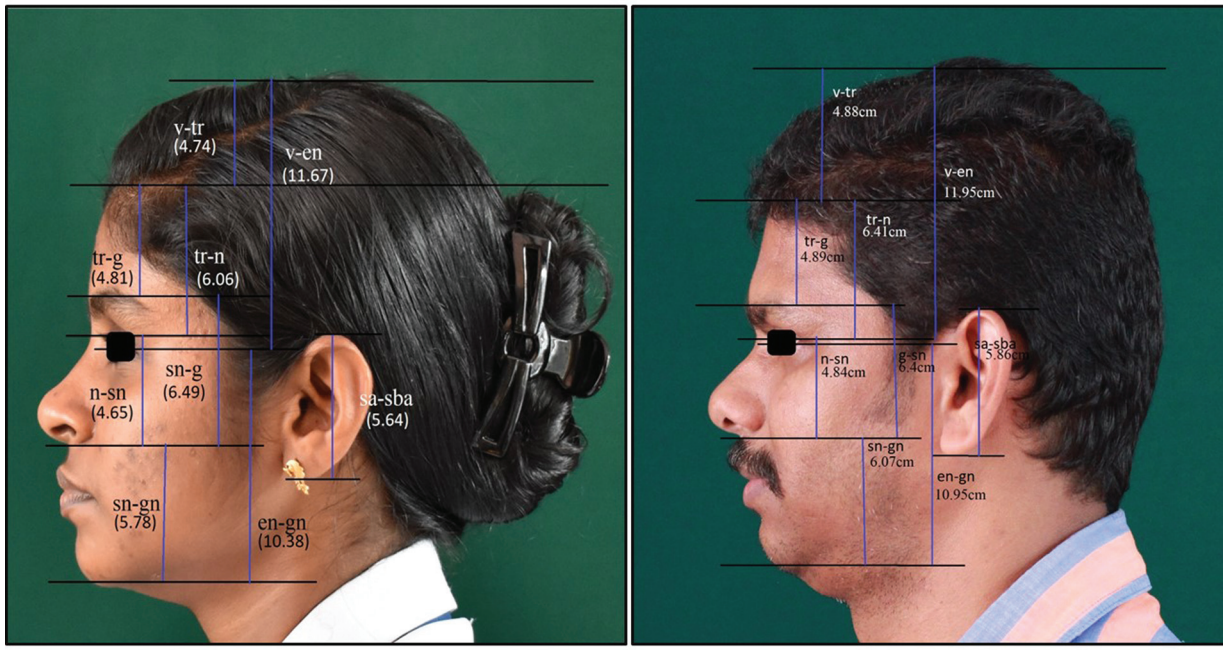

Fig. 4 Vertical height measurements: v-en = special forehead height; en-sn = special face height; tr-g = forehead height 1; tr-n = forehead height 2; g-sn = upper face height; n-sn = midface height/nasal length; sn-gn = lower face height; and sa-sba = ear length.

wise breakup of subjects is shown in ►**Fig. 6**. The analysis was done as follows.-

Part 1: Variation between Male and Female Study Subjects

Male and female facial measurements were compared using standard unpaired *t*-test. Statistically significant differences ($p < 0.05$) existed between men and women of the study population in 14 of 19 measurements taken. The average Keralite male has a wider and longer face than the average Keralite female ►**Supplementary Table S1** (available online only).

In general, males had a greater upper facial width (14 ± 1.16 vs. 13.7 ± 1.01 cm), lower face width (12.2 ± 0.95 vs. 11.54 ± 0.8 cm; $p < 0.00001$), nasal width (ala-ala; 4.21 ± 0.45 vs. 3.98 ± 0.36; $p < 0.00001$), intercommissural distance (ch-ch; 5.56 ± 0.51 5.39 ± 0.5), and longer lower faces (6.07 ± 0.68 vs. 5.79 ± 0.82 cm). Males also had a smaller

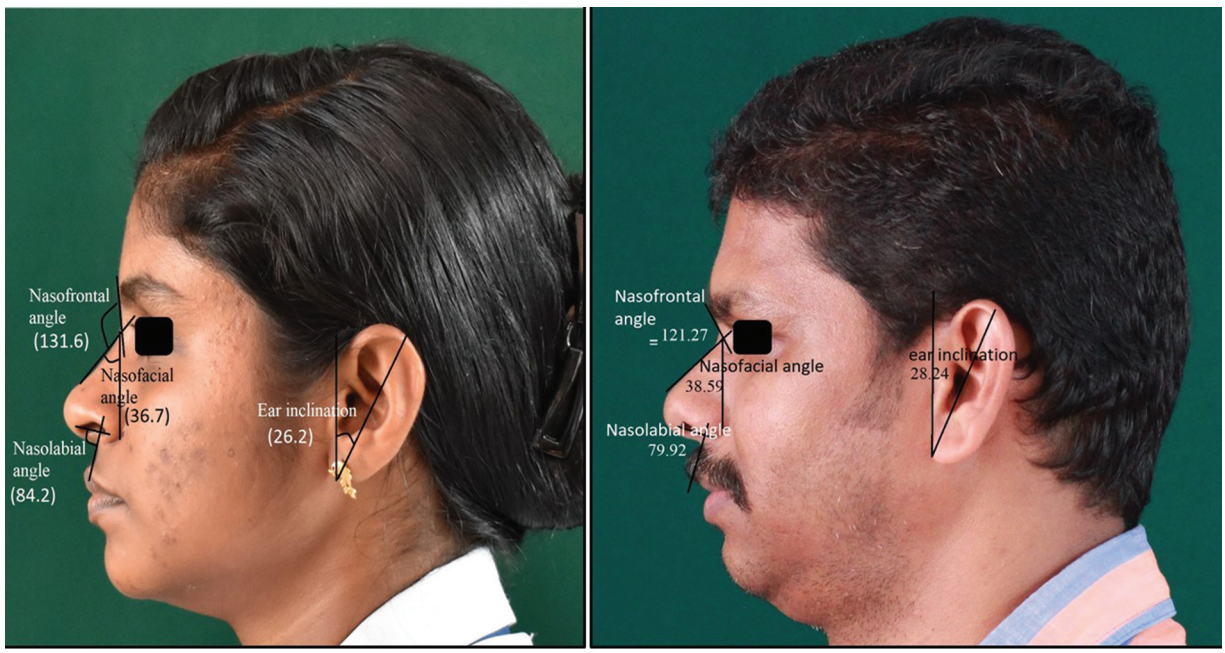

Fig. 5 Angle measurements of the face.

Table 1 Neoclassical canons

Canon	Description	Representation
Horizontal canons		
Nasofacial proportion canon	Nasal width is one-fourth the facial width	Ala-ala = 1/4 (zy-zy)
Nasoaural inclination canon	Inclination of the nasal dorsum is equal to that of the ear	Nasofacial angle = ear inclination
Orbital proportion canon	Intercanthal distance is equal to the eye fissure width	En-en = ex-en
Orbitonasal proportion canon	Intercanthal distance is equal to the nasal width	En-en = ala-ala
Naso-oral proportion canon	Intercommissural width is 1.5 times the nasal width	Ch-ch =1.5 (ala-ala)
Vertical canons		
Two-section canon	Special forehead height is equal to the special facial height	v-en = en-gn
Three-section canon	Forehead height 2, midface height, and lower face height are equal	Tr-n = n-sn = sn-gn
Four-section canon	Calva height, forehead height 1, upper facial height and lower facial height are equal	v-tr = tr-g = g-sn = sn-gn
Nasoaural proportion canon	Midface height is equal to the vertical length of the ear	n-ns = sa-sba

Abbreviations: Ala, alare; ch, chelion; en, endocanthion; ex, exocanthion; g, glabella; go, gonion; gn, gnathion; n, nasion; sa, superaurale; sba, subaurale; sn, subnasion; tr, trichion; V, vertex; zy, zygion.

nasofrontal angle (121.3 ± 11.4 vs. 131.7 ± 7.8 degrees; $p < 0.00001$) and nasolabial angle (79.9 ± 10.6 vs. 84.1 ± 8.3 degrees) and a greater nasofacial angle (38.6 ± 5.1 vs. 36.6 ± 4.7 degrees; $p = 0.001$).

Part 2: Comparison with Published Indian Data

The measurements obtained in the study were compared with published Indian norms taken from the worldwide anthropometric study done by Farkas et al[5] using the unpaired Student's *t*-test ►**Supplementary Table S2** (available online only).

Five of 10 measurements in females and 6 of 10 measurements in males were statistically significant. The women had a greater upper facial width (13.7 ± 1.01 vs. 12.4 ± 0.84 cm) and lower facial width (11.53 ± 0.88 vs. 9.74 ± 0.54 cm) in comparison to the published norms. Also, they had wider

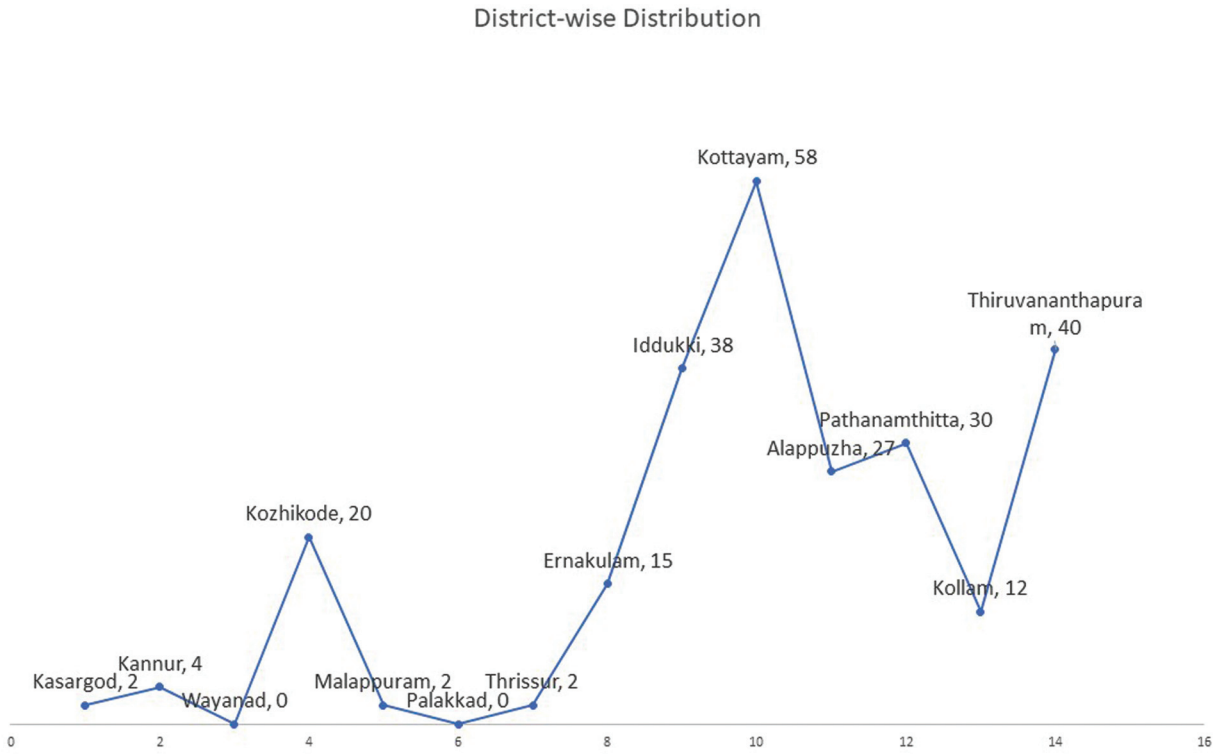

Fig. 6 District-wise breakup of the study population.

mouths (5.39 ± 0.5 vs. 4.65 ± 0.3 cm) and larger midface height (4.65 ± 0.72 vs. 4.37 ± 0.36 cm).

The men had findings similar to those of the women.

Part 3: Comparison with Neoclassical Canons

Differences were calculated using the chi-squared test.

Horizontal Canons

The nasofacial proportion canon held true only in 1.6% of the subjects ($n = 6$). The majority of the study population had a nasal width greater than one-fourth of the upper facial width. The orbital proportion canon held true in 37.2% of subjects ($n = 93$). In all, 45.3% of males and 45.8% of females had a shorter intercanthal distance compared to the eye fissure size. The intercanthal distance was lesser than the nasal width in 98.5% of females ($n = 142$) and 98.1% of males ($n = 104$). The rest of the subjects ($n = 4$) fitted the orbitonasal proportion. Thirty-three subjects (13.5%) fitted the naso-oral proportion canon. The intercommissural width was less than 1.5 times the nasal width in 87.7% males and 79.2% females. The nasal inclination was greater than the ear inclination (nasoaural inclination canon) in 92.7% males and 91.7% females in the study cohort ►**Supplementary Table S3** (available online only).

Vertical Canons

With respect to the two-section canon, the special forehead height (v-en) was equal to the special face height (en-gn) in only 30.2% of males ($n = 32$) and 15.3% of females ($n = 22$). The majority of the study subjects (66.9% males and 84% females) had a special face height greater than the special forehead height. With respect to the three-section canon, 79.9% of the females and 47% males had an upper face (sn-g) larger than their lower face (sn-gn). The forehead height 1 (tr-g) measurement was uniformly small in both sexes. With respect to the four-section canon, in the majority of the subjects, the forehead height 2 (tr-n) was greater than the nasal height (n-sn) and the lower face height (sn-gn). The calva height (v-tr) was nearly equal to the nasal height in all the subjects (mean calva height $= 4.8 \pm 0.7$ cm; mean nasal height $= 4.73 \pm 0.65$ cm). The ear length was greater than the total nasal length in 88.7% males and 93.7% females. Only 2.6% ($n = 14$) of the subjects fitted in the nasoaural proportion canon ►**Supplementary Table S4** (available online only).

Discussion

The face, a mosaic of lines, depressions, prominences, and contours producing reflections of light and shadow, is the most scrutinized part of the body.[1] The symmetry of the face is determined by a number of measurements and proportions, the analysis of which can be done in many ways, such as the Neoclassical canons, the golden proportion (phi), facial indices, etc.[7,8] The majority of studies on the facial proportions, including the landmark paper by Farkas on the interregional and interethnic variation of facial proportions, were based on the Neoclassical canons[3–6,9] and also provided the measurements of the average Indian face.[5] Hence, the Neoclassical canons were chosen over the others in this study.

The facial architecture can be altered to obtain favorable symmetry or enhancement or correction in such cases as posttraumatic disfigurement, congenital deformity, transgender facial aesthetic alteration, etc. Knowledge of the facial proportional standards pertaining to the concerned ethnicity is essential to achieve optimal outcome. The Neoclassical canons, a set of facial proportions that define the ideal face, were formulated based on artworks of the Renaissance period. They were eventually found to be nonideal, with numerous interracial differences, as published in many volumes of work by Farkas. The enormous volumes of works, however, do not give enough information on the variety found in the Eastern populations and more so within the Indian Subcontinent. We have attempted to elucidate the facial proportions and variations from published standards in a subset of population from the South Indian state of Kerala.

In our study, the average Keralite man was found to have a larger face compared to the average Keralite woman in terms of the upper and lower facial widths and lower facial height. The men also had a significantly deeper radix (nasofrontal angle: 121 ± 11.4 vs. 131.7 ± 7.8 degrees) and a droopier nasal tip than women (nasolabial angle: 79.9 ± 10.6 vs. 84.06 ± 8.3 degrees). Uzun and Ozdemir demonstrated similar differences among Turkish male and female young adults. The average Turkish male had a smaller nasofrontal angle (123.8 ± 13.2 vs. 133 ± 8.89 degrees; $p < 0.05$) and nasolabial angle (97.9 ± 8.8 vs. 98.9 ± 10 degrees; $p < 0.05$) than the average Turkish female.[10]

The measured values were compared with published Indian values taken from Farkas' paper titled "International anthropometric study of facial morphology in various ethnic groups/races"; it was found that our study subjects, both males and females, had greater upper and lower facial widths, wider mouth, and wider nasal base. Farkas, however, takes the Indian Subcontinent as one unit, not considering the regional variations. This variation within Indians was demonstrated by Prasanna et al in their comparative study between South and North Indians.[11] The subjects of our study had wider faces than the values of North Indian faces given in that study. They were also able to establish that Indian males (South and North Indian) have wider upper faces (zy-zy) than females (North Indian males $= 12.2 \pm 3.1$ cm vs. North Indian females $= 10.8 \pm 4.1$ cm and South Indian males $= 11.9 \pm 4.7$cm vs. South Indian females $= 11.8 \pm 4.9$cm; $p < 0.005$). In our study, it was also noted that the vertical facial heights were similar to the published values for the Indian population, except the midface height/nasal length, wherein Keralites had significantly longer midfaces. This finding was also noted by Prasanna et al in their study.

The average Keralite face did not conform to the Neoclassical canons.

The majority of the study subjects had a greater nasal width (96.8%), shorter intercanthal distance (73.2%), and a greater nasal inclination than ear inclination (92%) as per the respective horizontal canons. The oral fissure narrower than 1.5 times the nasal width in 82.8% of the subjects. Similarly, Kusugal et al, who studied the prevalence of

Neoclassical canons in Indian and Malaysian women, found that their Indian subjects had shorter intercanthal distances (76.7%), greater nasal widths (73%), and narrower intercommissural widths (56.7%) as per the respective horizontal canons.[9]

None of the vertical height measurements of the face were equal, as proposed by the Neoclassical canons. The special facial height (en-gn) was greater than the special forehead height (v-en) in 97% of the subjects. In the three-section canon, it was noted that the forehead height 1 (tr-g) was lesser than the upper face height (g-sn) and the lower face height (sn-gn). In 66% subjects, the upper face was longer than the lower face. With respect to the four-section canon, the study subjects had the greatest height in the forehead (tr-n) and then the lower face (sn-gn). The nasal height and calva height were almost equal.

Kusugal et al noted in their study that 100% of their Indian subjects had a forehead height (tr-n) greater than the lower face height (sn-gn), and 96.67% Indian women had a forehead height greater than the nasal length/midface height.[9] These findings are consistent with our study. Kusugal et al also noted a nasal length/midface height greater than the lower face height in 56.67% and lower than the lower face height in 40% of their Indian subjects. However, in our study, 91.2% subjects had greater lower face heights than the midface height.

This study attempts to define an average Keralite face. But being an institution-based study, the population studied is somewhat skewed with greater representation from Central and South Kerala. Also, the study sample is small and not representative of the entire South India. However, we hope that this study will pave the way, as a pilot study, for a larger population-based anthropometric studies of various ethnic groups in India.

Conclusion

In this study, we found that the Keralite face is unique in many respects. The average Keralite face is wider and rounder than those in the published Indian norms, with respect to the upper facial, lower facial, nasal, and intercommissural widths. The average Keralite female has a longer midface compared to the published Indian norms.

We found that the average Keralite male face is longer and wider than the female face. Also, males have a narrower nasofrontal and nasolabial angle and a wider nasofacial angle than females.

According to the findings of our study, the average Keralite face does not conform to the Neoclassical canons.

Note
This study was conducted as thesis for M.Ch. Plastic Surgery course by the first author. It was submitted to and approved by the Kerala University of Health Sciences.

Author Contributions
M.C. was responsible for collection of data, analysis, and preparation of the manuscript. L.M. contributed with study design, supervised the data collection and analysis, reviewed and approved the final manuscript.

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Conflict of Interest
None declared.

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