Full Length Research Paper

Study of some face physical dimensions in Iranian boys

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Anthropometry is applied in medical profession, such as maxillofacial surgery, growth and development studies, plastic surgery, bioengineering and non-medical branches such as respiratory equipment and eye-glasses industries. The aim of this study was to determine face physical dimension and cephalo-facial anthropometric ratios in 4 to 11-year-old boys of Iranian Kurmanj population. This cross sectional analytical study was conducted randomly on 564 boys from North Khorasan (bojnourd), with normal face patterns. Cephalo-facial ratios and face physical dimension were estimated and compared. The regression line and the growth coefficient were determined for each parameter. Finally, the mean values of these parameters were determined. Data were analyzed by SPSS software. Paired t-test was used for statistic analysis. Anthropometric results obtained from 4 to 11-year old Kurmanj boys residing in the city of Bojnourd show that there is a special discipline in growth of different parts of the face and skull. We reached formulas (Table 2) that may have a wide range of applications, such as prediction of facial situation of an individual before or after his/her present situation. Such predictions can be helpful in forensic medicine, for instance in finding the lost kids. Reaching a normal range for face dimensions through studies about growth will play an important role in maxillofacial surgery and plastic surgery as well as in the study of growth disorders. Based on our findings in Kurmanj 4 to 11-year boys, we concluded that by age, craniofacial dimensions change at different rates and different craniofacial dimensions do not grow at consistent rates. Some parts grow slower as compared to others. There are different factors, such as ecologic, racial, age and sex besides all genetic factors that influence the human cephalo-facial dimensions and the way of its growth and development. Since the Iranian peoples is a compound one and consists of different races, and there are a wide variety of body dimensions in different parts of Iran, it is necessary to conduct more studies according to the geographical factors and the facial and skull anthropometric data shall be studied in different tribes of Iran.

Key words: Anthropometry, cephalic, physical dimensions, face.

INTRODUCTION

As a part of physical anthropology, anthropometry measures and examines linear and angular skeletal dimensions on living individuals (Mariclode, 1997). Understanding anthropometric parameters of face and cranium gives researchers and clinicians considerable insight into craniofacial growth and development which, in turn, has many practical applications including classify-cation, diagnosis and treatment of craniofacial anomalies (Ainsowrth, 1979; Ramanathan and Chellappa, 2006), correction of craniofacial deformities using maxillofacial

and plastic surgical methods and forensic medicine. By finding the mean value of anthropometric parameters in normal samples of a population, it is possible to create a template for facial analysis of this specific population (Mariclode, 1997).

As anthropometric and cephalometric parameters vary considerably depending on age, sex, geographical habitat and racial and ethnic backgrounds of human beings (Mariclode, 1997; Williams et al., 1995), each anthropometric study should be conducted on a particular and predetermined age range, sex or racial group (Afak and Turgut, 1998). In his study, Porter (2004) compared anthropometric parameters of African-American males with those of North American whites and found significant

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differences. In a similar study, Choeks et al. (2004) showed significant differences between facial anthropometric measurements of Korean-American women and those of North American women. Farkas et al. (2005) depicted that the breadth of nose in Asians and Africans is larger than in North American whites. However, Middle Eastern people have nasal width similar to that of North American whites (Farkas et al., 2005). By analyzing the anthropometric features of a group of 18 to 21-year-old Croatians, Buretic-Toljanovic et al. (2007) showed that cranial measurements are influenced by geographical conditions. Only in recent years has the validity of these canons been systematically investigated. These initial studies, based on anthropometric techniques, led to comparisons of facial anthropometric differences. Baral et al. (2010) in an anthropometric study showed that there is evidence of statistically significant differences of the upper and lower face height proportions among the different racial groups. By analyzing the stature from cephalo-facial anthropometry in North Indian population, Krishan and Kumar (2007) indicated that all the cephalo-facial measurements are strongly and positively cor-related ($P < 0.001$) with stature (Krishan, 2008). The aim of this study was to determine face physical dimension and cephalo-facial anthropometric ratios in 4 to 11-year-old boys of Iranian Kurmanj population.

MATERIALS AND METHODS

This cross sectional analytical study was done randomly on 564 4 to 11-year-old boys of Kurmanj ethnic origin from Shirvan, with normal face patterns. Using the Krejcie and Morgan sample size table, we found that our sample size should be 564 participants (Krejcie and Morgan, 1970). We chose to use convenience random sampling to select participants from different preschool and schools. Participants were native of Shirvan city (North Khorasan, Iran), which has been selected by the dialects and the questionnaires. These people should have Kurmanj parents and grandparents. All participants had angle class I dental occlusion and no history of orthodontic treatment, tooth extraction, maxillofacial surgery, cleft lip and palate or other facial anomalies. A D40 Nikon digital camera with 18/135 lens (Nikon inc., Japan, 2007) was used to take frontal full-face photographs of each child while his/her head was in natural head position (NHP). The samples were relaxed during imaging and no special facial expressions, such as smiling, laughing or frowning were detectable in their faces. A 10 mm wide sticker on each sample forehead was employed to calculate the image magnification.

The images were transferred to a computer and classified according to the age of samples. Using Adobe Photoshop software (Adobe Inc., USA), the points indicating the desired anthropometric landmarks were put on each image. Newly developed software by the Orthodontic Department of Mashhad Dental School which is called "Smile Analyzer" was used to measure the anthropometric parameters on each image. This software has specifically been designed for precise measuring of desired distances or angles on images and radiographs.

The following Thirteen measurements were taken in this study (Figure 14):

1. The width of the nose or Alare width (al-al)
2. The width of the mouth or the distance between Cheilion points (ch-ch)

3. Intercanthal width or the distance between left and right Endocanthion points (en-en)
4. Biocular width or the distance between left and right Exocanthion points (ex-ex)
5. Forehead width or the distance between soft tissue Frontotemporale points (ft'-ft')
6. Intergonial width or the distance between left and right soft tissue Gonion points (go'-go')
7. Facial height or the distance between soft tissue Nasion and Gnathion (n'-gn')
8. The height of the nose or the distance between soft tissue Nasion and Subansal points (n'-sn)
9. The depth of the upper third of face or the distance between Tragion and soft tissue Glabella (t-g')
10. The depth of the lower third of face or the distance between Tragion and soft tissue Gnathion (t-gn')
11. The depth of the middle third of face or the distance between Tragion and Subnasal points (t-sn)
12. Cranial base width or the distance between Tragion points (t-t)
13. Facial width or the distance between soft tissue Zygion points (zy'-zy')

Cephalo-facial ratios were estimated and compared. Data was analyzed using t-test, analysis of variance (ANOVA) and linear regression models of the SPSS software (SPSS Inc., Chicago, Il, USA).

RESULTS

As shown in Table 1, 564 4 to 11-year-old boys of Kurmanj ethnic origin participated in the study. The table also includes the mean and standard deviation of 13 anthropometric measurements.

Anthropometric parameter al-al

Figure 1 shows a gradual increase in mean alare width by age although it suddenly drops at age 8.

Anthropometric parameter ch-ch

Figure 2 depicts a sharp increase in mouth width between 5 and 6 years of age followed by a steady growth. Ch-ch/age equation shows more growth in mouth as compared to nose width by age (Table 2).

Anthropometric parameter en-en

According to Figure 3, intercanthal width shows a sharp drop between 4 and 5, and then a dramatic increase between 5 and 6 followed by a gradual rise after 7.

Anthropometric parameter ex-ex

Figure 4 indicates that the biocular width follows a noticeable increase between 5 and 6 years of age to reach a plateau between 6 and 7 and then, it rises gradually.

Table 1. Mean and SD of measured parameters by age.

| Age	4	5	6	7	8	9	10	11
Number	74	66	62	87	62	64	86	63
al-al (mm) (mean±SD)	28.95 ± 1.61	29.14 ± 1.74	30.12 ± 2.10	30.43 ± 1.96	30.22 ± 1.85	31.08 ± 2.22	31.58 ± 2.15	32.90 ± 2.12
ch-ch (mm) (mean±SD)	35.14 ± 2.59	35.43 ± 2.49	38.36 ± 2.78	38.86 ± 2.49	39.54 ± 2.77	40.92 ± 2.98	42.39 ± 3.37	44.10 ± 3.37
en-en (mm) (mean±SD)	26.38 ± 1.89	25.87 ± 2.27	27.74 ± 2.30	27.68 ± 1.99	27.93 ± 1.92	28.10 ± 2.33	28.35 ± 2.28	28.68 ± 2.62
ex-ex (mm) (mean±SD)	73.12 ± 3.49	73.57 ± 4.25	77.59 ± 4.11	77.75 ± 3.50	79.12 ± 3.43	79.66 ± 3.64	81.21 ± 4.00	82.84 ± 3.74
ft'-ft' (mm) (mean±SD)	95.39 ± 4.19	96.44 ± 4.81	99.07 ± 9.33	100.34 ± 4.54	102.32 ± 5.60	102.86 ± 4.63	104.87 ± 4.86	106.54 ± 4.52
go'-go' (mm) (mean±SD)	83.57 ± 5.55	84.71 ± 5.66	89.21 ± 5.14	90.15 ± 5.29	90.55 ± 5.11	90.64 ± 5.75	93.69 ± 6.47	96.79 ± 6.11
n'-gn' (mm) (mean±SD)	82.26 ± 5.43	84.03 ± 5.31	88.45 ± 5.24	89.54 ± 4.51	92.11 ± 4.50	93.39 ± 5.38	98.63 ± 5.99	100.31 ± 5.67
n'-sn (mm) (mean±SD)	35.23 ± 6.26	36.27 ± 2.62	37.60 ± 2.49	37.87 ± 2.26	40.11 ± 2.96	40.85 ± 3.38	43.92 ± 2.94	44.63 ± 2.87
t-g' (mm) (mean±SD)	61.71 ± 4.74	62.04 ± 4.50	65.88 ± 4.69	65.89 ± 3.85	66.58 ± 4.64	67.22 ± 5.16	68.30 ± 4.83	71.27 ± 5.09
t-gn' (mm) (mean±SD)	84.88 ± 4.80	88.15 ± 5.90	90.82 ± 4.55	91.20 ± 4.70	94.09 ± 4.97	96.53 ± 5.46	99.62 ± 6.08	99.92 ± 5.37
t- sn (mm) (mean±SD)	58.04 ± 3.58	60.01 ± 3.96	61.97 ± 3.76	61.88 ± 4.13	63.72 ± 4.44	65.09 ± 4.35	66.54 ± 4.98	67.01 ± 4.72
t-t (mm) (mean±SD)	106.93 ± 5.94	109.42 ± 6.01	114.45 ± 5.64	114.50 ± 5.23	115.70 ± 5.64	117.76 ± 6.08	120.22 ± 6.52	123.60 ± 6.30
zy'-zy' (mm) (mean±SD)	99.35 ± 5.56	101.10 ± 5.68	105.70 ± 5.23	106.76 ± 5.30	107.65 ± 5.38	109.73 ± 6.29	112.68 ± 6.39	115.25 ± 5.90
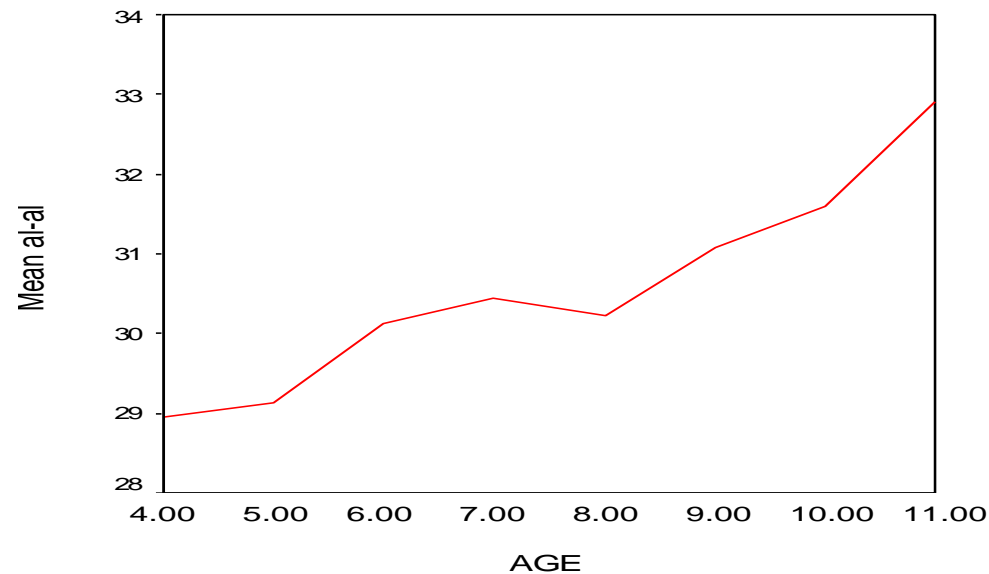
Figure 1. Mean al-al by age.
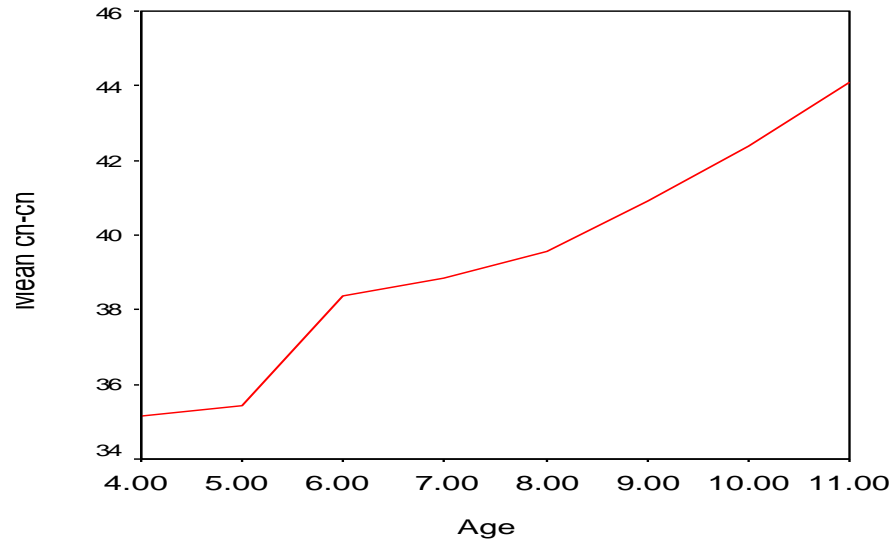
Figure 2. Mean ch-ch by age.

Table 2. Linear regression equation between anthropometric ratio and age.

Anthropometric ratio	Regression equation	Anthropometric ratio	Regression equation
al-al	0.5 × age + 26.8	n'-sn	1.4 × age + 29
ch-ch	1.25 × age + 30	t-g'	1.2 × age + 57
en-en	0.35 × age + 25	t-gn'	2.2 × age + 76.6
ex-ex	1.35 × age + 68	t-sn	1.28 × age + 53.4
ft'-ft'	1.6 × age + 89	t-t	2.1 × age + 99
go'-go'	1.7 × age + 77.3	zy'-zy'	2.17 × age + 90.98
n'-gn'	2.6 × age + 71.5		
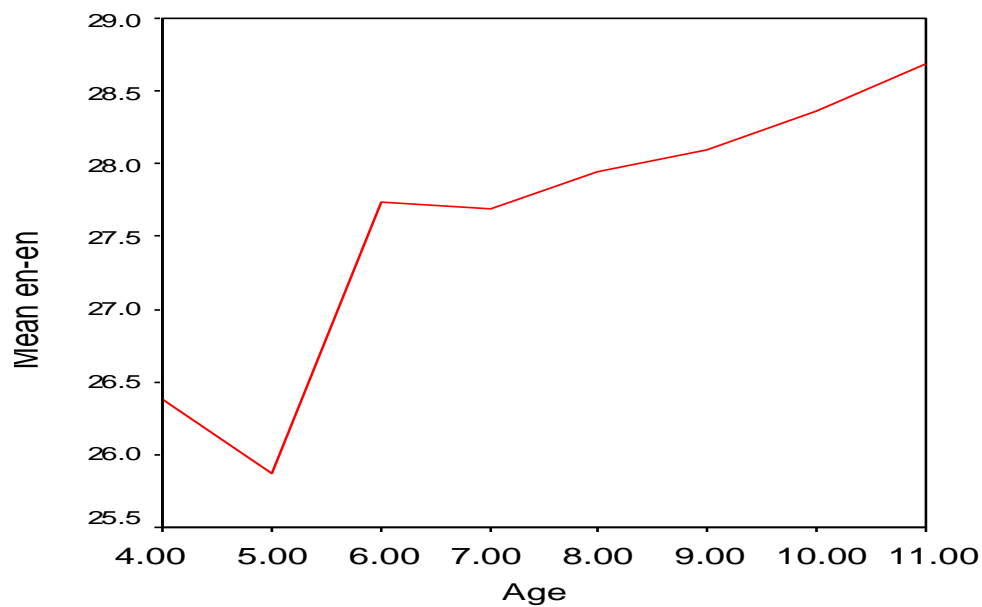
Figure 3. Mean en-en by age.
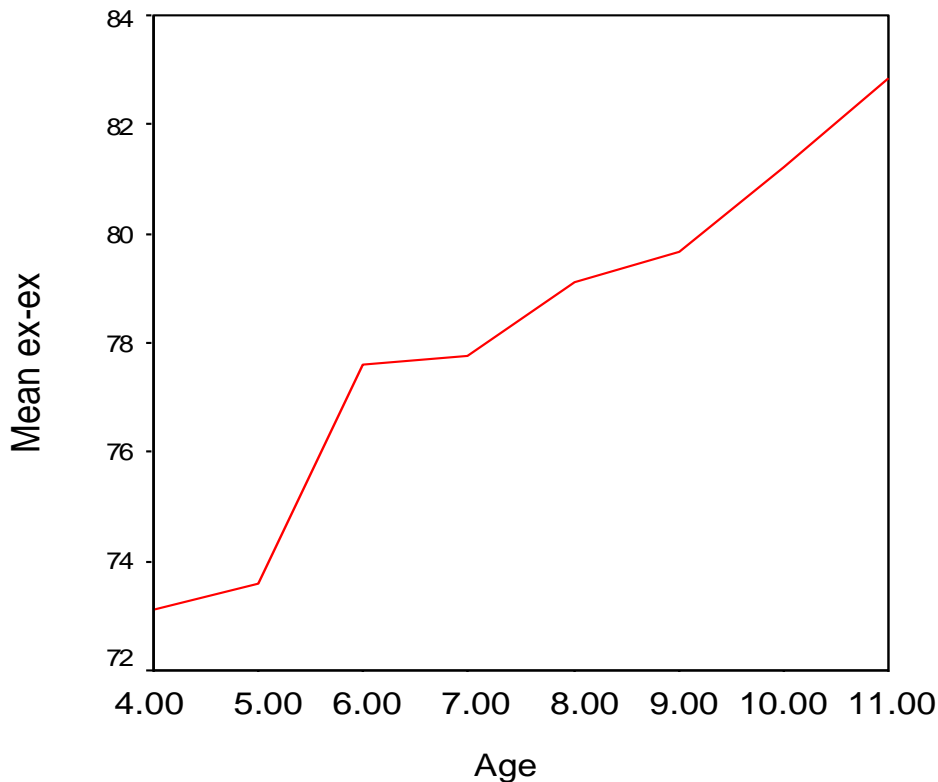
Figure 4. Mean ex-ex by age.

Figure 5. Mean ft'-ft' by age.

Anthropometric parameter ft'-ft'

Forehead width increases more steadily as compared to other aforementioned parameters (Figure 5).

Anthropometric parameter go'-go'

Figure 6 demonstrates two growth acceleration periods between 5 to 6 and 9 to 11 years in intergonial width separated by an almost steady state.

Anthropometric parameter n'-gn'

According to Figure 7, facial height increases gradually by age, although it accelerates at 5 to 6 and 9 to 10 intervals. Based on the n-gn/age equation, facial height has the largest growth rate among anthropometric measurements of the face (Table 2).

Anthropometric parameter n'-sn

The height of nose accelerates in three age ranges: 4 to6, 7 to 8 and 9 to 10 (Figure 8). The equation shows the changes is nasal height as age increases (Table 2).
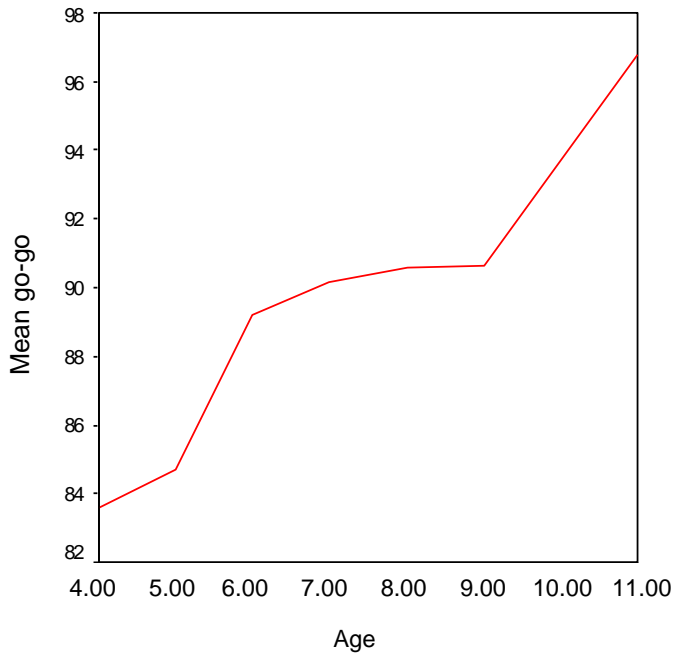
The biocular width/age equation reveals that the binocular growth rate is about four times as growth rate as the intercanthal width (Table 2).

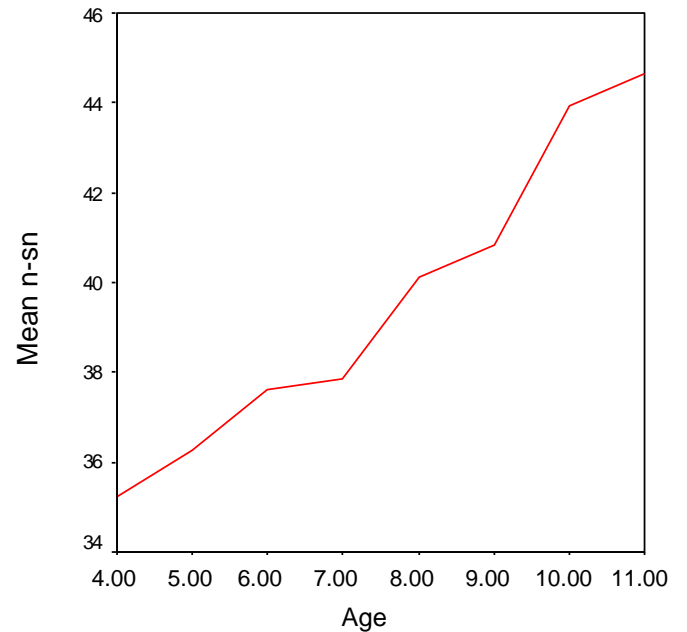**Figure 6.** Mean go'-go' by age.
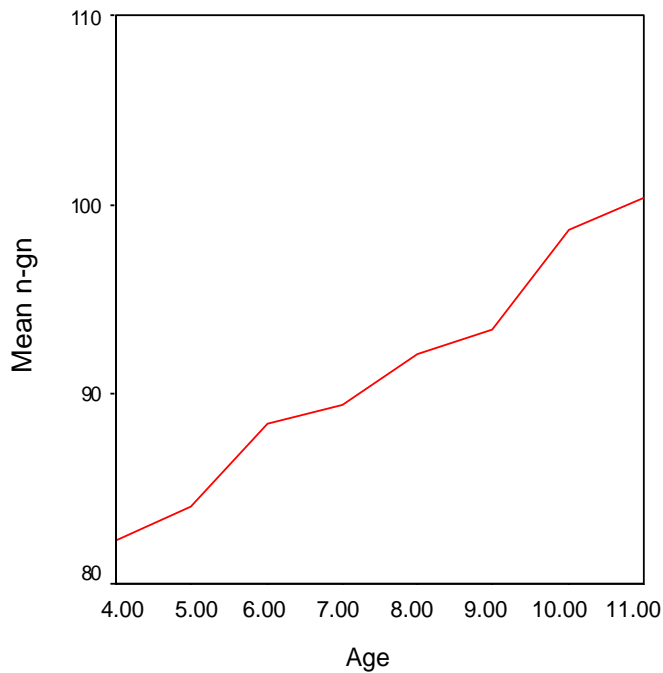

Figure 8. Mean n'-sn by age.
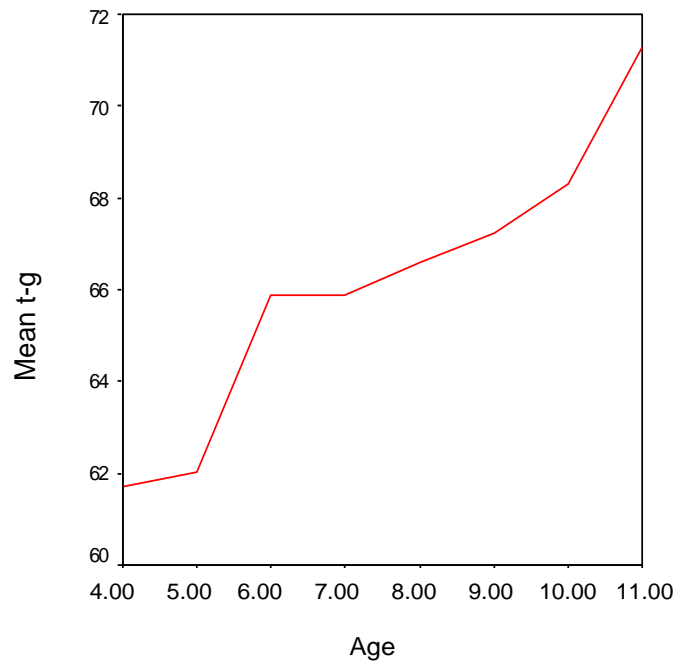

Figure 7. Mean n'-gn' by age.

Figure 9. Mean t-g' by age.

Anthropometric parameter t-g'

The depth of the upper third of face increases dramatically between 5 to 6 and 10 to 11 years (Figure 9).

Anthropometric parameter t-gn'

Figure 10 illustrates that the depth of the lower third face increases steadily except for two plateaus between 6 to 7 and 10 to 11 years of age. The t-gn equation suggests rapid growth in this part of face (Table 2).
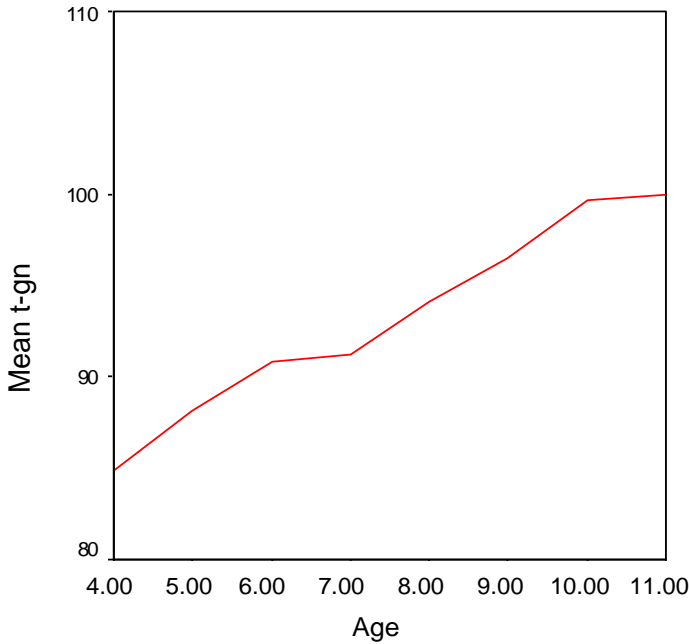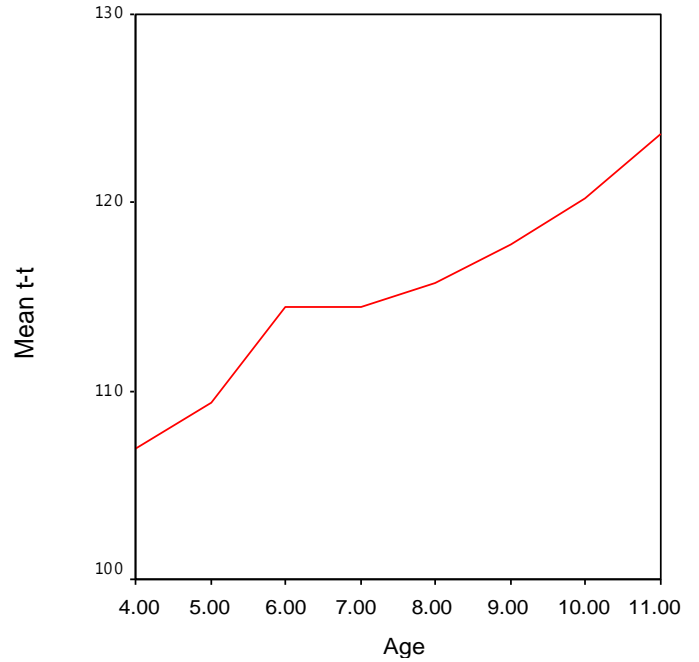
Figure 10. Mean t-gn' by age.
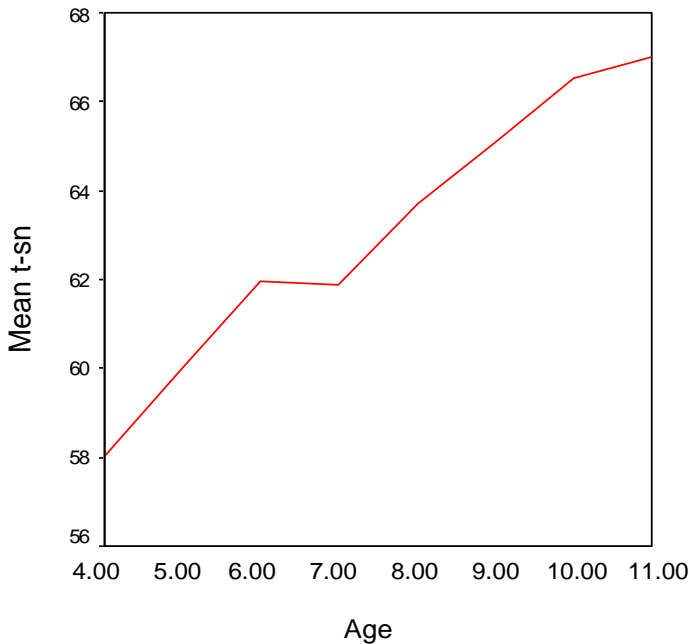

Figure 12. Mean t-t by age.

Figure 11. Mean t-sn by age.

Anthropometric parameter t-t

As Figure 12 represents, the growth curve of the cranial base width follows a sharp rise between 5 and 6 years to reach a plateau and then increase gradually after 7. The equation indicates a relatively fast growth in cranial base width (Table 2).

Anthropometric parameter zy'-zy'

Facial width growth rate increases almost gradually except for a sharp rise between 5 and 6 years (Figure 13). The zy-zy equation shows that facial width has a rapid growth rate as compared to most other parts of the face (Table 2).

DISCUSSION

As each racial and ethnic group possesses its own specific cephalo-facial form which changes by age as well, to determine the anthropometric standards, it is essential to specify that anthropometric parameters are determined among which ethnic group and in which age range. The aim of our study was to measure 13 anthropometric parameters on facial frontal images of 564 4 to 11-year-old boys of Kurmanj ethnic origin to determine and predict growth-related changes in this age range.

The photo-anthropometric method (Ferrario et al., 2003) was employed to measure the desired anthropometric dimensions. The method is relatively simple and fast, the required equipments are easily accessible and

Anthropometric parameter t-sn

Growth-related changes in the depth of the middle third of the face resemble those of the lower third (Figure 11). However, the growth rate is slower according to t-sn equation.
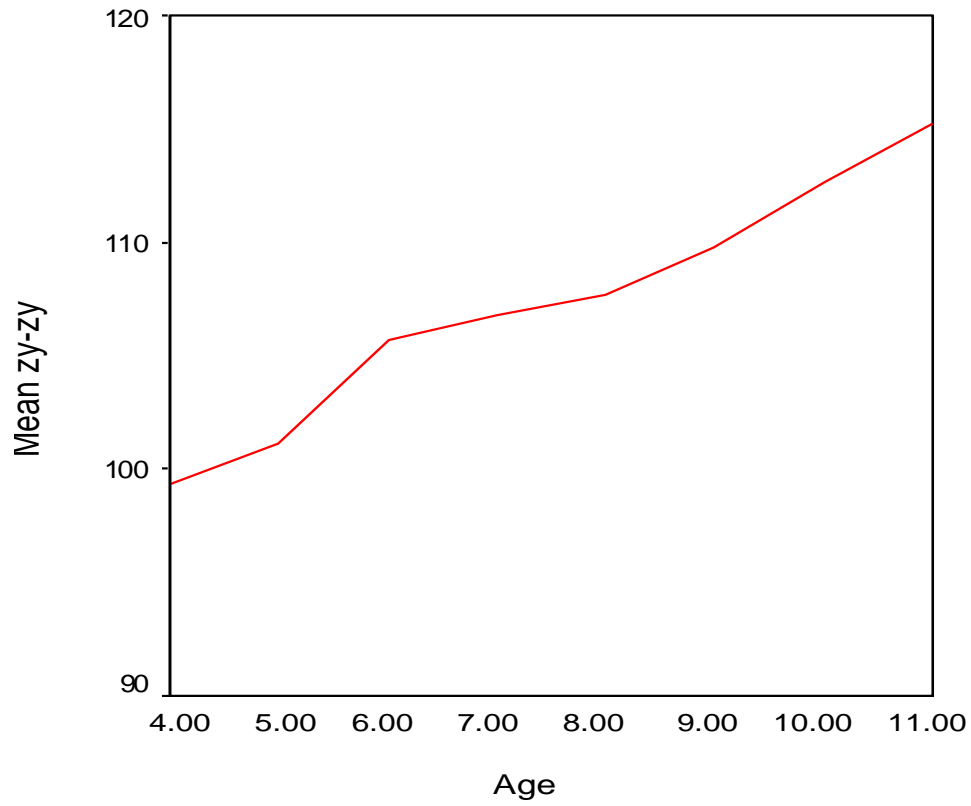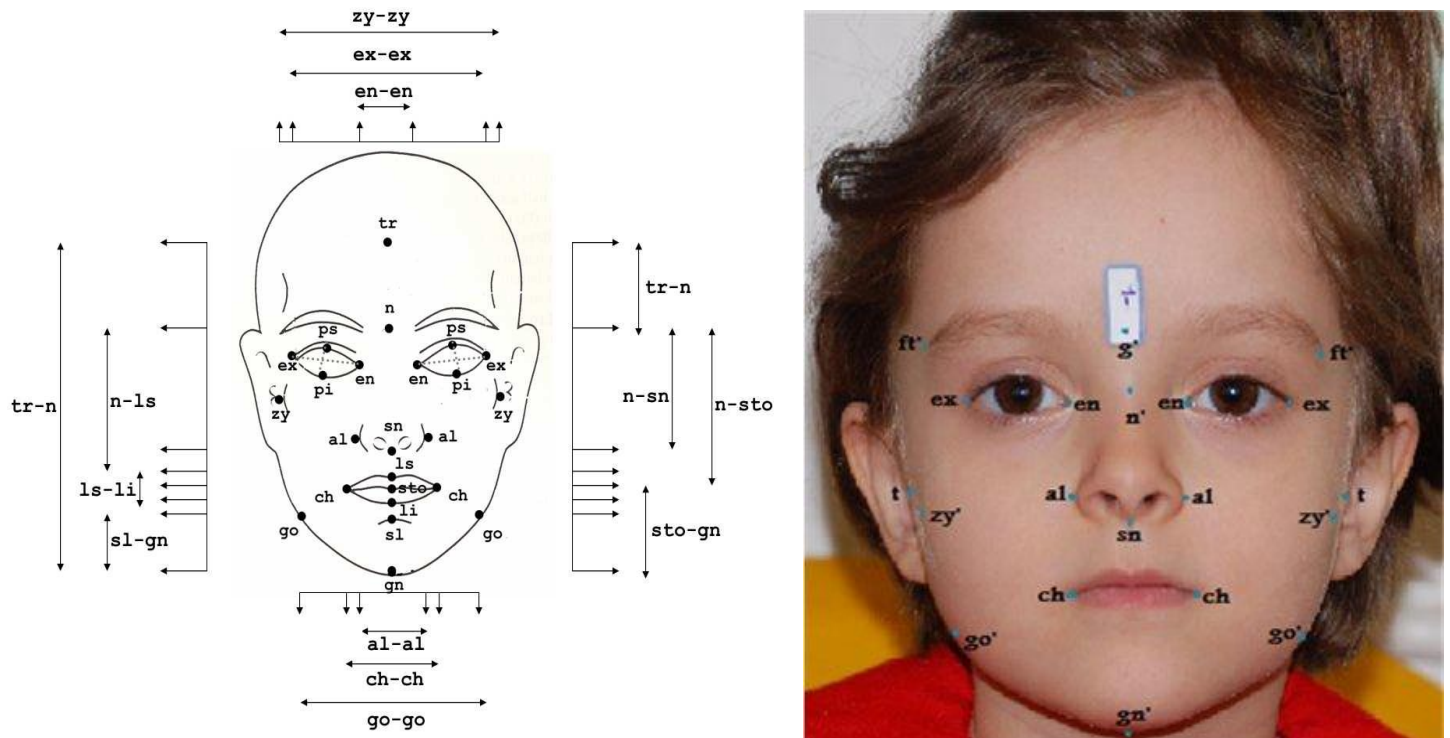
Figure 13. Mean zy'-zy' by age.

Figure 14. Face anthropometry of the 57 facial landmarks defined in Ramanathan and Chellappa (2006).

the findings are reliable. During imaging, the subject should stand still with no detectable facial expression. Photographs should be taken with a high resolution camera to ensure that all angles and lines are easily identifiable. To reduce the measuring error, all measurements were performed by the same operator. However, some landmarks, such as cheilion or endocanthion are more precisely identifiable as compared to landmarks like gonion.

Our findings show that craniofacial dimensions change at different rates at each age range, as other investigators mentioned as well (Enlow and Hans, 1996; Proffit et al., 2007). In other words, the changes may be faster at an age but insignificant at another age. Interestingly, in almost all measured dimensions, we found significant growth acceleration between 5 and 6 years of age. Another growth spurt was also seen between 9 and 11, although it was less significant.

Comparing the linear regression equations suggest that different craniofacial dimensions do not grow similarly. Some parts grow at much slower pace as compared to others. The intercanthal width has the least growth rate followed by the alar width while facial height and then facial width show slower growth.

The intercanthal width growth curve displays a dramatic rise before 7 years of age. The growth of this dimension is related to the growth of brain and cranial base which is essentially complete by this age (Proffit et al., 2007). The orbital dimensions also reach the adult size at about 7. This is the reason why intercanthal growth continues much slowly after age 7. As body grows by age, facial height increases more than facial width. We found faster growth rate in facial height as compared to width.

Being able to predict an individual's facial form at different ages has many practical applications. For instance, in forensic medicine, by analyzing a picture of a kidnapped child, the experts can guess how his /her facial form is after many years. Based on our and other researchers' findings and by using artificial intelligence technology, computer programs can be designed to reconstruct facial forms of the individuals from a specific ethnicity at different ages.

Conclusions

Based on our findings in Kurmanj 4 to 11-year boys, we concluded that:

1. By age, face physical dimensions change at different rates.
2. Different craniofacial and face physical dimensions do not grow at consistent rates. Some parts grow slower compared to others.
3. The intercanthal width has the slowest growth.
4. Facial height shows the fastest growth.
5. Using linear regression equations, at any age, each face physical dimension can easily be determined.

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