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## Original Research Article

## Evaluation of golden proportions among three ethnic groups of Indian females

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## ABSTRACT

**Background:** The study aimed to assess and compare the presence of golden proportions among three ethnic groups of Indian females: North Indian, North East Indian, and South Indian. Understanding ethnic variations in facial measurements and assessments related to golden proportions has implications for aesthetic treatments and facial reconstruction procedures.

**Materials and Methods:** A cross-sectional observational study was conducted, involving 150 Indian females aged 18-35 years from the three ethnic groups. Facial measurements were collected using photographs captured using high-resolution Canon EOS 1500D camera with 18-55mm & 55-250 mm macro lens. Evaluators independently assessed facial photographs based on the golden proportion principle of Ricketts' Golden Ratio. Statistical analyses, including Analysis of Variance (ANOVA) and post-hoc tests were performed to compare the measurements and assessments among the ethnic groups.

**Results:** Statistically significant differences in facial measurements and assessments were observed among the North Indian, North East Indian, and South Indian ethnic groups. The TR - ME:LC-ME (Total Facial Height: Length of face between Lateral Canthus of Eyes to Menton) was exactly in relation to the golden proportions in all three groups. The total facial height was thus in golden proportion to the middle and lower facial sections in all three groups. LNr:CHr and TSr:LCr were similar to the golden proportion in North Indian and North East Indian ethnicity, while LNr:CHr was similar to the golden proportion in South Indian ethnicity. Variations in intercanthal distance, interalar width, and philtrum height indicated distinct facial proportions within each ethnic group. The evaluators' assessments of facial proportions also varied significantly among the ethnic groups, highlighting the influence of cultural and societal beauty standards on aesthetic perceptions.

**Conclusion:** The study findings underscore the importance of considering ethnic variations in golden proportions when planning aesthetic treatments and facial reconstruction procedures for Indian females. Recognizing and appreciating the diversity in facial aesthetics can lead to more personalized and culturally sensitive care, resulting in enhanced patient satisfaction and outcomes. Further research is needed to explore golden proportions in other ethnic groups and their impact on treatment preferences and outcomes.

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## 1. Introduction

Beauty is a subjective concept that has been studied extensively across cultures and time periods. While the definition of beauty may vary, certain aesthetic

standards have emerged as universal ideals that transcend geographical boundaries. One such principle is the concept of the "Golden Proportions," which refers to the mathematical ratios believed to define facial and bodily beauty.<sup>1,2</sup> In recent years, there has been a growing interest in exploring how the Golden Proportions manifest among

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different ethnic groups, acknowledging the rich diversity within the realm of beauty. India, known for its vibrant cultural tapestry, is home to numerous ethnicities, each with its unique physical features and beauty ideals. As such, understanding the manifestation of Golden Proportions among various Indian ethnic groups holds significant relevance for the field of aesthetics and anthropological studies.<sup>3,4</sup>

Ricketts devised a golden proportion calliper to establish and evaluate the ratios between various elements of the attractive face. In the 1980s, Ricketts used the golden divider in his morphologic dentofacial analysis; i.e. he established divine or golden proportions among the different parts of the face (width of the nose/width of the mouth, length of the upper lip/nasal length, facial height).<sup>5</sup> The golden proportion has been well known for hundreds, perhaps thousands, of years, but Ricketts might have been the first orthodontist to apply it to the composition of facial hard and soft tissues.<sup>6</sup> In orthodontics, Ricketts was the first to claim that the analysis of a physically beautiful face should be approached mathematically, and he advocated the use of golden proportions in that respect.<sup>7</sup> Several studies have focused on establishing whether there were mathematical relationships, in particular golden proportions, between different measurements of the human body and face. In particular, faces considered attractive should possess a general harmony among the various measurements, with ratios approaching the golden proportions. Indeed, esthetic criteria have been defined in almost all cultures, but the actual existence of codified facial ratios in attractive subjects is still a matter of debate.<sup>8</sup>

The three ethnic groups selected for this study are representative of different regions in India, each with its distinct cultural heritage and physical attributes. By including participants from North India, South India, and North East India, we aim to capture a comprehensive representation of the country's diverse population. To carry out this assessment, a multidisciplinary approach will be adopted, integrating elements from anthropometry, facial analysis, and aesthetics. A combination of quantitative measurements, visual assessments, and subjective evaluations will be employed to gather data and draw meaningful conclusions regarding the presence or absence of Golden Proportions within each ethnic group.

The findings of this study have the potential to contribute to both scientific research and practical applications. They may provide valuable insights into the unique beauty standards and facial features prevalent among the chosen Indian ethnic groups, helping professionals in fields such as orthodontic treatment, plastic surgery, cosmetology, and digital modelling to better cater to the specific needs and preferences of these populations. Ultimately, by examining the manifestation of Golden Proportions among Indian females from diverse ethnic backgrounds, this study aims to

celebrate the beauty of India's multicultural landscape and promote a more inclusive understanding of aesthetics that encompasses the rich tapestry of human diversity.

## 2. Materials and Methods

### 2.1. Study design

A cross-sectional observational study design was employed on 150 Indian females to capture data from the three ethnic groups. Each group comprised of 50 females. This design allowed for a one-time assessment of the golden proportions among participants representing different ethnic backgrounds.

### 2.2. Ethical considerations

Ethical approval was obtained from Ethics committee of Divya Jyoti College of Dental Science and Research centre, Modinagar. Informed consent was obtained from all participants, clarifying the purpose of the study, procedures involved, and data confidentiality. Participants' privacy and anonymity were protected throughout the study, and data were securely stored in compliance with data protection regulations.

### 2.3. Inclusion criteria

1. Age between 18-35 years
2. No history of facial trauma compromising its symmetry or proportions
3. Complete permanent dentition up to all the 2<sup>nd</sup> molars present in the oral cavity.

### 2.4. Exclusion criteria

1. History of orthodontic treatment or maxillofacial surgery.
2. History of restoration or prosthetic crowns in the anterior teeth.
3. History of periodontal surgery in the anterior arch.

**Table 1:** Study groups

Groups	Sample N (150)	Sex	Ethnicity	Area
North India (N.I)	N = 50	F	Aryans	Delhi, Punjab, Haryana, U.P, Jammu & Kashmir
Northeast India (N.E.I)	N= 50	F	Mongoloids	Arunachal, Manipur, Meghalaya Sikkim, Tripura, Nagaland, Assam
South India (S.I)	N= 50	F	Dravidians	Andhra Pradesh, Telangana, Karnataka, Kerala, Tamil Nadu

## 2.5. Method

For the study, extra oral facial photographs were obtained in:

1. Frontal view.

## 2.6. Image capturing technique

1. Photographs were taken in natural head position (NHP) in the photographic studio of the department.
2. Camera : Canon EOS 1500D with 18-55mm & 55-250 mm macro lens was mounted on a tripod with the camera parallel to the floor at the level with the subjects head.
3. A soft white background with millimetric scale printed on it was used for the photography for the standardization of the photographs in the ratio of 1 : 1.
4. Indirect illumination of the subjects was done from 110V AC flash unit in soft box (Simplex) and was used to simultaneously set off the flash with the centre of the lens is at the anterior nasal spine region.
5. The subjects were seated in a relaxed position on an adjustable stool with lips in repose, looking straight ahead with the stool to background distance of 0.8m, while the camera to subject distance was standardized at 1.6m.

## 2.7. Photographic evaluation

1. Standardization of photographs was obtained by using a millimetric scale positioned in the background of each photograph.
2. The photographs were imported into Adobe Photoshop, photographs were then printed on Kodak photographic paper.
3. 5 photos from each group were randomly selected and the magnification was observed using the millimetric scale for reference.
4. No significant magnification was evident.
5. Tracings were done on lead acetate tracing sheets using a 0.5mm graphite pencil.
6. 10 photographs were randomly selected and measured to assess if any intra observer differences existed. No significant differences were found.
7. Facial evaluation were done by Ricketts' Golden Ratio

Ricketts' Golden Ratorating scale<sup>8</sup> based on the golden proportion principle was used to evaluate the facial proportions. Evaluators assessed features such as the symmetry of the eyes, the balance between the nose and lips, and the overall harmony of the facial proportions. Each evaluator provided individual assessments, and the average scores were used for data analysis.

### 2.7.1. Ricketts' Golden Ratio

Landmarks to be traced –

1. Height relations : (Figure 1)

- (a) TR – (Trichion), a point at the top of the forehead at the junction (hairline) of the face and skull fascia
- (b) LC – Point at lateral canthus of eyes
- (c) LN – Point at lateral rim of the nose
- (d) CH – (Chelion), point at corner of the mouth
- (e) ME – soft-tissue menton.

2. Width relations : (Figure 2)

- (a) TSr – width of lateral border of temple at the level of eyebrows (EB)
- (b) LCr – Width of eyes
- (c) LNr – Width of lateral rim of nose
- (d) CHr – Width of mouth

### 2.7.2. Evaluation of facial height and width proportions

1. Proportion of Total Face Height : (Figure 3)

- (a) TR – LC : TR – ME (Upper Facial Section)
- (b) LC – CH : TR – ME (Middle Facial Section)
- (c) LN – ME : TR – ME (Lower Facial Section)

2. Proportion of Face Height : (Figure 4)

- (a) TR – ME : LC – ME (Total Facial Height: Length of face between Lateral Canthus of Eyes to Menton)
- (b) TR – LC: LC – ME ( Length of face between Trichion to Lateral Canthus of Eyes : Length of Face between Lateral Canthus of Eyes to Menton)
- (c) LN – ME: TR – LN (Length of face between Lateral Rim of The Nose to Menton: Length of face between Trichion to Lateral Rim of Nose)
- (d) LC – LN: LN – ME (Length of face between Eyes and Lateral Rim of The Nose: Length of face between Lateral Rim of The Nose to Menton)
- (e) CH – ME: LC – CH (Length of face between Corner of Mouth to Menton: Length of Face between Lateral Canthus of Eyes to Corner of the Mouth)
- (f) LN – CH: LC – LN (Length of face between Lateral Rim of The Nose to Corner of Mouth : Length of face between Eyes and Lateral Rim of The Nose)
- (g) LN – CH: CH – ME (Length of face between Lateral Rim of The Nose to Corner of Mouth : Length of face between Corner of Mouth to Menton)

3. Proportion of Face Width : (Figure 5)

- (a) LNr: CHr (Width of Nose : Width of Mouth)

- (b) LCr: CHr (Width of Eyes : Width of Mouth)
- (c) TSr: LCr (Width of Head : Width of Eyes)

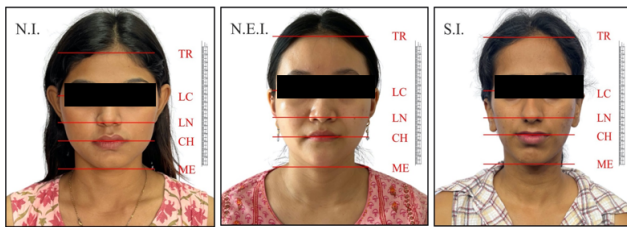


Figure 1: Landmarks for facial height evaluation

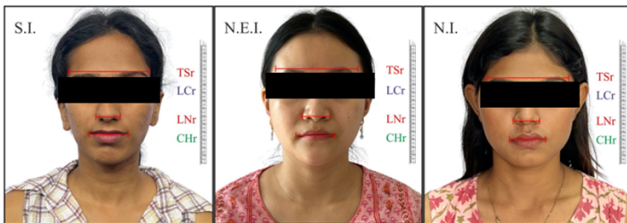


Figure 2: Landmarks for facial width evaluation

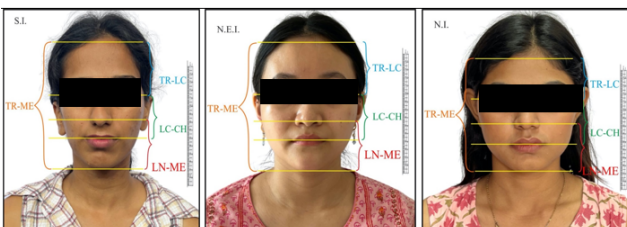


Figure 3: Proportion of total face height



Figure 4: Proportion of face height



Figure 5: Proportion of face width

### 2.8. Data analysis

Statistical analyses were conducted using Statistical software for Social sciences 25.0 version. The mean for different readings between facial height and width among samples was compared using one sample ‘t’ test. One way ANOVA was used to test differences in facial section (upper, middle and lower) between different ethnicities. Tukey’s post hoc analysis was applied to find inter group differences for facial section. P value lesser than 0.05 was considered to be statistically significant. Confounding variables, such as age and facial symmetry, were considered and controlled for in the analysis.

### 3. Results

Facial proportions in the photographs of 150 female participants were analyzed. The middle facial section was smaller in all three ethnic groups of Indian females, and the

shortness of the middle facial section was compensated by a slightly larger lower facial section in all three ethnic groups, according to the comparison of the relationship of the golden proportions in the height component in the current study. (See Tables 1 and 2) According to TR - ME:LC-ME (Total Facial Height: Length of face between Lateral Canthus of Eyes to Menton), which was exactly in relation to the golden proportions in all three groups, the total facial height was thus in golden proportion to the middle and lower facial sections in all three groups. CH - ME:LC-CH (Length of face between Corner of Mouth to menton: Length of face between Lateral Canthus of Eyes to Corner of Mouth)

Two measurements (LNr:CHr and TSr:LCr) out of three measurements were similar to the golden proportion in North Indian and North East Indian ethnicity, and one measurement (LNr:CHr) out of three measurements was similar to the golden proportion in South Indian ethnicity, according to the present study’s comparison of the relationship between golden proportions in the width component. In each of the three groups, there were three different face width measurements. This study suggests that

because the values of LCr:CHr were lower than the golden proportion in all three groups, all three groups displayed small eyes width with mouth width. (Table 3)

In the present study, out of the seven measurements of facial height proportions three of them i.e. TR-ME:LC-ME,LC-LN:LM-ME and LN-CH:LC-LN, were in golden proportion in North and South Indian females. While in North East Indian females two out of seven i.e. TR-ME:LC-ME,LC-LN:LM-ME were in golden proportion. While comparing the facial width proportions in all the three groups North Indian and North East Indian ethnicity showed that two out of three width facial proportions i.e. LNr:CHr and TSr:LCr were close to golden proportion and South Indian ethnicity showed only one out of the three i.e. LNr:CHr width were close to golden proportion.

#### 4. Discussion

Facial esthetics is always a prime concern in human civilization. Similarly, the golden proportion has been fascinating from the time of ancient Greek history. Ricketts<sup>9</sup> was the first Orthodontist to apply divine proportion to the composition of facial hard and soft tissues. He showed that the proportions in a face generally perceived as being beautiful are intimately related to the golden ratio. He also found that several proportions in face were in harmony with golden proportion and suggested that esthetics was not only the matter of subjective perception. In fact, it can be defined scientifically with the golden proportion. It has become standards for esthetics especially facial esthetics regardless of gender, age, race, etc.

India is a fascinating country where people of many different communities and religions live together in unity. Indian Population is polygenetic and is an amazing amalgamation of various ethnicity and cultures. There is no information in the literature about facial golden proportion among North Indian, South Indian and North East Indian females. It would be interesting to understand the soft tissue differences due to ethnicity amongst them and to evaluate if there is any difference in the golden proportion between the groups. This dissertation was undertaken with such an aim and objective. However, the population types limited to were, essentially North Indian, South Indian and North East Indian as they were available in the area of study. Only female population of these ethnic groups was included in the study. Thus, the main objective of the study was to evaluate the relationship between facial parameters and golden proportion in Indian females for better orthodontic treatment planning.

The results of this study provide light on how different ethnic groups perceive and measure the face in relation to the golden ratio, which has ramifications for aesthetic operations and facial reconstruction surgeries.

The study findings included a number of significant conclusions. First, statistically significant variations were

found when comparing facial measurements, such as intercanthal distance, interalar breadth, and philtrum height, between the three ethnic groups. These variations imply that each ethnic group may have particular face proportions that affect the harmony and balance of their overall facial features. For instance, the intercanthal lengths between the North Indian group and the North East Indian or South Indian groups may differ, reflecting different eye proportions. These results underline how crucial it is to take into account ethnic differences when designing cosmetic or reconstructive operations in order to produce results that are both culturally appropriate and visually acceptable.

Fan et al<sup>10</sup> studied the relationship between facial attractiveness and facial proportions by creating average features of facial images from famous ladies of China, Japan and Korea with the help of computer software. They pointed out various proportions that were close to the golden proportion. However, studies showed that there was a significant difference existing in the soft tissue morphology in various ethnic groups.<sup>11</sup>

In the present study done, three measurements of proportions of total facial height, were close to 1:1:1 ratio, which indicated good proportions in all the three ethnic groups. Middle facial section was relatively smaller and there was statistically significant difference between the three groups. North Indian females had the shortest facial height than South Indian and North East Indian females. These results were similar to the findings of the study done by Packiriswamy et al<sup>12</sup> which showed that out of 100 Indian subjects, 20 had a normal size, 75 had a short face, and 5 had a long face. The shortening of the facial height could be due to the relatively smaller middle facial section. Sunil kumar et al<sup>13</sup> also found that total facial height proportions among North Maharashtra Population was in 1:1:1 ratio. Mizumoto et al<sup>7</sup> conducted a similar study which had three groups of Japanese females, the ratios were also found to be 1:1:1. Saurabh et al<sup>14</sup> also found that proportions of total facial height was in 1:1:1 ratio on assessment of facial golden proportions among central Indian population.

Though the middle facial section was smaller it was still proportionate in nature, which would mean, that the upper lip and nose were in golden proportions in both South Indian and North Indian females. However in North East Indian females it was deviated from golden proportions as proved by LN – CH:LC – LN (Length of face between Lateral Rim of Nose to Corner of Mouth : Length of face between Eyes and Lateral Rim of Nose). This proportion was matching the golden proportions in South and North Indian but significantly deviated in North East Indian females. Results of South and North Indian females were similar to the study conducted by Ricketts<sup>9</sup> on a random selection of ten photographs in the frontal view and he also found that the nose and upper lip is the area of balance or congruence and it could give orthodontist and oral surgeons a starting

**Table 2:** Proportion of total face height components with golden proportions

Proportion	North Mean ± SD	North East Mean ± SD	South Mean ± SD	P-value (N and N.E)	P-value (N and S)	P-value (N.E and S)
<b>Total Face</b>	2.43940 +	2.54424+	2.74428 +	.000*	.000*	.000*
Section : <b>Upper</b> Facial Section	0.029881	0.071834	0.089810			
<b>Total Face</b>	2.3547 +	2.4476 +	2.6693 +	.000*	.000*	.000*
Section: <b>Middle</b> Facial Section	0.10743	0.10126	0.10637			
<b>Total Face</b>	2.5610 +	2.6489 +	2.7221 + 0.9343	.000*	.001*	.000*
Section : <b>Lower</b> Facial Section	0.07509	0.10963				

**Table 3:** Inter group comparison of facial height components with golden proportions (North Indian, North East Indian & South Indian)

Proportion of Face Height	North Indian		North East Indian		South Indian	
	Mean	P-Value	Mean	P-Value	Mean	P-Value
TR – ME:LC - ME	1.6788	.000*	1.6459	.010*	1.67600	.039*
TR – LC: LC - ME	1.4411	.000*	1.4609	.000*	1.45717	.003*
LN – ME :TR - LN	1.4442	.000*	1.4940	.000*	1.42667	.005*
LC – LN:LN - ME	1.6478	.000*	1.6194	.883(NS)	1.60383	.647(NS)
CH – ME : LC - CH	1.4622	.000*	1.5535	.000*	1.53270	.044*
LN – CH: LC - LN	1.6531	.004*	1.4679	.000*	1.61617	.668(NS)
LN – CH :CH - ME	1.5778	.001*	1.4258	.000*	1.55233	.177(NS)

\*=Significant; NS=Not Significant

**Table 4:** Inter group comparison of facial width in golden proportions (North Indian, North East Indian & South Indian)

Proportion of Face Width	North Indian		North East Indian		South Indian	
	Mean	P-Value	Mean	P-Value	Mean	P-Value
LNr:Chr	1.62790	.000*	1.60456	.000*	1.61678	.223 (NS)
LCr:Chr	1.54783	.000*	1.56400	.000*	1.58332	.000*
TSr:LCr	1.60616	.000*	1.62432	.000*	1.59102	.000*

\* The mean difference is significant at the  $\leq 0.05$

\*=Significant; NS=Not Significant

reference. This was similar to the results of the study done by Tripathi AA<sup>15</sup> on North Indian females and study conducted by Mizumoto et al<sup>7</sup> on three groups of Japanese females.

These findings have ramifications for the realm of aesthetic and reconstructive procedures. Orthodontists and plastic surgeons can customise their approaches to match the unique aesthetic goals of people from diverse ethnic origins by being aware of the ethnic variances in the golden ratios. It emphasises how crucial it is to take into account the distinctive facial features and proportions that constitute attractiveness within each ethnic group.

The width of the nose was in golden proportions to the mouth in all three groups, and eyes were in the golden proportion to the width of the head in North East and North Indian which was not similar to the study done by Ricketts.<sup>9</sup> Saurab et al<sup>14</sup> and Khan et al<sup>16</sup> found that all the face width measurements were significantly deviated from the ideal ratio. The horizontal facial proportions were also deviated from the golden ratio in the study conducted by Nguyen et

al.<sup>17</sup>

It is important to note that there are some limitations to this study that need to be noted. First off, the study only looked at a narrower age range and excluded older people. Therefore, for older or younger members of certain ethnic groups, the data might not accurately reflect the golden ratio. Additionally, the study's sample size might have been small, making it impossible to generalise the results to all Indian women. Future studies with larger and more varied sample sizes would offer a more thorough grasp of the golden ratios within various ethnic groups.

## 5. Conclusion

The study concluded that there were substantial differences in the measurements of the face and assessments of the golden proportions between the North Indian, North East Indian, and South Indian ethnic groups. These findings highlight the importance of taking ethnic differences into account when organising aesthetic operations and facial

restoration surgeries. Healthcare professionals may give individualised, culturally sensitive treatment and ultimately improve patient satisfaction and results by acknowledging and embracing the diversity in facial appearances. The impact of golden proportions on patient preferences and treatment outcomes has to be investigated in more detail in relation to different ethnic groups.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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