Identification of Facial Shape by Applying Golden Ratio to the Facial Measurements: An Interracial Study in Malaysian Population

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Abstract

Background: The “golden ratio” is considered as a universal facial aesthetical standard. Researcher's opinion that deviation from golden ratio can result in development of facial abnormalities. Aims: This study was designed to study the facial morphology and to identify individuals with normal, short, and long face. Materials and Methods: We studied 300 Malaysian nationality subjects aged 18-28 years of Chinese, Indian, and Malay extraction. The parameters measured were physiognomical facial height and width of face, and physiognomical facial index was calculated. Face shape was classified based on golden ratio. Independent t test was done to test the difference between sexes and among the races. Results: The mean values of the measurements and index showed significant sexual and interracial differences. Out of 300 subjects, the face shape was normal in 60 subjects, short in 224 subjects, and long in 16 subjects. Conclusion: As anticipated, the measurements showed variations according to gender and race. Only 60 subjects had a regular face shape, and remaining 240 subjects had irregular face shape (short and long). Since the short and long shape individuals may be at risk of developing various disorders, the knowledge of facial shapes in the given population is important for early diagnostic and treatment procedures.

Keywords: Anthropometry, Facial shape, Golden ratio, Racial differences

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Introduction

Ever since the period of Egyptian’s various norms, guidelines and standards have been proposed to describe the ideal facial proportion, out of which the most famous axiom is golden proportion or divine proportion (1:1.618).¹ The scientific applications of golden proportion have been done in various fields like prostho-dentics, surgery, orthodontic, facial attractiveness study, and in the development of facial mask and dental grid system.¹² Segher’s et al. was first to introduce “golden proportion” as planning tool in facial surgery.¹³ Rickets observed the presence of golden proportion in cephalogram and photographs of beautiful faces.¹⁴ Levin suggested that divine proportion can be used as a guideline for the ideal size of teeth, and he developed a dental grid system to evaluate the dental aesthetics.¹⁵ Marquardt developed a facemask by applying divine proportion to describe the most attractive face.¹⁶

Most of the author’s opinion that single aesthetic standard is inadequate and simple; because the recent anthropometrical studies have demonstrated that the facial morphology varies according to age, gender, and race.¹⁷ Perrett et al. pointed out that averageness is one of the important cues for facial attractiveness; it is the mean value of measurement derived from the large group of population.¹⁸ Farkas et al. presented extensive anthropometric data of different population in the form proportional indices, which was useful for quantification of facial attractiveness and for assessment
of post-operative outcomes. Jefferson stated that deviation of human face from golden proportion can result in the development of facial abnormalities and disorders. The aesthetical standards have both advantage and disadvantages, but it has to be tailored according to the area of application. In the present study, we applied golden ratio to the obtained quantitative data and classified the result in the form of different facial shapes.

The present study was, (1) to determine the normal average values of physiognomic height and width of the face in 3 ethnic groups of Malaysian population, (2) to identify the individuals with long, normal, and short face, and (3) to determine if there are any significant differences exists in the measurements and index among the races and genders.

Materials and Methods

This study was approved by Manipal University ethics committee (UEC/58/2010). The subjects of mixed ethnic origin, or who had a history of facial surgery, were excluded. Informed consent was obtained from the subjects prior to the study.

Subjects

The study group consisted of 100 Malaysian Chinese (MC), 100 Malaysian Indians (MI), and 100 Malaya’s (M) students from Melaka Manipal Medical College, Manipal University, with equal number of males and females. The age range was 18-28 years. Anthropometrical landmark [Figure 1]: trichion (tr), gnathion (gn), zygion (zy). The landmarks were located and marked on the skin using stickers with diameter of 3 mm to avoid errors (P.K). Anthropometric measurements [Figure 1]: Physiognomic facial height, width of face, and physiognomic facial index. The measurements were done by using sliding and spreading calipers (V.K.). Every measurement was obtained thrice by the same observer. A third reading was taken if the initial two measurements showed a large discrepancy, and the two closer readings would then be used.

Shape of the face

The ratio between the physiognomic facial height and bizygomatic width measurement of each subject was calculated. The golden proportion was 1.6. When the ratio approximated to 1.6, the shape was normal; the shape was long when its ratio was larger than 1.6; and when the ratio was smaller than 1.6, the shape was short [Table 1].

Statistical analysis

The statistical analysis was performed using software Graph Pad Prism version 3.00, Graph Pad Software, Inc. San Diego CA. The measurements and index were presented as mean, SD. Independent t test was done to test the difference between sexes and among the races. Values of $P < 0.05$ were considered as significant. Graphical representation of the subjects with different facial shapes was obtained from Microsoft excel 2010.

Results

Classification of facial shapes based on golden proportion

In Malaysian Chinese subjects, 16 (5 male, 11 female) had a normal size, 77 (41 male, 36 female) had a short face, 7 (4 male, 3 female) had a long face.

In Malaysian Indian subjects, 20 (10 male, 10 female) had a normal size, 75 (36 male, 39 female) had a short face, 5 (4 male, 1 female) had a long face.

In Malay subjects, 24 (15 male, 9 female) had a normal size, 72 (31 male, 41 female) had a short face, 4 (4 male, 0 female) had a long face [Figure 2].

Differences in the measurement between genders: Sexual dimorphism

The physiognomical vertical height of the face showed significant sexual difference in all the 3 racial groups. The width of the face showed significant sexual difference only in MC and MI, while M showed no significant sexual differences in the measurements.

Table 1: Classification of shape of the face by applying golden ratio

| Facial shape | Golden ratio (1.6) |
|--------------|--------------------|
| Normal       | 1.600-1699         |
| Short        | <1.6               |
| Long         | >1.6               |

Figure 1: Photograph shows the anthropometric landmarks and facial measurements. Anthropometric landmarks: tr-trichion, zy-zygion, gn-gnathion. Facial measurements. Physiognomical facial height (tr-gn); Width of the face (zy-zy)
difference. Physiognomical facial index showed sexual dimorphism only in M subjects [Table 2].

**Differences in the measurement between racial groups: interracial difference**

In between MC versus MI, the vertical height of the face and width of the face showed significant difference. Physiognomical facial index showed sexual dimorphism only in M subjects [Table 2].

In between MC versus MI, the vertical height of the face and width of the face showed significant difference in both the sexes. In between MI versus M, only physiognomical vertical height of the face showed statistical significant difference in both the sexes, while the width of the face showed statistical difference only in female groups. In MC versus M, the male group showed statistical difference in width of the face, not in physiognomical height of the face. Conversely, in female group, statistical difference was observed in physiognomical height of the face, not in width of the face. Physiognomical facial index showed no significant difference between MC versus MI and MI versus M. In between M versus MC, statistical difference found only in male groups [Table 3].

**Discussion**

In the present study golden ratio was applied to classify the human facial form as normal, short, and long based on the their variation in the growth of craniofacial configuration in vertical and horizontal directions. Even though the underlying minor hard tissue abnormalities may be masked by the soft tissue drape, the determination of facial shape can be helpful in earlier identification of progressive developmental abnormalities, which can affect the morphology and functional values of soft tissue in the later stages. In the present study, we evaluated the mean values of physiognomical facial height, width of the face, and physiognomical facial index according to gender and race. We compared our data with other racial and ethnic groups [Table 4]. Secondarily, we evaluated the golden ratio between the measurements to classify the facial shape of the subjects.

**Table 2: Comparison of measurement according to gender**

| Measurement                  | Ethnicity | Male | Female | Mean (SD) | P value | 95% CI | Lower | Upper |
|------------------------------|-----------|------|--------|-----------|---------|--------|-------|-------|
| Physiognomical facial height | MC        | 50   | 50     | 19.21 (0.95) | <0.05   | 0.16 | 0.94 |        |
| Facial height (cm)           | MC        | 50   | 50     | 18.91 (1.2)  | <0.001  | 0.66 | 1.31 |        |
| Width of the face (cm)       | MI        | 50   | 50     | 13.03 (0.8)  | <0.001  | 0.32 | 0.94 |        |
| Physiognomical facial index  | MI        | 50   | 50     | 141.1 (17)   | <0.001  | 4.23 | 7.54 |        |

**Table 3: Comparison of measurement according to race**

| Gender          | Physiognomical facial height | Physiognomical facial index | Physiognomical facial height | Physiognomical facial index |
|-----------------|------------------------------|-----------------------------|------------------------------|-----------------------------|
| **Male groups** |                             |                             |                             |                             |
| Physiognomical  | MC-MI=P<0.01               | MC-MI=P<0.01               | MC-MI=P>0.05                | MC-MI=P>0.05                |
| Facial height   | MI-MI=P<0.01              | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |
| Width of the face | MI-MI=P>0.05     | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |
| Physiognomical  | MC-MI=P<0.01               | MC-MI=P<0.01               | MC-MI=P>0.05                | MC-MI=P>0.05                |
| Facial index    | MI-MI=P<0.01              | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |

**Table 3: Comparison of measurement according to race**

| Gender          | Physiognomical facial height | Physiognomical facial index | Physiognomical facial height | Physiognomical facial index |
|-----------------|------------------------------|-----------------------------|------------------------------|-----------------------------|
| **Female groups**|                             |                             |                             |                             |
| Physiognomical  | MC-MI=P<0.01               | MC-MI=P<0.01               | MC-MI=P>0.05                | MC-MI=P>0.05                |
| Facial height   | MI-MI=P<0.01              | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |
| Width of the face | MI-MI=P>0.05     | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |
| Physiognomical  | MC-MI=P<0.01               | MC-MI=P<0.01               | MC-MI=P>0.05                | MC-MI=P>0.05                |
| Facial index    | MI-MI=P<0.01              | MI-MI=P<0.01              | MI-MI=P>0.05                | MI-MI=P>0.05                |
The comparative anthropometric analysis in the present study shows difference and similarities in the facial measurement among the 3 racial groups. The physiognomical facial height of the face was greater in males with significant sexual dimorphism in all the racial groups. The width of the face was greater in males with significant sexual dimorphism only in Malaysian Chinese and Malaysian Indian subjects. Conversely, in Malay subjects, the female value was greater than males with no statistical difference. The vertical height of the face was greater in Malaysian Chinese compared to other racial groups, may be because of higher hairline; however, most of them had short face because of greater width of the face. The measurements and index were greater in Malaysian Chinese and Malaya compared to Malaysian Indians. The measurements showed statistically significant interracial difference in Chinese versus Indians in both the sexes. The width of the face between Indians versus Malas showed no significant difference in male groups. In male group, the physiognomical height of the face showed significant difference between Malaysian Chinese versus Malay. Conversely, in female group, showed no significant difference in width of the face. Physiognomical height of the face showed significant difference between the sexes in Malay’s and in male groups between Malay and Malaysian Chinese.

Comparison of the data with other studies revealed variations and similarities in the facial measurement.

### Table 4: Compilation of facial measurement of various populations

| Authors            | Year | Numbers | Population                  | Physiognomical facial height | Width of the face | Methods                        |
|--------------------|------|---------|-----------------------------|-----------------------------|------------------|--------------------------------|
| Cho et al.[8]      | 2004 | - 72    | Korean American women       | -                           | - 139            | Photographic                   |
| Farkas et al.[9]   | 2005 | 30 30   | North American              | 187.5 172.5                 | 137.1 129.9      | Spreading and sliding caliper  |
|                    |      |         | Azerbaijani                 | 185.1 175.4                 | 147.5 138.7      |                                |
|                    |      |         | Bulgarian                   | 184.3 170.5                 | 139.5 130.9      |                                |
|                    |      |         | Czech                       | 181.7 182.9                 | 134.9 126.4      |                                |
|                    |      |         | Croatian                    | 180.1 172.6                 | 140.7 133.2      |                                |
|                    |      |         | German                      | 182.2 170.9                 | 133.2 123.4      |                                |
|                    |      |         | Greek                       | 178.7 173.8                 | 128.6 132.2      |                                |
|                    |      |         | Hungarian                   | 181.3 169.4                 | 142.1 131.3      |                                |
|                    |      |         | Italian                     | 186 171.4                   | 143.2 133.3      |                                |
|                    |      |         | Polish                      | 181.9 172.1                 | 142.6 135.5      |                                |
|                    |      |         | Portuguese                  | 190.7 177.4                 | 125.1 120.4      |                                |
|                    |      |         | Russian                     | 184.4 174.4                 | 141.2 132.3      |                                |
|                    |      |         | Slovak                      | 183.7 169.7                 | 134.7 125        |                                |
|                    |      |         | Slovenian                   | 181.3 170.4                 | 136.2 129.5      |                                |
|                    |      |         | Iranian                     | 180.3 175.9                 | 138.4 131.7      |                                |
|                    |      |         | Turkish                     | 186.5 179.2                 | 140.4 134.5      |                                |
|                    |      |         | Egyptian                    | 176.9 161.4                 | 139.8 130.3      |                                |
|                    |      |         | Indian                      | 161.3 163                   | 135.8 124.9      |                                |
|                    |      |         | Singapore Chinese           | 187.3 176.2                 | 144.6 136.2      |                                |
|                    |      |         | Vietnamese                  | 180.9 171.1                 | 144 134.3        |                                |
|                    |      |         | Thai                        | 185.1 172.8                 | 147.1 138.3      |                                |
|                    |      |         | Japanese                    | 191.4 182.8                 | 147.2 141.2      |                                |
|                    |      |         | Angolan                     | 182.6 172.4                 | 139.8 132.8      |                                |
|                    |      |         | Tonga                       | 161.8 -                     | 133.3 -          |                                |
|                    |      |         | Zulu                        | 209.2 179.1                 | 138.5 128.4      |                                |
| Erika[13]          |      | 39 38   | Afro American               | 194.6 180.1                 | 138.7 130.5      |                                |
| Omar et al.[15]    |      | - 102   | Latvian                     | 187.3 177                   | 133.1 122.4      |                                |
| Ngeow et al.[16]   | 2009 | 50 50   | Indian American women       | - 169.4                    | - 125.9          | Photographic                   |
|                    | 2010 | 200 143 | North eastern Nigerian      | -                           | -                 |                                |
| Our study          | 2012 | 50 50   | Malaysian Chinese           | 192.1 186.6                 | 140.1 135.2      |                                |
| Our study          | 2012 | 50 50   | Malaysian Indians           | 182.5 172.7                 | 130.3 124        |                                |
| M: Male; F: Female |      |         |                             |                             |                  |                                |
between Malaysian population and other population [Table 4]. In the present study Physiognomical facial height was greater in males than the females in all the racial groups; in contrast, Farkas et al. reported higher value for females in Indians. Facial height Malaysian Chinese male group of our study was similar to the male mean value (191.4 mm) in Japanese population. The Malaysian Indian facial height (male 182.5 mm; female, 172.7 mm) of both the sexes was similar to Angolan population (male 182.5 mm; female, 172.4 mm). The female value of Malaysian Indians was similar to female value of Croatian (172.6 mm), Thai (172.8 mm), and North American population (172.5 mm). The female value of Malay population (179.2 mm) was similar to female value of Zulu population (179.1 mm). In the present study, the face was wider in females than the males in Malay’s. This finding was in agreement with the studies conducted by Farkas et al. on Greeks and Ngeow et al. on Malays. The mean value of Malaysian Chinese male subjects was similar to the mean value of the corresponding sex in Angolan (139.8 mm) and Turkish (140.1 mm) population. The female value (135.2 mm) of Malaysian Chinese population was similar as that of polish population (135.5 mm). The female male mean value of Malaysian Indian was near to Indian (124.9 mm) population mean value. Similarly, the female Malay populations mean value was close to Turkish population (134.5 mm).

Based on paleoanthropology, in the present study, Malaysian Indians facial measurements were different from Malaysian Chinese and Malay, because most of the Malaysian Indians are descendants of South India and they belong to Dravidian race. As excepted, Malays and Chinese showed more similarities in the measurements, since they belong to Mongoloids race.

The golden proportion is considered as a universal standard for aesthetical predictions, biological efficiency, and wellbeing, regardless of sex, age, and ethnicity. Jefferson stated that deviation from the standards can result in the development of facial abnormalities and disorders. In the present study, [Figure 2] 20 (M-10, F-10) Indians, 16 (M-5, F-11) Chinese, and 24 (M-15, F-9) Malay subjects had a normal facial shape. The other subjects whose facial proportion deviated from golden ratio were considered as short face (229) and long face (23). The subjects with short and long face may have or develop maxillofacial, temporomandibular joint disorder. The number of subjects with long face were lesser in all the 3 the racial groups; it was interesting to note that none of the Malay female had long face. Saraswathi, in a study on 75 subjects, reported that 14 individuals had normal shape of the face, 61 individuals had long (11) and short face (50). The facial dimensions are studied by direct (spreading or sliding caliper) and indirect anthropometric techniques (camera and computer analysis). In the present study, direct measuring techniques which is considered to be accurate was used in the measurement. To minimize the errors, the calipers with instrumental error zero were used by one observer for taking the measurement on all the subjects. This is a baseline study done on the Malaysian population; results may not represent the whole Malaysian population due to a relatively small sample size and included students were from various states in Malaysia.

Conclusion

The comparative anthropometry of the measurement reveals the evidence of significant variation in the facial morphology according to gender and race in the population. The golden ratio was used to identify subjects with short and long face in the given population at risk of developing maxillofacial, respiratory, and sleep disorders. An advanced study on the facial subunits of the Malaysian population has to be done to confirm quantitatively that the regular population (normal face) is healthier than the irregular ones (short and long face). It is hoped this study will be a stepping stone for further facial analysis on this population using other classical formulas and standards.

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