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SECULAR CHANGES IN CEPHALIC INDEX-A STUDY OF SERBIAN SCHOOL CHILDREN

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Craniofacial anthropometry is used to determine similarities and differences within a single population or between populations, as well as to determine the secular trends. The aim of the study is to determine differences in the cephalic index of school children from the city of Niš (southeastern Serbia) in two periods-in 1983 and 2010. Subjects were aged 7-15. The first group of subjects (from 1983) included 968 children of both genders, while the second group of subjects (from 2010) included 1037 children, also of both genders. The test was performed according to the instructions of the International Biology Program (IBP). The head length and head breadth were measured, and based on these parameters the cephalic index was determined. The results show that during the time debrachycephalization appeared, because brachycephalic was dominant with the children from 1983, while mesocephalic was dominant with the second group (2010). Genderual dimorphism exists in both groups of subjects.

Key words: cephalic index, children, debrachycephalization, head dimensions, secular changes, Serbia

INTRODUCTION

Craniofacial area is a part of the body that is subject to changes and mostly to uneven ones, which occur during growth and development periods. The newborns have relatively big heads, approximately *1/4* of the total length (height) of the body, whereas after the end of the growth period the head is *1/8* of the entire height of the body. So, it is obvious that the extremities grow faster when compared to the head growth (DJURAŠKOVIĆ, 2009). The growth is particularly uneven when certain periods of life of individuals are observed, so that, with the exception of the fetal period, important and the fastest changes occurs after the birth during the first three years of life and during puberty. Characteristics of the head are caused by genetic, but

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the occurrence of a particular phenotype is affected by the environment in which the organism develops (climate, nutrition, sleeping position in infancy, migration, and socioeconomic status), gender, and evolutionary changes in the long run.

Craniofacial anthropometry is used to determine the morphological features of the head and face, which is important both in anthropology and medicine, as well as in forensic investigations. Such measurements are used for comparison of healthy subjects with patients (ASHA et al., 2011), to compare values between children and adults and to determine the belonging to a particular population, as well as to determine the secular trends (KONDO *et al.,* 1999; KOUSHI 2000; RADOVIĆ *et al*., 2000; LITTLE *et al*., 2006; REXHEPI *et al*., 2008).

The aim of this study is to define the possible differences between the two groups of students from different time periods with a special emphasis on the influence of gender and age differences. It is also important to identify possible differences based on the determination of the average values of certain parameters, the significance of these differences, as well as the cephalic index determination.

MATERIALS AND METHODS

Samples

The research was conducted by comparing two samples of school children aged 7-15 from the city of Niš (southeastern Serbia). The study involved 968 students measured in 1983. (504 boys and 464 girls), and 1037 measured in 2010 (545 boys and 492 girls). Both groups were healthy children from the regular city schools. Students were divided into three groups according to the age: 7-9 years (under school age), 10-12 years (preadolescence) and 13-15 years (early adolescence).

Methods

The test was performed according to the instructions of the International Biology Program (IBP). The head length and head breadth were measured, and based on these parameters the cephalic index was determined. For each respondent the anthropological questionnaire was filled in which included the following elements: the respondent's name, date and place of birth, the breadth and length measures of the head.

Statistical analysi

The data were statistically analyzed. The mean value (*X*) and standard deviation (*SD*) were determined. To determine the statistical significant difference between the groups of respondents Student's t–test was performed. Statistical analysis was processed in MS Excel 2007. Belonging to a particular type of head shape was determined by the cephalic index, for the males and females separately. The resulting indices were used for the comparison of two samples in order to determine whether during the time the change had occurred. The cephalic index was obtained by the formula: *maximal head breadth×100/ maximal head length.*

RESULTS

The results are presented in Tables 1, 2 and 3, for both samples, and Figures 1 and 2, also for both samples. The mean value (*X*) and standard deviation (*SD*) for the breadth and length of the head are shown in Table 1.

Table 1. Comparison of cephalic measurements between genders and age groups (1983, 2010)

Parameters	BOYS						GIRLS					
	1983.			2010.			1983.			2010.		
	age	n	X (*cm*) ±SD	age	n	X(*cm*) ±SD	age	n	X(*cm*)±SD	age	n	X(*cm*) ±SD
Cranial length	7-9	155	17,94±0,69	7-9	138	18,78±0,67	7-9	156	17,59±0,61	7-9	133	18,07±0,64
	10-12	142	18,20±0,79*	10-12	200	18,88±1,02*	10-12	86	17,86±0,53	10-12	202	18,48±0,66
	13-15	207	18,59±0,75	13-15	207	19,52±0,76	13-15	222	18,10±0,73	13-15	157	18,85±0,61
Cranial breadth	7-9	155	14,66±0,59	7-9	138	15,11±0,40*□	7-9	156	14,20±0,59	7-9	133	14,62±0,51
	10-12	142	15,13±0,78	10-12	200	15,36±0,95	10-12	86	14,84±058	10-12	202	15,06±1,32
	13-15	207	15,36±0,67	13-15	207	15,64±0,61□	13-15	222	14,97±0,75	13-15	157	15,10±0,51
Cephalic index	7-9	155	81,85±4,51	7-9	138	79,77±2,98	7-9	156	80,84±4,44	7-9	133	80,96±3,30
	10-12	142	83,28±5,60	10-12	200	81,39±8,53	10-12	86	83,13±3,68	10-12	202	81,62±7,64
	13-15	207	82,74±4,42	13-15	207	80,19±3,79	13-15	222	82,85±5,28	13-15	157	80,15±3,17
	total	504			545			464			492	

*significant differences between gender □significant differences between the period of time

*□p<0,05

Table 2. Precise values of Student´s t-test

Age	p–in relation to the gender (1983-2010)				Age	p-in relation to the time period (1983-2010)			
	Cranial length		Cranial breadth			Cranial length		Cranial breadth	
	1983	*2010*	*1983*	*2010*		*Boys*	*Girls*	*Boys*	*Girls*
7-9	3,99	5,84	2,49	0,000*	7-9	1,17	6,69	0,003*	2,49
10-12	0,000*	0,000*	0,14	0,17	10-12	4,77	3,01	0,25	0,14
13-15	1,71	5,92	0,10	1,76	13-15	1,18	1,14	0,000*	0,10

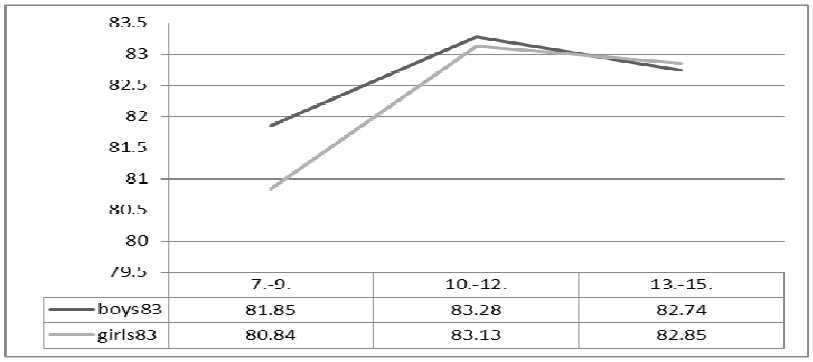
Table 3. The frequency of cephalic phenotype-total

	Boys		Girls	
	1983	2010	1983	2010
Hiperdolichocephalic	0,20%	0,31%	0,65%	0%
Dolichocephalic	6,35%	5,33%	4,53%	3,90%
Mesocephalic	31,35%	**52,66%**	31,03%	**51,62%**
Brachycephalic	**37,30%**	34,48%	**44,83%**	38,64%
Hyperbrachycephalic	21,83%	5,34%	17,02%	4,87&
Ultrabrachycephalic	2,97%	1,88%	1,94%	0,97%

The significance of the differences in relation to the period and gender is displayed in the Table 1, while the precise values of Student's t-test are displayed in the Table 2. There are significant differences when comparing values in relation to both gender and the time period in particular age groups.

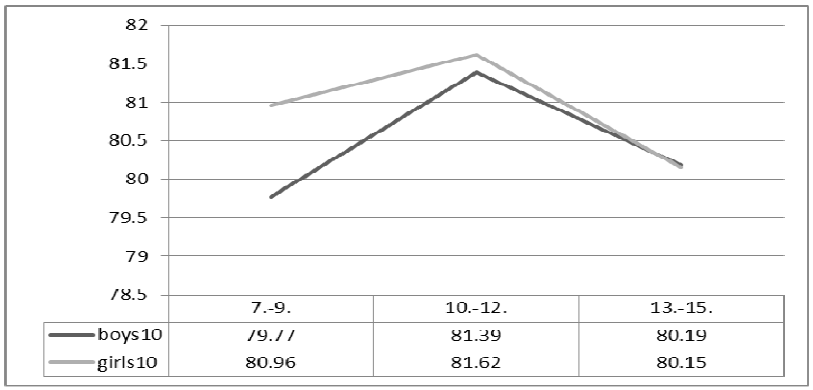
Percentage of the head types in total is shown in Table 3. The change of the cephalic index is noticed, as well as the reduction of percentage of the brachycephalic head type over time.

Figures 1 and 2 show the comparison of cephalic index with respect to gender (1983 in Figure 1 and 2010 in Figure 2) with the highest values in the age of 10-12 for both genders and for both periods of time.



	7.-9.	10.-12.	13.-15.
boys83	81.85	83.28	82.74
girls83	80.84	83.13	82.85

Figure 1. Comparison of cephalic index in relation to the gender (1983)



	7.-9.	10.-12.	13.-15.
boys10	79.77	81.39	80.19
girls10	80.96	81.62	80.15

Figure 2. Comparison of cephalic index in relation to the gender (2010)

DISCUSSION

Variations in the cephalic index, i.e. shape of the head, occur as a result of interaction of genetic factors and environmental factors that influence the expression of genetic potential of an individual. By comparing samples from two periods of time considerable data on the impact of various external factors on the observed characteristics can be obtained.

Previous studies have shown that in many populations a secular trend occurred, i.e., a change in some observable characteristics. In certain populations brachycephalization occurs, as observed in Asia: KONDO *et al*. (1999), by comparing three generations (40, 20 years ago, and in 1999) observed brachycephalization and secular changes in measured characteristics. Also, KOUCHI (2000), by comparing Japanese and Korean population, noted the emergence of brachycephalization, which was associated with a flat face, a specific type of Mongoloid people, while HOSSAIN *et al*.(2004) showed that the increase in mean cephalic index in Japanese adult females was primarily influenced by the increase of head breadth and also suggest (2005) that brachycephalization has been occurring for approximately about 35-85 years in adult Japanese males. ILAYPERUMA (2011), on a sample of 400 subjects aged 20-23 in Sri Lanka, noted brachycephalization and significant differences among the genders. VOJDANI *et al.* (2009) pointed out that with children aged 14-18 in Iran brachycephalization was most common with girls, and hyperbrachycephalization with boys, and SWAMY *et al*. (2013) studying school children of Malaysia, said that the cephalic index for girls aged 7-17 was ranged from 77. 99 to 82.02, and for boys of the same age group it was from 80.61 to 82.35. Also, outside of the Asian continent, LITTLE *et al.* (2006) , comparing the head size of school children aged 6-13 in a part of Mexico for the period 1968-2000, observed the appearance of brachycephalization in both sexes. Among Ogonis in Nigeria, OLAPIDO *et al*. (2009) showed that mean cephalic index puts Ogonis in the brachycephalic population.

However, in some parts of the European continent, various studies indicate the appearance of debrachycephalization. BURETIĆ *et al*. (2004), analyzing the cephalic measures of students of the Medical Faculty of Rijeka (Croatia), aged 19-20, noted debrachycephalization and a frequent occurrence of dolichocephalic and mesocephalic, i.e., decrease of cephalic index value. Same author (2006) observed ongoing dolichocephalization in Croatian younger adults. REXHEPI *et al.(*2008) showed a comparison of the cephalic indices of the Balkan peoples, the Serbs being the most common among dolicephalic (39.20%) and mesocephalic (30.70%) and with those values were predominant in comparison with the Bulgarians, Greeks and Albanians for the same indices. The same comparison showed the Bulgarians as the most dolicephalic (34%), while the Greeks and Albanians were usually brachycephalic (48.97% and 79.50%). RADOVIĆ *et al.* (2000) by comparing South Dalmatia population with a population of northern Croatia noted that mesocephalic appeared with the first, while brachycephalic was more prevalent with the other group. Debrachycephalization was observed in the Czech Republic (PAULOVA *et al.,* 2000), as well as in a research of young people aged 7-17 from the region of eastern Rhodopi (TINESHEV, 2009). ZELLNER *et al.* (1998) reported secular changes of the head in the sense of debrachycephalization in Jena school children (Germany). GODINA (2011) came to the conclusion that in some Russian population were noticeable changes in head and face measurements. GRBEŠA *et al.* (2007) , by comparing the Croatian and Syrian population, came to the conclusion that for the first group the mean cephalic index value was 72.60 (dolichocephalic) , while with the others it was much higher (82.04-brachycephalic).

The data obtained in this study support the debrachycephalization that has been reported in this part of Europe in recent decades (PAULOVA *et al*., 2000; BURETIĆ *et al.,* 2004; GRBEŠA *et al*., 2007). In the first sample the most present was brachycephalization, in both sexes. In the second sample there was a change in cephalic index to mesocephalic by its decreasing, also in both genders. KOUCHI (2000) states that the increase in the head breadth is crucial both for brachycephalization and for debrachycephalization. In the present study, an increase in the values for both the breadth and length of the head has been noticed, which resulted in the above mentioned cephalic index change. Particularly, the significant difference in males when comparing the two periods for the breadth value of the head has been emphasized. The values are higher with girls, too, but with no statistically significant difference. These data indicate a change over time, i.e., the secular trend, as observed in the previously mentioned studies.

Also, it can be noted that the values of cephalic index are higher with the children aged 10-12 when compared to two other groups, although it would be expected that the head size increases along with aging process. SWAMY et al. (2013) has similar observations he got by comparing the cephalic indices of children and adolescents in Malaysia. He notes that the value of this index is lower with children 14-17 years old than the index of children aged 10-13. KARACAN et al. (2013) in Turkey, whose study also showed the lower values for 14-17 years old subjects in relation to the group of 9-13 years old subjects when the size of the head was measured, observed the same fact. As Swamy stated, this trend was observed in the communities which were growing rapidly, and the fact may be related to the economic development and a better public health care. Appearance of decreasing cephalic index may be associated with better socioeconomic conditions, nutrition, better health care and changing of living conditions at all. Migrations as a factor that leads to the change in the presence of a particular phenotype should not be ignored, too.

This study also shows that there are differences between the genders, i.e., that the measured values are lower with girls than with boys, which may be correlated with earlier studies that indicated higher average values of general physical characteristics of boys and some secular changes over time for those physical characteristics (ĆIRIĆ *et al.,* 2001; RADENKOVIĆ *et al.,* 2001; NIKOLIĆ *et al*., 2010.; RADENKOVIĆ *et al,* 2010), and thus the higher average values of the cephalic measures. In particular, a significant difference in the length of the head during the period of 10-12 years old, on behalf of the males with both samples (1983, 2010) is highlighted.

It can be concluded that there has been a change over the past 27 years, especially if we take into account that the data obtained by measuring performed in the same part of Serbia (Niš, city schools). Also, there has been a decrease of cephalic index and more frequent appearance of mesochephalization in both genders, and gender differences are evident in both samples (Figures 1 and 2). The real causes of the secular trends are not specifically known, but in addition to migration, leading to changes in the percentage of representation of certain types of head, and which were particularly common to the territory of Serbia in 1990s, the changes that occur in other areas should be taken into account, such as economic and social development, changes in diet, medical care. The actual data can be important for any kind of anthropological research and comparison with other populations, since they are relevant enough, especially if we take into account the size of the sample. It would be good if these data are compared with data on the cephalic measures for children and adolescents from the other parts of Serbia, in order to

obtain a more complete picture, but also to take into account certain specific external factors and determine their direct effect, or correlation with the change of head measures.

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REFERENCES

ASHA, KR., S. LAKSHMIPRABHA, CM. NANJAIAH, SN.PRASHANTH (2011): Craniofacial anthropometric analysis in Down Syndrome. Indian J Pediatr. *78*(9):1091-5

BURETIĆ-TOMLJANOVIĆ, A., S. RISTIĆ, B, BRAJENOVIĆ-MILIĆ, S, OSTOJIĆ, E, GOMBAČ, M.KAPOVIĆ (2004): Secular Change in Body Height and Cephalic Index of Croatian Medical Students (University of Rijeka). American journal of physical anthropology *123*:91–96 2004.

BURETIĆ-TOMLJANOVIĆ, A., S. OSTOJIĆ, M.KAPOVIĆ (2006): Secular change of craniofacial measures in Croatian younger adults. Am J Hum Biol., *18*(5):668-75

ĆIRIĆ, M., M, RADENKOVIĆ, M. NIKOLIĆ, S. NAJMAN, S. CEKIĆ, S. VELJKOVIĆ (2001): Impact of a twelve-year interval on some development indicators fifteen-year girls of Nis region. Communication from XL Congress of Anthropological Society of Yugoslavia with international participation, 2001; 95

DJURAŠKOVIĆ, R. (2009). Sports Medicine (third revised edition). Publishing Center of the Faculty of Sport and Physical Education, University of Nis

GODINA, EZ. (2011): Secular trends in some Russian populations. Anthopol Anz., *68*(4):367-77

GRBEŠA, D., R. PEZEROVIĆ-PANIJAN, MN. KALAYA, I. GORSIĆ, A. CAVCIĆ, N. ZURA, B. BERBEOVIĆ (2007): Craniofacial Characteristics of Croatian and Syrian Populations. Coll.Antropol. *31*(4):1121-1125

HOSSAIN, MG., PE. LESTREL, F. OHTSUKI (2004): Secular changes in dimensions of Japanese females over eight decades. Anthropological science, *112*: 213-218

HOSSAIN, MG., PE. LESTREL, F.OHTSUKI (2005): Secular changes in head dimensions of Japanese adult male students over eight decades. Homo, *55*(3):239-50

ILAYPERUMA, I. (2011): Evaluation of cephalic indices: a clue for racial and sex diversity. Int. J. Morphol., *29*(1):112-117, 2011.

KARACAN, K., KOSAR, MI., CIMEN, O., SOLAK, B. SAHIN (2013): Determination of Lateral Ventricle and Brain Volume in Children with Stereological Method Using MRI. International Journal of Morphology, *31*:211-216

KONDO, S., E. WAKATSUKI, H. SHIBAGAKI (1999). A somatometric study of the head and face in Japanese adolescents. Okajimas Folia Anat Jpn. 1999 Oct;*76*(4):179-85.

KOUCHI, M. (2000). Brachycephalization in Japan has ceased. Am J Phys Anthropol. 2000 Jul; *112*(3):339-47.

LITTLE, BB., PH. BUSCHANG, PENA ME. REYES, SK. TAN, RM.. MALINA (2006). Craniofacial dimensions in children in rural Oaxaca, southern Mexico: secular change, 1968-2000. Am J Phys Anthropol. 2006 Sep; *131*(1):127-36.

NIKOLIĆ, M., R. DJURAŠKOVIĆ, S. PANTELIĆ, G. NIKOVSKI (2010). Comparing the indicators of growth and development of seven year old girls from different intervals. Journal of Anthropological Society of Serbia. *45*:327-334

OLAPIDO, GS., JE. OLOTU, Y.SULEIMAN (2009): Anthropometric Studies of Cephalic indices of the Ogonis in Nigeria. Asian Journal of Medical Sciences, *1*(2):15-17

PANTELIĆ, S., M, NIKOLIĆ, R. DJURASKOVIĆ (2010). Developmental characteristics of seven year old boys from different time period. Journal of Anthropological Society of Serbia. *45*:319-326

PAULOVA, M., P. BLAHA, V. VIGNEROVA, J. RIEDLOVA (2000). Influence of positioning of infants on long-term changes of cephalic dimensions. Central European Journal of Public Health 2000, *8*(2):83-87

RADENKOVIĆ, M., S. VELJKOVIĆ, A. NIKOLIĆ, S. NAJMAN, M, ĆIRIĆ, J. ŽIVANOV-ČURLIS, M ANTIĆ(2001). Impact of a twelve-year interval on some development indicators fifteen-year boys of Nis region. Communication from XL Congress of Anthropological Society of Yugoslavia with international participation, 2001; 96

RADOVIĆ, Z., Ž. MURETIĆ, V. NJEMIROVSKIJ, V. GAŽI-ČOKLICA (2000). Craniofacial Variations in a South Dalmatian Population. Acta Stomat Croat 2000; 391-398

REXHEPI, A., V.MEKA (2008): Cephalofacial morphological characteristics of Albanian Kosova population. Int. J. Morphol., *26*(4):935-940, 2008.

SWAMY, KB., AL. ZUBAIDI, ABH. SUWAIBAH, H. AZMI, K. NORIZAHAR, MAR. HUSBANI, H.ROHAYAH (2013): The Craniofacial Indices Correlate with Age, Gender and Environmental Influences-A Study in Malaysian School Children. World Applied Sciences Journal *27* (2): 250-256, 2013

TINESHEV, SA. (2009): Secular changes in growth and sexual maturation in children and adolescents from the region of eastern Rhodopi. Proceedings from XIX Congres of Anatomy; may 29-31,2009

VOJDANI, Z., S. BAHMANPOUR, S. MOMENI, A. VASAGHI, A. YAZDIZADEH, A. KARAMIFAR, A. NAJAFIFAR, S. SETOODEHMARAM, A. MOKHTAR (2009): Cephalometry in 14-18 years old girls and boys of Shiraz-Iran high school. Int. J.Morphol., *27*(1):101-104, 2009.

ZELLNER, K., U. JAEGER, K. KROMEYER-HAUSCHILD (1998): The phenomenon of debrachycephalization in Jena school children. Anthropol Anz. *56*(4):301-12

SEKULARNI TREND KEFALIČNOG INDEKSA - STUDIJA UČENIKA SRPSKIH ŠKOLA

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Izvod

Kraniofacijalna antropometrija se koristi za određivanje sličnosti i razlika unutar jedne populacije ili između populacija, kao i za određivanje sekularnog trenda. Mnoge studije su pokazale da je vremenom, a naročito poslednjih decenija došlo do promena u obliku glave. Time je postavljen cilj ovog rada, odnosno upoređivana su dva uzorka školske dece Niša (jugoistočna Srbija) uzrasta 7-15 godina iz istog mesta, ali različitih vremenskih perioda-1983 i 2010, sa rasponom od 27 godina. Prvi uzorak čini 968 deteta oba pola, a drugi njih 1037, takođe oba pola. Posmatrana su dva parametra, širina glave i dužina glave, na osnovu kojih je određen kefalični indeks. Podaci do kojih se došlo upućuju na to da je vremenom došlo do debrahicefalizacije, odnosno da je, za razliku od prvog uzorka (1983) kada je dominirala brahicefalija, u drugom uzorku procentualno zastupljenija mezokefalija i to kod oba pola. Ovakvi podaci podržavaju slične studije rađene zadnjih godina u ovom delu Evrope. Polni dimorfizam postoji u oba uzorka i u korist je muškog pola.

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