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ASSESSMENT OF FACIAL GOLDEN PROPORTION IN A SAMPLE OF DUHOK POPULATION (PHOTOGRAMMETRIC STUDY)

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ABSTRACT

Background and Objectives: Beautiful face proportions are likely to approximate the Divine proportion or golden ratio (1.618:1). This study set out to determine the facial proportions of adults from Duhok and to compare the findings to what are known as golden or divine proportions. Also, to assess the proportions of males and females who joined up in this study.

Methods: 176 participants (88 females, 88 males) with well-balanced facial features and class I Angle's malocclusion were chosen and frontal photographs were taken for them. Facial proportion in height and width were assessed and compared in both genders. The facial golden proportion was established.

Results: Based on the results, more deviation from golden ratios found in male faces than female faces. Male and female ratios were noticeably varied from one another and from other world's population.

Conclusion: In comparison to the golden ratio, the population of Duhok has balance in facial soft-tissue. Nevertheless, some variables deviate somewhat from the golden ratio.

KEYWORDS: Golden ratio, Photographic Evaluation, Facial Height, Facial Width

INTRODUCTION

Photogrammetry was first suggested in orthodontics, comparing the before and after treatment photographs with desired photographs. Soft tissue parameters have been added to photogrammetry by a variety of authors, and standardized photogrammetric method was employed in a variety of facial soft tissue analyses (Moshkelgosha *et al*, 2015).

Long noted as the primary reason that patients choose to undergo orthodontic treatment is the improvement in facial appearance. Understanding the interaction between the facial bones and soft tissue is the key factor in determining facial esthetics. It was previously believed that the skeletal configuration was principally responsible for the soft tissue profile's configuration. However, as soft tissue has a wide range of thicknesses and is thought to be the primary determinant of a patient's final facial profile, reports have suggested that soft tissue functions independently of the underlying dentoskeletal base (AlBarakati, 2011; Perović and Blažej, 2018).

It is crucial to develop population norms in order to address the averageness cue and provide information on gender differences and youthfulness (Yeung *et al*, 2015).

Various facial features, their functions in facial esthetics, and the general composition of the face all were evaluated in the previous. Conventionally, the locations of the lip and chin were assessed using lateral photographs or lateral cephalograms. However, only a limited number of studies were used frontal photographs for facial assessments. Numerous studies were showed that a desirable lip proportion is a crucial component of an aesthetically attractive lower face. Other studies were demonstrated that visual perception a face preferred targets are the eyes, nose, and mouth (Jang *et al*, 2017).

It is believed that the golden ratio, commonly referred to as the Divine proportion, holds the key to understanding the mystery of beauty and attractiveness in human form (Bashour, 2006).

Orthodontic, orthopedic and surgical procedures can be used in conjunction with the introduction of a standard known as the Divine Proportion for the evaluation of face to achieve optimum facial beauty (Rupesh *et* al, 2014). It was proposed that certain of measurable proportions of attractive faces have values that are likely near to the Divine Proportion (Jahanbin *et al*, 2008).

Frontal photographic facial soft tissue measurements for Duhok population adults were chosen for this study to determine the difference between male and female in facial measurements. Given that the golden ratio is regarded as a necessary element of facial esthetics. Furthermore, the golden proportions of the face and norms of facial measurements of Duhok population are not covered in the literature. Hence, it is necessary to define a norm for both surgical and orthodontic treatment objectives.

PARTICIPANTS AND METHOD

A sample of the study:

The sample number selected for this study was 176 participants (88 males and 88 females), this size was selected according to many golden proportions researches like two Indian studies from different regions of Indian, where their sample size was 200 participants (Saurabh *et al*, 2016) and the other 120 participants (Kandala *et al*, 2015) , in addition to that another Japanese study included 74 participants (Mizumoto *et al*, 2009), while a Serbian study included 107 participants (Milutinovic *et al*,2014). Although Indian and Japanese population have greater population size number than Duhok population, the sample size selected in this study was taken as a high number for Duhok city, certainly to ensure high degree of accuracy for the results of this study. The participants were chosen based on inclusion and exclusion criteria from dental patients who attended University of Duhok - College of Dentistry for routine dental treatment and also male and female students from Shahid Mala Amin and Zirka preparatory schools in center of Duhok city, the age of concluded participants ranges from (18-35) as this range characterized by eruption of mostly all permanent dentition and reasonably good periodontal health.

The inclusion criteria and exclusion criteria involved the following:

- The sample of this study were 3rd generation adults from Duhok city that their parents and grandparents were born in Duhok.
- Class I molar occlusion according to the Angle classification of molar occlusion with mild degree of dental malocclusion.
- Class I canine relation with normal overbite.
- Complete sets of permanent teeth, regardless of the presence or absence of third molars.
- Selecting individuals with normal BMI (body mass index) as soft tissue thickness in obese patients could mask accuracy of identification of landmarks.
- No prior maxillofacial or plastic surgery (e.g rhinoplasty), prosthetic or orthodontic treatment.
- Individuals having any facial asymmetry or trauma were not included.
- No history of facial managing with Botox or Filler.
- Individuals with any congenital anomalies like cleft lip and palate were not included.

Study Setting and ethics approval:

This study was conducted between October 2021 and August 2022. The clinical examination and photographs were taken in Shahid Mala Amin and Zirka preparatory schools in Duhok city and also University of Duhok-College of Dentistry (Pedodontics, Orthodontic and Preventive Dentistry) department. Finally, analysis of photographs done with (AutoCAD 2018). The research protocol was accepted by Research Ethics Committee-Duhok Directorate of Health to conduct the research on participants. Also written approvals taken from Directorate of Education of Duhok West District to conduct the research on students of specific schools (Shahid Mala Amin and Zirka preparatory schools) in Duhok city. The procedure was explained to the participants and signed consents taken from them according to Research Ethics Committee rules.

METHOD

Clinical examination and photographic standardization:

Each participant seated for clinical examination. A brief questionnaire to determine the state of residence, origin of the participant and also to help in sample selection was obtained. Depending on clinical examination (extra-orally and intra-orally) diagnosis was made to include class I skeletal and dental relationships.

photographic set-up and participant position:

Nikon D7100, 24.1 megapixels camera was used in its manual position, to keep the natural proportions, a 100 mm focal lens was chosen, the shutter speed was 1/125 per second and the opening of the aperture was f/2.8 (Fernández-Riveiro *et al*, 2003). To get a clear photo, the participant was positioned at a standard distance of 5 feet (150 cm) from the center of the camera lens (Negi *et al*, 2017). The participants were photographed in Natural Head Position (NHP). In order to take the records for frontal views of the participant in natural head position, participants were asked to walk a few steps and place their arms at their side. Also, the modified protractor adapted to a plumb line to evaluate head posture was placed at the nose tip and soft tissue pogonion and the head was adjusted so that the interpupillary line parallel and the plumb line at a 90-degree angle to the floor. (Negi *et al*, 2017). Teeth in centric relation and lips should be relaxed as in their natural position during the day. Before starting the recording procedure, participants were instructed to remove the eye glasses and the operator made sure that during the recording, the patient's forehead, neck, and ears all be seen clearly. (Fernandez Riveiro *et al*,2003). Figure (1, 2)

Fig. (1): photographic set-up: using modified protractor with plumb

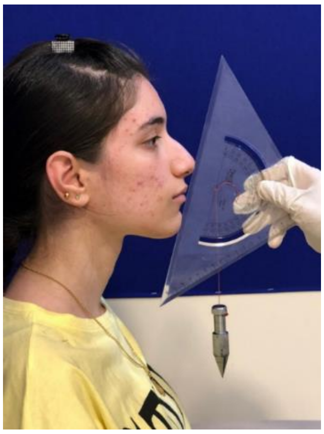


Fig. (2): participant position: Positioning of Camera in front of participant

Photogrammetric analysis:

Photographs after recoding were imported to the AutoCAD program, and appeared in the master sheet, on which the points and planes were determined, then the linear soft tissue landmarks were marked and photogrammetric analysis was carried out. When inter and intra-examiner reliability was compared, there was no discernible difference. For the purpose of calculating the mean value for various proportions, statistical analysis was carried out using SPSS version 28,0 of the Statistical Package for the Social Sciences. As a goal of comparing the means of our study population, an unpaired t-test was used. The expected magnification in the linear measurements was not greater than 1mm and was corrected by using a scale for each photograph with appropriate equation (Aksu *et* al, 2010; Nasir and Abd-Alwhab, 2013).

$$A = \frac{BxC}{D}$$

A= Corrected linear measurement

B= Any linear measurement on the photograph

C= Actual ruler length

D= ruler length measured on the photograph

Soft Tissue Landmarks

Facial landmarks (Fernández-Riveiro *et al*, 2002)

1. Point Tri (trichion): the midpoint of the forehead that outlines the hairline.
2. Point (Lc): the point that located at the lateral canthus of the eyes.
3. Point (Ln): the point that located at the lateral rim of the nose.
4. Point Ch (Cheilion): the point that located at the corner of the mouth.
5. Point Me' (Menton soft tissue): the most inferior point of the inferior edge of the chin.
6. Point (TS): the temporal soft tissue area above the ears at the level of eyebrows.

Proportion of facial width from frontal view:

(Sunilkumar *et al*, 2013) (figure 3)

Ln (right-left): Ch (right-left)

Ts (right-left): Lc(right-l eft)

Lc (right-left): Ch(right-left)

Considering that the golden ratio is 100%, mean measurements will be converted to percentages.

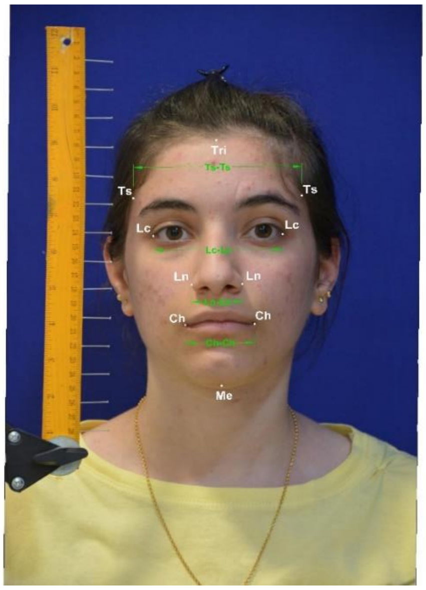


Fig. (3): frontal view showing different facial widths.

Proportion of facial height from frontal view: (Sunilkumar *et al*, 2013) (figure 4)

1. Tri-Me’: Lc-Me’
2. Tri-Lc: Lc-Me’
3. Ln-Me’: Tri-Ln
4. Lc-Ln: Ln-Me’
5. Ch-Me’: Lc-Ch
6. Ln-Ch: Lc-Ln
7. Ln-Ch: Ch-Me’

Considering that the golden ratio is 100%, mean measurements will be converted to percentages.

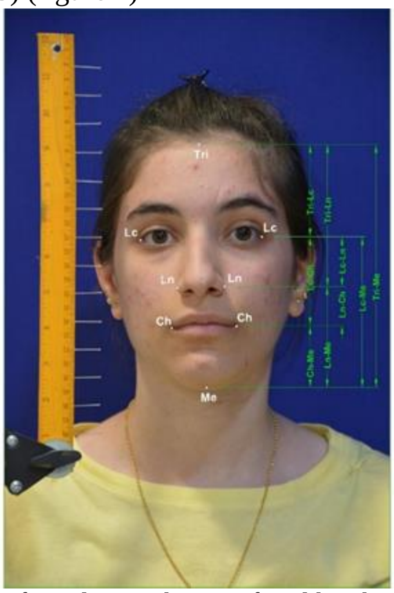


Fig. (4): frontal view showing facial heights.

RESULTS

Photographs of 176 participants’ faces were assessed for facial proportions (Table 1). (Figure 5, 6). Only Tri-Me: Lc-Me' and Ln-Me': Lc-Ln in both males and females of Duhok population, according to face height findings, are in the golden ratio.

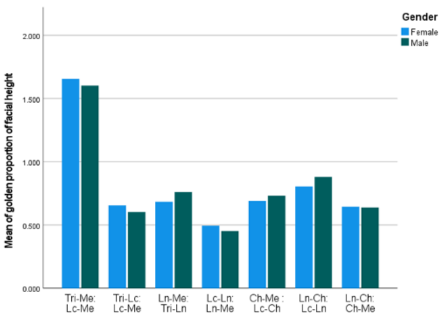
Lc-Me’: Tri-Lc, Tri-Ln: Ln-Me’, Lc-Ch: Ch-Me’ and Ch-Me’: Ln-Ch in females are closer to the golden ratio. In males Lc-Me’: Tri-Lc and Ch-Me’: Ln-Ch are closer to the golden ratio. Only Lc-Ln: Ln-Ch shows deviation from golden ratio in females, however; Tri-Ln: Ln-Me’, Lc-Ch: Ch-Me’ and Lc-Ln: Ln-Ch show deviation from golden ratio in males.

Facial width findings in Duhok population show that only Lc-Lc: Ch-Ch is in the golden ratio in both males and females. While Ch-Ch: Ln-Ln and Ts-Ts: Lc-Lc show deviation from golden ratio in Duhok males and females.

Table (1): Facial height and width proportions.

Component	Male (88)		Female (88)	
	Mean (% respect to golden ratio)	**SD**	**Mean (% respect to golden ratio)**	**SD**
Facial height				
Tri-Me: Lc-Me’	1.6 (100%)	0.05	1.66 (103.7 %)	0.06
Lc-Me’: Tri-Lc	1.67 (104.3%)	0.15	1.54 (96.2%)	0.14
Tri-Ln: Ln-Me’	1.33 (83.1%)	0.13	1.47 (91.8%)	0.13
Ln-Me’: Lc-Ln	2.26 (141.2%)	0.34	2.05 (128.1%)	0.27
Lc-Ch: Ch-Me’	1.38 (86.2%)	0.12	1.46 (91.2%)	0.13
Lc-Ln: Ln-Ch	1.17 (73.1%)	0.20	1.27 (79.3%)	0.20
Ch-Me’: Ln-Ch	1.58 (98.7%)	0.15	1.57 (98.1%)	0.17
Facial width				
Ch-Ch: Ln-Ln	1.31 (81.8%)	0.10	1.4 (87.5%)	0.10
Lc-Lc: Ch-Ch	1.88 (117.5%)	0.13	1.85 (115.6%)	0.13
Ts-Ts: Lc-Lc	1.38 (86.2%)	0.07	1.32 (82.5%)	0.07

*Statistical analysis by one-factor student t-test significance level (S) P<0.05.



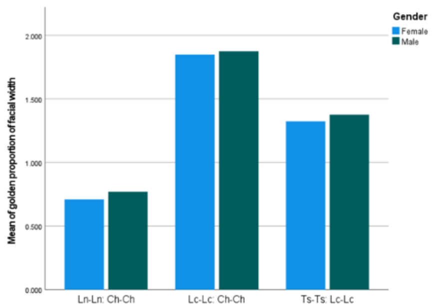


Fig. (5)(6): Golden proportion of facial height and width between genders.

DISCUSSION

Golden proportion of facial height:

The initial step in examining facial proportions is examining the face from the frontal view. (Proffit *et al*, 2019). In

Orthodontics, (Ricketts, 1982) was the first to advocate for using mathematics to analyze a physically attractive face. (Pancherz *et al*, 2010) discovered that attractive people had faces that were nearer to divine proportions than unattractive people. Similarly (De Castro *et al*, 2006) demonstrated that pleasant smiles that were evaluated were closer to divine proportions.

The results of this study showed that total face height in proportion with eye to menton height (Tri-Me: Lc-Me), eye to menton height in proportion with trichion to the eye height (Lc-Me: Tri-Lc) and nose to menton height in proportion with eye to nose height (Ln-Me: Lc-Ln) mean values were golden ratio or higher than golden ratio.

Total facial height in proportion with eye to menton height (Tri-Me: Lc-Me) shows 103.7 % for females and 100% for males in agreement with findings of (Mizumoto *et al*, 2009) study for 74 Japanese women with mean percentage 100.8% for femlaes, (Mahmoud, 2010) study for 40 Iraqi adults with mean percentage 102.3% for females and 100.2% for males, (Sunilkumar *et al*, 2013) study for 300 North Maharashtrian Indian adults with mean percentage 103.1% and (Saurabh *et al*, 2016) study for 200 central Indian adults with mean percentage 104% for females and 103% for males.

Eye to menton height in proportion with trichion to the eye height (Lc-Me: Tri-Lc) shows golden ratio for males 104.3 % but slightly less than golden ratio for females 96.2 % in agreement with findings of (Mizumoto *et al*, 2009) study for 74 Japanese women with mean percentage 95.5% for females , (Mahmoud, 2010) study for 40 Iraqi adults with mean percentage 94.7% for females and 100.4% for males and (Sunilkumar *et al*, 2013) study for 300 North Maharashtrian Indian adults with mean percentage of 95%, but in reverse with findings of (Saurabh *et al*, 2016) study for 200 central Indian adults that showed deviation from golden ratio with 89% for females and 91% for males.

Nose to menton height in proportion with eye to nose height (Ln-Me: Lc-Ln) shows golden ratio, 128.1% for females and 141.2% for males in agreement with findings of (Mizumoto *et al*, 2009) study for 74 Japanese women with mean percentage 113.9% for females, (Mahmoud, 2010) study for 40 Iraqi adults with mean percentage 115.8% for females and 137.6% for males, (Sunilkumar *et* al, 2013) study for 300 North Maharashtrian Indian adults with mean percentage 138.1% and (Saurabh *et al*, 2016) study for 200 central Indian adults with mean percentage 115% for females and 127% for males.

Other measurements like trichion to nose height in proportion with nose to the menton height (Tri-Ln: Ln-Me) and cheilion to the menton height in proportion with nose to the cheilion height (Ch-Me: Ln-Ch:) were close to the golden ratio similar to findings of four studies: (Mizumoto *et al*, 2009) study for Japanese women, (Mahmoud, 2010) study for Iraqi adults, (Sunilkumar *et al*, 2013) study for North Maharashtrian Indian adults and (Saurabh *et al*, 2016) study for central Indian adults.

On the other hand, eye to the cheilion height in proportion with cheilion to menton height (Lc-Ch: Ch-Me) mean findings also was close to the golden ratio and show slight deviation similar with mean findings of (Kawakami *et al*, 1989) study of 60 Japanese adults, (Sunilkumar *et al*, 2013) study for 300 North Maharashtrian Indian adults, however in reverse with mean findings of (Saurabh *et al*, 2016) study for 200 central Indian adults. The deviation may be due to shorter Ch-Me than Lc-Ch in Duhok population.

The last measurement that shows great deviation from golden ratio in Duhok population is eye to the nose height in proportion with nose to cheilion height (Lc-Ln: Ln-Ch) with mean percentage 79.3% for females and 73.1% for males, similar mean percentage findings were seen in (Mizumoto *et al*, 2009) study for Japanese women with 86.4% for females, (Mahmoud, 2010) study for Iraqi adults with 86.8% for females and 70.9% for males, (Sunilkumar *et al*, 2013) study for North Maharashtrian Indian adults with 71.2% and (Saurabh *et al*, 2016) study for central Indian adults with 84% for females and 75% for males.

Golden proportion of facial width:

In orthodontic surgeries, the facial widths proportions can be used to change the shape of the jaws to enhance dental occlusion stability, achieve better temporomandibular joint function (corrective jaw surgery), and correct bilateral asymmetries to improve the patient's facial proportions.

According to (Medici Filho *et al*, 2007) a link found between facial esthetics and divine proportion. The divine proportion was more closely matched by the ratios of mouth width to nose width and eye width to mouth width, thus improved face esthetics.

In the present study the width of mouth in proportion with width of the nose width Ch (r-l) **:** Ln (r-1) and bitemporal width in proportion with the biocular width Ts (r-1) **:** LC (r-1) shows deviation from golden ratio in both genders.

Width of mouth in proportion with width of nose Ch (r-l) **:** Ln (r-1) in Duhok population is less than golden ratio with mean percentage 87.5% for females and 81.8% for males, similar with mean percentage findings of Iraqi adults' study of (Mahmoud, 2010) with 84.7% for females and 79.8% for males, North Maharashtrian Indian adults' study of (Sunilkumar *et al*, 2013) with 78.7% and Central Indian population study of (Saurabh *et al*, 2016) with 80% for females and 79% for males.

Width of bitemporal in proportion with width of biocular Ts (r-1) **:** LC (r-1) mean percentage findings in Duhok population were less than golden ratio with 82.5% for females and 86.2% for males, in agreement with mean percentage findings of North Maharashtrian Population study of (Sunilkumar *et al*, 2013) with 86.8%, Central Indian population study of (Saurabh *et al*, 2016) with 74% for females and 75% for males and Iraqi adults study of (Mahmoud, 2010) with 78.7% for females and 85.1% for males.

While, only one measurement shows greater proportion than golden ratio in Dohuk population which is width of biocular in proportion with the width of mouth Lc (r-1) **:** Ch (r-1) with mean percentage 115.6% for females and 117.5% for males similar to the mean percentage findings of three previous studies: first study of Iraqi adults (Mahmoud, 2010) included 40 Iraqi Arab dental students (20 males and 20 females) with 111.8% for females and 109.8% for males, second study of North Maharashtrian Population (Sunilkumar *et al*, 2013) this study included 300 North Maharashtrian adults with 121.8% and the third study of Central Indian population (Saurabh *et al*, 2016) included 200 Central Indian adults (136 females and 64 males) with 112% for males, but in this study females show deviation from golden ratio with 80%. This explained that biocular width in proportion with the mouth width are in golden ratio in Duhok adults similar to Iraqi, North Maharashtrian Indian and Central Indian adults.

CONCLUSION

It is concluded from this study, that the null hypothesis, which states that there is no deviation in the soft-tissue facial balance's golden ratios among adults of Duhok population and accepted 100% in facial height and width components. The golden ratios regarding genders parameters showed that young Duhok women have balanced facial height and width proportions, while Duhok men have less balanced proportions.

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