

## Original Research Article

# Arnett's soft tissue norms in north western Himalayan population: a cephalometric study

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## ABSTRACT

**Background:** This study was conducted to establish soft tissue cephalometric norms and compare males and females of north western Himalayan range population with that of soft tissue Arnett's norms.

**Methods:** The study group comprised of 110 subjects (51 females and 59 males) within age 18-25 years, having class I molar relation with well-balanced faces. The null hypothesis was there will be no statistically significant difference in the soft tissue parameters between the groups. Cephalograms were manually traced and the mean values of various parameters were compared with Arnett's norms of Caucasian population as well as between males and females of the study group.

**Results:** The overjet, overbite, lip thickness, facial length, maxillary projection and mandibular projection were decreased in the study group when compared to the controls. Statistically significant differences were found in various parameters between males and females of the study group as compared to the control group. Males had increased overjet, increased lower facial height, retrusive maxilla, procumbent lips than females.

**Conclusions:** This study concluded that the norms of Arnett's Caucasian population cannot be applied to the population of other geographic regions.

**Keywords:** Arnett's, Caucasians, Norms, Soft tissue analysis

## INTRODUCTION

Arnett and Bergman presented the facial keys as a three-dimensional clinical blueprint for soft tissue analysis and orthodontic and orthognathic surgical treatment planning.<sup>1</sup> It is based on natural head position and emphasizes soft tissue outcome and lessens the emphasis of overjet as the sole indication of success. It correlates various soft and hard tissue structures which determine balance and harmony as well as to a true vertical line (TVL) in both sagittal and vertical planes. However, the norms in the Arnett's analysis were given for the Caucasian population. It is a known fact that facial features of different ethnic groups differ significantly. Therefore, it is essential to rely on norms established for individual ethnic groups instead of relying on norms established for the Caucasian population.<sup>2</sup>

The aim of this study was to assess the Arnett's soft tissue cephalometric norms for the north western Himalayan population to guide the orthodontists towards better diagnosis and treatment planning of dentofacial deformities for the local population.

## METHODS

The study was conducted in department of orthodontics and dentofacial orthopedics, Himachal Pradesh Government Dental College and Hospital, Shimla (HP) between the time period January 2022 to January 2023. Ethical clearance from institutional ethical committee, Himachal Pradesh Government Dental College, Shimla was approved with ref no: HFW (GDC) B (12) 50/2015:3358 on 26.12.2020. Type of study was an original research article.

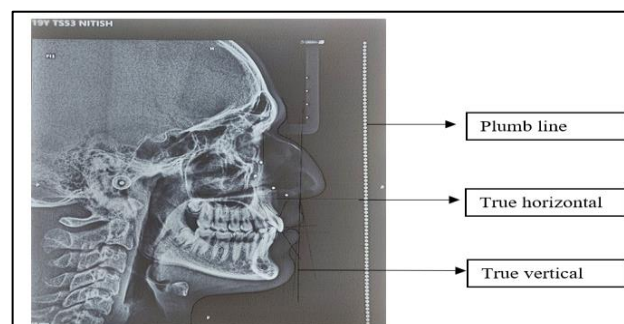
The study sample consisted of group 1 (study group) which comprised of 110 subjects (51 females and 59 males) within age 18-25 years with Angle's class I molar relationship and well-balanced faces who were residents of north western Himalayan ranges, no missing teeth except for the third molars and group 2 (control group) comprised of Arnett's norms of Caucasian population. Any previous orthodontic treatment or orthognathic surgery, or a craniofacial anomaly, patients with overjet exceeding 2-3 mm and anterior open bite were excluded. It was hypothesized that there will be no statistically significant difference in the soft tissue parameters between the groups.

Standardized digital lateral cephalograms were taken with the digital cephalometric machine Carestream CS8100SC with the patient standing in the natural head position with lips in rest position. Standardized 8"×10" dry view laser imaging film was used for each subject. The cephalograms were taken with a voltage 80 Kvp, current 10 mA and exposure time of 10 seconds. All lateral cephalograms were then transferred to a computer with CS 8100SC imaging software and hard copies were printed with the help of a x-ray printer (dry view 5700 laser image).

A plumb line was constructed by suspending a metal chain which was allowed to hang freely in front of the film cassette and grid and anterior to the subject's soft-tissue profiles. Lead bead metallic markers were placed on the right side of the face using micropore tapes to mark key midface structures. The metallic beads were placed on the model's face on the following 4 regions: i) orbital rim marker, ii) cheekbone contour, iii) sub-pupil marker, iv) alar base marker.

The cephalometric landmarks were manually traced on 0.36 mm acetate tracing paper with 4H lead pencil on a view box using transilluminated light. TVL was established by drawing a true horizontal perpendicular to plumb line and then a true vertical line perpendicular to

the true horizontal passing through subnasale (Figure 1). To avoid intra operator error due to fatigue, not more than five cephalograms were traced per day. The linear and angular measurements were done with the help of millimeter ruler and protractor. Totally 45 parameters were traced and measured and statistical analysis using student 't' test was obtained (Tables 1 and Table 2).



**Figure 1: TVL established.**

All statistical analysis was performed with software, Epi Info version 7.2.5 by CDC Atlanta, Georgia, USA. The mean, standard deviation and standard error of mean was determined. The p value was significant at  $p < 0.05$  (\*). The means were compared with student 't' test between the study and control groups.

## RESULTS

The mean values of overjet, overbite, upper and lower lip thickness, soft tissue chin and menton thickness, facial length values were statistically significant between study and control group (Table 1). Among the mean values of projection to TVL, alarbase, subpupil, nasal projection, A', B', upper and lower lip anterior, pog' were statistically significant. Among the mean values of facial harmony, Md1-pog', Throat length, A'-B', facial angle, orbital rim-A' and orbital rim -pog' were statistically significant (Table 1).

**Table 1: Mean, standard deviation and p values of group 1 and group 2.**

| Variables                     |                          | Group 1<br>males (n=59) | Group 2<br>males (n=20) | P value  | Group 1<br>females<br>(n=51) | Group 2<br>females<br>(n=26) | P value  |
|-------------------------------|--------------------------|-------------------------|-------------------------|----------|------------------------------|------------------------------|----------|
|                               |                          | Mean±SD                 | Mean±SD                 |          | Mean±SD                      | Mean±SD                      |          |
| <b>Soft tissue parameters</b> |                          |                         |                         |          |                              |                              |          |
| Dentoskeletal factors         | Mx occlusal plane        | 95.0±1.4                | 95.8±3.5                | 0.3153   | 95.6±1.8                     | 96.47±4.4                    | 0.1926   |
|                               | Mx1 to Mx occlusal plane | 57.8±3.0                | 57.9±4.9                | 0.8787   | 56.8±2.5                     | 56.53±5.4                    | 0.8297   |
|                               | Md1 to Md occlusal plane | 64.0±4.0                | 66.2±5.5                | 0.0991   | 64.3±3.2                     | 64.37±5.5                    | 0.9099   |
|                               | Overjet                  | 3.2±0.6                 | 2.90±0.46               | 0.0028*  | 3.2±0.4                      | 2.68±0.59                    | <0.0001* |
|                               | Overbite                 | 3.2±0.7                 | 2.65±0.77               | 0.0067*  | 3.2±0.7                      | 2.69±0.90                    | <0.0005* |
| Soft tissue structure         | Upper lip thickness      | 14.8±1.4                | 13.33±1.91              | 0.0025*  | 12.6±1.8                     | 12.04±1.4                    | 0.0584   |
|                               | Lower lip thickness      | 15.1±1.2                | 11.85±1.24              | <0.0001* | 13.6±1.4                     | 10.8±1.2                     | <0.0001* |
|                               | Pog-pog'                 | 13.5±2.3                | 11.62±1.82              | 0.0004*  | 11.8±1.5                     | 11.3±1.8                     | 0.1241   |
|                               | Me-me'                   | 8.8±1.3                 | 7.29±1.72               | 0.0006*  | 7.4±1.6                      | 6.6±1.5                      | 0.01435* |
|                               | Nasolabial angle         | 106.4±7.7               | 102±10.3                | 0.0085*  | 103.5±6.8                    | 98.00±11.2                   | 0.0029*  |
|                               | Upper lip angle          | 8.3±5.4                 | 6.0±7.94                | 0.2436   | 12.1±5.1                     | 9.5±8.1                      | 0.0382*  |

Continued.

| Variables                 |                                         | Group 1<br>males (n=59) | Group 2<br>males (n=20) | P value  | Group 1<br>females (n=51) | Group 2<br>females (n=26) | P value  |
|---------------------------|-----------------------------------------|-------------------------|-------------------------|----------|---------------------------|---------------------------|----------|
|                           |                                         | Mean±SD                 | Mean±SD                 |          | Mean±SD                   | Mean±SD                   |          |
| Facial length             | Na'-me'                                 | 137.7±6.5               | 121.8±4.75              | 0.0001*  | 124.6±4.7                 | 119.0±1.4                 | <0.0001* |
|                           | Upper lip length                        | 24.4±2.5                | 20.03±2.21              | <0.0001* | 21.0±1.9                  | 18.5±2.1                  | <0.0001* |
|                           | Interlabial gap                         | 2.4±1.1                 | 1.62±.55                | 0.0001*  | 3.3±1.3                   | 1.598±.62                 | <0.0001* |
|                           | Lower lip length                        | 54.3±2.4                | 45.86±3.32              | <0.0001* | 46.9±2.3                  | 40.6±6.1                  | <0.0001* |
|                           | Lower 1/3 <sup>rd</sup> of face         | 81.1±4.7                | 66.41±8.94              | <0.0001* | 71.1±3.5                  | 61.5±4.5                  | <0.0001* |
|                           | Mx1 exposure                            | 3.9±1.2                 | 3.77±2.74               | 0.8399   | 4.7±1.6                   | 3.3±1.3                   | <0.0001* |
|                           | Maxillary height                        | 28.4±3.2                | 21.83±2.58              | <0.0001* | 25.7±2.1                  | 20.2±2.1                  | <0.0001* |
|                           | Mandibular height                       | 56.0±3.0                | 47.59±3.60              | <0.0001* | 48.6±2.4                  | 43.2±3.7                  | <0.0001* |
| <b>Projections to TVL</b> |                                         |                         |                         |          |                           |                           |          |
|                           | Glabella                                | -8.0±2.5                | -8.85±3.73              | 0.3441   | -8.5±2.4                  | -8.7±4.0                  | 0.6104   |
|                           | Orbital rims                            | -22.4±2.7               | -22.14±2.67             | 0.7133   | -18.7±2.0                 | -19.2±3.0                 | 0.1288   |
|                           | Cheek bone                              | -25.2±4.0               | -24.20±3.49             | 0.2913   | -20.6±2.4                 | -20.08±3.7                | 0.4351   |
|                           | Subpupil                                | -18.4.0±1.9             | -16.47±2.81             | 0.00058* | -14.8±2.1                 | -13.1±3.3                 | 0.0030*  |
|                           | Alar base                               | -15.0±1.7               | -8.13±2.14              | <0.0001* | -12.9±1.1                 | -6.3±2.5                  | <0.0001* |
|                           | Nasal projection                        | 17.4±1.7                | 13.07±6.65              | <0.0001* | 16.0±1.4                  | 12.6±4.1                  | <0.0001* |
|                           | Subnasale                               | 0                       | 00±000                  | 0        | 0                         | 00                        |          |
|                           | A point'                                | -0.3±1.0                | -1.68±1.60              | 0.0005*  | -0.1±1.0                  | -1.2±1.3                  | <0.0001* |
|                           | Upper lip anterior                      | 3.3±1.7                 | 1.21±2.27               | 0.0003*  | 3.7±1.2                   | 1.9±1.8                   | <0.0001* |
|                           | Mx1                                     | -12.1±1.8               | -11.88±5.15             | 0.8533   | -9.2±2.2                  | -9.1±3.8                  | 0.9265   |
|                           | Md1                                     | -15.4±1.9               | -14.06±7.03             | 0.4075   | -12.4±2.2                 | -11.3±5.5                 | 0.2232   |
|                           | Lower lip anterior                      | 1.0±2.2                 | -1.25±2.59              | 0.0008*  | 1.9±1.4                   | -0.2±2.4                  | <0.0001* |
|                           | B point'                                | -7.1±1.6                | -9.62±4.03              | 0.0080*  | -5.3±1.5                  | -7.4±3.3                  | 0.0001*  |
|                           | Pogonion'                               | -3.5±1.8                | -6.25±4.53              | 0.0101*  | -2.6±1.9                  | -4.9±3.74                 | 0.0001*  |
| <b>Facial harmony</b>     |                                         |                         |                         |          |                           |                           |          |
| Intermandibular relations | Md1-pog'                                | 11.9±2.8                | 8.28±4.70               | 0.0017*  | 9.8±2.6                   | 7.3±3.4                   | 0.0001*  |
|                           | Lower lip anterior-Pog'                 | 4.4±2.5                 | 5.23±2.80               | 0.2407   | 4.5±2.1                   | 4.6±2.1                   | 0.6564   |
|                           | B'-pog'                                 | 3.6±1.3                 | 3.32±1.83               | 0.5338   | 2.7±1.1                   | 2.6±1.71                  | 0.8282   |
|                           | Throat length (neck throat point -Pog') | 61.4±7.4                | 49.99±6.33              | <0.0001* | 58.2±5.9                  | 51.6±4.7                  | <0.0001* |
| Interjaw relations        | Subnasale'-pog'                         | 4.0±1.7                 | 7.44±7.76               | 0.0538   | 3.2±1.9                   | 5.2±3.4                   | 0.0001*  |
|                           | A'-B'                                   | 6.8±1.5                 | 8.18±2.73               | 0.00345* | 5.2±1.6                   | 6.1±2.3                   | 0.0116*  |
|                           | Upper lip anterior-lower lip anterior   | 2.3±1.2                 | 2.63±1.59               | 0.3914   | 1.8±1.0                   | 2.1±1.58                  | 0.1001   |
| Orbit to jaws             | Orbital rim'-A'                         | 22.1±3                  | 20.22±2.62              | 0.0092*  | 18.5±2.3                  | 17.7±2.9                  | 0.1823   |
|                           | Orbital rim'-pog'                       | 18.9±2.8                | 15.11±4.69              | 0.0010*  | 16.0±2.6                  | 13.7±5.27                 | 0.0081*  |
| Full facial balance       | Facial angle                            | 169.4±3.2               | 163.6±8.13              | 0.0031*  | 169.3±3.4                 | 165.9±4.5                 | <0.0001* |
|                           | Glabella'-A'                            | 7.8±2.8                 | 7.20±3.70               | 0.5119   | 8.4±2.7                   | 7.490±4.25                | 0.2093   |
|                           | Glabella'-pog'                          | 4.6±2.2                 | 4.55±4.12               | 0.9598   | 5.9±2.3                   | 5.569±4.38                | 0.6636   |

Group 1- study group (North Western Himalayan population, Group 2- control group (Arnett's Caucasian population), \*statistically significant

**Table 2: Mean, standard deviation and p values of males and females of group 1.**

| Variables              |                          | Males (n=59) | Females (n=51) | P value |
|------------------------|--------------------------|--------------|----------------|---------|
|                        |                          | Mean±SD      | Mean±SD        |         |
| Soft tissue parameters |                          |              |                |         |
| Dentoskeletal factors  | Mx occlusal plane        | 95.6±1.8     | 95.6±1.8       | 0.406   |
|                        | Mx1 to Mx occlusal plane | 56.8±2.5     | 56.8±2.5       | 0.144   |
|                        | Md1 to Md occlusal plane | 64.3±3.2     | 64.3±3.2       | 0.079   |
|                        | Overjet                  | 3.2±0.4      | 3.2±0.4        | 0.033*  |
|                        | Overbite                 | 3.2±0.7      | 3.2±0.7        | 0.787   |
| Soft tissue structure  | Upper lip thickness      | 12.6±1.8     | 12.6±1.8       | 0.000*  |
|                        | Lower lip thickness      | 13.6±1.4     | 13.6±1.4       | 0.000*  |
|                        | Pog-pog’                 | 11.8±1.5     | 11.8±1.5       | 0.374   |
|                        | Me-me’                   | 7.4±1.6      | 7.4±1.6        | 0.054   |
|                        | Nasolabial angle         | 103.5±6.8    | 103.5±6.8      | 0.054   |
|                        | Unner lip angle          | 12.1±5.1     | 12.1±5.1       | 0.026*  |

Continued.

| Variables                 |                                         | Males (n=59)<br>Mean±SD | Females (n=51)<br>Mean±SD | P value |
|---------------------------|-----------------------------------------|-------------------------|---------------------------|---------|
| Facial length             | Na'-Me'                                 | 124.6±4.7               | 124.6±4.7                 | 0.000*  |
|                           | Upper lip length                        | 21.0±1.9                | 21.0±1.9                  | 0.001*  |
|                           | Interlabial gap                         | 3.3±1.3                 | 3.3±1.3                   | 0.796   |
|                           | Lower lip length                        | 46.9±2.3                | 46.9±2.3                  | 0.000*  |
|                           | Lower 1/3 <sup>rd</sup> of face         | 71.1±3.5                | 71.1±3.5                  | 0.001*  |
|                           | Mx1 exposure                            | 4.7±1.6                 | 4.7±1.6                   | 0.334   |
|                           | Maxillary height                        | 25.7±2.1                | 25.7±2.1                  | 0.001*  |
|                           | Mandibular height                       | 48.6±2.4                | 48.6±2.4                  | 0.000*  |
| Projections to TVL        |                                         |                         |                           |         |
|                           | Glabella                                | -8.5±2.4                | -8.5±2.4                  | 0.913   |
|                           | Orbital rims                            | -18.7±2.0               | -18.7±2.0                 | 0.000*  |
|                           | Cheek bone                              | -20.6±2.4               | -20.6±2.4                 | 0.000*  |
|                           | Subpupil                                | -14.8±2.1               | -14.8±2.1                 | 0.000*  |
|                           | Alar base                               | -12.9±1.1               | -12.9±1.1                 | 0.000*  |
|                           | Nasal projection                        | 16.0±1.4                | 16.0±1.4                  | 0.718   |
|                           | Subnasale                               | 0                       | 0                         | 0       |
|                           | A point'                                | -0.1±1.0                | -0.1±1.0                  | 0.166   |
|                           | Upper lip anterior                      | 3.7±1.2                 | 3.7±1.2                   | 0.074   |
|                           | Mx1                                     | -9.2±2.2                | -9.2±2.2                  | 0.002*  |
|                           | Md1                                     | -12.4±2.2               | -12.4±2.2                 | 0.028*  |
|                           | Lower lip anterior                      | 1.9±1.4                 | 1.9±1.4                   | 0.037*  |
|                           | B point'                                | -5.3±1.5                | -5.3±1.5                  | 0.002*  |
|                           | Pogonion'                               | -2.6±1.9                | -2.6±1.9                  | 0.106   |
| Facial harmony            |                                         |                         |                           |         |
| Intermandibular relations | Md1-pog'                                | 9.8±2.6                 | 9.8±2.6                   | 0.247   |
|                           | Lower lip anterior-pog'                 | 4.5±2.1                 | 4.5±2.1                   | 0.234   |
|                           | B'-pog'                                 | 2.7±1.1                 | 2.7±1.1                   | 0.050*  |
|                           | Throat length (neck throat point -pog') | 58.2±5.9                | 58.2±5.9                  | 0.128   |
| Interjaw relations        | Subnasale'-pog'                         | 3.2±1.9                 | 3.2±1.9                   | 0.061   |
|                           | A'-B'                                   | 5.2±1.6                 | 5.2±1.6                   | 0.000*  |
|                           | Upper lip anterior-lower lip anterior   | 1.8±1.0                 | 1.8±1.0                   | 0.151   |
| Orbit to jaws             | Orbital rim'-A'                         | 18.5±2.3                | 18.5±2.3                  | 0.000*  |
|                           | Orbital rim'-pog'                       | 16.0±2.6                | 16.0±2.6                  | 0.163   |
| Full facial balance       | Facial angle                            | 169.3±3.4               | 169.3±3.4                 | 0.084   |
|                           | Glabella'-A'                            | 8.4±2.7                 | 8.4±2.7                   | 0.706   |
|                           | Glabella'-Pog'                          | 5.9±2.3                 | 5.9±2.3                   | 0.213   |

\*statistically significant

On comparison between males and females of study group, the mean values of overjet, lip thickness, upper lip angle, facial lengths were statistically significant (Table 2). Among the projections to TVL, the values of orbital rim, alarbase, cheek bone, subpupil, B' point were statistically significant. The mean values of B'-pog', A'-B' and OR'-A' were also statistically significant (Table 2).

## DISCUSSION

The present study was conducted at the department of orthodontics and dentofacial orthopedics, Himachal Pradesh Government Dental College, Shimla which lies in the north-western ranges of the Himalayas. The purpose of the study was to establish the soft tissue

cephalometric norms and compare males and females of north western Himalayan range population with that of soft tissue Arnett's norms.

The mean values of overjet and overbite were significantly decreased in the study group. Whereas the overjet was increased in males than females of study group. The nasolabial angle and upper lip angle reflect the position of the upper incisor teeth and the thickness of the soft tissue overlying these teeth.<sup>1</sup> Upper and lower lip thickness, soft tissue chin thickness, soft tissue menton thickness and nasolabial angle were significantly reduced in the males of the study group whereas in females, the lower lip thickness and soft tissue menton thickness was significantly decreased. The upper lip angle was significantly decreased in females of the study group and

this could be due to proclined upper incisors. The soft tissue thickness was greater in males than females of the study group. Males showed significantly increased upper and lower lip thickness and decreased upper lip angle than females. The facial length values were significantly decreased in group 2 compared to group 1. This might be due to decreased lower one third of the face which could be because of decreased maxillary height, deep bite and mandibular retrusion. Similar findings were also reported by Chhajed et al in central Indian population, Tikku et al in North Indians and Kalha et al in South Indians.<sup>3-5</sup>

All facial length values were significantly increased in males than females. This could be because of increased maxillary and mandibular height in males than females. This significant difference in facial heights between men and women might be significant in treatment planning because these differences can be indications to increase or decrease facial height.

Among the projections to TVL, the orbital rim, subpupil, cheek bone contour and alar base indicates the anteroposterior maxillary position (retrusive or protrusive).<sup>1</sup> The mean values of subpupil and alar base to TVL were significantly decreased and less negative in group 2 suggesting that the maxillary projection was increased and protrusive midface as compared to Arnett's population. The anteroposterior maxillary projection was decreased in males compared to females which denoted that the midface was less developed in males.<sup>4</sup> This was also reported by Chhajed et al in Central Indian population and Watanabe et al in Japanese males' population than the Caucasian population.<sup>3,6</sup>

The A' point was more negative from TVL in males of group 2 as compared to group 1. This could be due to deeper maxillary sulcus contour in the study group as compared to controls. According to Arnett and Bergman deeper maxillary sulcus contour is due to thick and flaccid lips.<sup>7,8</sup> The mean values of upper lip anterior and lower lip anterior to TVL were significantly decreased in the study group indicating less procumbent upper and lower lips compared to Arnett's population. The retrusive lip profile could be attributed to the retrognathic maxillary and mandibular base and thinner soft tissue structures in the study group as compared to the controls. The mean values of Mx1 and Md1 to TVL were more negative in males compared to females, due to more proclined maxillary and mandibular incisors in females compared to males.

The mean values of lower lip anterior and B' point to TVL showed that males had less procumbent lower lips and had deeper mandibular sulcus contour (mentolabial sulcus) than females. This could be because of lower lip protrusion, which might compensate for a retruded mandible during lip closure. Al-Gunaid et al in his soft tissue cephalometric study conducted on Yemeni population concluded that the mentolabial sulcus depth was greater in Yemeni population because of lower lip

protrusion as a compensation for retruded mandible.<sup>9</sup> Similar findings were also been reported by Aggarwal in Himachali ethnic population, Tikku et al in north Indians and Chhajed et al in central Indian population.<sup>2-4</sup>

The mean values of pog' to TVL indicated the chin projection was decreased in group 2 with more retruded chin. The mean value of MD1-pog' was decreased in group 2 indicating proclined lower incisors in relation to chin with decreased chin projection. The throat length was significantly decreased because of mandibular retrusion and decreased chin projection in the females than males. In diagnosis and surgical planning, these norm values can be used by the clinician. This is in accordance to Arnett who explained that a patient with decreased throat length (sagging/short throat length) is not a good candidate for mandibular setback, and long throat length indicates mandibular protrusion and is an indication for a mandibular setback.<sup>1</sup> Similar results were found by Tikku et al in north Indians, Chhajed et al in central Indian population, Kalha et al in south Indian population and Watanabe et al in Japanese population.<sup>3-6</sup>

The mean value of Sn-pog' was increased in females of group 2 than group 1. This could be because of decreased chin projection in the study group than the controls. Similar findings were also observed by Tikku et al in North Indian population, Chhajed et al in central Indian population, Kalha et al in south Indian population and Watanabe et al in Japanese population.<sup>3-6</sup>

The orbital rim is an anteroposterior indicator of maxillary position.<sup>3,7</sup> Group 2 showed decreased maxillary projection which might be due to a retruded maxilla because the osseous structures are often deficient as groups, rather than in isolation.<sup>3</sup> The facial angle value indicates the harmonious relations of forehead, midface and lower face.<sup>10</sup> Forehead and lower face were retrusive in relation to midface with a convex facial profile in the study group and similar results were found by Aggarwal in Himachali ethnic population, Kalha et al in South Indian population and Chhajed et al in Central Indian population.<sup>2,3,5</sup> This was in contrast to the study which showed that upper Shimla hill subjects had retrognathic maxilla with concave profile when compared to Caucasian norms.<sup>11</sup> Similar results were reported for Polish population and Iowan and Norwegian population.<sup>12,13</sup>

Limitations of the study are further studies should be conducted with more larger samples and norms for the other soft tissue cephalometric analyses should be established for the same population. Also the study conducted was a 2D cephalometric analysis and further 3D studies must be conducted on hard and soft tissues.

## CONCLUSION

The present study was carried out to compare the Arnett's soft tissue norms with the population of north western



Himalayan region and also compare between males and females of the same population to determine sexual dimorphism among the population. On comparing the study group with the control group, decreased soft tissue thickness, decreased facial lengths, less procumbent lips, decreased overjet and overbite, proclined upper and lower incisors, increased maxillary projection, posteriorly positioned forehead, decreased chin projection and more convex facial profile were seen in the study group. On comparing males and females of the study group, males had increased soft tissue thickness and increased facial lengths as compared to females. Females had less procumbent upper lips, proclined upper and lower incisors and increased maxillary projection as compared to males. Males had less procumbent lower lips, deep mentolabial sulcus, decreased chin projection and more convex facial profile as compared to females of the study group. Thus, new norms were determined for the males and females of the population of north western Himalayan region with statistically significant values. They show distinctive facial features which vary from Caucasian population and this will be a guide to determine orthodontic treatment planning based upon their soft tissue norms.

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