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Changeableness of selected characteristics of the head in the Rzeszów children and adolescents aged 4 to 18 in during a 35-year period

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ABSTRACT

Introduction. Over the past decades, anthropometric studies have focused more on secular changes in body height and weight, and less on changes in head features. Meanwhile, changing socio-economic conditions, especially the nutritional status of the human population, support the need to document some of the metric head features in children and adolescents.

Aim. The aim of this study was to determine whether there has been changes over time in the morphological development of the head with respect to socio-economic conditions at the turn of the last century on sample population of children and adolescents from Rzeszów.

Material and methods. In the years 1978/79, 1993/94, 2003/04 and 2013/14, a total of 9041 Rzeszów children aged 4 to 18 were examined. Anthropometric measurements were based on a technique developed by Martin and Saller. The following features were taken into account: head length and width, morphological face height, maximum face width, nose height and width, and head circumference. The relevant head, face and nose indices were calculated from the measured data. New indices for head circumference have also been proposed.

Results. Such changes as head elongation, shortening of morphological face and nose height, and widening of the nose from hyperleptorrhinus to leptorrhinus were found in both sexes.

Conclusions. 1. During the past 35 years there have been noticeable changes in the morphological characteristics of the head, face and nose. 2. Further follow-up to the development of head features is recommended.

Keywords. time changes, children and adolescents, head indices, head circumference

Introduction

Over the past century anthropological research was characterized by the interest in the micro-evolutionary variability of the morphological construction of the skulls of the Central European population. Attention was drawn to the variability of selected features of the skull, especially from the Neolith to the early Middle Ages.[1,2] The perceived changes were associated with nat-

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ural selection and the migration of human groups. According to Piontek, the flow of genes, with regard to the characteristics of migrants, was secondary in microevolutional variability because the level of natural selection limited the amount of genetic information reproduced in the individual generations. [3] In the Polish lands, based on skeletal materials, the process of brachycephalisation was observed in the feudal period. [4] Czekanowski describing the process of doligocephalization and brachycephalisation, was the first to draw attention to the temporal variability of some craniometric features. [5] Based on statistical analysis of craniometric parameters and their temporal variability, it has also been found that over the last 700-800 years the process of facial regression has been taking place. [6] In the anthropometric features of the head, clear signs of accelerated development appear in its circumference. There is the view that temporal changes in some metric features of the head show dependence on changing socio-economic conditions, and especially on the nutritional status of the population. [7] Very well documented were secular changes in body height and weight and, to a lesser extent, head morphology, therefore, the study of the variability of head features occurring in the present is justified.

Aim of the study

The primary aim of the research on physical development of children and adolescents aged 4-18 years from Rzeszów was to determine, on a sample of the regional population, whether there are time changes in the morphological structure of the head with respect to socio-economic and cultural conditions at the turn of the 20th and 21st centuries.

Material and methods

Evaluations of changes occurring in physical development of children and adolescents from Rzeszów were carried out successively in 1978/79, 1993/94, 2003/04 and 2013/14. Over the years, the research methodology was based on the same principles. [8,9] Anthropometric research in 1978/79 covered 2332 subjects (1176 boys and 1056 girls), 1993/94 - 2586 (1300 boys and 1286 girls), while in 2003/04 2560 people (1280 boys and 1280 girls). A sample of children and adolescents was selected randomly in all three series, so as to be representative. In the years 1978/79-2003/04, on average 80 boys and 80 girls were examined in every age group. [10] Samples were randomized without repetition. Written consent for the study was obtained from the Education Board, the President of the City of Rzeszów, the directors of individual schools and parents, and oral consent was expressed individually by every child before the measurements. In the years 2013/14, the respondents were selected in the same way as in the previous series, with attempts to maintain a similar number of boys and girls in different age groups, but difficulties were encountered in this regard. They concerned the consent of the parents and the subjects themselves to carry out measurements which, is obviously not invasive and, therefore, do not pose any health or life threat. Finally, more than 5% of the population of Rzeszów children and adolescents aged 4 to 18 in every age group were tested. Data on live births of boys and girls born in the studied age groups were obtained from the Central Statistical Office in Rzeszow. A total of 1563 people were examined, including 779 boys and 784 girls. It was observed that the primary group, both boys and girls, was not less than 50 persons in each age group [8]. The children studied were healthy and did not have a disability certificate. We failed to collect a suitably large group of 3-year old boys and girls due to the lack of parental consent. The study of 3-year-olds was also disproportionately extended over time. [11,12]

For all the aforementioned series, anthropometric measurements were based on the technique proposed by Martin and Saller. [9] Anthropometric studies took into account the following features: head length (g-op) and head width (eu-eu), morphological face height (n-gn) and maximal face width (ny), and nose height (n-sn) and nose width (al-al). In the 2013/2014 series, the head circumference was also measured. The collected data were compiled statistically and graphically. The selected numerical characteristics of the tested parameters were designated: arithmetic mean (x) - in all discussed series, median (Me), standard deviation (s) in all discussed series, 25th and 75th centile (C25, C75). The following indicators were also calculated: head width-length index (main), total morphological face index and nose index. Indices of proportions differentiation - head size in relation to body size were taken into consideration. [13] Previously published data: body height and BMI were used for the calculation of the indices. [12] Formulas of indices are presented in Tables 15-16. For statistical calculations, ANOVA technique was used. [10-12] In order to answer the question whether the population of children and adolescents from Rzeszów continues to show the phenomenon of secular trend, the comparative analysis of statistical characteristics of selected anthropometric features and proportional coefficients was performed in the series 1978/79, 1993/94, 2003/04 and 2013/14. [10]

Results

In the analysis of the data of head features during 35-year period 1978/79-2013/14, it can be observed whether the phenomenon of time changeableness has still been present and what is its nature. Tables 1-12 show the arithmetic mean and standard deviations in such features as head length and width, facial height, facial height, nose width and height in 1978/79, 1993/94, 2003/04 with statistical characteristics of parameters discussed for the subjects in 2013/14 series. The changes

Table 1. Comparison of mean values of head length (g-op) in the Rzeszow boys [mm]

Age	Head length (g-op) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	167,4	5,1	171,4	6,2	175,4	7,6	163,9	161,0	6,3	160,0	170,0
5	170,2	4,8	173,5	6,5	176,7	8,1	168,3	169,0	4,7	164,0	172,0
6	171,4	4,8	175,2	6,3	177,9	7,2	171,7	171,0	5,2	167,0	178,0
7	172,3	5,2	176,1	6,2	178,5	8,4	173,3	174,0	6,4	169,0	179,0
8	174,6	5,7	177,1	6,0	179,4	6,9	175,4	176,0	8,5	173,0	180,0
9	176,4	6,0	177,5	5,8	181,4	7,9	176,2	176,0	5,2	173,0	179,5
10	177,0	6,5	177,6	6,2	182,9	7,7	176,8	177,0	7,7	173,0	180,0
11	177,8	6,6	178,7	6,5	183,3	8,0	178,3	178,0	9,0	173,5	182,5
12	178,6	6,2	180,4	5,3	184,4	7,9	180,3	180,0	9,4	177,0	185,0
13	179,1	6,0	181,7	7,1	185,1	7,6	180,7	182,0	4,3	180,0	183,0
14	180,0	6,0	183,3	6,4	185,3	8,1	183,9	184,0	3,4	181,0	188,0
15	182,3	6,8	185,3	6,8	186,3	8,9	185,6	185,0	5,9	183,0	190,0
16	184,5	5,6	188,0	5,7	186,9	9,3	188,0	190,0	6,6	182,5	192,0
17	186,1	5,5	188,4	6,9	187,9	7,4	188,5	190,0	7,5	185,5	193,0
18	187,3	6,3	188,6	5,4	189,3	5,1	188,6	190,0	5,3	185,0	192,0

Table 2. Comparison of mean values of head length (g-op) in the Rzeszow girls [mm]

Age	Head length(g-op) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	164.3	4,7	168,9	5,8	169,8	7,7	165,1	165,0	6,1	160,0	170,0
5	165,0	4,8	169,9	5,9	172,5	8,4	165,2	165,0	5,5	160,5	169,5
6	166,9	5,4	170,5	6,9	173,7	7,0	165,5	164,5	5,7	160,0	172,0
7	168,4	5,7	171,4	5,0	174,3	8,2	168,2	168,0	11,1	162,5	175,0
8	169,4	5,9	171,6	5,4	176,2	6,5	169,6	171,5	7,2	168,0	174,0
9	170,9	6,2	172,7	5,9	176,5	9,0	170,9	170,0	6,7	165,0	174,5
10	172,9	6,2	174,0	5,6	177,9	7,9	172,0	169,0	5,7	168,0	172,0
11	174,0	6,4	174,8	5,0	179,9	7,1	172,6	174,0	3,1	170,0	176,0
12	174,5	5,8	176,7	4,9	181,1	6,3	172,9	175,0	5,2	170,0	175,0
13	176,3	5,2	177,6	5,2	181,5	6,5	174,0	175,0	7,0	171,0	179,0
14	177,8	5,4	178,6	5,5	181,8	7,4	175,0	175,0	4,2	172,0	177,0
15	178.3	5,2	179,5	5,9	182,0	6,9	177,5	177,5	6,4	172,0	183,0
16	178,8	5,4	180,5	5,9	181,9	8,2	177,8	179,0	6,4	174,0	180,0
17	178,9	5,3	181,1	5,1	182,1	6,5	181,2	182,2	4,4	178,0	185,0
18	179,1	4,5	181,8	5,6	182,3	5,1	182,1	183,0	4,8	178,0	185,0

that took place during 25-year period 1978/79-2003/04 were published in 2008.[10]

During 10-year period 2003/04-2013/14 the average head length values in boys decreased from 4 to 15 years as well as at the age of 18, and the width - up to 16 years of age. With regard to face parameters, this phenomenon was observed for face height from 4 to 6 yrs., its width - up to 17 yrs. and for the features of the nose, such as height - throughout whole examined ontogenesis period and width 4-7 and 13-18 yrs. The dimensions of the face height increased from 8 to 18 yrs. within the range of 0.3 mm (8 years) to 3.7 mm (13 and 15 years) (Table 13). In girls in the period 2003/04-2013/14, lower mean values of the head features are predominant in the individual age groups. The head length and total face height in 18-year-olds have similar values, face width at the age of 9 and 12, and nose width, generally between 8 and 12 yrs (mean values in this period range from 0.3 to 0.4 mm) (Table 13).

Over the 35-year period (1978/79-2013/14), in boys increasing head lengths in 7- and 8-year-olds and 11 to 18-year-olds were observed. Head width, total

Table 3. Comparison of mean values of head width (eu-eu) in the Rzeszow boys [mm]

Age	Head width (eu-eu) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	145,8	5,0	145,1	5,4	142,5	6,0	140,7	140,0	6,9	136,0	146,0
5	147,2	4,6	147,5	5,3	146,0	7,6	141,4	141,0	5,1	137,0	145,0
6	147,9	5,3	149,5	5,5	146,8	6,9	144,5	146,0	6,7	140,0	149,0
7	149,3	5,5	150,3	4,7	148,2	7,3	144,7	145,0	6,1	140,0	148,0
8	150,6	5,3	151,2	4,8	150,2	6,5	144,8	144,0	6,8	140,0	146,0
9	151,5	5,0	152,4	4,8	151,5	5,9	145,0	145,0	6,7	140,0	148,0
10	152,1	4,8	153,1	4,6	152,0	6,9	145,2	144,0	8,2	141,0	149,0
11	152,7	4,8	153,8	5,1	152,1	6,0	145,8	145,0	6,3	143,0	150,0
12	153,4	5,1	154,3	5,0	152,7	6,1	147,3	146,0	3,7	145,0	151,0
13	154,1	5,3	155,1	5,4	152,9	5,9	148,4	148,0	7,0	145,0	151,5
14	155,7	5,3	157,2	5,2	153,0	8,1	151,2	152,0	4,2	147,0	154,0
15	157,7	5,2	157,7	4,9	153,4	5,5	151,4	151,0	5,6	147,0	156,0
16	159,1	5,2	158,5	5,5	153,8	8,1	152,7	152,0	6,3	150,0	157,0
17	159,4	4,9	158,5	5,7	154,5	6,6	154,7	155,0	4,6	151,5	159,0
18	159,5	4,9	158,6	5,8	154,7	6,5	*155,0*	*155,5*	9,2	152,0	*160,0*

Table 4. Comparison of mean values of head width (eu-eu) in the Rzeszow girls [mm]

Age	Head width (eu-eu) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	141,2	4,9	140,0	4,0	141,4	6,7	135,6	134,0	6,8	131,0	140,0
5	142,9	4,5	142,2	4,9	142,6	6,1	135,7	135,0	5,8	131,0	140,0
6	144,4	4,5	145,4	7,0	144,6	5,7	136,9	136,0	2,7	135,0	139,0
7	145,3	4,6	146,2	6,2	145,7	6,5	137,7	137,5	4,3	134,0	140,0
8	146,0	4,7	147,0	4,8	146,8	5,9	139,9	139,0	4,5	136,0	143,0
9	146,6	4,5	147,9	5,1	148,0	5,9	140,8	141,0	5,2	138,0	144,0
10	147,0	4,5	148,2	4,3	148,6	5,5	141,4	140,0	5,6	138,5	145,0
11	148,9	5,3	148,6	5,4	149,0	7,0	141,7	140,0	3,9	139,0	145,0
12	150,5	5,1	149,3	5,1	149,2	6,9	142,4	142,0	4,2	138,0	145,0
13	150,9	4,8	150,1	5,4	149,6	6,5	144,3	142,0	8,0	138,5	145,0
14	151,3	4,9	150,9	4,8	149,9	6,1	144,6	145,0	4,5	141,0	147,0
15	152,0	4,5	151,8	4,5	150,0	6,4	146,3	145,0	5,8	141,0	150,0
16	152,9	4,7	152,3	4,8	150,5	5,5	147,1	147,0	6,5	141,5	151,0
17	153,3	4,9	152,4	4,6	151,0	6,9	147,1	149,0	4,4	143,0	150,0
18	153,9	5,1	152,4	4,7	151,4	4,4	147,2	149,0	4,4	143,0	150,0

face height and width and nose height - were reduced, while the width of the nose showed some fluctuations throughout the study period (Table 14). In girls in the same period, the increase in head length at 4, 17 and 18 years can be observed. Head width, total face height and width, and nose height in the age range of 4 to 18 yrs - decreased, while nose width from 8 to 18 years showed an upward tendency (Table 14).

Clear directional variability over time can be observed based on the data included in Tables 17-22, which show proportional indices that complement the informa-tion about head changes during 35-year period. These ta-bles also include statistical characteristics of indices for the 2013/14 series. The comparison of 2013/14 series with earlier series showed reduction in the average head width and head length indices in both sexes. Boys from the 1978/79 sample aged from 4 to 17 were characterized by hyperbrachycephalus, which in the 2013/14 sample ap-peared only in 4-year-olds. The boys have brachycephalus in the whole age range in the 2003/04 series, while in the 2013/14 series - from 5 and 18 yrs. In all compared series, 18-year-old boys had brachycephalus. The average value

Table 5. Comparison of mean values of length of morphological face (n-gn) in the Rzeszow boys (mm)

Age	(n-gn)											
	Boys											
	1978/79		1993/94		2003/04		2013/14					
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	91,4	5,0	94,8	4,6	92,6	5,3	90,2	91,2	2,9	88,1	92,1
5	94,1	4,6	97,5	6,2	94,2	4,9	92,4	91,5	4,9	88,5	96,5
6	96,6	4,4	99,8	4,5	96,0	4,5	95,3	95,7	4,6	92,7	100,7
7	99,8	4,3	100,4	5,3	97,4	5,9	97,3	96,5	4,4	94,5	100,5
8	102,7	4,2	101,6	4,2	99,9	5,9	100,2	101,4	4,7	96,4	103,4
9	104,5	4,1	102,7	4,4	100,4	6,9	103,4	103,4	3,7	99,4	104,6
10	106,4	4,4	103,4	4,5	103,0	6,9	104,7	103,4	5,4	99,7	105,3
11	107,7	4,8	107,5	5,2	104,5	5,3	106,1	103,4	7,8	99,4	108,4
12	109,4	5,0	108,5	5,2	105,1	6,0	108,3	110,3	7,8	101,7	112,3
13	112,3	5,8	110,2	5,0	106,0	5,9	109,7	111.4	5,8	102,4	113,4
14	115,1	6,3	113,5	6,2	108,1	5,8	111,5	112,1	7,6	106,1	118,0
15	118,4	5,9	116,8	6,6	111,9	5,9	115,6	116,3	7,9	109,8	122,8
16	121,7	6,1	117,7	5,8	115,7	6,1	118,0	119,0	6,4	114,5	123,0
17	122,9	6,2	118,4	6,6	117,2	5,7	120,0	119,0	8,9	115,0	123,0
18	123,1	5,9	118,5	5,3	119,2	5,7	120,7	119,5	6,2	115,5	123,0

Table 6. Comparison of mean values of length of morphological face (n-gn) in the Rzeszow girls (mm)

Age	(n-gn) [mm]											
	Girls											
	1978/79		1993/94		2003/04		2013/14					
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	88,9	4,5	90,1	3,9	91,7	4,7	88,2	86,5	2,7	86,1	90,1
5	91,6	4,2	93,6	4,3	93,3	5,6	90,6	90,3	4,4	87,3	92,8
6	94,8	4,2	95,9	3,5	94,5	5,0	92,5	93,6	4,6	88,6	95,6
7	97,5	4,4	97,3	4,9	97,1	4,4	95,0	94,7	5,4	92,7	96,7
8	100,1	4,1	98,7	4,1	98,8	5,4	97,1	96,3	4,2	94,3	101,0
9	101,9	4,2	101,4	4,7	99,5	5,9	97,8	97,8	5,7	94,3	101,8
10	103,7	5,0	102,1	5,0	99,9	5,1	98,5	97,7	6,1	93,7	103,7
11	105,9	5,1	104,2	4,5	101,1	5,6	99,7	97,3	8,0	96,3	105,0
12	107,8	4,8	106,7	5,0	102,1	5,8	101,5	100,0	7,2	99,1	106,0
13	109,3	5,2	108,5	6,0	104,2	6,9	104,6	104,0	3,3	102,0	106,0
14	111,3	5,6	110,3	5,7	106,4	5,6	105,0	105,0	4,4	102,0	107,0
15	113,4	5,7	111,1	6,0	106,5	6,6	105,5	104,0	6,3	100,5	110,0
16	114,3	5,3	111,6	5,0	107,7	7,1	106,1	104,4	6,3	100,9	110,3
17	114,5	5,1	111,7	5,8	108,0	4,8	106,8	104,1	4,3	103,0	110,4
18	114,6	4,6	111,9	4,9	108,3	4,4	108,1	108,0	2,7	106,0	110,4

of the index in question in the 35-year period was declining, although in the 2003/04 and 2013/14 series it could be considered to be approximate (Table 17). Girls of the 1978/79, 1993/94 and 2003/04 series in all age groups had brachycephalus, and the mean head width-to-length index was lower in subsequent trials. Exceptions were the subjects in 1978/79 at the age of 5 and 6, who had hyperbrachycephalus. Further decrease in the average values of the index in question in the 2013/14 series indicated a more advanced process of head elongation in 35-year period in girls. The subjects from the 2013/14 series at the age of 17 and 18 years, were characterized by mesocephalus. From 4 up to 16 years old the mean head width-to-length index in the girls was approaching the arbitrarily defined boundary between brachycephalus and mesocephalus (Table 18).

Varied changes were also present in the mean values of morphological face index in both sexes in the compared series. Euryprosopus was a hallmark of the boys from the 1978/79 series between the ages of 4 and 8; from 1993/94 - since 4 to 13 years old; 2003/04 - since 4 to 15 years, and 2013/14 - since 4 to 8 years (similar to

Table 7. Comparison of mean values of face width (zy-zy) in the Rzeszow boys (mm)

Age	(zy-zy) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	116,6	5,3	115,3	4,2	115,5	4,6	111,4	111,5	6,5	107,5	114,0
5	118,4	5,0	117,5	4,7	117,8	4,6	114,6	115,0	6,7	110,5	117,5
6	119,6	4,4	120,0	4,5	120,9	6,6	117,7	117,0	5,8	113,5	120,5
7	121,6	4,3	122,1	4,4	121,9	7,1	119,4	119,0	8,3	114,5	123,0
8	123,2	4,1	123,0	4,3	124,1	7,3	120,6	119,5	9,1	115,5	127,0
9	124,4	4,1	123,7	4,7	125,3	6,8	122,0	119,5	8,1	115,5	130,5
10	125,2	4,4	125,8	4,5	126,9	7,1	123,3	123,0	6,8	117,0	130,0
11	125,8	4,4	128,3	4,6	128,5	7,3	125,3	125,0	6,9	121,0	129,5
12	127,9	4,5	130,1	4,8	130,0	5,8	127,0	127,0	6,0	123,0	131,0
13	130,7	4,9	132,0	4,6	131,5	6,0	128,5	129,0	6,5	125,0	133,0
14	132,9	5,1	134,1	4,2	134,7	5,4	131,8	131,5	8,4	127,5	134,0
15	135,6	5,2	136,1	5,1	136,5	5,5	133,6	133,0	5,8	130,0	137,0
16	137,5	4,8	138,8	4,4	137,5	6,2	136,1	135,0	8,4	133,0	136,5
17	138,1	4,0	139,0	5,0	138,1	5,0	137,2	137,0	6,0	136,0	139,0
18	139,0	4,2	139,8	4,5	138,8	5,7	138,5	138,0	6,6	136,0	140,0

Table 8. Comparison of mean values of face width (zy-zy) in the Rzeszow girls (mm)

Age	(zy-zy) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	113,2	4,1	112,4	4,3	112,9	5,6	110,8	109,0	5,7	108,0	114,5
5	115,3	4,6	115,0	3,9	114,8	6,4	113,1	112,0	6,4	110,0	120,0
6	117,5	4,9	117,0	4,1	116,8	5,2	114,7	114,0	7,5	110,5	119,0
7	118,9	4,0	119,6	4,8	117,3	5,3	116,7	116,0	8,2	112,0	120,0
8	119,7	4,2	121,4	4,0	118,3	5,6	117,7	117,0	9,4	114,0	121,5
9	121,1	4,0	123,3	4,4	118,8	6,3	118,7	118,5	3,8	115,5	122,0
10	122,3	3,9	123,8	3,4	119,4	7,2	120,2	120,0	8,7	117,0	123,0
11	124,0	4,2	125,5	5,5	122,1	6,1	121,7	121,5	3,7	119,0	124,5
12	126,5	4,6	128,4	3,9	122,9	6,0	123,0	122,0	8,4	119,0	130,0
13	128,8	4,6	129,3	4,2	125,4	6,1	125,9	126,0	6,8	120,5	131,0
14	130,1	4,4	131,0	4,5	129,9	6,3	128,2	127,5	8,7	121,5	133,0
15	130,7	4,0	131,4	4,0	132,6	5,1	129,5	129,0	4,7	123,0	135,0
16	131,8	3,9	133,3	4,8	133,7	5,3	131,0	131,0	4,0	124,0	137,0
17	132,5	4,4	133,6	4,1	133,9	4,2	132,1	132,0	3,5	125,0	139,0
18	132,7	4,7	134,1	4,6	134,5	4,2	132,4	133,0	7,9	125,0	139,0

the 1978/79 series). The subjects from the 1978/79 series were mesoprosopus since 9 to 15 years old, and since 16 to 18 they were leptoprosopus. In the subsequent series, the latter feature no longer appeared while mesoprosopus was present in the 1993/94 series since 14 to 18 years old, 2003/04 - since 16 to 18 years and the longest in the 2013/14 series since 9 to 18 years (Table 19). The observed phenomenon resulted from the simultaneous reduction and narrowing of morphological face in boys in 35-year period. It was difficult to determine the tendency of changes in morphological face construction in girls in 35-year period due to fluctuations in subsequent series. The average values of this indicator after 35 years decreased. In the 2013/14 series they approximated the limits between the class of euryprosopus and mesoprosopus according to Saller classification. Girls at the age of 18 in the 1978/79 series were leptoprosopus, 1993/94 - mesoprosopus, 2003/04 - euryprosopus and 2013/14 - mesoprosopus as were their peers in the 1993/94 series (Table 20). However, it can be generally stated that after 35 years there was a tendency to face shortening and narrowing (Table 14).

Table 9. Comparison of mean values of nose height (n-sn) in the Rzeszów boys (mm)

Wiek Age	(n-sn) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	40,7	3,1	40,3	3,8	40,0	3,2	37,0	37,0	2,5	35,0	39,0
5	42,1	2,9	43,1	3,7	40,9	2,4	39,0	38,5	2,0	37,0	40,0
6	43,7	2,8	44,9	3,1	41,6	2,2	38,1	38,0	3,7	34,0	42,0
7	45,5	3,0	45,4	3,8	41,6	3,3	39,4	39,0	3,7	37,0	42,0
8	47,5	2,8	45,9	2,8	41,7	3,2	40,2	40,0	4,0	37,0	44,0
9	49,7	2,9	46,4	2,9	43,3	3,8	41,2	40,5	3,4	39,0	44,0
10	51,2	3,3	46,6	2,8	43,7	3,3	42,1	42,0	2,5	40,5	43,5
11	52,1	3,5	48,4	3,0	44,8	3,2	43,8	43,5	3,0	42,5	44,0
12	53,4	3,7	48,8	3,3	46,9	3,7	45,8	46,0	3,8	43,0	48,0
13	54,8	3,7	51,2	3,3	47,5	3,9	46,7	46,0	2,8	44,0	48,0
14	56,1	3,9	52,5	3,4	48,0	4,0	47,0	48,0	2,7	45,0	48,0
15	58,5	3,8	53,3	4,1	49,3	3,5	48,2	48,0	3,7	46,0	50,0
16	60,4	3,5	53,8	3,5	51,0	4,2	49,9	50,0	3,9	47,0	53,0
17	60,6	3,8	54,3	3,8	53,0	3,6	51,8	52,0	2,7	49,5	54,0
18	60,9	3,9	54,8	4,1	53,9	3,0	52,2	52,0	2,8	50,0	54,0

Table 10. Comparison of mean values of nose height (n-sn) in the Rzeszów girls (mm)

Age	(n-sn) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	39,7	3,1	39,3	3,2	39,7	2,4	35,2	35,5	1,9	34,0	36,0
5	41,0	2,9	42,2	3,5	40,0	2,4	36,1	36,0	2,8	34,0	38,0
6	42,7	3,0	44,0	3,1	41,4	2,5	37,4	38,0	2,3	36,0	39,0
7	44,8	3,2	44,8	4,1	43,1	4,5	40,0	39,0	3,1	37,0	42,0
8	46,8	2,9	45,7	2,9	43,9	3,3	41,1	40,0	4,6	38,0	44,0
9	49,3	2,9	46,6	2,8	45,4	3,3	42,0	42,0	4,0	39,0	45,0
10	50,9	3,1	47,3	2,7	46,0	3,5	42,6	42,0	3,7	39,5	44,5
11	51,7	3,0	48,8	3,4	47,5	3,1	44,0	43,5	1,8	43,0	45,5
12	53,1	3,1	49,8	3,2	47,9	3,7	45,3	45,5	1,8	43,5	46,5
13	53,8	3,2	51,1	3,2	47,9	3,5	45,6	45,0	3,0	43,5	46,0
14	54,5	3,3	51,1	3,9	48,9	3,6	46,3	45,5	4,2	43,0	47,0
15	55,7	3,9	51,1	3,4	49,2	3,6	46,9	47,0	2,1	45,0	48,0
16	56,6	3,8	51,2	3,8	49,3	2,9	47,1	47,0	2,0	46,0	48,0
17	56,7	3,1	51,3	3,2	49,5	3,6	48,7	49,0	2,9	47,0	50,0
18	56,6	2,9	51,4	3,3	49,6	3,8	49,0	49,0	1,6	47,0	51,0

The differences between the average values of the nose index of the analyzed boys and girls indicated shortening of the nose, and in girls - also its widening. In the 1978/79 series, in boys aged 4 to 9 years, and in girls aged 4 to 8 years, leptorrhinus was present, and in the later age groups up to 18 years only hyperleptorrhinus. The subjects from the 1993/94, 2003/04, and 2013/14 series in all age groups were characterized by leptorrhinus. In both sexes after the 35 year period,

widening of the nose from hyperleptorrhinus to leptorrhinus was observed. As a result of the changes in boys from the 2013/14 series at the age of 18 were characterized by brachycephalus, mesoprosopus, and leptorrhinus, and girls from the same sample were characterized by mesocephalus, mesoprosopus and, like their male peers, leptorrhinus (Tables 17-22).

The 2013/2014 series was enriched with new parameters that will also be evaluated in successive time

Table 11. Comparison of mean values of nose width (al-al) in the Rzeszów boys (mm)

Wiek Age	(al-al) [mm]										
	Chłopcy (Boys)										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	25,6	1,6	25,8	1,9	27,2	2,1	25,4	25,0	2,5	23,0	28,0
5	25,9	1,6	27,1	1,7	27,5	2,5	25,7	26,0	2,5	23,0	28,0
6	26,5	1,7	27,2	1,9	27,8	2,2	26,1	26,0	3,7	22,0	29,0
7	27,1	1,7	27,4	1,4	28,1	2,5	26,6	26,0	2,5	25,0	28,0
8	27,3	1,6	28,2	2,2	28,5	2,9	28,1	28,0	2,2	26,0	30,0
9	27,3	1,6	28,7	1,8	28,9	2,8	28,7	30,0	2,3	27,0	31,0
10	27,3	1,7	28,7	1,8	29,1	2,9	28,7	29,0	1,4	28,0	30,0
11	27,6	1,8	29,0	1,8	29,5	2,8	30,0	30,0	3,2	27,0	31,0
12	28,5	2,0	29,7	2,3	29,9	2,9	30,1	30,0	3,2	28,0	33,0
13	29,7	2,3	30,4	2,8	31,5	3,0	30,1	31,0	3,0	28,0	33,0
14	30,7	2,4	31,7	2,6	32,2	2,9	30,3	30,0	3,2	29,0	33,0
15	31,5	2,3	32,6	2,6	33,2	2,8	30,3	30,0	2,7	28,0	32,0
16	31,9	2,3	32,8	2,1	33,6	3,1	31,8	32,0	2,3	31,0	34,0
17	32,2	2,3	33,1	2,2	34,2	3,0	32,3	32,0	1,3	31,0	33,0
18	32,6	2,4	33,1	2,0	34,3	3,0	32,7	32,0	3,0	32,0	35,0

Table 12. Comparison of mean values of nose width (al-al) in the Rzeszów girls (mm)

Age	(al-al) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	24,8	1,6	25,5	1,3	26,4	2,4	24,6	24,5	2,5	23,0	26,0
5	25,4	2,0	25,9	1,5	26,6	1,9	25,2	25,0	1,9	23,5	26,5
6	26,0	1,9	26,2	1,6	27,4	2,1	25,9	26,0	2,9	24,0	27,0
7	26,2	1,4	27,0	2,5	27,9	3,0	26,2	26,0	2,7	24,0	28,0
8	26,3	1,5	27,2	1,9	27,8	2,2	28,1	26,5	3,8	25,0	30,0
9	26,5	1,6	27,7	1,9	28,1	2,9	28,3	28,0	2,0	27,0	30,0
10	26,8	1,5	28,5	2,0	28,8	2,4	28,4	29,0	3,6	26,0	30,0
11	27,0	1,8	28,6	1,9	28,9	2,8	28,8	29,0	1,8	27,0	30,0
12	27,7	2,0	29,3	1,9	29,9	2,9	29,5	30,0	2,5	28,0	31,0
13	28,7	1,9	29,6	2,3	30,1	3,0	29,6	30,0	1,9	28,0	31,0
14	29,4	1,9	29,8	2,3	30,7	2,7	29,8	31,0	2,5	28,0	32,0
15	29,7	2,1	29,9	2,1	31,0	2,9	30,2	30,0	1,6	29,0	32,0
16	29,7	2,1	30,2	2,0	31,2	2,5	30,4	31,0	2,7	28,0	33,0
17	29,7	2,1	30,4	2,0	31,5	3,0	30,8	30,0	2,7	29,0	34,0
18	29,8	2,1	30,4	2,0	31,6	2,9	31,0	31,0	3,0	29,0	32,5

periods. The head circumference in examined children was compared to biological reference system centile charts developed by Palczewska and Niedźwiecka which were published in health books until 2015 and were considered to have normative values for the Polish population.[14,15] The mean head circumference values of the boys surveyed were generally between the 25 and 50 centile, except for 13 and 18-year-olds, where

Table 13. Absolute differences between mean values of head length and width, face height and width, and nose length and width in the Rzeszow boys and girls from the 2003/04 and 2013/14 series (mm)

Boys						Wiek	Girls					
g-op	eu-eu	n-gn	zy-zy	n-sn	al-al		g-op	eu-eu	n-gn	zy-zy	n-sn	al-al
-11,5	-1,8	-2,4	-4,1	-3,0	-1,8	4	-4,7	-5,8	-3,5	-2,1	-4,5	-1,8
-8,4	-4,6	-1,8	-3,2	-1,9	-1,8	5	-7,3	-6,9	-2,7	-1,7	-3,9	-1,4
-6,2	-2,3	-0,7	-3,2	-3,5	-1,7	6	-8,2	-7,7	-2,0	-2,1	-4,0	-1,5
-5,2	-3,5	-0,1	-2,5	-2,2	-1,5	7	-6,1	-8,0	-2,1	-0,6	-3,1	-1,7
-4,0	-5,4	0,3	-3,5	-1,5	-0,4	8	-6,6	-6,9	-1,7	-0,6	-2,8	0,3
-5,2	-6,5	3,0	-3,3	-2,1	-0,2	9	-5,6	-7,2	-1,7	-0,1	-3,4	0,2
-6,1	-6,8	1,7	-3,6	-1,6	-0,4	10	-5,9	-7,2	-1,4	0,8	-3,4	-0,4
-5,0	-6,3	1,6	-3,2	-1,0	0,5	11	-7,3	-7,3	-1,4	-0,4	-3,5	-0,1
-4,1	-5,4	3,2	-3,0	-1,1	0,2	12	-8,2	-6,8	-0,6	0,1	-2,6	-0,4
-4,4	-4,5	3,7	-3,0	-0,8	-1,4	13	-7,5	-5,3	0,4	0,5	-2,3	-0,5
-1,4	-1,8	3,4	-2,9	-1,0	-1,9	14	-6,8	-5,3	-1,4	-1,7	-2,6	-0,9
-0,7	-2,0	3,7	-2,9	-1,1	-2,9	15	-4,5	-3,7	-1,0	-3,1	-2,3	-0,8
1,1	-1,1	2,3	-1,4	-1,1	-1,8	16	-4,1	-3,4	-1,6	-2,7	-2,2	-0,8
0,6	0,2	2,8	-0,9	-1,2	-1,9	17	-0,9	-3,9	-1,2	-1,8	-0,8	-0,7
-0,7	*0,3*	1,5	-0,3	-1,7	-1,6	18	-0,2	-4,2	-0,2	-2,1	-0,6	-0,6

Table 14. Absolute differences between mean values of head length and width, face height and width, and nose length and width in the Rzeszow boys and girls from the 1978/79 and 2013/14 series (mm)

Boys						Age	Girls					
g-op	eu-eu	n-gn	zy-zy	n-sn	al-al		g-op	eu-eu	n-gn	zy-zy	n-sn	al-al
-3,5	-5,1	-1,2	-5,2	-3,7	-0,2	4	0,8	-5,6	-0,7	-2,4	-4,5	-0,2
-1,9	-5,8	-1,7	-3,8	-3,1	-0,2	5	0,2	-7,2	-1,0	-2,2	-4,9	-0,2
0,3	-3,4	-1,3	-1,9	-5,6	-0,4	6	-1,4	-7,5	-2,3	-2,8	-5,3	-0,1
1,0	-4,6	-2,5	-2,2	-6,1	-0,5	7	-0,2	-7,6	-2,5	-2,2	-4,8	0,0
0,8	-5,8	-2,5	-2,6	-7,3	0,8	8	0,2	-6,1	-3,0	-2,0	-5,7	1,8
-0,2	-6,5	-1,1	-2,4	-8,5	1,4	9	0,0	-5,8	-4,1	-2,4	-7,3	1,8
-0,2	-6,9	-1,7	-1,9	-9,1	1,4	10	-0,9	-5,6	-5,2	-2,1	-8,3	2,2
0,5	-6,9	-1,6	-0,5	-8,3	2,4	11	-1,4	-7,2	-6,2	-2,3	-7,7	1,8
1,7	-6,1	-1,1	-0,9	-7,6	1,6	12	-1,6	-8,1	-6,3	-3,5	-7,8	1,8
1,6	-5,7	-2,6	-2,2	-8,1	0,4	13	-2,3	-6,6	-4,7	-2,9	-8,2	0,9
3,9	-4,5	-3,6	-1,1	-9,1	-0,4	14	-2,8	-6,7	-6,3	-1,9	-8,2	0,4
3,3	-6,3	-2,8	-2,0	-10,3	-1,2	15	-0,8	-5,7	-7,9	-1,2	-8,8	0,5
3,5	-6,4	-3,7	-1,4	-10,5	-0,1	16	-1,0	-5,8	-8,2	-0,8	-9,5	0,7
2,4	-4,7	-2,9	-0,9	-8,8	0,1	17	2,3	-6,2	-7,7	-0,4	-8,0	1,1
1,3	*-4,5*	-2,4	-0,5	-8,7	0,1	18	3,0	-6,7	-6,5	-0,3	-7,6	1,2

they ranged between the 10 and 25 centile (Table 15). The mean head circumference values of girls surveyed were generally between the 50 to 75 centile, except for the 13-year-olds where they were between the 25 and 50 centile (Table 16). Taking into account the proportions between head circumference and body height and Michalski's classification[13] boys aged 4-11 years were characterized by a very large head, 12-13 years – a large head, 14 years – a medium head, 15-18 years – a small head (Table 15), while girls aged 4-11 years – a very large head, 12 years – a large head, 13-17 years – a medium head, 18 years – a small head (Table 16).

Table 15. Descriptive statistics related to head circumference and proposed proportion indices in boys from the 2013/14 series

| Age | Boys | | | | | | | | | | | | | | |
| | Head circumference [cm] | | | | | Head circumference [cm] / Body height [cm] | | | | | Head circumference [cm] x BMI [kg/m²] | | | | |
	$\overline{x}$	Me	s	c_{25}	c_{75}	$\overline{x}$	Me	s	c_{25}	c_{75}	$\overline{x}$	Me	s	c_{25}	c_{75}
4	50,8	51,0	1,1	50,0	51,6	0,495	0,497	0,026	0,475	0,519	8,05	8,06	0,67	7,64	8,45
5	51,2	51,0	1,8	50,2	52,3	0,475	0,473	0,023	0,461	0,486	8,18	8,07	0,80	7,65	8,68
6	52,0	52,0	1,4	51,0	53,7	0,440	0,442	0,019	0,420	0,453	8,86	8,75	1,36	7,79	9,52
7	52,1	52,0	1,5	51,0	53,2	0,413	0,411	0,018	0,401	0,425	8,84	8,79	1,03	8,01	9,74
8	52,6	52,6	1,3	52,0	53,5	0,405	0,407	0,017	0,394	0,417	8,76	8,18	1,42	7,88	9,83
9	52,7	53,0	1,3	52,0	53,7	0,385	0,380	0,012	0,377	0,389	10,39	9,71	2,28	8,87	12,10
10	52,6	53,0	1,4	51,6	53,5	0,371	0,372	0,017	0,358	0,381	9,76	9,44	1,69	8,38	10,77
11	52,6	52,4	1,6	51,8	53,5	0,361	0,359	0,014	0,354	0,368	9,69	8,65	2,08	8,17	11,42
12	54,0	54,0	1,4	53,4	54,5	0,354	0,353	0,013	0,342	0,360	10,58	10,49	1,73	9,26	11,81
13	53,3	52,6	1,6	52,3	54,7	0,346	0,347	0,011	0,340	0,357	10,18	10,09	1,66	8,81	10,72
14	55,3	55,2	1,4	54,4	56,3	0,329	0,329	0,015	0,320	0,337	11,61	11,36	1,56	10,37	12,92
15	55,7	55,7	1,1	55,0	56,0	0,310	0,310	0,013	0,301	0,319	10,75	11,04	1,08	10,16	11,52
16	56,4	56,5	1,4	55,2	57,4	0,319	0,322	0,009	0,314	0,326	11,29	11,35	1,07	10,38	11,94
17	55,9	56,5	1,5	54,3	57,0	0,311	0,313	0,012	0,301	0,321	12,26	11,80	1,46	11,06	13,86
18	55,2	55,0	1,1	54,5	55,5	0,307	0,302	0,011	0,298	0,315	11,72	12,14	1,60	10,33	12,80

Table 16. Descriptive statistics related to head circumference and proposed proportion indices in girls from the 2013/14 series

| Wiek [lata] | Girls | | | | | | | | | | | | | | |
| | Head circumference [cm] | | | | | Head circumference [cm] / Body height [cm] | | | | | Head circumference [m] x BMI [kg/m²] | | | | |
	$\overline{x}$	Me	s	c_{25}	c_{75}	$\overline{x}$	Me	s	c_{25}	c_{75}	$\overline{x}$	Me	s	c_{25}	c_{75}
4	50,1	50,8	1,6	48,7	51,5	0,495	0,499	0,016	0,487	0,506	8,36	8,18	0,63	8,05	8,75
5	50,4	50,5	1,4	49,6	51,0	0,465	0,465	0,018	0,452	0,481	7,79	7,74	0,79	7,39	8,30
6	51,1	51,1	1,8	50,0	52,2	0,451	0,453	0,015	0,439	0,457	8,23	8,16	0,86	7,46	8,96
7	51,7	51,1	1,3	50,8	52,7	0,417	0,410	0,026	0,398	0,432	8,77	8,58	1,76	7,60	9,72
8	52,2	51,6	1,1	51,3	53,0	0,404	0,402	0,018	0,396	0,412	10,00	9,87	1,84	8,46	11,07
9	52,5	52,0	2,0	51,0	53,0	0,389	0,388	0,023	0,373	0,394	9,02	8,80	1,30	8,25	10,38
10	52,4	52,5	1,3	51,2	53,6	0,373	0,370	0,019	0,363	0,386	9,14	8,79	1,68	8,11	10,12
11	51,7	51,7	1,2	51,2	52,1	0,362	0,363	0,014	0,352	0,372	9,97	9,94	1,10	9,03	10,76
12	53,9	53,9	1,9	52,3	54,2	0,350	0,356	0,020	0,335	0,364	10,82	10,52	1,78	9,59	12,08
13	53,4	54,0	1,3	51,6	54,6	0,323	0,325	0,011	0,316	0,329	9,60	9,68	0,96	8,69	10,11
14	54,3	54,0	1,5	53,0	55,0	0,331	0,328	0,015	0,325	0,337	10,92	10,39	1,55	9,94	11,45
15	55,0	55,4	0,9	54,5	56,0	0,335	0,333	0,018	0,324	0,346	10,44	10,30	1,08	9,59	11,10
16	54,4	54,5	1,6	52,4	56,0	0,339	0,340	0,018	0,321	0,353	11,50	11,53	1,30	10,24	12,85
17	52,6	52,2	1,2	51,6	53,7	0,313	0,311	0,015	0,306	0,323	11,05	11,01	0,58	10,73	11,09
18	53,6	53,4	1,5	52,5	55,0	0,320	0,321	0,012	0,313	0,329	11,11	11,12	0,95	10,45	11,68

Discussion

With age, body dimensions increase and its proportions differentiate.[16] Various anthropometric parameters are used to describe the growth process, and the body proportion indices are used for typological characteristics. Various examples of proportion parameters and indices used in classical anthropometric studies can be found in the literature. An acknowledged anthropometric feature used to evaluate a head size is the maximum occipitof-rontal head circumference.[17,18] Therefore, this parameter was added in the 2013/14 series. The cephalometric parameters and proportional indices presented by other authors are the same as in this study[19] or differ, taking into account: the length of the body of the mandible (gn-go).[20] In some cases, osteometric parameters were used for life testing, for example the head length was assumed to be the chord of the head (g-i)[21,26] or the height of the nose (n-ns)[22] and the head width[21] or head, nose indices[22] were

Table 17. Comparison of mean values of head width-length index in the Rzeszów boys

Age	$\dfrac{eu-eu}{g-op}$										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	87,2	3,6	84,5	4,8	81,5	5,3	85,5	84,8	4,8	82,6	88,3
5	86,5	3,6	84,9	4,3	82,3	5,5	83,9	84,1	4,9	82,0	86,6
6	86,3	3,9	85,0	4,8	82,7	5,0	84,0	83,3	4,5	80,0	88,6
7	86,7	4,2	85,4	4,3	83,0	5,7	83,4	83,8	4,9	81,1	85,8
8	86,3	4,2	85,1	3,5	83,4	4,7	82,3	81,9	7,2	79,6	85,5
9	85,9	3,9	85,7	4,0	83,3	4,5	82,1	81,1	6,0	79,6	84,0
10	85,9	3,7	85,7	3,6	83,3	4,9	81,9	81,4	6,0	78,9	83,5
11	85,9	3,8	85,9	4,0	83,0	4,9	81,5	81,4	6,1	78,7	83,9
12	85,9	3,6	85,3	3,6	82,9	4,0	81,5	81,5	7,5	80,1	83,0
13	85,9	3,4	85,2	3,9	82,8	8,4	82,0	81,3	3,4	79,9	84,5
14	86,4	3,4	85,5	3,9	82,5	5,2	82,1	81,1	4,5	80,1	84,0
15	86,6	3,4	85,1	3,3	82,3	4,8	81,7	81,4	4,7	78,9	84,0
16	86,4	3,2	84,1	3,9	82,3	4,5	81,6	81,6	4,7	80,1	83,0
17	85,5	3,2	83,8	3,6	82,1	4,8	81,9	80,9	4,5	79,5	83,5
18	85,1	3,2	84,4	3,4	81,9	4,5	82,7	82,5	3,6	80,0	84,5

Table 18. Comparison of mean values of head width-length index in the Rzeszów girls

Age	$\dfrac{eu-eu}{g-op}$										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	c_{75}
4	86,0	3,9	82,8	3,7	83,2	4,5	82,0	81,1	4,6	78,8	86,5
5	86,7	3,7	83,5	4,9	82,6	4,5	82,5	81,4	5,0	79,6	86,5
6	86,7	4,0	84,9	4,7	83,2	6,0	82,3	82,1	4,6	79,1	85,8
7	86,4	4,2	85,1	4,8	83,5	4,3	82,5	82,0	2,9	80,2	85,9
8	86,1	4,0	85,2	3,9	83,5	5,3	82,9	81,7	4,8	78,8	84,7
9	85,9	4,0	85,4	4,3	83,8	4,1	82,7	81,0	5,1	78,9	85,7
10	85,1	4,0	84,8	3,6	83,6	4,5	82,5	82,7	3,0	79,7	85,7
11	85,4	3,9	84,9	3,8	82,8	4,5	82,2	82,4	4,6	79,1	85,9
12	85,9	3,2	84,1	3,7	82,5	4,5	82,1	81,4	5,0	78,5	86,0
13	85,5	2,9	84,2	3,5	82,4	5,0	82,4	81,5	2,3	79,5	85,5
14	85,1	3,1	84,6	3,4	82,4	4,7	82,5	82,0	3,4	79,5	85,0
15	85,2	3,2	84,5	3,7	82,5	4,8	82,3	82,2	3,7	79,1	85,5
16	85,6	3,2	84,2	3,3	82,8	4,4	82,5	82,2	3,0	70,4	85,9
17	85,8	3,0	84,0	3,1	82,9	4,0	81,6	81,1	3,1	78,8	85,0
18	86,0	2,9	83,7	3,0	82,9	3,9	81,1	80,0	3,0	78,5	84,9

calculated based on parameters from two groups: cephalometric and osteometric. Different typological classifications were also observed based on the width-length index: according to Saller[19] and Franz Boas.[23] Posthumous examinations of skulls were based on traditional osteometry. Skull chords and arches were evaluated.[24] In addition to the traditional anthropometric method assessing face morphology, also photogrammetric method was used including: morphological upper face height (n-sto), morphological face height / length (n-gn), lower face height (sto-gn), nose height (n-sn), upper lip height (sn-sto), lower lip height (sto-sm), height of vermilion border of the upper lip (ls-sto), height of vermilion border of the lower lip (ls-sto), nose width (al- al), rima oris width (ch-ch), external interocular width (ex-ex) and internal interocular width (en-en) and proportional indi-

Table 19. Comparison of mean values of morphological face index in the Rzeszów boys

Age	$\dfrac{n-gn}{zy-zy}$										
	Boys										
	1978/79		1993/94		2003/04		2013/14					
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	78,5	4,6	81,9	4,8	80,5	5,4	81,5	80,0	6,9	77,9	83,5
5	79,5	4,2	82,8	5,2	80,0	4,3	81,0	80,9	6,1	77,8	84,0
6	80,9	3,6	83,0	4,5	79,4	4,5	81,5	80,5	5,7	77,5	83,5
7	82,2	3,7	82,2	4,1	80,0	6,5	81,9	82,4	4,0	81,0	84,0
8	83,4	3,9	82,2	3,5	80,6	6,4	82,8	82,0	6,5	79,5	85,5
9	84,1	3,7	82,6	3,9	80,5	7,0	84,0	83,5	4,0	80,0	86,5
10	85,0	3,3	82,0	2,3	81,1	7,4	84,7	85,0	5,5	81,5	87,0
11	85,5	3,4	83,5	4,4	81,5	5,9	84,9	85,0	5,6	81,6	87,0
12	85,4	3,7	83,2	4,7	80,8	5,5	85,0	85,5	5,7	81,9	87,5
13	85,8	4,1	83,2	3,9	80,8	5,9	85,5	85,6	5,5	81,5	88,5
14	86,5	4,5	84,4	5,1	80,4	5,0	85,0	84,9	6,0	82,0	88,0
15	87,2	4,8	85,5	4,8	82,0	5,7	85,9	86,5	5,7	82,3	89,0
16	88,2	4,8	84,4	4,2	84,0	6,6	86,2	86,6	4,9	83,1	89,5
17	88,6	4,5	84,0	5,0	84,3	5,4	86,8	86,6	4,8	82,8	90,5
18	88,5	4,0	84,7	4,1	85,5	5,1	87,5	86,9	3,5	84,5	91,0

Table 20. Comparison of mean values of morphological face index in the Rzeszów girls

Age	$\dfrac{n-gn}{zy-zy}$										
	Girls										
	1978/79		1993/94		2003/04		2013/14					
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	78,2	4,7	80,0	3,9	81,0	5,0	79,5	78,7	4,5	74,9	80,5
5	79,5	4,4	81,2	4,1	81,3	7,1	79,9	80,2	5,0	77,6	84,0
6	80,7	3,8	81,4	4,0	81,0	5,5	80,4	82,4	5,5	77,4	84,5
7	82,1	4,0	81,6	4,7	82,9	5,9	81,7	80,0	6,5	77,5	84,0
8	83,7	4,1	81,6	4,2	83,3	6,0	82,1	82,5	5,9	78,0	85,0
9	84,2	4,0	82,1	4,1	83,8	6,6	82,6	83,0	5,0	77,9	86,0
10	84,8	4,2	82,6	3,8	83,6	7,5	82,2	83,1	6,5	78,9	86,5
11	85,4	4,1	83,3	4,4	82,9	5,8	82,4	81,5	6,0	79,0	87,0
12	85,3	4,1	83,0	3,7	83,0	7,0	82,5	83,1	5,6	79,0	87,0
13	84,8	3,9	84,3	4,1	83,1	7,1	83,5	83,3	4,0	80,0	86,9
14	85,6	4,0	84,4	4,3	82,0	5,5	82,3	82,0	4,7	78,6	86,0
15	86,7	4,1	84,4	5,1	80,3	5,5	81,9	82,1	6,0	78,2	86,0
16	86,7	4,0	83,3	4,9	80,6	7,0	81,9	80,7	4,0	79,0	86,4
17	86,4	4,0	83,1	4,6	80,7	4,9	81,5	82,7	3,9	80,0	86,7
18	86,2	3,9	83,0	4,0	80,5	4,4	81,9	82,3	3,7	78,9	86,0

ces were calculated.[25] The method of magnetic resonance imaging was also used. In the sagittal projection the measurements of the traditional cephalometric points: nasion (n), basion (ba), ophisthion (o), zygion (zy), and non-traditional: sella, menton, anterior and posterior nasal spine were plotted.[26] It was also necessary to describe the relationship between head and body size - hence the two proportional indices were calculated (Table 15-16). The head circumference was used in the studies in the 1960s and is currently underestimated.[13] In animals, there was a correlation between brain size and body size and was described by the encephalization index.[27] A study of 5079 Turkish children and adolescents aged 5 to 18 in 2010-2013 indicated significant positive correlation between

Table 21. Comparison of mean values of nose index in the Rzeszów boys

Age	al-al n–sn										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	63,0	5,4	63,5	6,8	67,9	7,3	68,1	67,5	5,9	63,5	70,0
5	61,8	5,1	62,4	6,6	67,5	5,5	65,7	64,0	6,0	60,0	71,5
6	60,8	5,0	60,4	6,2	66,5	5,3	68,3	67,9	6,5	62,2	73,0
7	59,9	5,1	60,3	5,7	67,6	7,5	67,9	68,1	7,5	62,2	73,5
8	57,6	4,7	61,8	6,4	68,2	8,5	69.6	69,2	6,5	65,5	74,0
9	55,0	4,4	61,8	5,2	66,9	7,6	69,4	68,9	7,0	65,4	74,0
10	53,5	4,6	61,4	5,5	66,6	7,5	68,5	67,5	6,7	64,5	73,5
11	53,1	5,0	59,8	5,9	66,0	7,1	68,5	68,2	6,5	64,0	73,0
12	53,6	5,0	60,7	5,8	63,9	6,8	66,0	66,6	6,0	61,7	72,1
13	54,5	4,6	59,2	5,5	66,0	7,9	64,3	63,3	7,5	56,3	70,0
14	54,8	4,9	60,7	6,1	66,9	7,0	64,3	63,6	7,5	56,9	69,5
15	54,0	5,2	60,9	6,3	67,3	6,8	62,7	62,8	4,8	58,0	67,6
16	52,9	5,0	61,2	5,7	65,8	7,5	63,5	62,9	5,0	59,3	67,3
17	53,3	5,0	61,2	6,3	64,7	6,4	62,5	60,9	6,9	58,3	67,0
18	53,7	5,1	60,8	5,8	63,7	6,0	62,6	61,3	7,0	58,5	67,0

Table 22. Comparison of mean values of nose index in the Rzeszów girls

Age	al-al n–sn										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	62,9	4,7	64,8	5,8	66,5	6,0	69,5	68,2	6,4	65,1	74,5
5	62,1	4,4	61,4	6,5	66,4	5,8	69,3	69,9	6,0	65,5	75,0
6	60,9	3,8	59,6	5,9	66,0	6,5	68,9	68,6	7,4	63,2	74,0
7	58,4	4,0	60,0	7,2	64,5	7,9	65,5	65,7	5,8	60,0	71,9
8	56,1	4,1	60,1	4,9	63,2	4,8	68,1	67,8	7,9	62,2	73,5
9	54,2	4,0	59,3	4,9	62,0	4,5	67,2	67,4	6,1	63,6	71,0
10	53,0	4,2	60,1	5,1	62,5	4,4	66.4	66,6	6,9	63.6	69,6
11	52,3	4,1	58,4	5,0	61,0	5,0	65,1	64,0	7,9	56,9	70,0
12	52,3	4,1	59,1	5,1	62,3	5,5	65,0	67,1	7,8	58,0	70,2
13	53,5	3,9	58,1	5,4	62,9	5,9	64,9	63,6	8,0	56,6	70,1
14	54,2	4,0	58,2	6,4	62,8	6,1	64,5	63,6	7,6	56,6	70,0
15	53,4	4,1	58,3	5,1	63,1	5,7	64,2	63,7	7,5	56,4	70,3
16	52,3	4,0	59,1	6,5	63,3	4,9	64,4	63,8	7,5	56,6	70,0
17	52,3	4,0	59,1	6,3	63,5	7,1	63,2	62,8	4,9	59,3	67,4
18	52,6	3,9	59,2	6,1	63,6	5,0	63,1	62,5	5,0	59,4	67,5

head circumference and body height and head circumference and body weight.[28]

An important direction of anthropometric research is the establishment of development standards, and also the creation of a biological reference system. The mean values and standard deviations shown in the tables of 2013/2014 cephalometric parameters (Table 1-12, 15-16) can be used as a biological reference system. Since

2015, in Poland, the normative values of head circumference according to the WHO for children aged 0 to 3 years are presented in the Child Health Book.[29] The head circumference was monitored among 27,209 Colombian children and adolescents aged 0-20 years from families with good and average economic status. Measurements were made in 2009-2010 and were considered as normalized values, useful for assessing the development of children and adolescents from Colombia and other Latin American countries.[30] In Norway, between 2003 and 2006 similar studies were conducted among 8299 children and adolescents aged 0-19 years to develop reference values, including the head circumference for the Norwegian population.[31] Based on the photogrammetric assessment of the face of 514 Chinese subjects aged 12, developmental norms and characteristic types of faces for this age group have been established, normative values and gender differences. They were found useful in plastic surgery and orthodontics [25]. Detailed evaluation of anthropometric features and indices using basic research tools can be used to monitor patients treated for the premature fusion of the cranial sutures.[32]

Some developmental rules are also sought. Latvian studies have allowed to trace certain head development patterns in this population. The study covered 503 newborns born between 2004 and 2007. The head width-length index was similar for the newborns in both sexes, and in the first months of life it decreased, and in the following months it increased, it was generally higher in boys. The dolichocephalus type was more common between 1 and 3 months of life. The most common type in infant boys was brachycephalus, similarly in girls, except for 9-12 months of age - when mesocephalus dominated.[23] In 2005-2007 also in Latvia, 1359 boys aged 7-18 were examined. Increasing head dimensions occurred throughout all age categories and is the most intense between 14-15 years of age. On the basis of the value of the head width-length index in this age group in the boys were distinguished types from hyperbrachycephalus to brachycephalus, but the most typical type was mesocephalus, especially typical of the people of Northern Europe.[20] In our research in the 2013/2014 series, a change in the head circumference and body height in both sexes was observed: from a very large head at the age of 4 to a small head at the age of 18. The typological changes were different for both sexes over 11 years of age.

Some authors point out that the morphological development of the head differs from other parts of the body because it remains closely connected with the development of the brain.[20] However, no disturbances in head index differentiation were found based on the head width-length index in children with neurodysfunctions and abnormal brain structure. The study was conducted in 2012, the values of the index were compared in 112 children of both sexes aged 0-18 years with abnor-

mal brain structure and 218 healthy individuals in the same age group.[33] As it is known, somatic development is determined by genetic factors, and is different in both sexes.[16] For example, between 1992 and 2006 the study on the development of Turkish children aged 0-19 was conducted. There were 2391 boys and 2102 girls aged 0-5 years, 1100 boys and 1020 girls aged 6-19. The results were compared with WHO, Belgian and Norwegian reference values. Turkish children and adolescents over 5 years of age have been found to have higher head circumference than those indicated by WHO and over 9 years of age than Belgian and Norwegian children and adolescents. This fact was related to genetic conditions.[17] Another study has shown that there is a difference in white and black skull construction. A total of thirty-two MRI examinations were performed in healthy, white and black children aged 4-8 years. There was a difference between white and black races, especially in face height determined as the distance between nasion and menton points.[26] Head length, width, and head width-length index of 700 children and adolescents aged 11-20 from the Nigerian Ogbia tribe have indicated that the dominant type of head width- length index is mesocephalus.[21]

Endogenous non-genetic maternal factors[34], exogenous environmental factors, including socioeconomic conditions[19,35] and chronic diseases[14,22,36] modify the course of somatic development. Pedersen et al. have shown that neurotoxic acrylamide, which is produced during heat treatment of carbohydrate-containing foods, penetrates the placenta and affects the reduction of intrauterine growth of the fetus and contributes significantly to the reduction of the head circumference at birth. 1101 pregnant women living in Denmark, England, Greece, Norway and Spain were included in the study in 2006-2010.[34] In the years 2004/2005, the study on the morphological development of the head was conducted among 3696 boys and girls aged 6-19 from rural areas of the Podkarpackie Province. The results of the study were compared to those presented in this paper (the series 2003/2004 and 6-19 age group was considered). It was found that children and adolescents from rural areas of Podkarpacie had lower head length than those from Rzeszów with more pronounced brachycephalus and leptorrhinus. Head length was considered the most ecosensitive parameter.[19] The relationship between head shape and certain chronic genetic diseases was also considered. There was no significant difference in the shape of the face between Nigerian children with sickle cell anemia and children in the control group. In addition to the abnormal genome, major factor in developmental disorders was primarily seen in recurrent ischemic episodes. The study was conducted in 2004-2007. A total of 600 children were studied, 100 of whom suffered from sickle cell anemia and the others were the

control. Parameters characterizing the structure of the nose were lower than in the control group, and it was elevated in case of philtrum height, platyrrhine type was dominating.[22].

Extremely interesting were studies on the changes in somatic development that take place between the generations or the secular trend. This phenomenon is considered to be non-evolutional, not related to the genome, which is adaptive, influenced by changes in the development of civilization.[24,37] It was found that during the period of significant epidemiological changes, manifested by the reduction of infant mortality and life expectancy increase, migration of people to cities, increase in access to medical care, there was a secular trend in the development of the skull. It was noted that during 150 years in the United States, the most significant changes were the increase in the size of the posterior cranial fossa, which develops most significantly in the fetus and in the first year of life, and in Portugal - the facial skeleton and the lateral cranial fossa, which develop the most intensively between 3 and 9 years of age. These differences were related to different patterns of mortality in the same period, in both populations. Portugal entered into the mentioned period of significant epidemiological changes later. The examined skulls came from people born between 1802 and 1975. A total of 1720 skulls were examined. There was a correlation between birth year and osteometric parameters.[24] Research on the secular trend was also carried out in the urbanized area of Sardinia, Italy. The largest head length and width and head width-length index were compared in children between 3 and 5 years of age between 1986 and 2001. The sample size was 262 and 414 children, respectively. There was an increase in head length and a decrease in head width-length index between 1986 and 2001.[37] Research conducted in the 35-year period 1978/79-2013/14 in the population of children and adolescents from Rzeszów showed some changes in the development of the head. The characteristic feature of this population during this period in both sexes is: head elongation, shortening of morphological height of face and nose and its broadening. The observed developmental changes are more pronounced in girls than in boys. Tracking developmental changes over time is important because it allows to update biological reference systems in the form of standards for evaluating the somatic development of children and adolescents in the traditional sense.

Conclusions

1. In the analyzed 35-year-period the phenomenon of head elongation is observed in boys, and to a greater extent in girls from Rzeszów.
2. At the same period, boys and girls experienced shortening of the height of the morphological face and nose. This process is more pronounced in girls.
3. In both sexes after 35 years the nose gets widened from hyperleptorrhinus to leptorrhinus.
4. Further studies on variation in morphology (shape) of the head are recommended due to the differences observed in the development of head features over the 35-year period.
5. There is a need to update biological references used to assess the physical development of children and adolescents.

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