



PHOTOMETRIC FACIAL ANALYSIS IN GARHWAL REGION: A PRELIMINARY STUDY

Anatomy

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ABSTRACT

Introduction: The face is the most important aspect of human identification. Shape of the human face depends on the structure of the bone and the soft tissue that covers it. Aim: The aim of this study was to evaluate vertical and angular photometric norms & to identify sexual dimorphism in Garhwali population.

Material & Methods: Study was carried out on 70 Individuals (35 males and 35 females) in the department of Anatomy, of age group between 18 to 25 years. Standardized photographs were taken in natural head position using a digital camera. The vertical and angular measurements were taken and statistical analyses.

Results: The lower face was greater than the middle face in both males and females. All vertical measurements were statistically insignificant in gender differentiation. The difference between mean values of nasofrontal angle was found statistically significant in males and females.

Conclusions: Garhwali's have bigger lower face with prominent nose. Glabella is more prominent in males with bigger chin.

KEYWORDS

Lower face, middle face, nasofrontal angle, nasofacial angle, nasomental angle, mentocervical angle, Garhwali, Photometric.

Introduction:

The physical appearance of an individual should be socially well accepted, reflecting psychological well-being and the self-esteem. The facial appearance is one of the primary functions of physical appearance. There are many factors involve like culture, personality, ethnic background, age, sex which governs the facial traits of an individual (Sahin saglam and Gazilerli, 2001)¹.

The Aryan sub family classified with reference to common characteristics and sociolinguistic tendencies, into branch Indo-Aryan, Mediate sub-branch /Inner Sub-Branch -Pahari, Group central Pahari and subgroup Garhwali spread along the district Chamoli, Dehradun, Haridwar, Pauri (Pauri Garhwal), Rudrapur, Tehri and Uttarkashi of Himalayan region from Uttarakhand (Bhasin MK)².

The shape of the human face depends on the structure of the bone and the soft tissue that covers it³. Soft tissue should be analysed for correct assessment of an underlying skeletal discrepancy because of individual differences in soft tissue thickness. The quantitative assessment of the size and shape of the facial soft tissue is widely used in several medical fields such as orthodontics, maxillofacial and plastic surgery, and clinical genetics for diagnosis, treatment planning, and postoperative assessment⁴. Obtaining measurements of the facial soft tissue is important in terms of achieving aesthetic criteria. With the recent advances in surgical techniques, facial harmony is considered and even incorporated as a treatment goal. The inter-relationships of the facial features must be in balance in order to achieve facial harmony⁵. The most challenging areas of facial surgery are to correct the nasal deformity.

The application of photogrammetry in orthodontics was first proposed by Stoner (1955)⁶.

Powell and Humphreys introduced the aesthetic triangle formed by nasofrontal angle, nasofacial angle, nasomental angle and the cervicomental angle for facial aesthetic analysis. They formulated suitable relationship between face and nose⁷.

Arnett and Bergman (1993 a, b) introduced frontal and lateral views of photographic records for analysis, taken in the natural head position (NHP).

They also described the facial profile into three type of classes according to the angle of the facial convexity i.e. Classes according to the facial convexity Class I (165- 175 degree), Class II (< 165 degree),

and class III (>175 degree)^{8,9}.

Extensive literature of baseline records is available for north-American and Europeans. The cephalometric standards for Iranians¹⁰, Saudis¹¹, Jordanians¹² and Egyptians^{13, 14} have been established for skeletal, dental and soft tissue structures by numerous researchers but similar baseline records are not available for Garhwali people.

A single standard of facial aesthetic is not appropriate for application to diverse racial and ethnic groups^{15,16}. There is a need to establish the aesthetic standards of a face that could guide the surgeons to achieve a favourable aesthetic soft tissue treatment goal in Garhwali patients.

The patients are not accustomed to viewing and interpreting cephalogram or their tracings. The use of photographic images for evaluation would reduce or eliminate patient's exposure to radiation. Moreover, Photograph provides a more conventional documentation of the soft tissue of the face (Bishara et al, 1995)¹⁷.

Aims of the study:

- 1) To establish angular photometric norms from standardized photographs of Garhwali population
- 2) To identify possible gender difference between Garhwali males and females
- 3) To compare Garhwali norms with the norms of other investigators who studied facial aesthetics.

Materials and methods:

A cross sectional study was carried out using 70 Individuals in the department of Anatomy. There were 35 males and 35 females respectively, of age group between 18 and 25 years. Parents and grandparents of Individuals were all native of Garhwali region origin. Consent was obtained from the Individuals. Also prior to commencement of study, permission was obtained from research and ethics committee of the VCSGMS and RI under Uttarakhand Technical University.

All the Individuals had complete dentition, class I occlusion, competent lips without symptoms and signs of craniofacial anomalies. There was no history of orthodontic, maxillofacial treatment. Individuals with any Congenital Dentofacial abnormality, cleft lip and palate etc. were excluded.

The standardized photometry method was used to take photographs of frontal and lateral views of subject faces, using a digital lens camera. All the photographs were taken with Individuals sitting in relaxed position with their head held in natural head position and framed

alongside a vertical scale divided into five segments. From the scale hung a plumb line held by thick black thread that indicated the true Vertical (TV). Using the meter rule on the side as a guide all photographic record was scaled to life size (1:1) making linear measurements possible in frontal view photographs.

The photographic set up consists of a tripod (Sony DSL 300) supporting a digital camera (Samsung S850). Adjustment of the tripod height allows the optical axis of the lens to be maintained in a horizontal position. Each subject was asked to relax with both hands hanging beside the trunk. A mirror was placed in front of the subject. The subject has to look into their eye in the mirror with their lip relaxed so that both the front and side view profile was taken in natural position. The operator ensures that the subject forehead, neck and ear were clearly visible and their lip in repose.

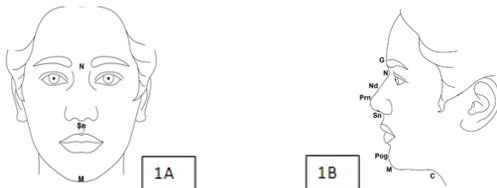


Figure 1. Soft tissue landmarks used in Photographic images as shown in A (lateral) and B (frontal) views.

Computer assisted analysis of the facial photograph was done. The photographs were transferred into computer by a universal serial bus (USB) cord. The following soft tissue points were introduced on the photographic images: as shown in **Figure 1A & 1B**.

Landmarks: Glabella (G), Nasion(N), Nasal dorsum(Nd), Pronasale(Prn), Subnasale(Sn), Pogonion(pog), Menton(M) and Cervical©

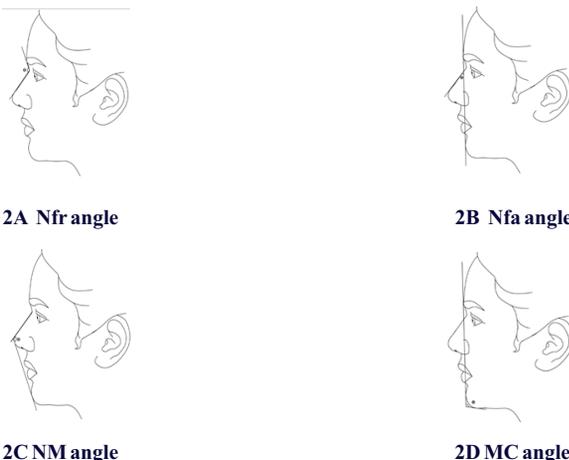
Angular measurement: Following angle are drawn and measured. The Nasofrontal (Nfr) angle is formed by a line tangent to glabella and the nasion, which intersects another line drawn tangent to the nasal dorsum as shown in **Figure 2A**.

The Nasofacial (Nfa) angle is formed by drawing a vertical line tangent to forehead at the glabella, and tangent to the chin at the Pogonion so that another line drawn along the nasal dorsum intersects it as shown in **Figure 2B**.

The Naso-Mental (NM) angle is formed when a line drawn through the nasal dorsum, intersects a line drawn from the nasal tip to the chin at the Pogonion as shown in **Figure 2C**.

The Mento-Cervical (MC) angle is formed by a vertical line tangent to the forehead, passing at glabella which intersects another line drawn tangent to the chin at the Pogonion as shown in **Figure 2D**.

Figure 2 Angular measurements



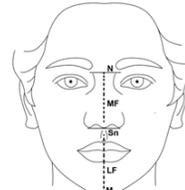
Linear measurement

Middle face: This is the distance between the nasion (N) and

Subnasale (SN) (**Figure: 3**) expressed in percent ratio by dividing it with the distance from nasion (N) to Menton (M) and multiplying by 100 (i.e. N-SN/N-Mx100).

Lower face: This is the distance between the Subnasale (SB) and Menton (M) (**Figure: 3**) expressed in percent ratio by dividing it with the distance from nasion (N) to Menton (M) and multiplying by 100 (i.e. SN – M/N X100).

Figure 3 Vertical measurements



Nasion (N) , Middle Face(MF),Subnasale(Sn),Lower Face(LF), Menton(M)

The screen protractor 4.0 software (Iconic Software Copyright (C) 2004 -6 Iconic ,New York) program for the window operating system was used to measure the Nasofrontal, Nasofacial, Nasomental and Mentocervical angles as shown in **Figure 2**. The linear measurement will be analysed using screen callipers 4.0 (Iconic Software Copyright (C) 2004 -6 Iconic, New York) software program for the Window operating system.

The data was analysed using the statistical Package for Social Sciences (SPSS) version 24. The test for significant was applied using Student's t test between male and female individuals. The reliability of the measurement was examined on the records of all 70 Individuals, by repeating the point marking and digitizing procedures within a 4 week interval by the same examiner.

Results:

Measurement of facial angles and vertical measurements of middle third and lower third were taken and analysed by student t- test. The mean measured values for the vertical measurements in males and females are shown in **Table: 1& 2**.

Table 1: Vertical Measurements of face in Garhwali Population

Measurements	Gender	Range	Mean	Standard Deviation
Middle face (MF)	Male	37.96 – 53.99	45	3.5
	Female	35.79 – 56.29	44.04	3.25
Lower face (LF)	Male	46.38 – 62.04	55.27	3.4
	Female	43.71 – 64.21	55.07	3.25
Total face height (TFH)	Male	84.34 – 116.03	100.27	5.31
	Female	79.50 – 120.50	100.12	6.45

Statistically significant (P<0.05)

Table 2: Vertical Measurements of face (%) in Garhwali Population

Vertical length	Male	Female
MF (%)	44.68±3.69	44.98 ± 3.28
LF (%)	55.32± 3.96	55.02 ± 3.28

MF (%): Middle face proportion, LF (%): Lower face proportion
There was no significant difference in middle face (P = 0.958), lower face (P = 0.811) and total face height (P = 0.916) in males and females. Lower faces are greater than middle face in both males and females.

The measured values for the angular measurements are shown in **Table: 3**.

Table 3: Angular Measurements of face in Garhwali Population

Measurements	Gender	Range	Mean	Standard Deviation
Nasofrontal *	Male	104.85 -137.27	123.44	9.32

	Female	113.89 – 143.03	130.38	7.17
Nasofacial	Male	29.07 – 47.99	37.83	3.74
	Female	27.84 – 44.60	36.16	4.03
Nasomental	Male	113.62 – 134.10	124.13	5.11
	Female	112.81 – 134.27	125.67	5.37
Mentocervical	Male	83.34 – 118.82	97.10	6.77
	Female	81.88 – 109.36	94.79	6.54

* denotes Significant P < 0.05

The nasofrontal and nasomental angle were wider in females. The greatest variability was found for the nasofrontal angle, which had the highest standard deviation. In angular measurements significant difference were found only in nasofrontal angle, while difference in other angles were insignificant in gender differentiation.

Discussion:

We have investigated vertical and angular variables that define the soft tissue profile in Garhwali populations by using standardized photogrammetry record taken in the natural head position.

Photogrammetric analysis offers some advantages in terms of human profile analysis. (Malkoc et al 2005) firstly, with photogrammetric analysis, angular measurements are not affected by photographic enlargement as in cephalometric analysis. Thus technique can be used clinically for both pre-treatment planning and evaluation of patient's post-operative results. Secondly, every profile fiducial point can be moved freely on a computer monitor using the cephalometric software program to determine the most appropriate profile points. Finally, angular photogrammetric profile analysis does not require expensive equipment and complex procedures, and it offers digitized results that are easily evaluated. Furthermore, the collected data can be arranged in unified charts¹⁸.

Leonardo da Vinci divided the face into thirds, from the frontal hair line to the root of the nose, the nasal root to nasal base and the nasal base to the bottom of chin¹⁹. Larrabee (1987), because the frontal hairline may be absent in some individuals the proportions of mid and lower face need only be analysed²⁰.

Comparative data of vertical and angular measurements among different populations were shown in Table 4 & 5 respectively.

Table 4: Comparative data of vertical measurements in different populations

Author	Population	MF (%)	LF (%)
Powell and Humphries(1984) ⁷	North American Caucasians	47	53
Jain et al (2004) ²¹	Himachalis	44.63	55.67
E.L. Oghenemavwe et al (2010) ²²	Urhobos	42.2 ± 3.17 (M) 43.51 ± 3.67 (F)	57.73 ± 3.63(M) 56.49 ± 3.69 (F)
P Hatwal et al. (2015) ²⁴	Garhwali	UFH: 48.05(M) UFH: 45.86 (F)	57.34 (M) 54.8 (F)
M Tandel et al.(2015) ²³	Gujarati	38.99 ± 3.42(M) 40.29 ± 3.27 (F)	61.01 ± 3.42(M) 59.71 ± 3.27 (F)
Present study	Garhwali	44.68 ± 3.96 (M) 44.98 ± 3.28 (F)	55.32 ± 3.96 55.02 ± 3.28

MF (%): Middle face, LF (%): Lower face, UFH: Upper face height, M: Male, F: Female

Table 5: Comparative data of angular measurements in different populations.

Author	Population	Nfr	Nfa	NM	MC
Powell and Humphries(1984) ⁷	North American Caucasians	122.5	35	126	87.5
Epkar(1992) ²⁶	Caucasians	130			
Jain et al.(2004) ²¹	Himachalis	134.00	33.26	128	99.88
Sandra et al .(2008) ²⁷	Croatians	136.38(M) 139.11(F)			

E.L.oghenemavwe et al (2010) ²²	Urhobos	121.75(M) 127.85 (F)	40.77(M) 35.60(F)	121.95(M) 126.55(F)	93.33(M) 90.88(F)
M Tandel et al.(2015) ²³	Gujarat	123.33(M) 129.31(F)	38.13(M) 36.13(F)	124.23(M) 124.71(F)	102.43(M) 100.82(F)
Present study	Garhwali	123.44(M) 130.38(F)	37.83(M) 36.16(F)	124.13(M) 125.67(F)	97.10(M) 94.79(F)

Nfr: Nasofrontal angle, Nfa: Nasofacial angle, NM: Nasomental angle, MC: Mentocervical angle

In the present study lower face is greater than the middle face in both males and females these are well correlates with studies on the North American Caucasian population⁷, Himachalis of India²¹ and Urhobos of Nigeria²².

M Tandel et al (2015) studies showed that the proportion of lower third of face was higher than middle third of face in both males and female in people of Gujarat region. (2015).and difference in all vertical measurement was statistically significant in males and females²³.

P Hatwal et al (2015) studies on Garhwali population of Uttarakhand observed that the maximum value for upper, lower, and total facial height in males were greater in comparison to female, and also the lower face is greater than upper facial height in both sex²⁴.

Extensive evaluation of angular relationship are essential in soft tissue profiling as not as facial traits directly follow the underlying dentoskeletal Profile (Subtenly, 1959)²⁵. The angles measured in this study were the Powell and Humphries (1984) aesthetic triangle⁷. The nasofrontal angle showed statistically significant sexual dimorphism (P<0.05) in our study, with mean values of 123.44± 9.32 for males, 130.38 ± 7.17 for females. In the present study nasofacial and mentocervical angle is larger in males while nasofrontal and nasomental angle is greater in females which well correlates with the study of E.L.oghenemavwe et al (2010) on Urhobos²² and M Tandel et al (2015) on Gujarati populations²³. Mean value of nasofrontal angle of this study agrees with finding Epkar (1992) on Caucasians populations²⁶. This value is low compared to study of Jain et al (2004) on Himachalis²¹ and Sandra et al (2008) on Croatians populations²⁷. The reason for low value may be due to prominent glabella. Sexual dimorphism observed in this study agrees with the finding of Sandra et al (2008)²⁷, E.L.oghenemavwe et al (2010)²² & M Tandel et al (2015)²³.

Nasofacial angle an average of 35 degree and 32.26 degree has been reported for North American Caucasians⁷ and Himachalis population²¹ respectively. These values are low compare to present study. Higher nasofacial angle suggest the projection of nose in Garhwalis is more than Himachalis and North American Caucasian.

The mean value of nasomental angle in the present study is well correlates with the study of M Tandel et al (2015) on Gujarati populations²³. Bigger lower face correlates well with the high nasomental angle.

In the present study mean value of Mentocervical angle is lower than that of study of Jain et al (2004) on Himachalis²¹ and M Tandel et al (2015) on Gujarati populations²³ it is due to more prominent glabella leads to lower mentocervical angle.

Conclusion:

Racial and ethnic difference in the facial structure is a well-accepted fact. Garhwalis have bigger lower face (Higher nasomental angle) with prominent nose. Glabella is more prominent in male's leads to lower nasofrontal and mentocervical angles. It is imperative that effort should be made to establish general norms for different races and ethnic groups with consideration for certain individual characteristic features.

This study has shown that the vertical & angular variables that the tissue profile are sexually dimorphic among the Garhwalis of Uttarakhand.

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