치의학박사학위논문

# 장안모와 전안모 높이와의 상관관계에 대한 종단적 분석

A longitudinal study of the relationship between long-face and anterior facial height

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국문초록

# 장안모와 전안모 높이와의 상관관계에 대한 종단적 분석

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1. 목 적 : 본 연구의 목적은 전안모를 장안모, 중안모, 단안모 등으로 분류하고 성장에 따른 변화를 비교하여 장안모 해당자의 상, 하 전안모의 차이를 확인하는 것이다.

2. 방 법 : 총 167명 아동의 방사선 사진을 이용하여 6세에서 14세까지 추적 조사하였다. 측정 항목은 total anterior facial height (TAFH), upper anterior facial height (UAFH), lower anterior facial height (LAFH) and the closest distance from the Frankfort horizontal plane (FH) to the nasion (NFH) 등의 항목이었다. 대상을 14세 때 LAFH/TAFH의 비율을 사용하여 세 군으로 분류하고 군간 차이를 통계학적으로 분석하였다.

3. 결 과 : 장안모 군의 LAFH는 남녀 모두에서 전 연령에 걸쳐 다른 군에 비하여 큰 값을 나타냈다. 반면 중안모 군은 긴 UAFH 값을 나타냈으며, 단안모의 UAFH 값은 전 연령의 여학생과 12, 13, 14세 남학생에서 다른 군에 비하여 큰 값을 나타냈다.

4, 결론 : 장안모 군은 상전안모는 다른 군과 차이가 없었으며, 장안모는 주로 하전안모의 길이에 의하여 결정되었다.

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주요어 : 전안모, 장안모, 중안모, 단안모, 방사선 사진, 추적 조사
학 번 : 2008-31050

**Abstract**

# A longitudinal study of the relationship between long-face and anterior facial height

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1. ***Objectives:*** The aim of the present study was to investigate and compare the anterior facial height of long-, normal- and short-faced children during growth and to discover whether long-faced subjects have long dimensions in both the upper and lower anterior facial heights compared to others.

2. ***Methods:*** Longitudinal lateral cephalometric data of 167 children (83 females and 84 males) from 6 to 14 years of age were used. Total anterior facial height (TAFH), upper anterior facial height (UAFH), lower anterior facial height (LAFH) and the closest distance from the Frankfort horizontal plane (FH) to the nasion (NFH) were measured. The samples were classified as long-, normal- and short-faced

according to the LAFH/TAFH at 14 years old. All data were analyzed statistically and compared between groups according to age.

3. ***Results:*** The mean LAFH in the long-faced group were larger than in the normal- and short-faced groups for all ages in both sexes. In contrast, subjects in the normal group had a longer mean UAFH than subjects in the long-faced and short-faced groups. In addition, the mean UAFH of the short faced group was larger than the long faced group in case of female in all ages and in case of male in 12, 13, 14 years.

4. ***Conclusions:*** The long-faced children did not have longer upper facial heights compared to normal- and short-faced children and their long face is mainly determined by the length of the lower face.

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Keywords: long anterior face, longitudinal study, cephalometry

***Student Number*** **:** 2008-31050

# 1. Introduction

The improvement of facial appearance is an objective common to a variety of clinicians including orthodontists, and facial balance is a cardinal concern.1 In the formulation of the orthodontic treatment plan and prognosis of treatment, the facial type of patients is considered as important.2 There have been numerous facial type classifications based on the view perspective, and the vertical relationship is particularly important, since vertical skeletal discrepancies have been considered as a still difficult challenge to orthodontists.3,4

Under the vertical facial type classification, the face is identified as either long or short compared to normal, although some use the terms dolichofacial (leptoprosopic) or brachyfacial (euryprosopic).5 Severe cases of these vertical dysplasias have been characterized as skeletal open bite or hyperdivergent and skeletal deep bite or hypodivergent.6,7 Some authors have also used the term "long face syndrome"8 and "short face syndrome".9

Patients with long faces have characteristic facial appearances, including a long lower anterior facial height with or without a dental anterior open-bite, and have several accompanying manifestations, such as lip incompetence, posterior rotation of the palatal plane, excessive eruption of the posterior maxillary teeth, and clockwise rotation of the mandible.10,11 The upper third of the face of the long face syndrome patient is usually within normal limits according to Bell and McBride.12 Schendel et al.8 originally described the most important feature of the long face syndrome as vertical maxillary excess, although the later report stated there is variation in this syndrome.13

Our questions arose in response to these reports, in particular regarding

whether long-faced patients have a morphology that is evenly long throughout the entire face or whether they have only a long lower anterior face. If the latter is true, it may be more pertinent to denote them as long lower (third)-faced patients.

Until now, little attention has been paid to the upper anterior facial height and its growth in long faced persons. In the present investigation, we followed the growth changes of anterior facial heights of long faced adolescents and compared them with those of normal- and short-faced adolescents using 9-year longitudinal cephalometric data. The aim of the present study was to compare the changes in the upper anterior facial height between long-faced and normal- and short-faced adolescents and to discuss the appropriateness of the term, “long face”.

## 2. MATERIAL AND METHODS

The study subjects were selected from participants in the Korean Dental Growth Study,14,15 which took place from 1995 to 2003. A total of 410 subjects from northern Gyeonggi-do, Korea participated in this study, and they were all healthy without systemic diseases or developmental anomalies. No one had received any treatments interfering with growth or had any records of orthodontic treatment before or during the observation period. The parents/guardians of all subjects provided written informed consent. Among the subjects, we chose to examine lateral cephalometric radiographs from 167 children (83 males and 84 females) with full sets of 9-year data sufficient to clearly trace all of the measurements of the present study and followed annually from 6 to 14 years of age, with the exception of their tenth year in

which the study was temporarily suspended for financial cause. The Institutional Review Board for the Protection of Human Subjects reviewed and approved the research protocol (S-D2010013).

All radiographs were traced by a single observer in order to rule out inter-examiner variability and analyzed using Vceph version 6.0 (Osstem, Seoul, Korea). Landmarks, reference planes, and measurements are shown in Figure 1. The following four linear measurements were taken from cephalometric radiographs of all children at all ages: (1) total anterior facial height (TAFH), from nasion to menton; (2) upper anterior facial height (UAFH), from nasion to anterior nasal spine; (3) lower anterior facial height (LAFH), from anterior nasal spine to menton; and (4) the closest distance from the FH to the nasion (NFH).

In selecting long- and short-faced subjects, the protocol from a previous study was followed.(Moon et al., 2013) One radiograph obtained at 14 years of age was used for the final measurements, since it represented each subject's most mature state. On the basis of LAFH/TAFH, the subjects who exhibited the most extreme values at both ends of the distribution (i.e., 1 > SD from the mean) were selected as long-faced or short faced ones from the cohort of 167 subjects. The subjects who showed the in-between values designated as normal-faced. Subsequently, female subjects were classified into 12 long-faced, 57 normal-faced and 14 short-faced, and the male subjects were classified into 15 long-faced, 56 normal-faced and 13 short-faced. Then, the records of all measurements were looked back to 6 years of age according to the group and gender, to trace the changes of anterior facial heights longitudinally.

SPSS software (SPSS for Windows, version 12.0, Chicago, IL, USA) was

used for statistical analysis. All the data showed normal distribution according to the Shapiro-Wilk normality test. Analysis of variance (ANOVA) with post hoc test was used to determine significant differences between groups according to age. Significance was set at the 0.05 level of confidence, but was also assessed at the 0.01 level of confidence for more detailed analysis.

## 3. RESULTS

Intra-examiner reliability coefficients ranged from 0.927 to 0.976. In terms of root mean square values, the random errors of estimation were less than 0.67 mm for linear measurements and 1.02 ° for angular measurements. None of the variables were significantly different between test and retest measurements. Descriptive statistics and results of the comparison between the genders are shown in Table I and II. Graphic representations are shown in Figure 2 and 3. The mean TAFH exhibited the statistically significant differences among the groups in 6 and 14 years of female subjects and 6, 7, 8, 9, 11, 12 years of male subjects. Generally, the long-faced subjects had longest TAFH, the normal-faced next, and the short-faced have shortest, however, the normal-faced group had the larger TAFH than the long-faced group in 6, 7, 8 years of female subjects although not significantly different.

The mean LAFH showed statistically significant differences among the groups in all ages within each gender ($P<0.05$). All the 3 groups were different subsets in 11,12,13,14 years of female subjects and 7, 8, 9, 12, 13, 14 years of male subjects according to the post hoc tests. The long-faced subjects had longest LAFH, the normal-faced next, and the short-faced have shortest.

The mean UAFH also showed statistical significant differences among the

groups in all ages within each gender ($P<0.05$). However, normal-faced subjects always had longest mean value than both long-faced and short-faced subjects. In case of females, the long-faced group had smaller mean UAFH even in comparison with the short-faced group. The mean UAFH of long-faced males in 12, 13, 14 years were also smaller than those of short-faced males.

Only females at 13 years of age showed statistically significant differences of mean NFH value although other age groups were not different. The maximum values of normal- or short-faced children for all variables were always larger than the mean value of long-faced children in both genders.

## 4. DISCUSSION

The long face pattern of deformity that usually accompanies open bite is considered to be unattractive and often socially unacceptable,16 and patients with this appearance are expected to be more likely to seek orthodontic or surgical treatment.17 Treatment of adults with a long face is still among the most challenging cases for the orthodontist and surgeon although there have been a number of novel and effective therapies.18

Related with “long face”, American Association of Orthodontists (AAO) Glossary 2012,19 defined - the “long face syndrome” as a craniofacial pattern characterized by a long and narrow face, an increased mandibular plane angle, and an anterior open bite malocclusion and lip incompetence. It is thought by some to result partly from an inadequate airway. The etiology of the syndrome and facial type determination has not been fully elucidated. In addition, the role of respiration in determining facial form is controversial.20

The term of “long face syndrome” was originally introduced to cover a wide spectrum of clinical manifestations under different titles into a single entity and has since become widely recognized.8,9,12 Vertical maxillary excess is considered to be one of the main features of this syndrome: however, Schendel et al. reported one subgroup of this syndrome with a normal maxilla.13 Although averaging of patient features and a biased sample selection in previous studies probably obscured the clear-cut characterization of the syndrome, a simple explanation of complex biologic phenomena is, by nature, inadequate.

The definition of the syndrome implies that it is not simply the appearance of a “long face” or a “long and wide face.” As Fields et al. stated, this terminology has led to confusion in the literature due to various reasons,11 and some cast doubts as to whether it is a indeed a true syndrome in the strict sense of the word.21 Recently, it has been reported that this term was used with malocclusion patients.22

In the present study, the anterior facial heights of children from 6 years to 14 years were measured in terms of TAFH, UAFH, LAFH and NFH. The NFH was measured because the researchers wanted to observe the growth of the upper maxillary region containing the orbit separately from the UAFH. The method of classification into long, normal or short face was adopted from the previous study14 and primarily based on the LAFH/TAFH ratio of 14-year-olds. The results showed that the mean UAFH of long-faced children was not long compared with normal- and short-faced subjects. In the mean TAFH, long-faced children exhibited the longer face, but the difference was not large enough to reach the significance especially between normal-faced

children.

There is a wide difference in cephalometric norms, including vertical dimensions,23 that might be explained by sample bias24. However, the longer UAFH of short faced subjects can be found in some previous studies, though the difference did not reach the statistical significance.7,8,25,26 Based on the present study, either long-faced or short-faced children have shorter UAFH compared to normal-faced children. Taken together, long-faced children do not have a longer upper face than expected and their long faces are mere regional disproportionate phenomenon, that is, the difference is located below the palatal plane, due to vertical chin excess or clockwise rotation of the mandible.

In contrast to the mean value, the maximum values of all variables for normal- and short-faced children were always larger than the mean value of long-faced children, indicating that for some faces both the LAFH and TAFH were quite long in absolute dimensions. These children did have long faces de facto, but they were not selected as long-faced children in the present study. Anthropologists are also concerned with facial classifications used by orthodontists, but one notable difference is that they use facial breadth additionally.2,27 Perhaps, it can be explained by that most orthodontic literature has focused solely on sagittal relationships, possibly because we are familiar with the lateral cephalogram.

Another issue to be addressed is to what extent we should define the face. In general, the human face includes the forehead region. However, the “total” anterior facial heights are usually defined as the distance between nasion and menton. Nasion is the highest point in most of cephalometric analysis

although there are the “bregma” and the “crinion.” The reason might be that the current cephalogram does not provide information about the part containing them and there is a difficulty in defining the crinion due to confounding hair position. In addition, orthodontists do not have any effective tools to control for dysplasia in the upper third of the face. In this respect, subjects generally recognized as long-faced to the public could be classified as normal or short face under our criterion if we rely on the lateral cephalogram only. Thus, it might be better to define nasion to menton as “orthodontic face.”

Facial type classifications are subject to change according to the criterion used. For example, it was reported that leptoprosopic type was most common adult Turkish males according to the anthropometric norms. Orthodontic and orthognathic treatments should always be planned according to each patient’s individual needs and desires,27 and orthodontists are generally produce the first clinical impressions to choose subjects who need treatment. 11,28

Longitudinal data were used in order to observe and compare the change of facial dimensions clearly in a chronological manner, however, this study is limited by the absence of data after 14 years of age which would miss a peak in growth that is especially possible in males. Further studies could be recommended such as an investigation on young adult subjects and incorporation of skeletal maturity index for interpreting the longitudinal data.

## 5. CONCLUSIONS

Using 9-year longitudinal cephalometric data, the anterior facial heights of long-, normal- and short-faced children were measured and compared. The

mean LAFH of long-faced children were larger than normal- and short-faced children. In contrast, the mean UAFH of normal-faced children was the largest among the 3 groups. The long-faced children did not have a long upper face and the length of their face was found to be mainly determined by the lower face. Furthermore, this study highlights the limitations of typical orthodontic measurements for characterizing the face.

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FIGURES

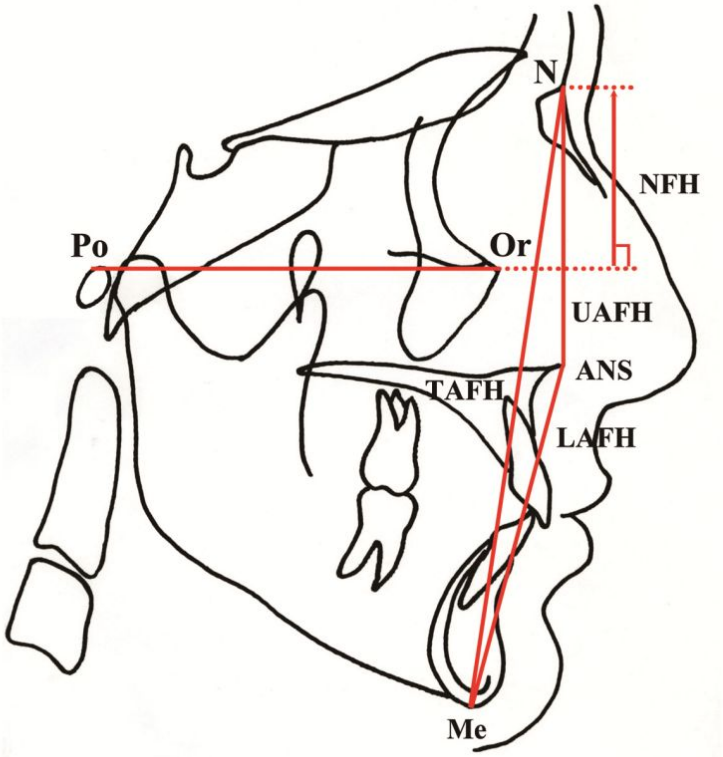


Fig 1. Cephalometric landmarks: nasion (N), sella (S), menton (Me), porion (Po), orbitale (Or), Anterior nasal spine (ANS); Cephalometric measurements: total anterior facial height (N-Me, TAFH), upper anterior facial height (N-ANS, UAFH), lower anterior facial height (ANS-Me, LAFH), distance from nasion to Frankfort horizontal plane (NFH).

Fig 2. Graphic representation of mean absolute value for 5 measurements of female according to group.

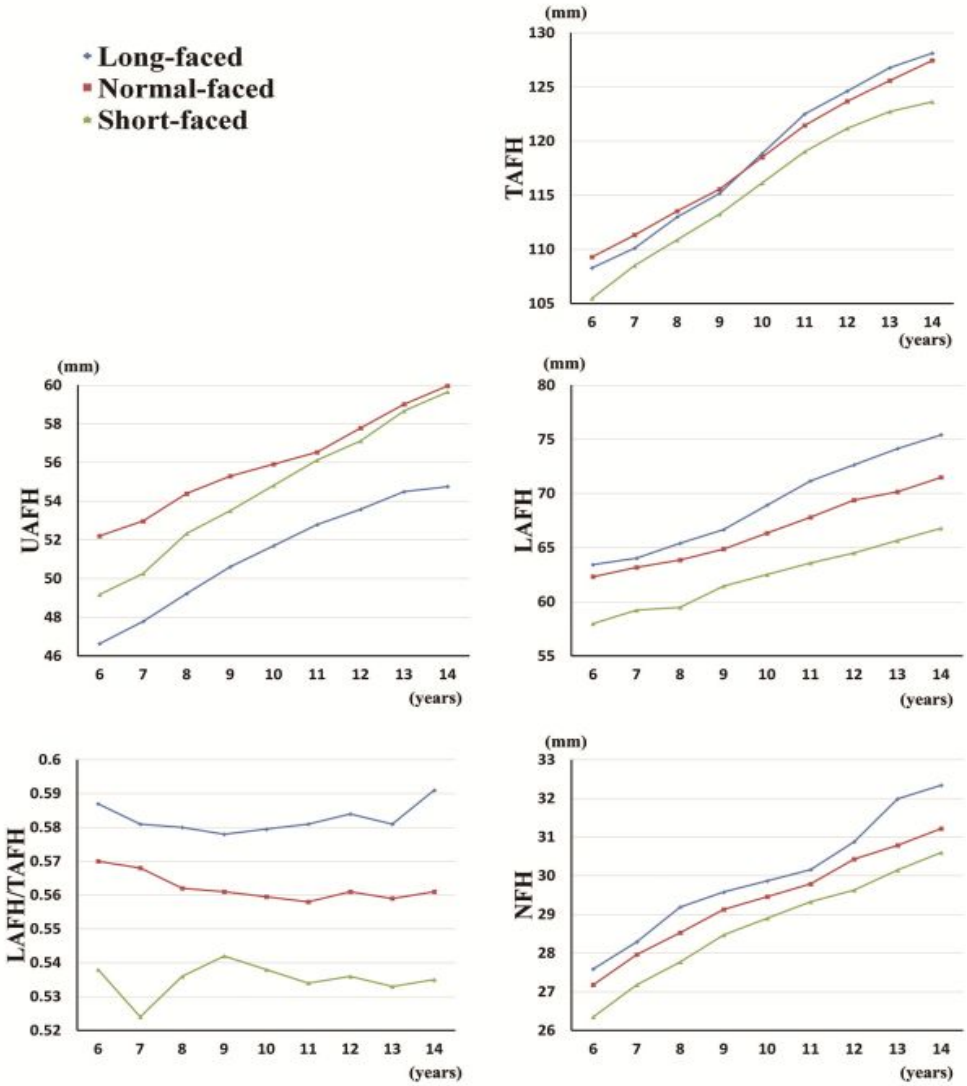

Fig 3. Graphic representation of 5 mean absolute value for 5 measurements of male according to group.

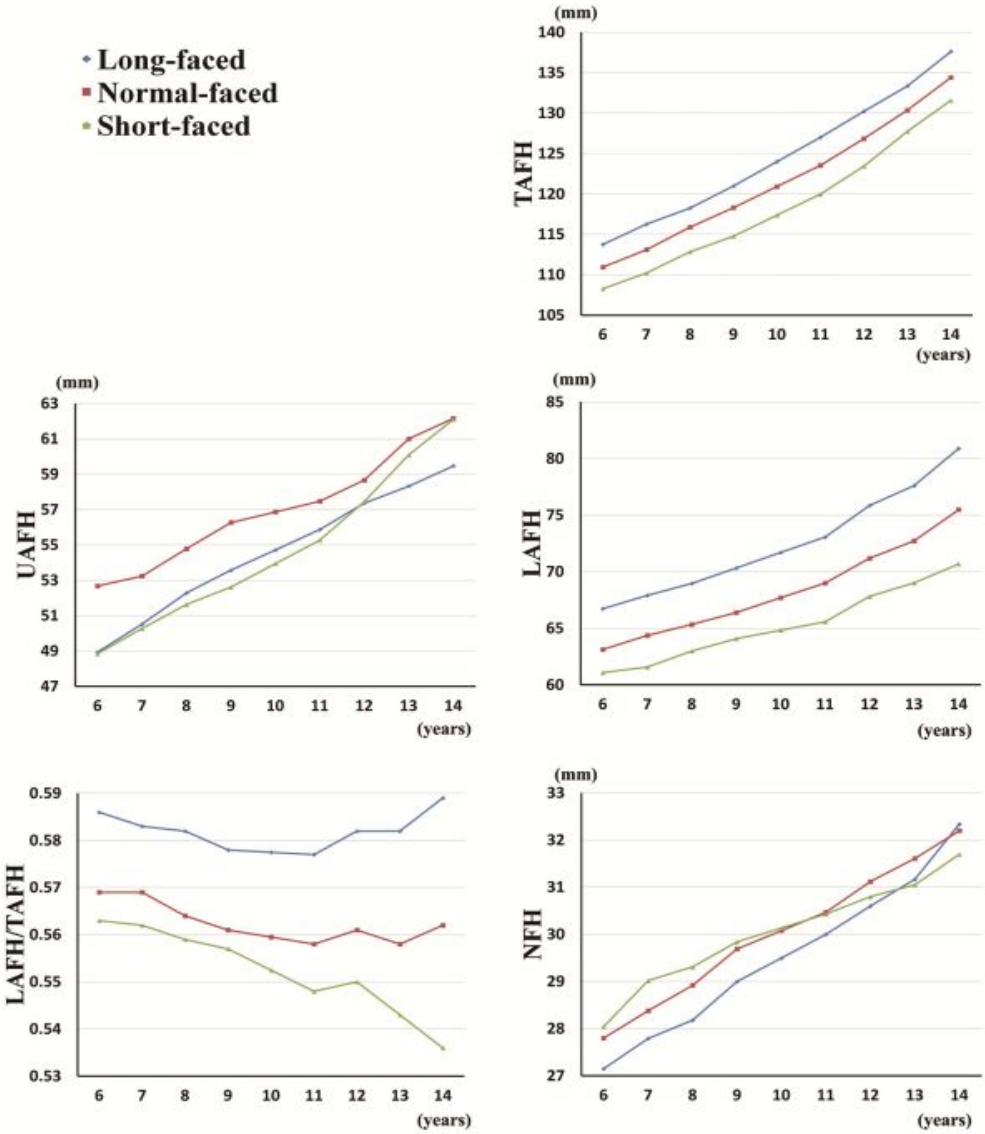

Table I. Comparison of the ratio of lower anterior facial height to total anterior facial height (LAFH/TAFH) for long-, normal- and short-faced group at 14 years of age

| | Female subjects | | | | Male Subjects | | | |
|---|---|---|---|---|---|---|---|---|
| | n | Mean (SD) | Max | Min | n | Mean (SD) | Max | Min |
| Long-faced | 12 | 0.591 (0.010) | 0.603 | 0.58 | 15 | 0.589 (0.007) | 0.601 | 0.581 |
| Normal-faced | 57 | 0.561 (0.010) | 0.579 | 0.544 | 56 | 0.562 (0.010) | 0.581 | 0.547 |
| Short-faced | 14 | 0.535 (0.008) | 0.544 | 0.527 | 13 | 0.536 (0.013) | 0.546 | 0.523 |
| Total | 83 | 0.562 (0.015) | 0.603 | 0.527 | 84 | 0.560 (0.016) | 0.601 | 0.523 |

Table II. Comparisons between groups of anterior facial height dimensions (mm) according to age in females using analysis of variance (ANOVA). The superscripts a, b or c denote homogeneous subsets according to the *post hoc* test.

| Age | Long-faced | | | Normal-faced | | | Short-faced | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | Max | Min | Mean (SD) | Max | Min | Mean (SD) | Max | Min |
| Total anterior facial heights (TAFH) | | | | | | | | | |
| 6** | 108.29 (3.83)[a,b] | 115.29 | 101.62 | 109.30 (3.95)[a] | 116.52 | 97.42 | 105.48 (2.61)[b] | 110.15 | 100.26 |
| 7 | 110.12 (4.23) | 118.03 | 104.26 | 111.33(4.67) | 120.46 | 98.46 | 108.51 (3.58) | 115.08 | 101.34 |
| 8 | 113.00 (4.29) | 121.43 | 106.93 | 113.54 (4.98) | 124.46 | 102.59 | 110.88 (3.35) | 115.95 | 104.85 |
| 9 | 115.18 (4.38) | 123.34 | 109.68 | 115.56 (5.20) | 126.01 | 103.18 | 113.27 (3.43) | 119.00 | 107.08 |
| 11 | 122.51 (5.11) | 128.49 | 113.45 | 121.45 (5.36) | 131.57 | 107.55 | 119.03 (4.67) | 124.42 | 108.85 |
| 12 | 124.62 (4.73) | 132.63 | 116.44 | 123.68 (5.19) | 133.08 | 110.56 | 121.18 (3.69) | 125.68 | 113.34 |
| 13 | 126.78 (5.73) | 138.26 | 116.44 | 125.59 (5.44) | 134.9 | 113.61 | 122.73 (3.82) | 129.94 | 115.73 |
| 14* | 128.12 (5.12)[a] | 138.26 | 120.87 | 127.45 (5.15)[a,b] | 134.9 | 113.61 | 123.64 (3.61)[b] | 129.95 | 116.45 |
| Upper anterior facial heights (UAFH) | | | | | | | | | |
| 6**† | 46.63 (1.53)[a] | 48.95 | 43.24 | 52.21 (3.40)[b] | 60.28 | 44.87 | 49.18 (2.12)[c] | 54.02 | 46.11 |
| 7** | 47.79 (2.29)[a] | 51.37 | 43.88 | 52.98 (3.88)[b] | 65.58 | 44.77 | 50.27 (2.53)[a,b] | 54.88 | 45.99 |
| 8**† | 49.23 (2.52)[a] | 54.06 | 45.13 | 54.40 (3.74)[b] | 64.64 | 45.98 | 52.33 (1.82)[b] | 55.77 | 49.57 |
| 9** | 50.61 (2.31)[a] | 54.16 | 45.47 | 55.30 (3.43)[b] | 64.8 | 47.63 | 53.51 (2.10)[b] | 56.39 | 50.34 |
| 11** | 52.79 (2.83)[a] | 57.69 | 46.41 | 56.54 (3.19)[b] | 66.54 | 49.20 | 56.13 (1.79)[b] | 58 | 52.13 |
| 12** | 53.58 (3.22)[a] | 57.09 | 47.28 | 57.79 (3.36)[b] | 68.39 | 50.59 | 57.12 (1.79)[b] | 59.67 | 53.19 |
| 13**† | 54.50 (3.29)[a] | 59.55 | 47.2 | 59.02 (3.79)[b] | 67.57 | 49.22 | 58.67 (1.42)[b] | 60.92 | 56.62 |
| 14** | 54.76 (2.83)[a] | 59.6 | 51.09 | 59.97 (3.63)[b] | 71.26 | 51.65 | 59.66 (1.25)[b] | 61.2 | 57.34 |
| Lower anterior facial heights (LAFH) | | | | | | | | | |
| 6** | 63.43 (2.87)[a] | 68.2 | 57.73 | 62.32 (2.40)[a] | 67.70 | 57.06 | 57.98 (1.94)[b] | 60.31 | 52.99 |
| 7** | 64.03 (3.18)[a] | 68.59 | 59.61 | 63.18 (2.97)[a] | 71.60 | 56.79 | 59.23 (2.15)[b] | 61.9 | 53.74 |
| 8**† | 65.41 (2.75)[a] | 68.94 | 60.65 | 63.86 (3.58)[a] | 71.85 | 56.54 | 59.48 (2.45)[b] | 63.07 | 53.92 |
| 9** | 66.67 (3.42)[a] | 72.3 | 61.42 | 64.87 (3.25)[a] | 70.59 | 57.26 | 61.45 (2.28)[b] | 64.17 | 56.73 |
| 11** | 71.17 (3.33)[a] | 76.53 | 65.48 | 67.81 (3.68)[b] | 74.37 | 59.80 | 63.58 (2.93)[c] | 67.86 | 55.74 |
| 12** | 72.64 (3.45)[a] | 79.57 | 66.98 | 69.39 (3.49)[b] | 75.02 | 61.84 | 64.51 (2.87)[c] | 69.21 | 58.41 |
| 13** | 74.15 (3.55)[a] | 82.43 | 68.45 | 70.16 (3.62)[b] | 77.38 | 62.24 | 65.66 (3.63)[c] | 70.38 | 57.43 |
| 14** | 75.42 (3.51)[a] | 82.17 | 70.18 | 71.49 (3.36)[b] | 79.31 | 64.45 | 66.79 (2.57)[c] | 70.48 | 61.36 |
| NFH | | | | | | | | | |
| 6† | 27.59 (1.56) | 31.12 | 25.34 | 27.18 (2.07) | 35.25 | 22.50 | 26.35 (1.55) | 28.49 | 22.25 |
| 7 | 28.29 (1.77) | 31.66 | 25.73 | 27.96 (2.03) | 33.60 | 23.27 | 27.18 (1.58) | 29.78 | 23.94 |
| 8† | 29.19 (1.47) | 31.47 | 26.10 | 28.53 (2.02) | 33.34 | 23.46 | 27.77 (1.50) | 30.66 | 25.08 |
| 9 | 29.58 (1.44) | 31.32 | 26.53 | 29.13 (1.97) | 33.61 | 24.12 | 28.47 (1.48) | 30.81 | 25.76 |
| 11 | 30.16 (1.06) | 32.14 | 28.11 | 29.79 (1.89) | 34.31 | 25.26 | 29.33 (1.63) | 31.60 | 26.59 |
| 12 | 30.88 (1.43)[a] | 33.25 | 28.38 | 30.43 (1.91)[a,b] | 35.96 | 25.63 | 29.63 (1.55)[b] | 32.09 | 26.94 |
| 13* | 31.99 (1.92)[a] | 37.24 | 30.02 | 30.79 (2.04)[a] | 36.10 | 25.55 | 30.15 (1.51)[b] | 32.38 | 27.49 |
| 14 | 32.34 (1.74) | 36.90 | 30.44 | 31.22 (1.92) | 37.44 | 25.50 | 30.60 (1.62) | 33.85 | 27.67 |

* statistically significant difference between groups ($P < 0.05$);
** statistically significant difference between groups ($P < 0.01$);
† Dunnet T3 *post hoc* test was used instead of Tukey's because the sample does not meet the hypothesis of homoscedasticity.

Table III. Comparisons between groups of anterior facial height dimensions (mm) according to age in males using analysis of variance (ANOVA). The superscripts a, b or c denote homogeneous subsets according to the post hoc test.

| Age | Long-faced | | | Normal-faced | | | Short-faced | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | Max | Min | Mean (SD) | Max | Min | Mean (SD) | Max | Min |
| Total anterior facial heights (TAFH) | | | | | | | | | |
| 6* | 113.77 (5.37)[a] | 123.34 | 105.68 | 110.96 (4.18)[a,b] | 118.78 | 100.81 | 108.28(3.41)[b] | 114.6 | 102.69 |
| 7** | 116.27 (5.46)[a] | 124.85 | 108.21 | 113.11 (3.94)[a,b] | 120.29 | 103.69 | 110.21 (4.37)[b] | 117.13 | 102.71 |
| 8* | 118.26 (6.39)[a] | 130.64 | 109.44 | 115.88 (3.91)[a,b] | 121.82 | 107.24 | 112.84 (4.71)[b] | 121.44 | 106.30 |
| 9** | 120.99 (6.22)[a] | 132.34 | 110.60 | 118.31 (3.88)[b] | 125.97 | 111.02 | 114.78 (4.57)[b] | 121.03 | 108.43 |
| 11** | 127.01 (6.97)[a] | 138.30 | 117.79 | 123.53 (4.79)[a,b] | 133.8 | 114.89 | 119.98 (5.35)[b] | 128.45 | 112.72 |
| 12* | 130.23 (7.17)[a] | 143.37 | 121.08 | 126.85 (5.76)[a,b] | 137.97 | 112.41 | 123.45 (5.33)[b] | 132.31 | 115.98 |
| 13 | 133.37 (8.71) | 148.37 | 121.78 | 130.38 (5.95) | 142.34 | 113.91 | 127.76 (5.43) | 137.14 | 118.83 |
| 14† | 137.63 (8.88) | 154.68 | 124.70 | 134.41 (4.85) | 145.35 | 124.76 | 131.57 (5.51) | 154.68 | 124.70 |
| Upper anterior facial heights (UAFH) | | | | | | | | | |
| 6** | 48.93 (3.77)[a] | 56.55 | 43.87 | 52.68 (3.10)[b] | 61.03 | 45.80 | 48.85 (1.69)[a] | 51.68 | 45.27 |
| 7** | 50.52 (2.56)[a] | 54.65 | 45.67 | 53.24 (2.67)[b] | 58.50 | 47.21 | 50.27 (2.66)[a] | 53.67 | 45.37 |
| 8** | 52.29 (2.74)[a] | 56.22 | 46.65 | 54.78 (2.85)[b] | 61.13 | 48.56 | 51.64 (2.37)[a] | 54.84 | 48.12 |
| 9** | 53.57 (2.83)[a] | 57.16 | 49.09 | 56.27 (2.75)[b] | 63.40 | 49.33 | 52.62 (2.01)[a] | 54.85 | 49.91 |
| 11*† | 55.87 (3.28)[a] | 61.47 | 52.57 | 57.47 (2.62)[a] | 64.72 | 53.78 | 55.28 (1.89)[b] | 57.39 | 51.79 |
| 12* | 57.37 (2.53)[a] | 62.45 | 54.76 | 58.67 (2.89)[b] | 67.10 | 50.84 | 57.45 (2.93)[a] | 63.36 | 53.1 |
| 13* | 58.33 (2.90)[a] | 63.55 | 54.73 | 61.00 (3.61)[b] | 69.74 | 52.91 | 60.10 (2.65)[a,b] | 65.13 | 54.45 |
| 14* | 59.47 (3.18) | 65.03[a] | 54.79 | 62.16 (2.84)[b] | 68.87 | 56.18 | 62.11 (3.33)[b] | 67.92 | 54.09 |
| Lower anterior facial heights (LAFH) | | | | | | | | | |
| 6** | 66.73 (2.78)[a] | 71.44 | 62.8 | 63.13 (3.08)[b] | 68.46 | 57.14 | 61.08 (2.83)[b] | 65.78 | 56.99 |
| 7** | 67.91 (3.77)[a] | 73.54 | 61.88 | 64.36 (3.10)[b] | 69.99 | 56.12 | 61.57 (3.33)[c] | 70.14 | 57.66 |
| 8** | 68.97 (4.25)[a] | 76.65 | 62.69 | 65.33 (2.86)[b] | 71.10 | 58.67 | 62.98 (3.52)[c] | 69.62 | 57.59 |
| 9** | 70.33 (4.21)[a] | 78.39 | 63.94 | 66.39 (3.16)[b] | 72.85 | 59.39 | 64.07 (4.01)[c] | 74.19 | 58.92 |
| 11** | 73.07 (4.52)[a] | 80.77 | 66.4 | 69.00 (3.34)[a] | 77.06 | 63.08 | 65.58 (4.17)[b] | 74.63 | 60.82 |
| 12** | 75.86 (4.93)[a] | 85.91 | 69.14 | 71.20 (3.83)[b] | 81.97 | 64.35 | 67.83 (4.17)[c] | 77.84 | 62.6 |
| 13** | 77.61 (6.11)[a] | 88.19 | 68.34 | 72.72 (4.43)[b] | 81.21 | 56.16 | 69.01 (4.31)[c] | 78.14 | 64.4 |
| 14** | 80.89 (5.68)[a] | 92.86 | 72.58 | 75.49 (3.37)[b] | 81.96 | 69.29 | 70.69 (3.77)[c] | 78.55 | 65.75 |
| NFH | | | | | | | | | |
| 6 | 27.15 (1.74) | 29.56 | 24.32 | 27.80 (2.06) | 32.81 | 21.03 | 28.04 (2.71) | 33.27 | 24.43 |
| 7 | 27.79 (1.62) | 30.27 | 24.64 | 28.38 (1.98) | 33.43 | 21.19 | 29.02 (2.17) | 33.46 | 25.77 |
| 8 | 28.18 (1.66) | 31.41 | 25.97 | 28.92 (1.92) | 34.74 | 22.78 | 29.31 (2.23) | 33.89 | 26.07 |
| 9 | 29.00 (1.57) | 31.49 | 26.62 | 29.69 (1.79) | 35.05 | 26.27 | 29.84 (2.16) | 34.32 | 26.53 |
| 11 | 30.00 (1.23) | 31.74 | 27.94 | 30.47 (1.72) | 35.22 | 26.42 | 30.43 (2.08) | 35.08 | 27.79 |
| 12 | 30.60 (1.40) | 32.94 | 28.47 | 31.12 (1.67) | 35.38 | 27.23 | 30.80 (1.98) | 35.03 | 28.25 |
| 13 | 31.17 (1.38) | 33.92 | 29.29 | 31.61 (1.68) | 35.63 | 27.45 | 31.05 (1.96) | 35.01 | 28.77 |
| 14 | 32.34 (1.38) | 35.57 | 29.05 | 32.20 (1.81) | 37.91 | 27.67 | 31.70 (1.78) | 35.58 | 28.97 |

* statistically significant difference between groups ($P < 0.05$);
** statistically significant difference between groups ($P < 0.01$);
† Dunnet T3 *post hoc* test was used instead of Tukey's because the sample does not meet the hypothesis of homoscedasticity.