



Comparative evaluation of craniofacial morphology in underweight and normal weight orthodontic patients- A cephalometric study

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Abstract

Introduction: Researchers throughout the world are still fascinated by the complex interactions that exist between different physiological parameters and craniofacial shape in the field of orthodontics. One such factor, often overlooked yet significant, is the individual's body weight.

Aim: To assess and compare craniofacial morphology in underweight and normal weight orthodontic patients using cephalometric analysis and BMI.

Materials and Method: 86 patients with the mean age of 15- 25 years were divided into two equal groups of underweight and normal weight groups based on their calculated BMI. Various linear and angular measurements of lateral cephalograms were done using Audaxceph (6.0 version) software.

Results: Mandibular length (Co-Gn) and Corpus length (Go-Pog) were significantly less in underweight individuals than normal weight individuals. No significant difference was found in Midfacial length (Co-A), maxillary length (Co-ANS), (ANS-PNS), cranial base length (S-N) and anterior facial height (N-Me) of both the groups. In vertical dimension anterior facial height (N-Me) and posterior facial height(S-Go) in underweight individuals were somewhat lesser than normal weight patients, but there was no statistically significant difference.

Conclusion: Mandibular length (Co-Gn) and Corpus length (Go-Pog) of underweight patients are significantly lesser than in normal weight patients. Clinicians should consider nutritional status when assessing facial morphology and planning treatment for underweight patients.

Keywords: BMI, lateral cephalogram, underweight

Introduction

Nutrition, the science of food and its impact on health, encompasses a complex interplay of nutrients, physiological processes, and their effects on growth and development. Adequate nutrition is vital for optimal growth and well-being, with malnutrition posing significant challenges, particularly in countries like India, where underweight prevalence among children remains alarmingly high¹.

In the domain of orthodontics, where the focus extends beyond dental aesthetics to encompass facial harmony and function, the interaction between diet and orthodontic therapy is profound. Orthodontic treatment influences food consumption, while nutrition affects periodontal health, healing, and growth².

Craniofacial morphology, pivotal in determining facial aesthetics and function, is influenced by various factors, including body weight. Underweight and normal weight statuses can manifest distinct skeletal characteristics, impacting treatment planning and outcomes.

Gaur *et al.* ^[3] in India have established the effect of undernutrition or low BMI on dental development. According to their findings, undernutrition causes deciduous and permanent teeth to erupt later than they would normally. Hilda Lubis and Rachel Tiong ^[4] investigated the relationship between nutritional status and mandibular length in 100 children. All the subjects were photographed with their heads held in a natural position. The photographs were analyzed using the computer program CorelDraw X7

to measure the length of the mandible. The results of the study revealed that there was a difference in mandibular length between subjects with normal nutrition status and those with lower than normal nutrition status.

Mandibular bone size, mass, strength, morphology, and biomechanics are all impacted by protein deprivation, as demonstrated by a previous study by Bozzini *et al* ^[5].

Assessment of weight status, typically through BMI, plays a crucial role in understanding its effects on craniofacial morphology. Overweight and obese individuals exhibit distinct skeletal dimensions compared to their normal-weight peers, influencing orthodontic treatment planning.

Despite extensive literature on craniofacial morphology in overweight/obese individuals, research on the effects of decreased body mass on the craniofacial complex is scarce. Therefore, this study aims to address this gap by conducting a comparative evaluation of craniofacial morphology in underweight and normal weight orthodontic patients.

The objective of this study is to assess and compare the craniofacial morphology of underweight and normal weight orthodontic patients using lateral cephalograms.

Materials and Method

The study was initiated after obtaining ethical approval from Sai Tirupati University, Institutional Ethical Committee. A total of 86 subjects meeting the inclusion criteria were selected from the patients reported to the Department of Orthodontics & Dentofacial Orthopaedics, Pacific Dental

College and Hospital, Debari, Udaipur for fixed orthodontic treatment. Patients were divided into two equal groups based on their BMI (underweight and normal weight). The BMI was calculated using the height and weight of the subjects. Weight was measured using a standard weighing machine (beatXP)TM and height was measured using a standard mechanical scale (Prime surgical height measuring scale)TM.

To Calculate BMI

$$BMI = \frac{\text{Weight in kilograms}}{(\text{Height in meters})^2}$$

Inclusion criteria

1. Age group between 15 to 25 years
2. Pre treatment lateral cephalography radiographs of diagnostic quality.
3. Height and weight recorded within 3 months of the lateral cephalograph radiograph
4. BMI equal to or less than 18.5 to 25 (in patients above 18 years of age)
5. There is no history of systemic diseases.

Exclusion criteria

1. Patients with severe skeletal defects in anteroposterior or vertical dimensions.
2. A Significant medical condition that would affect physical growth and development.
3. BMI score above 25

The BMI recording procedure involved obtaining informed consent from participants and ensuring ethical considerations. Participants stood on a weight measuring scale to record their weight in kilograms. They then stood upright on a height measuring scale, barefoot and without head accessories, with the line of sight parallel to the floor. The height measurement in centimeters was converted to meters squared (m²). BMI was calculated using the weight and height measurements obtained. (Fig-1)



Fig 1: Measurement of Weight and Height for BMI

Group I: Underweight Orthodontic Patients

- BMI ≤ 18.5 (above 18 years)

Group II: Normal weight Orthodontic Patients

- BMI 18.5- 24.9 (above 18years)

A Kodak 800c machine (Kodak Carestream, NY, USA) was used for taking lateral cephalograms. Tracings of lateral cephalograms were made using Audaceph (6.0 version) software and the entry of the patient was created and a soft copy of the cephalograms was uploaded. Cephalometric points and contours were marked, and linear and angular measurements were obtained (Fig-2)

Measurements

Linear Measurements

- Mandibular length - Condylion (Co) to Gnathion (Gn),
- Corpus length - Gonion (Go) to Pogion (Po),
- Midfacial length - Condylion (Co) to point A,
- Maxillary length - Condylion (Co) to Anterior Nasal Spine (ANS),
- Anterior cranial base length - Sella(S) to Nasion (N),
- Posterior facial height - Sella(S) to Gonion (Go),
- Anterior facial height - Nasion(N) to Menton (Me), whereas,
- Anterior upper facial height and Anterior lower facial height-Nasion (N) to anterior nasal spine (ANS) and ANS to Menton (Me) respectively.

Angular Measurements

- ANB Angle (anteroposterior relationship of mandible to the maxilla)- formed by A point, Nasion, and B point,
- SNA Angle (anteroposterior relationship of maxilla to cranial base)- formed by Sella (S), Nasion(N), and A point(A),
- SNB Angle (relationship of cranial base with mandible)- formed by Sella(S), Nasion(N) to B point,
- Mandibular plane angle - formed between Sella(S), Gonion (Go) and Gnathion (Gn)

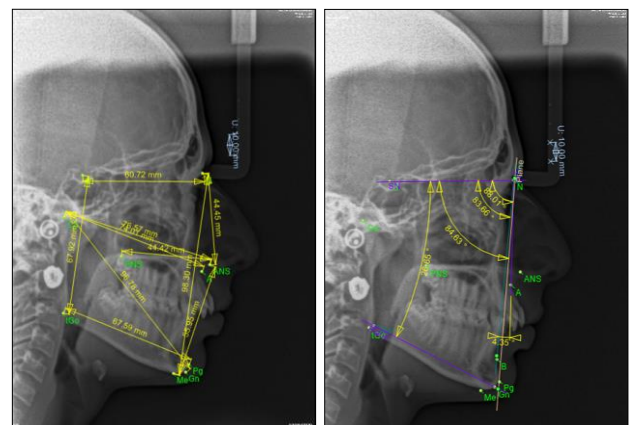


Fig 2: Linear and Angular measurements done using Audaex CEPH software Statistical Analysis

The data were entered in Microsoft Excel and analyzed statistically using the SPSS software, version 21; SPSS Inc., USA.

Descriptive statistics were used to calculate the mean and standard deviation values. An Independent student t test was carried out to determine the difference between groups for linear and angular measurements, respectively. All statistical tests were performed at a significance level of 5% (p < 0.05).

Results

A total of 86 patients were included in study and were divided into two equal groups. 11 males and 32 females were included in the underweight group with a mean age and BMI of 17.93 and 17.39, respectively. 18 males and 25 females were included in normal weight group with mean age and BMI of 21.76 and 19.07, respectively (TABLE-1). Underweight people were found to have statistically significant smaller mandibular lengths (Co-Gn) and corpus lengths (Go-Pog) than people with normal weights

(TABLE-2). In terms of the two groups maxillary length (Co-ANS), midfacial length (Co-A), and ANS-PNS, there was no statistically significant difference. Furthermore, no statistically significant variation was found in the cranial base length (S-N) or anterior facial height (N-Me). The anterior facial height (N-Me) and posterior facial height (S-Go) of underweight people were somewhat lower than those of normal weight patients in the vertical dimension, but no statistically significant difference was seen (TABLE-2).

Table 1: Demographic profile of the participants

Demographic variables	Underweight group N = 43	Normal Weight group N=43
<i>Gender</i>		
Male	11 (37.9%)	18 (62.1%)
Female	32 (56.1%)	25 (43.9%)
AGE	17.93 ± 1.05	21.76 ± 1.33
BMI	17.39 ± 3.09	19.07 ± 2.79

Table 1 shows the descriptive statistics with mean and standard deviation for Age, BMI, and gender for both the underweight and normal weight groups.

Table 2: Comparison of angular measurements of the participants in the underweight and normal weight groups

Measurements	Underweight N = 43	Normal Weight N=43	P-value
<i>Angular (°)</i>			
SNA	83.43 ± 4.53	84.17 ± 3.97	0.422
SNB	79.09 ± 5.22	80.53 ± 3.96	0.156
ANB	4.65 ± 2.51	4.06 ± 2.44	0.270
S-N-Pog	80.09 ± 5.71	81.44 ± 5.10	0.250
Sn-Go-Gn	26.72 ± 8.24	26.13 ± 8.06	0.737

All values are expressed as mean ± standard deviation (SD). The statistical test used: Independent student t Test; Level of significance: * p ≤ 0.05 is considered statistically significant

Table-2 shows the comparison of various angular measurements in normal weight and underweight patients. Independent student t test was applied to compare the data.

No significant difference was found between both the groups.

Table 3: Comparison of linear measurements of the participants in underweight and normal weight groups

Measurements	Study Group (Underweight) N = 43	Control Group (Normal Weight) N=43	P-value
<i>Linear (mm)</i>			
Co-Gn	92.94 ± 8.24	96.53 ± 7.60	0.039*
Go-Pog	60.52 ± 6.17	63.88 ± 4.83	0.006*
Co-A	73.35 ± 7.37	75.35 ± 6.71	0.190
Co-ANS	75.74 ± 7.54	78.05 ± 6.92	0.141
ANS-PNS	44.48 ± 4.95	46.89 ± 7.47	0.081
S-N	58.65 ± 5.76	60.13 ± 4.65	0.192
S-Go	65.62 ± 7.89	68.40 ± 6.26	0.075
N-Me	95.33 ± 10.43	97.02 ± 7.70	0.396
N-ANS	40.87 ± 4.44	42.15 ± 4.02	0.166
ANS-Me	54.58 ± 8.19	54.91 ± 6.01	0.831
UFAH (%)	43.03 ± 3.70	43.50 ± 3.34	0.531
LAFH (%)	57.08 ± 3.62	56.53 ± 3.27	0.462

All values are expressed as mean ± standard deviation (SD). The statistical test used: Independent student t Test; Level of significance: * p ≤ 0.05 is considered statistically significant

Table-3 shows the comparison of various linear measurements in normal weight and underweight patients. Independent student t test was applied to compare the data

and Co-Gn, Go-Pog was significantly smaller in underweight patients when compared to normal weight patients.

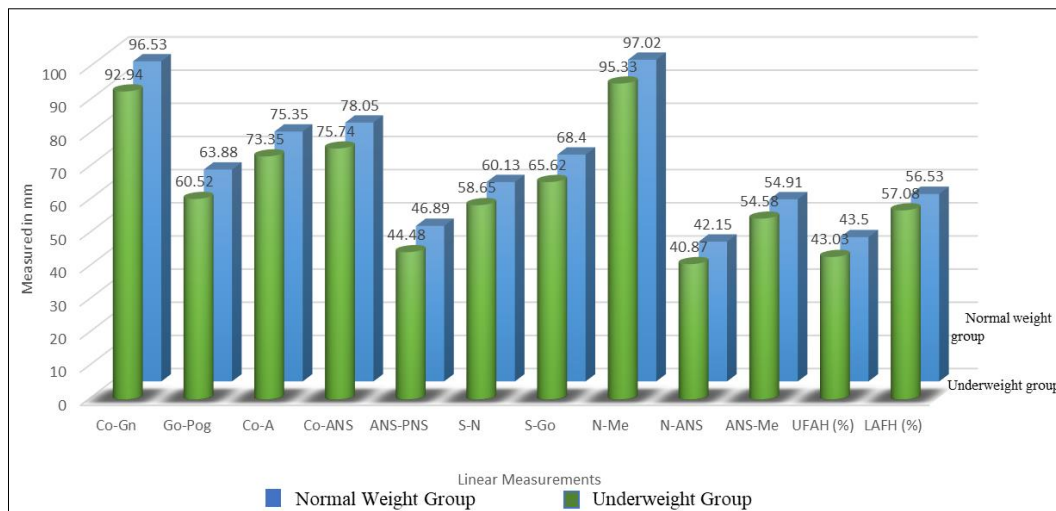


Fig 1: Linear measurements of the participants in Normal weight and underweight groups

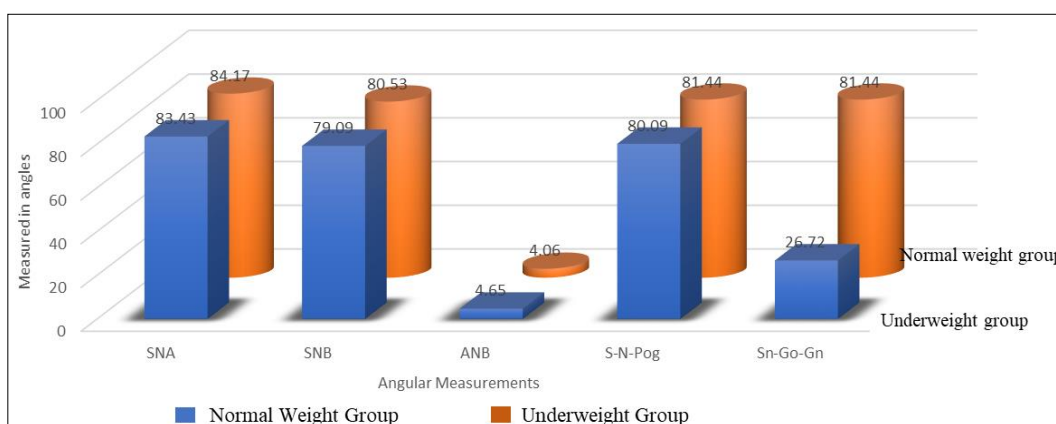


Fig 2: Angular measurements (in degrees) of the participants in underweight and normal weight groups

Discussion

Malnutrition is a complex illness that can develop early in infancy or intrauterine life, or it can develop later in life as a result of inadequate nutrition [6]. Even with a 50% growth in GDP since 2013, over one-third of the world's undernourished children reside in Indi [1]. Every organ system's recovery and functionality are impacted by malnutrition. Malnutrition is often most evident in weight loss resulting from the loss of muscle, fat, and organ mass [7]. Zhang *et al* [8]. (1994) identified the hormone leptin, which may have a regulatory role in body fat levels. Adipocytes release leptin, which acts through hypothalamic mediators to control hunger and metabolism. It has been demonstrated to gradually increase prior to puberty, speed up the hypothalamus' synthesis of a gonadotropin-releasing hormone, and maybe contribute to the onset of puberty. It has also been demonstrated to play a significant role in skeletal development and may have an effect on the growth of the mandible. Furthermore, it has been proposed that it stimulates chondrocyte differentiation and proliferation at the level of skeletal growth centers⁹. Numerous previous studies conducted by authors Olszewska [10], Ohrn *et al* [11], Sadeghianrizi *et al* [12]. in both normal weight and obese patients found that there were increases in several linear and angular measurements of the maxilla and mandible in the obese adolescents compared to the healthy controls. These findings are consistent with the increased levels of leptin hormone found in overweight patients.

According to research by Mayer *et al* [13]. those with lower BMIs tended to have jawlines that were sharper and more angular, whereas those with higher BMIs had jawlines that were rounder and wider. Mandibular bone size, mass, strength, morphology, and biomechanics are all impacted by protein deprivation, as demonstrated by a previous study by Bozzini *et al* [5]. The results of this study show that teenagers with lower BMI percentiles had shorter mandibles and shorter corpus than their counterparts who were of average weight. In underweight people, the mandibular length (Co-Gn) was 3.59 mm shorter than typical weight people. Additionally, underweight people's corpus length (Go-Pog) was 3.36 mm shorter than that of normal weight people. The mandibular growth may have been impacted by malnutrition or reduced protein absorption in underweight people. In terms of angular measurements, the sagittal dimension showed no significant variation, suggesting that the location of the jaws remained unchanged and that the only variation observed was in the jaws' length. Hilda Lubis and Rachel Tiong [4] found similar results in their study, concluding that subjects with normal nutritional status had mandibular lengths that were considerably longer than those of subjects with lower nutritional status. While our study was a cephalometric investigation with more reliable outcomes, the study was photographic and had less reliable measurements. In additional research, different authors have discovered a link between malnutrition and poor facial bone development

and growth. Malnutrition can cause a decrease in the height of the lower face, maxillomandibular width, jaw height, and skull base length. Crowding, impactions, and ectopic eruptions are caused by insufficient space for teeth to erupt as a result of altered growth of the craniofacial bones. Studies on animals have also demonstrated the importance of proteins in the development of teeth and jaws, which has a major impact on the size and form of the mandible¹⁴⁻²²

Also, in the current study, there was no significant difference between the two groups' maxillary length (Co-ANS), midfacial length (Co-A), or ANS-PNS. The cranial base length (S-N) and anterior facial height (N-Me) did not differ significantly. Although there was no significant difference, underweight people's anterior facial height (N-Me) and posterior facial height (S-Go) were somewhat lower than those of normal weight patients in the vertical dimension.

The study's findings are constrained by a small sample size and homogeneity in ethnicity. Limitations include the use of 2D imaging methods instead of 3D techniques like CBCT, MRI, and CT, as well as the absence of soft-tissue analysis using geometric morphometrics. Nutritional assessment can also be measured by various anthropometric measures such as the weight-for height index, waist circumference (WC), waist-hip ratio (WHR), and body fat percentage estimated by skinfold thickness (ST). Additionally, relying solely on BMI is insufficient. Incorporating nutritional status information could enhance diagnosis and facilitate timely treatment planning for catch-up growth. However, this study contributes to a relatively sparse body of research on craniofacial morphology in underweight individuals. Further, comprehensive research is necessary to validate these findings.

Conclusion

Underweight individuals show shorter mandibular and corpus lengths. No significant differences are observed in midfacial, maxillary lengths, cranial base, and anterior facial height. While vertical facial dimensions appear somewhat shorter in underweight individuals, differences are not statistically significant. Clinicians should consider these findings when assessing facial morphology and planning treatment for underweight patients.

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