

VARIATION OF CEPHALOMETRIC PARAMETERS IN PERI-PUBERTY CEPHALOMETRIC ASPECTS OF SEXUAL DYMORPHISM

A. MOTOC*, MARILENA MOTOC**, S. BOLINTINEANU*, CORINA MUȘUROI***,
ANDREEA POPESCU****, M. NICULESCU*

**Department of Anatomy, University of Medicine and Pharmacy "Victor Babeș", Timișoara;*

***Department of Biochemistry, University of Medicine and Pharmacy "Victor Babeș", Timișoara;*

****University "Tibiscus", Timișoara; ****student, University of Medicine and
Pharmacy "Victor Babeș", Timișoara*

Summary. The data regarding the global and segmental growth and development of the child are useful in pluri-disciplinary studies which view the human body as an entity where the biological aspects (both the normal and the pathological ones) interlace with the socio-cultural ones, thus offering the possibility to any specialist in the field of humanities and morphological studies to cover a wide range in contemporary anthropological research. The development of the skull takes place in two active stages separated by a stage of relative quiet during the age of seven and puberty when the skull has a dolicocephalic aspect. During the second stage of active growth (which starts with puberty) there is a transversal growth of the basis of the cranium followed by an anteroposterior growth. The degree of gender-related differences as far as the dimensions and proportions of the skull are concerned vary greatly according to race, therefore we may say that general ethnic differences are more pronounced than gender-related ones.

Key words: cephalometry, sexual dimorphism, anthropometric parameters.

INTRODUCTION

The study of human growth is more than 300 years old and offers a mirror of the human condition (Motoc, 2001; Bogin, 1995), and the material and moral conditions of a society are reflected in patterns of human growth and development (Tanner, 1986, 1962; Tanner *et al.*, 1976).

A synthesis of the data on growth and development, as well as the monitoring of these phenomena, has been made by auxology, a science that crosses the realm of theory into that of the possibilities of diagnosing and treating a potentially retarded child or excessive growth occurring during development (Ionescu and Mazilu, 1968; Tanner, 1962).

The present study focuses on cephalometric aspects of growth and development during puberty and adolescence from the perspective of development anatomy. The shape of the skull depends on genetic and race factors and it is already defined in the first year of life. Although a seven-year-old child displays relative dimensions and characteristics of the skull similar to those of the adult,

during puberty there may occur certain changes in the shape of the skull, revealed by variations of certain cephalometric parameters (Milcu, 1969, 1967; Tanner *et al.*, 1973, 1983; OMS, 1995).

MATERIAL AND METHODS

The study group consisted of 144 subjects (72 boys and 72 girls), aged between 7 and 18 years (Figure 1).

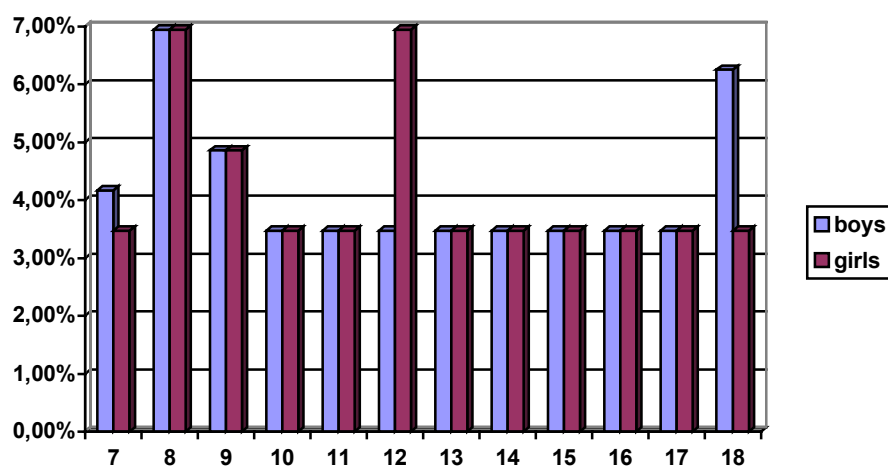


Figure 1 – The distribution of the study group according to age and gender

The study of cephalometric development was conducted by somatoscopic and somatometric methods. The somatoscopic method was used for assessing the harmonious development of the head and body [12].

The somatometric method was used for the direct determination of the following parameters:

- The main somatometric parameter – stature (S),
- The morphometric parameters of head and neck:
 - Biparietal diameter (Bipd);
 - Maximum anteroposterior diameter (Mapd);
 - Auricular height of head (Ah);
 - Total height of head (Th).

Data processing revealed the following:

- Assessment of derived cephalometric parameters (longitudinal cephalic index – LCI, vertical cephalic index – VCI, verticotrassversal index – VTI).

- Assessment of mean values (m), standard deviations (s), standard errors of the mean value (sm) for each parameter (using individual values).
- Assessment of the differences between the two genders within the same age group, using the unidirectional t-Student test.

RESULTS AND DISCUSSION

VARIATION OF THE MAIN SOMATOMETRIC PARAMETER – STATURE, WITH AGE AND GENDER

The variation curves of the mean values have an ascending trajectory in both genders, with a peak of the growth rate between the ages of 12 and 13 in boys and a year earlier in girls (Tabel 1).

VARIATIONS OF DIRECT CEPHALOMETRIC PARAMETERS RELATED TO AGE AND GENDER

Biparietal diameter (Bipd)

The highest growth rhythm of the biparietal parameter (responsible for the growth in width of the head and especially of the neurocranium) occurs in both sexes during the ages 7 and 10, but in boys it has higher values than in girls (this is also the period when top growth speed is reached both in boys and in girls).

The rhythm is slowed down during the ages 11 and 14, having however equal values for both sexes; still, between 15 and 18 years, the growth of Bipd is more pronounced in boys and keeps decreasing in girls. Based on these facts, it can be stated that the growth of the head's transversal diameter in girls is achieved by the ages 14–15 in a rhythm, which decreases, with age, while in boys the growth continues even after the age of 15 and is more pronounced during this last stage than during the ages 11–14 (Figure 2).

Anteroposterior diameter (Apd)

The anteroposterior diameter, expression of the lengthening of the head in sagittal plane, has a dynamics of its growth rhythm different from that of the Bipd. The maximum growth rhythm is reached in both sexes during the ages 11–14, when the value of this rhythm is 1.5 times higher in girls than in boys, although the top growth speed occurs only in girls in this period, while in boys it occurs five years later (Figure 3).

Auricular height (Ah)

The auricular height, expression of the development of the cranial vault, has a totally different growth rhythm in girls and boys. In boys, the most pronounced growth occurs during the ages 7–10, while the minimum value of the growth rhythm is recorded during the ages 11–14 (corresponding to a period of plateau on

the age-related variation chart). The growth rhythm of Ah has another more intense period during the ages 15–18 but without reaching the value of the period 7–10.

In girls, the maximum growth rhythm occurs in the period 11–14, which, in fact, also coincides with the top growth speed. This parameter increases with approximately the same rhythm during the ages of 7 and 10 (when it reaches only half of the values corresponding to the boys) and, between 15 and 18, respectively (approximately 4/5 of the rhythm of the boys) (Figure 4).

Table 1
Mean values of height related to age and gender

Age (years)	Boys height (cm)			Girls height (cm)		
	<i>m</i>	<i>s</i>	<i>sm</i>	<i>m</i>	<i>s</i>	<i>sm</i>
7	127.67	6.25	2.55	127.40	0.89	0.40
8	128.60	7.13	2.26	132.40	6.67	2.11
9	134.29	6.42	2.43	135.14	3.93	1.49
10	137.4	7.99	3.57	139	3.94	1.76
11	141	7.38	3.30	143	9.06	4.05
12	146	5.70	2.55	148.40	7.76	2.45
13	154	3.81	1.70	156	2.55	1.14
14	162	1.58	0.71	160.60	6.42	2.06
15	170	6.44	2.88	162.40	4.16	1.86
16	173.80	6.98	3.12	163.60	8.62	3.85
17	175	6.24	2.79	165.80	4.15	1.85
18	177	6.22	2.07	168	2.24	1

Bipd (cm)

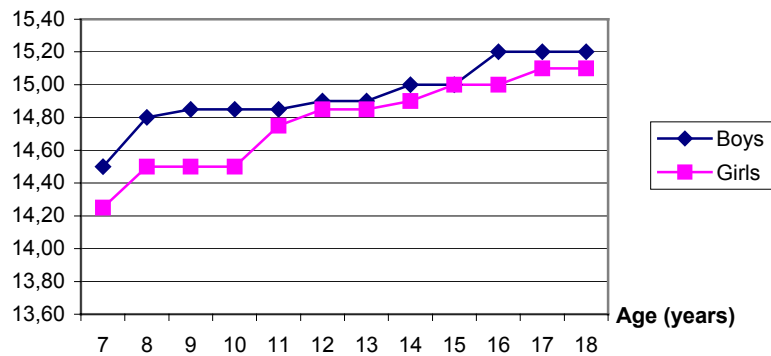


Figure 2 – Variation of mean values of the biparietal diameter related to age and gender

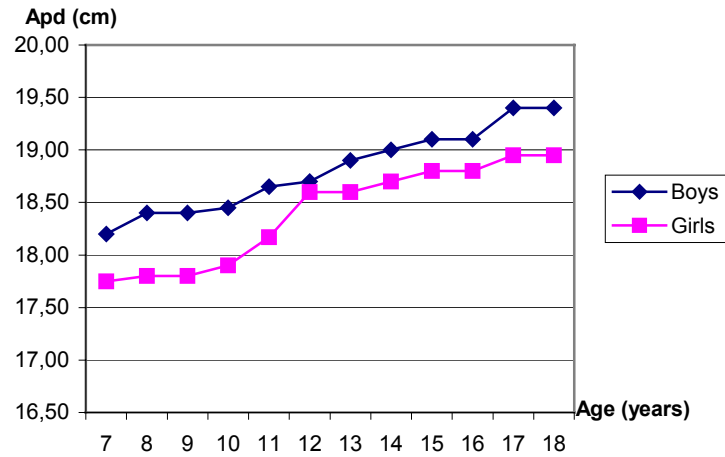


Figure 3 – Variation of mean values of the anteroposterior diameter related to age and gender

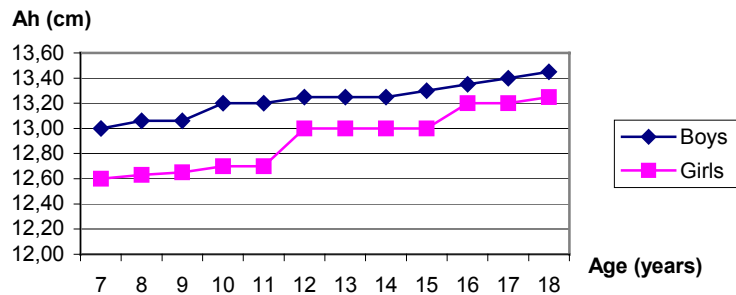


Figure 4 – Variation of mean values of the auricular height related to age and gender

Total height of head (Th)

The total height of the head, expression of the lengthening of the viscerocranium, reaches its maximum growth rhythm in both genders during the ages 7–10, and its minimum rhythm during the period 11–14. Between the ages 15–18 the growth rhythm becomes faster in boys only, while in girls it remains steady. The total height of the head grows in a different way from that of the

stature: in boys it is similar to that of the growth of the width and of the cranial vault, while in girls it resembles only that of growth of the width (Figure 5).

The growth rhythms of Bipd and Ah are approximately parallel processes in boys, differing from the rhythm of the Apd. In girls, the growth rhythm of the Ah progresses similarly to that of the Apd and differs from that of Bipd. It follows that the anteroposterior lengthening and the more pronounced development of the cranial vault reach a maximum between the ages of 11 and 14 in girls, unlike the growth in width which had its peak between the ages of 7–10. In boys, the growth in width and the more pronounced development of the cranial vault are minimal during the ages 11–14, unlike the sagittal lengthening, which is maximal in this period (Figure 6).

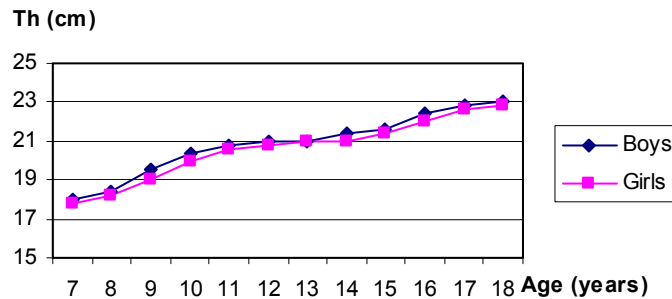


Figure 5 – Variation of the mean values of the total height of the head related to age and gender

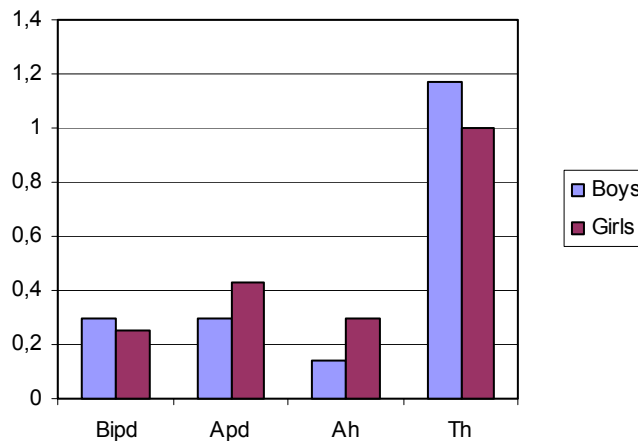


Figure 6 – Comparison between the growth peaks of the direct cephalometric parameters

By correlating the variation of size with that of the direct cephalometric parameters, it is obvious that the maximum growth rhythm for size occurs during the same period as that of the growth of the Apd and Ah in girls, while in boys it is parallel only with the maximum growth rhythm of the Apd.

VARIATIONS OF DERIVED CEPHALOMETRIC PARAMETERS RELATED TO AGE AND GENDER

Longitudinal cephalic index (LCI)

The longitudinal cephalic index helps determine the shape of the head in superior view. It is determined on the basis of the following formula: $LCI = \text{Bipd}/\text{Apd} \times 100$, where Bipd stands for the maximum biparietal or transversal diameter (cm), and Apd for the maximum anteroposterior diameter (cm).

Boys have LCI values characteristic for mezocephaly during the entire 7–18-year interval. At the ages of 8, 9 and 10, we assessed the maximum values of the LCI, which correspond to mezocephaly but are close to the borderline of brachycephaly (80.43–80.70%). At the age of 11, we recorded a decrease of the LCI values, but without crossing the characteristic limits for mezocephaly. Minimum LCI values were assessed at the ages of 17 and 18 (78.35%).

The girls of the study group fall within the characteristic limits of mezocephaly during the ages of 7–18, but between the ages 8–11 we recorded the LCI values closest to the borderline of brachycephaly (81.46–81%). Starting with the 12-year age group, there was a decrease of LCI, with a minimum at the age of 14 (79.67%), followed by a slight increase until the age of 17 (79.89%), value, which also appears at the age of 18.

The most pronounced tendency for brachycephaly is maintained at approximately the same age interval: 8–10 years for boys and 8–11 years for girls (Figures 7 and 8).

Vertical cephalic index (VCI)

The vertical cephalic index helps determine the shape of the head in anteroposterior plane, and can be determined according to the following formula: $VCI = \text{Ah}/\text{Apd} \times 100$, where Ah = auricular height (cm) and Apd = anteroposterior diameter (cm). The values of this index differ in the study of the isolated cranium from those obtained by cephalometry because Ah is replaced with the basion-bregma distance. The mean values of the VCI fall, for both sexes, within the characteristic limits of hypsicephaly: in boys VCI has a maximum at the age of 10 (71.50%) and a minimum at the age of 17 (69%); in girls, VCI has a maximum between the ages of 8 and 9 (71%) and a minimum at the age of 15 (69.10%). Both the maximum and the minimum occur in girls a year earlier than in boys (Figure 9).

Verticotraversal index (VTI)

The verticotraversal index determines the shape of the head in occipital view and is calculated according to the following formula: $VTI = Ah/Bipd \times 100$, where Ah = auricular height (cm) and Bipd = biparietal diameter (cm). The mean values of the VTI, for both sexes, fall within the category of acrocephaly. Boys have a maximum of this index at around the age of 7 (89.60%) and a minimum at the age of 17 (88%). Girls have a maximum of this index at the age of 14 (88.40%) and a minimum at the age of 15 (86.60%). We can notice that the values of the girls are smaller than those of the boys due to the lower values of both diameters during the entire period. The minimal values of the three indices occur at the same age, two years earlier in girls (15 years) than in boys (17 years) (Figure 10).

CONCLUSIONS

1. The following conclusions can be reached after having synthesized the data on the age-related development of cephalometric parameters in the study group:

- during the period 7–10 years old:
 - growth of the head is achieved mainly on account of the biparietal diameter in both sexes;
 - the minimum growth rhythm occurs in the anteroposterior diameter for boys, and in the auricular height for girls;
 - the maximum growth rhythm manifests itself at full height, involving facial growth for both sexes;
 - the length of the neck grows at a faster rhythm in girls than in boys.
- during the period 11–14 years old:
 - the head grows on account of the anteroposterior diameter for boys and the anteroposterior diameter and auricular height for girls (who also register higher growth rhythms as compared to boys);
 - the total height of the head and the length of the neck reduce their growth rhythm as compared to the previous period, a reduction that is more pronounced in boys.
- during the period 15–18 years old:
 - the growth of the head continues at a lesser rate than that of the preceding period for the anteroposterior diameter, and at a higher rate for auricular height in boys; in girls, it takes place mainly on account of the auricular height;
 - the total height of the head and the length of the neck grow in both sexes more prominently than in the preceding period.

2. From the point of view of the derived cephalometric parameters, the study group is characterized by the triad mezocephaly–hypsiccephaly–acrocephaly; however, it should be noted that in the age groups of 10 and 11 years both sexes manifest a prominent tendency for brachiccephaly.

3. In the age group 10–18 years, the differences between the two sexes are 100 per cent statistically significant for auricular height, 89 per cent (of all group ages) for the anteroposterior diameter and 78 per cent for the biparietal diameter.

4. By correlating the variation of stature with that of the direct cephalometric parameters, one can notice that the maximum growth rhythm of stature occurs in the same period with that of the anteroposterior diameter and auricular height in girls, and only with that of the anteroposterior diameter in boys.

5. The study of cephalometric parameters (linear and volumetric dimensions) provides the necessary data for the design of objects with a protective role with a view to optimising sensory functions or to mediating the interaction between the surrounding elements and the cephalic topographic regions. If we consider age, we may give examples in this sense, such as: protection helmets when riding a bike, skateboard or roller-skates (used by all the age groups in the interval studied), headphones, hearing devices, and glasses.

REFERENCES

- BOGIN B., Growth and development: recent evolutionary and biocultural research. In: BOAZ N., WOLFE L.D. (eds), *Biological Anthropology: The State of the Science*, International Institute for Human Evolutionary Research, Bend, Oregon, 1995, 49–70.
- IONESCU A.N., MAZILU V., *Creșterea normală și dezvoltarea armonioasă a corpului*, Ed. Consiliului Național pentru Educație Fizică și Sport, București, 1968, 20–28, 55–57, 84, 89, 91, 93.
- MILCU Șt., *Consecințele sociale ale procesului de accelerare a dezvoltării somato-sexuale a tinerilor*, Col Manif Științ Nr. 2, Centrul pentru Problemele Tineretului, București, 1969, 9–15.
- MILCU ȘT., MAXIMILAIN C., *Introducere în antropologie*, Ed. Științifică, București, 1967.
- MOTOC M., *Variabilitatea unor parametric morfologici în perioada peripubertară*, Teză de doctorat, U.M.F “Victor Babeș” Timișoara, 2001.
- OMS, *Série de Rapports techniques, 854. Utilisation et interprétation de l'antropométrie. Rapport d'un Comité OMS D'Experts*, Organisation Mondiale de la Santé, Geneve, 1995, 292–300, 340–342.
- TANNER J. M., *Growth at adolescence*, Blackwell Sci. Publ., Oxford, 1962.
- TANNER J.M. et al., *Standards for children's height at ages 2 to 9 years, allowing for height, weight velocity and the stages of puberty*, Arch Disease Childhood, 1976, 51:170–179.
- TANNER J.M., Growth as a mirror for the conditions of society: secular trends and class distinctions. In: DEMIRJIAN A. (ed), *Human growth: a multidisciplinary review*, Taylor and Francis, London, 1986.
- TANNER J.M., *Growth at adolescence*, Blackwell Sci. Publ., S.T., 1962.
- TANNER J.M., *Physical growth and development. Textbook of Paediatrics*. Eds. Forfar.
- TANNER J.M., LANDT R.W., CAMERON N., *Predicting adult height from height and bone age in childhood*, Arch Disease Childhood, 1983, 58:767.

Received: 5 October, 2004

Accepted: 22 November, 2004

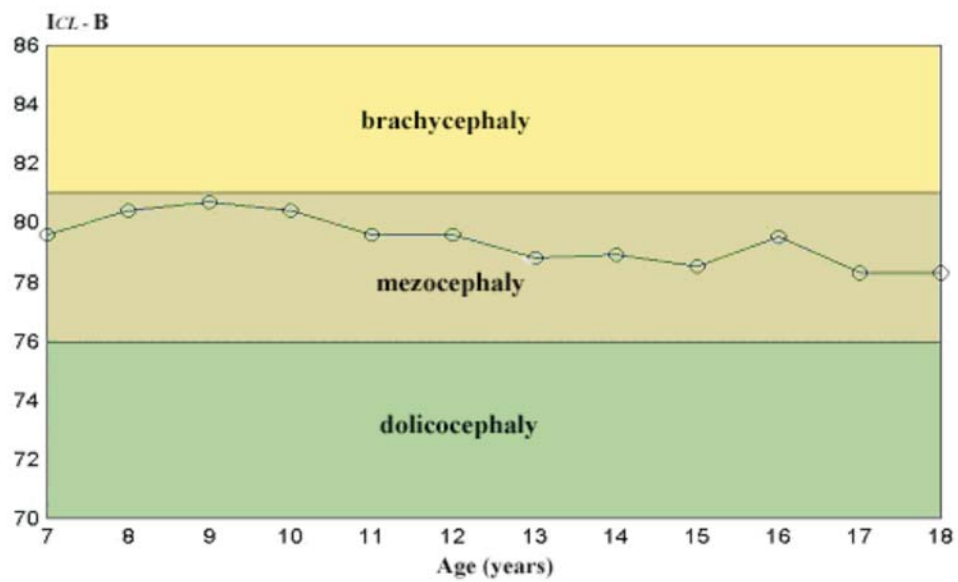


Figure 7 – Mean values of longitudinal cephalic index in boys (cf. Milcu & Maximilian, 1967)

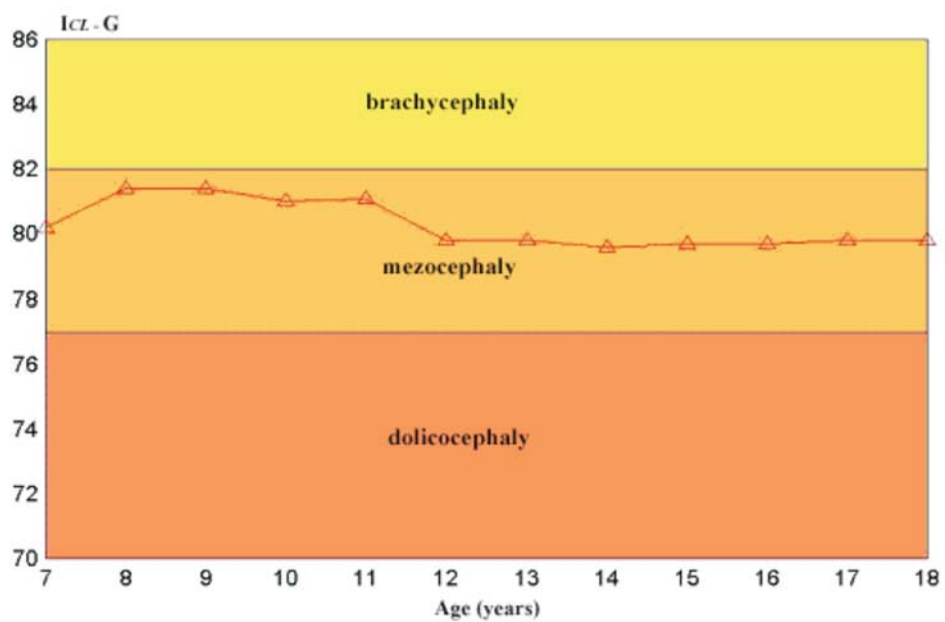


Figure 8 – Mean values of longitudinal cephalic index in girls (cf. Milcu & Maximilian, 1967)

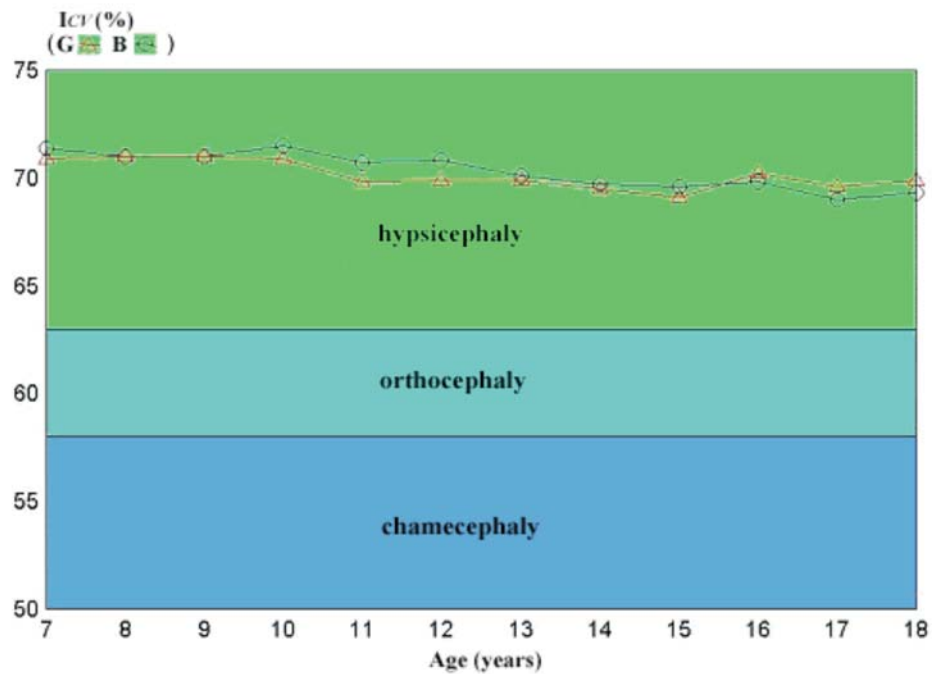


Figure 9 – Mean values of vertical cephalic index (cf. Milcu & Maximilian, 1967)

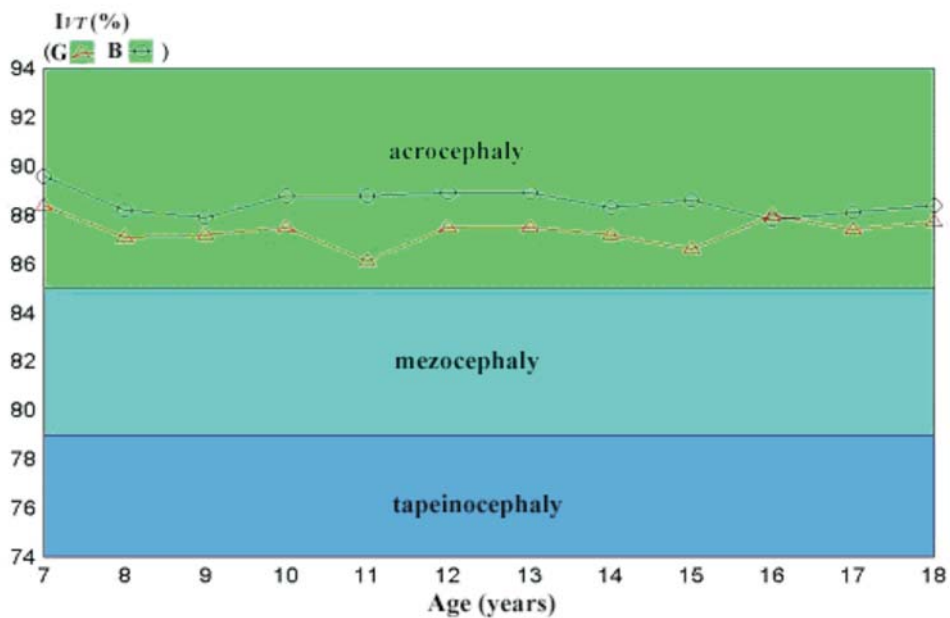


Figure 10 – Mean values of the verticotrassversal cephalic index (cf. Milcu & Maximilian, 1967)