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Generational Changes in the Growth of Children from Maribor and Slovenia

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A B S T R A C T

Among the numerous factors which influence a child's growth and development are also factors of changeable socio--economic environment and life style. Our aim was to evaluate these changes and contribute to preventive measures and evaluation of a child's growth in pediatric practice. Therefore, we decided to estimate the state of body growth in two generations of children from Maribor at five and six years of age of both gender, establish secular changes and define standards. On a representative sample (gender and age) of 1461 children from Maribor measured in 1996 and a sample of 608 children from Maribor, measured in 1966, 28 body features were studied and compared in each population unit. Variables were statistically and epidemiologically assessed and results were controlled by a test. The following anthropometric differences were significant: in 5-year old boys the measures in the 1996 generation are statistically higher than in 1966 – foot length, head length, upper arm skinfold, subscapular skinfold, arm length, arm diameter, upper thigh skinfold, stature (length), suprailiac skinfold, and body weight. Decreased measures are: abdomen circumference, knee circumference, sitting height, elbow circumference, biacromial diameter, and face heigth. In 6-year old boys additional features have increased in comparison with the year 1966: sternal height, tight circumference, hip width, chest circumference; following measures have decreased: face height, head circumference. In 5-year old girls: increased measures in comparison with the generation from 1966 are: lower leg length, head length, ankle circumference, upper arm skinfold, body weight, billiac diameter, body height, subscapular skinfold, chest circumference, hip circumference, sternal height, suprailiac skinfold, decreased measures are: head circumference, elbow circumference, face circumference, shoulder with, sitting height. In 6-year old girls additional measures are increased: wrist circumference, arm length and chest circumference. Changing trends show an increased tendency towards decrease or increase of most body measurements. In everyday practice the most commonly used measurements are: body mass, head circumference, body length in babies and body height in pre-school children. Our measurements proved, with a p-value of 0.001, that measurements of children in 1966, also shown in diagrams, are significantly different from measurements in 1996. In the second part of this paper we present a part of the anthropometric measurement study carried out for the standardization of the DENVER II developmental screening test. There were 1596 healthy Slovene children between zero and six and half years of age included into the observation. Children come from Maribor, Koper, Velenje and Ljubljana. We used the Cameron's measurement and statistical method. Diagrams were made for following body measures: body mass, body height, head circumference, upper arm circumference, thigh circumference and body mass index. A comparative analysis with the Euro-Growth study showed that our results correspond with the European standards. Therefore, our results are suggested to be applied in everyday pediatric practice.

***Key words**: child, auxological anthropometry, secular trend, diagrams of growth*

Introduction

Anthropology is multidiscipline science which examines a human being as a part of the nature in a defined environment and time[1,2]. Therefore, it also became a researching and professional method in medicine, including different kinds of knowledge: ecology, human physiology, psychology, sociology, and human kinesiology. The word anthropometry originates from two Greek words anthropos (ἄνθρωπος – »man«) and metron (μέτρον – »measure«) therefore »measurement of man«) and refers to the measurement of a human individual. Anthropometry

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deals with measurements of the single parts of the human body and defining their proportions as well as analyzing the results[3,4].

Auxology, sometimes called auxanology (from Greek αυξω, auxô, or αυξάνω, auxanô, »grow«; and -λογία, -logia), is a meta-term covering the study of all aspects of human physical growth (though it is also a fundamental of biology, generally speaking). Auxsological anthropometry is an expression used for the measurement of children and adolescents during their growth (dynamic anthropometry, anthropometry in time)[5,6].

In everyday practice at a consulting office for infants and during the systematic examination at the age of 1,9, 12, 18, 36, 60 months and 7, 9, 11, 13, 15 years we require adequate measures for evaluating their health status, assessing their nourishment and the speed of the body mass growth and height. At the outpatient clinics for acute and chronic treatment of ill children, we also require body measures standards for making a decision on a proper therapy dosage. After all, parents also expect to hear from us if their child's development is in accordance with their age[7,8].

Secular Trend

Since the 19th century, anthropologists have observed a secular trend of accelerated growth and development[9,10]. These secular changes were distinctively expressed after the Second World War[11]. Recently, they have been noticed in some developing countries, depending on their social economic development[12,13]. Because of a child's biological acceleration, the development period has been relatively shortened. A child grows faster; it matures earlier and achieves its final height. In the beginning of the 20th century most people achieved their final height at about the age of 25. Nowadays, the youth stops growing at the age of 20. Each decade, the height of preschool children increases for 1.3 cm and in adolescents for 2.5 cm in average[14,15]. Besides the secular development trend, we have also noticed an increase in the height in adults. In the last 100 years body height has increased in average for 10 centimeters, meaning one centimeter each decade. Accelerated growth has been noticed in our children aswell[16].

Population of the Study Carried Out in 1966

In the year 1966 there were 608 children included in our research, categorized in seven age groups, comprising an equal number of male and female children[17,18]. Research was carried out by Prof. Marij Avčin, a Slovene pediatrician. They chose children born to Slovene parents with the birth weight above 2500 grams. Children born with congenital or acquired disorders were not included. Before the measurement, children had been clinically examined. The Age of children varied ±14 days at most. All children were sent invitations according to their health records. Children of the same age were invited on the same day. Premises for measurement were apart from the premises where children were prepared for measurement. Very timid children were undressed in in the area of measurement. Premises were isolated from other dispensary premises to avoid disturbances. Measurements were recorded on a specially prepared form. Three people were present: a person who was holding a child, a measurer and an administrator. Twenty-eight measures were taken: body mass, body length/height, sitting height, supra sternal height, leg length, arm length, dactylon to dactylon, shoulder breadth, transversal chest diameter, elbow breadth, wrist breadth, knee breadth, ankle diameter, head length, head breadth, face height, face breadth, head circumference, chest circumference, abdomen/waste circumference, tight circumference, upper arm circumference, sub scapular skin folds, supra iliac – abdomen skin fold, upper arm skin fold, tight – femur skin fold.

Method Used in 1996

Participants in the research were children born in Maribor with a permanent address in Maribor. All of them were 5, 5.5, 6 and 6.5 years of age with the interval of ±14 days, on the day of measurement. They had to be healthy, so we could exclude congenital disorders or chronic disease and the parents had to give their consent. The children were sent an invitation; their data were taken randomly from the medical records at the Health Center Maribor. The sample consisted of 1461 children of 5, 6 and 6.5 years of age. 260 children were five, 390 were five and a half, 472 were six and 339 six and half years old. There were equal number of girls and boys. Each child was measured three times and each time by another measurer. The measurement method was chosen according to the International Biological Programme[19]. For comparative analysis we chose only five and six year old children.

The first step of the research was to prepare the material and assign tasks. The invitation sent to the parents' child contained an explanation of the research goal, asking parents for their consent. A special form, containing all items which have to be examined, was prepared, accompanied with a questionnaire summarizing the essential data on a child's family and life conditions, previous illnesses, pregnancies and delivery. The second part of the protocol was a clinical form, completed with the doctor's observations of a child's health and its possible irregularities. If the child was healthy, it was measured, and its kinesiological and psychological abilities were tested.

A special form for measurements was filled out. Each measurement was recorded immediately. A child went from one measurer to another. There were no more than two children and their accompanying person in the premises at the same time.

Forms were kept in special file and at the end of the testing sent to the Faculty of Arts in Maribor.

The research protocol was presented to the National Medical Ethics Committee to confirm its concordance with the ethical principals in medicine.

Method Used in 2001 – 2002 DENVER II Slovenia – Anthropometry

In the period from 2001 to 2002 standardization of the developmental test Denver II was carried out. After we tested a child's development, we performed anthropometric measurements. For this purpose we wrote a special manual with instructions how to measure children, how to use instruments and prepared software for data input, simultaneously controlling data calculation and transfer. The measurement protocol was written and measurers attended seminars on measurements[20]. Standard anthropometric method, equipment and procedures were applied[5,21,22].

The anthropologic list contains 22 measurements, including body mass and measures of length and width, circumferences and skin folds thickness.

Children were divided into 45 age categories/classes: 1–12 months for one month, from 12–78 months for two months.

Altogether, we measured 1586 children. Measurements were carried out at the dispensaries for children in Maribor, Velenje, Ljubljana and Koper. Each measurement was carried out twice and by two measurers.

Measurements marked with * are not carried out in children younger than two years of age.

General measurements

General measurements besides body mass include also length and height. This group shows body height and partial heights and particular body proportions: height – sitting height, sitting height – arm length, height – dactylon to dactylon etc. These data enable the calculation of certain indexes:

Measurements: body mass, body height, sitting height, dactylon to dactylon*, foot length.

Circumferences

These measurements include primarily soft body parts influenced by muscle and fat tissue development. Circumferences were measured with a metal tape; measures are expressed in cm with one decimal place.

We measured: head circumference, chest circumference, abdomen/waste circumference, upper arm circumference, and tight circumference – femur.

Diameter

This data group shows the strength of the skeleton development. It also provides information about the constitution and general skeleton proportions. Diameter of the joints shows the strength of the skeleton: strong, slim or middle/medium.

These measures also provide data on head-face proportions in comparison with the rest of the body. First signs of sex differentiation may be noticed as well.

Measurements: biacromic diameter, bitrochantric diameter, bi-iliac diameter – sagittal chest diameter*, wrist breadth, ankle diameter, head length and head breadth.

Thickness of the Skin Folds

This data enables us to estimate the nourishment of our children. Two measurements of the trunk and two measurements of the proximal parts of the limbs gave us an average adipose corpus skin fold thickness and data on body fat tissue distribution. Because of adipose corpus softness, measurements are less reliable.

Skinfolds are measured with skin fold measurement compasses – caliper and are expressed in mm.

Measurements: subscapular skinfold*, supra iliac – abdomen skinfold*, upper arm skinfold, thigh – femur skinfold*.

Measurement Registering

All measured values were registered on the special form. Measurements were carried out on each child two times. Children were sent from one measurer to another within the same premises. Measurements took place at the same time (between 8 and 12 o'clock in the morning).Thus, we avoid body mass variations/changeability during the day (dehydration, feeding, defecation). Immediately after the measurement, measures were stored into a computer. Especial software enabled us simultaneous control of the data input. It compared the differences between two equal measurements carried out by two measurers. Allowed deviance between the first and second measurement was at most 10%. In the opposite, program did not allow data input.

There were also control between each measurements, for example, sitting height had to be lower than the height, biiliac diameter had to be shorter than the shoulder width, bithrochanter diameter had to be bigger than the biiliac diameter, head length had to be bigger than the head breadth, etc. Thus, data collection ensured great level of regularity, i.e. we decreased possibility of the false data.

Statistical Data Analysing

A statistical method used for two generations of children, measured in 1966 and in 1996 was based on a comparison of two large samples with the t-test. We used Microsoft Windows XP® and Microsoft Excel® – Microsoft Office 2003®.

The following statistical functions were used:
– Average value (AVG)
– Standard deviation (STD)
– z-value

The highest degree of deviation was 5% and the difference in likelihood error only 0.001.

For Anthropometry DENVER II data analysis we used normal dispersion (Gauss dispersion), adequate appraisers, for average values, and standard deviation dispersion.

For approximation we used polynomials of 7th degree. Polynomial coefficients were found using the least square method. The polynomials of the fifth degree fitted the best and were used in diagrams. Percentiles were calcu-

TABLE 1
A COLLECTIVE TABLE OF MEASURED VALUES FOR BOYS

BOYS	1996						1966						t-test	t-test
	5 years			6 years			5 years			6 years			5 years	6 years
	N 1_5	AVG 1_5	STD 1_5	N 1_6	AVG 1_6	STD 1_6	N 2_5	AVG 2_5	STD 2_5	N 2_6	AVG 2_6	STD 2_6	z_5	z_6
Leg length (cm)	174	62.5	2.9	243	67.9	3.4	43	50.4	3.6	43	54.5	2.8	20.46[1]	27.9[1]
Head lenght (mm)	174	178.3	6.5	243	181.5	6.7	43	166.3	6.7	43	167.2	5.5	10.58[1]	15.2[1]
Forearm skin fold (mm)	174	10.9	2.5	243	9.8	3.2	43	7.9	2.1	43	7.4	1.9	8.062[1]	6.76[1]
Upper ark skin fold (mm)	174	6	2.4	243	6.4	3.5	43	4.7	1.2	43	4.6	1.1	5.038[1]	6.42[1]
Arm lenght (cm)	174	47.1	2.1	243	50.9	2.2	43	45.4	2	43	48.3	2.8	4.941[1]	5.78[1]
Dacytilon to dyctalon (cm)	174	111	4.6	243	117.8	4.7	43	107.8	4.4	43	114.9	4.6	4.232[1]	3.8[1]
Supra iliac-abdom skin fold (mm)	174	13.1	3.4	243	14.4	4.9	43	11.2	3.7	43	10.5	4.5	3.063[1]	5.17[1]
Body height (cm)	174	111.4	3.9	243	118.8	4.5	43	109.4	4.1	43	115.4	4.3	2.892[1]	4.75[1]
Thight-femur skin fold (mm)	174	6.7	3.3	243	7	4.2	43	5.5	2.3	43	4.8	2.1	2.785[1]	5.26[1]
Body mass (kg)	174	19.8	2.9	243	22.7	4.1	43	18.8	2.3	43	20.8	2.9	2.416[3]	3.69[1]
Supra sternale height (cm)	174	85.9	5.3	243	94	3.9	43	85	3.5	43	90.2	3.8	1.347[5]	6.02[1]
Tight-femur circcumference (cm)	174	33.5	3.3	243	36.1	4.3	43	33	2.4	43	33.9	2.6	1.128[5]	4.55[1]
Bithrochanter diameter (cm)	174	19.2	1.1	243	20.6	1.4	43	19	1.3	43	19.6	1.2	0.93[5]	4.91[1]
Chest sagital diameter (cm)	174	12.9	0.8	243	13.8	1.2	43	12.8	1	43	12.6	0.8	0.609[5]	8.32[1]
Chest transversal diameter (cm)	174	17.8	1	243	18.3	1.1	43	17.8	1.5	43	18.3	0.8	0[5]	0[5]
Head circcumference (cm)	174	50.9	1.3	243	51.6	1.3	42	51.1	1.4	43	51.7	2.9	–0.84[5]	–0.22[5]
Ankle diameter (mm)	174	53.2	3	243	55.7	3.3	43	53.6	2.7	43	55.5	2.7	–0.85[5]	0.43[5]
Chest circcumference (cm)	174	55.1	3	243	57.4	4.2	43	55.8	3.5	43	56.9	2.5	–1.21[5]	1.07[5]
Wrist breadth (mm)	174	38.7	2.2	243	39.9	2.3	43	39.2	2.4	43	40	2.6	–1.24[5]	–0.24[5]
Face height (mm)	174	91.5	4.3	243	93.4	4.1	41	93	6	41	96	6.6	–1.51[5]	–2.44[4]
Head breadth (mm)	174	139.9	5.5	243	141	5.1	42	141.8	7.3	43	144.7	6.6	–1.58[5]	–3.5[2]
Upper arm middle circcumference (cm)	174	16.7	1.4	243	17.1	1.7	43	17.2	1.6	43	16.9	1.3	–1.88[5]	0.88[5]
Abdomen-waste circcumference (cm)	174	51.2	3.9	243	52.4	5.1	43	52.6	3.2	43	53.2	3.1	–2.45[4]	–1.39[5]
Knee breadth (mm)	174	72.3	3.6	243	75	5	42	75	3.5	42	77.4	4.7	–4.46[2]	–3.03[2]
Sitting height (cm)	174	62.5	2.9	243	63.2	2.5	42	65.1	2.7	42	67.5	2.9	–5.52[2]	–9.05[2]
Elbow breadth (mm	174	47.4	2.9	243	49.2	3.5	42	50.1	2.7	43	52	2.8	–5.73[2]	–5.8[2]
Shoulder breadth – biacromial diameter (cm)	174	21.1	1.2	243	22.8	1.2	41	23.7	2.4	43	24.9	1.1	–6.74[2]	–11.4[2]
Face breadth (mm)	174	107.5	5.3	243	107.9	4.9	41	114.5	5.7	41	114	6.1	–7.17[2]	–6.08[2]

[1] $p<0.001$, values in 1996 are higher than in 1966; [2] $p<0.001$, values in 1996 are bigger than in 1966; [3] $p<0.05$, values in 1996 are higher than in 1966; [4] $p < 0.05$, values in 1996 are bigger than in 1966; [5] value no significanf diferences

N1_5: number of 5-year old children born in 1996, AVG1_5: arithmetic mean for 5-year old children born in 1996, STD1_5: standard error for 5-year old children born in 1996, N1_6: number of 6-year old children born in 1996, AVG1_6: arithmetic mean for 6-year old children born in 1996, STD1_6: standard error for 6-year old children born in 1996, N2_5: number of 5-year old children born in 1966, AVG2_5: arithmetic mean for 5-year old children born in 1966, STD2_5: standard error for 5-year old children born in 1966, N2_6: number of 6-year old children born in 1966, AVG2_6: arithmetic mean for 6-year old children born in 1966, STD2_6: standard error for 6-year old children born in 1966.

lated for each category/class (3, 5, 10, 15, 25, 50, 75, 85, 90, 95, 97) on the basis of z-values. Items were approximated with the fifth degree polynomial and achieved curves presented in the graphs. Those graphs were also used for the comparison with the results of the Eurogrowth study in NCHS&CDC[23–25].

Example of equation for 5 percentile calculation.

Discussion

The study included only healthy 5, 5.5, 6, 6.5-year old girls and boys. Because of the insufficient data from the comparative group, our observation could not include 5.5 and 6.5-year old boys and girls. Children were invited according to the immunization schedule and chosen ran-

TABLE 2
A COLLECTIVE TABLE OF MEASURED VALUES FOR GIRLS

GIRLS	1996						1966						t-test	t test
	5 years			6 years			5 years			6 years			5 years	6 let
	N 2_5	AVG 2_5	STD 2_5	N 2_6	AVG 2_6	STD 2_6	N 1_5	AVG 1_5	STD 1_5	N 1_6	AVG 1_6	STD 1_6	z_5	z_6
Leg length (cm)	136	63.2	3.1	229	67.9	3.4	45	50.6	3.6	43	54.4	2.9	21.04[1]	27.22[1]
Head length (mm)	136	174.1	5.9	229	181.5	6.7	44	162.7	4.9	43	165.9	6.2	12.73[1]	14.94[1]
Ankle diameter (mm)	136	53.2	0.3	229	55.7	3.3	44	50	2.4	43	52.8	3.1	8.82[1]	5.57[1]
Upper arm skin fold (mm)	136	12.2	2.9	229	9.8	3.2	45	9.3	2.8	43	8.9	2.5	5.97[1]	2.06[1]
Body mass (kg)	136	20.1	3.4	229	22.7	4.1	45	17.8	2.2	42	20.6	3.6	5.24[1]	3.40[1]
Dactylon to dactylon (cm)	136	110.2	4.8	229	117.8	4.7	45	106.2	4.4	42	112.9	4.9	5.17[1]	5.99[1]
Body height (cm)	136	111.5	4.1	229	118.8	4.5	45	107.5	5.3	43	114.5	4.8	4.63[1]	5.44[1]
Subscapular skin fold (mm)	136	7.2	2.9	229	6.4	3.5	45	5.6	1.8	43	5.3	1.7	4.37[1]	3.17[1]
Sag. prem. prsn. koša (cm)	136	12.8	0.8	229	13.8	1.2	45	12.3	0.9	43	12.3	1	3.32[1]	8.73[1]
Bithrochanter diameter (cm)	136	19.6	1.1	229	20.6	1.4	45	18.9	1.4	43	19.8	1.3	3.06[1]	3.66[1]
Sternale heigth (cm)	136	86.4	5	229	94	3.9	45	84.4	3.4	43	89.8	4	3.01[1]	6.34[1]
Supra iliac skin fold (mm)	136	8.4	4.3	229	7	4.2	45	6.7	3.5	43	7.3	4.9	2.66[1]	–0.38[5]
Tight circumference (cm)	136	35.2	3.7	229	36.1	4.3	45	33.8	3.9	43	35.5	3.8	2.11[3]	0.93[5]
Wrist breadth (mm)	136	37.9	2	229	39.9	2.3	45	37.3	2.2	43	39	2.7	1.62[5]	2.05[3]
Arm length (cm)	136	46.7	2.2	229	50.9	2.2	45	45.7	4.4	43	48.1	2.6	1.47[5]	6.63[1]
Chest circumference (cm)	136	54.7	3.6	229	57.4	4.2	45	54	2.5	42	55.8	3.5	1.45[5]	2.64[1]
Tran. prem. prsn. koša (cm)	136	17.6	1	229	18.3	1.1	45	17.4	1	43	18.1	1	1.16[5]	1.18[5]
Thight-femur skin fold (mm)	136	15.5	3.9	229	14.4	4.9	45	14.7	4.7	42	14	4.9	1.03[5]	0.49[5]
Abdomen/waste circumference (cm)	136	51.3	5.1	229	52.4	5.1	45	50.8	3.7	43	52.4	4.8	0.71[5]	0.00[5]
Upper arm middle circumfer. (cm)	136	16.9	1.6	229	17.1	1.7	45	16.8	1.2	43	17.5	1.8	0.44[5]	–1.35[5]
Head breadth (mm)	136	137.9	5.1	229	141	5.1	45	138.9	6	43	141.3	5.7	–1.00[5]	–0.32[5]
Face height (mm)	136	90.2	4.4	229	93.4	4.1	43	91.6	5.5	43	94	5.6	–1.52[5]	–0.67[5]
Knee breadth (mm)	136	69.8	4.9	229	75	5	45	71.1	4	43	74.6	5.6	–1.78[5]	0.44[5]
Head circumference (cm)	136	50	1.4	229	51.6	1.3	44	50.5	1.3	43	51	1.6	–2.18[4]	2.32[4]
Elbow breadth (mm)	136	46.2	3.1	229	49.2	3.5	45	48	3.7	43	51	3.6	–2.94[2]	–3.02[2]
Face breadth (mm)	136	107.5	4.8	229	107.9	4.9	43	112.5	5.9	43	112.6	7.6	–5.05[2]	–3.91[2]
Shoulder breadth (cm)	136	21.3	1.2	229	22.8	1.2	45	23.3	1.3	43	24.1	2.1	–9.12[2]	–3.94[2]
Sitting height (cm)	136	59.8	2	229	63.2	2.5	43	63.9	2.2	43	66	2.6	–10.88[2]	–6.52[2]

[1] $p<0.001$, values in 1996 are higher than in 1966; [2] $p<0.001$, values in 1996 are bigger than in 1966; [3] $p<0.05$, values in 1996 are higher than in 1966; [4] $p < 0.05$, values in 1996 are bigger than in 1966; [5] value no significanf diferences

N1_5: number of 5-year old children born in 1996, AVG1_5: arithmetic mean for 5-year old children born in 1996, STD1_5: standard error for 5-year old children born in 1996, N1_6: number of 6-year old children born in 1996, AVG1_6: arithmetic mean for 6-year old children born in 1996, STD1_6: standard error for 6-year old children born in 1996, N2_5: number of 5-year old children born in 1966, AVG2_5: arithmetic mean for 5-year old children born in 1966, STD2_5: standard error for 5-year old children born in 1966, N2_6: number of 6-year old children born in 1966, AVG2_6: arithmetic mean for 6-year old children born in 1966, STD2_6: standard error for 6-year old children born in 1966

domly regarding the birth date and sex. Prior to the measurement, all children were examined to exclude the possibilities of congenital, chronic or acute/present disease. We measured only health children.

Measurements were performed with a standardized Martin's anthropometric kit. Thus we excluded the possibility of a systematic error. Instruments were adjusted to the standard and checked during measurements according to the standard. After each series of 100 measurements, scales were adjusted with a 5-kilogram weight. Waste measurement tape was replaced after each series of 500 measurements. Unfortunately, the metal tape was not available, therefore a textile one, enforced with synthetic threads was used.

TABLE 3
CORRELATION VALUES EUROGROWTH 2000 AND SLOVENIA 2002

	X – average value			AGE IN MONTHS											
	S – standard deviation			1	2	3	4	5	6	9	12	18	24	*30*	36
Boys	BODY MASS (kg)	EUR	X	4349	5384	6216	6922	7549	8051	9284	10268	11728	12908	14070	15193
			S	512	564	643	732	796	840	982	1073	1215	1390	1544	1721
		SLO	X	4675	5432	6133	6780	7379	7933	9359	10494	12173	13417	14511	15615
			S	444	591	716	823	913	988	1146	1235	1342	1483	1717	2026
	BODY HEIGHT (cm)	EUR	X	54.4	58.0	61.0	63.7	66.0	67.9	72.2	76.0	82.6	88.1	92.8	97.0
			S	2.0	2.1	2.1	2.1	2.2	2.3	2.4	2.5	2.8	3.0	3.3	3.6
		SLO	X	55.8	58.5	61.0	63.3	65.5	67.5	72.8	77.2	83.9	89.1	93.6	97.8
			S	2.4	2.4	2.5	2.6	2.7	2.8	3.0	3.2	3.6	3.7	3.8	3.8
	UPPER ARM MIDDLE CIRCUMFERENCE (cm)	EUR	X	11.6	12.8	13.5	14.1	14.5	14.8	15.4	15.8	16.2	16.4	16.6	16.8
			S	1.1	1.1	1.1	1.2	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6
		SLO	X	12.0	12.5	13.0	13.5	13.9	14.2	15.0	15.5	15.9	16.0	16.0	16.1
			S	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.3	1.3	1.2	1.2
	HEAD CIRCUMFERENCE (cm)	EUR	X	37.7	39.6	41.0	42.2	43.2	44.0	45.9	47.1	48.5	49.5	50.0	50.5
			S	1.3	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.5
		SLO	X	38.0	39.3	40.4	41.5	42.4	43.2	45.2	46.6	48.2	48.9	49.3	3.8
			S	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3
Girls	BODY WEIGTH (kg)	EUR	X	4085	4957	5708	6392	6985	7491	8677	9648	11128	12448	13706	14846
			S	453	524	601	689	761	817	976	1088	1277	1485	1633	1839
		SLO	X	4413	5100	5743	6344	6906	7430	8803	9922	11604	12833	13881	14936
			S	759	736	729	737	757	787	924	1106	1496	1822	2045	2195
	BODY HEIGHT (cm)	EUR	X	53.6	56.8	59.7	62.3	64.5	66.4	70.8	74.8	81.5	87.2	92.1	96.4
			S	1.9	2.0	2.0	2.0	2.1	2.1	2.4	2.5	2.9	3.2	3.4	3.8
		SLO	X	54.6	57.2	59.6	61.9	64.1	66.1	71.4	75.8	82.6	87.8	92.3	96.5
			S	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.7	3.1	3.5	3.8	3.9
	UPPER ARM MIDDLE CIRCUMFERENCE (cm)	EUR	X	11.4	12.4	13.1	13.7	14.1	14.4	15.0	15.4	15.8	16.2	16.5	16.8
			S	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.4	1.6	1.7
		SLO	X	11.9	12.4	12.9	13.3	13.7	14.0	14.7	15.2	15.6	15.7	15.8	16.0
			S	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.4	1.5	1.5	1.5
	HEAD CIRCUMFERENCE (cm)	EUR	X	36.8	38.6	39.9	41.0	42.0	42.9	44.7	46.0	47.4	48.4	49.0	49.5
			S	1.2	1.2	1.2	1.2	1.2	1.2	1.0	1.3	1.3	1.3	1.4	1.4
		SLO	X	36.9	38.2	39.4	40.5	41.5	42.3	44.4	45.8	47.3	48.0	48.4	48.7
			S	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.2	1.2	1.3	1.4

EUR – data out of the EUROGROWTH study 2000, SLO – data from the anthropometry Denver II study 2002. X – Mean value, S – standard deviation.

Measurements were always carried out in the morning and in the premises where no other activities were performed. The personnel were calm and trained. The data collected were recorded on a special authorized form by measurers. Later, all the data were stored on a computer. Thus we avoided making mistakes during the measurements and storing data into the computer.

Review of the differences between the measured anthropometric measurements regarding reliability level estimation 0.001 or 0.05:

Anthropometric measures in 5-year old boys, higher in favor of 1996 generation:

1. error likelihood is less than 0.001: leg length, head length, upper arm skinfold, subscapular skinfold, arm length, dactylon to dactylon, thigh-femur skinfold, body height, supra iliac skinfold.

2. error likelihood is less than 0.05: body mass.

Anthropometric measures in 5-year old boys, which were lower in the 1996 generation:

1. error likelihood is less than 0.001: knee breadth, sitting height, elbow breadth, shoulder breadth-biacromial diameter, face breadth;

2. error likelihood is less than 0.05: abdomen/waste circumference.

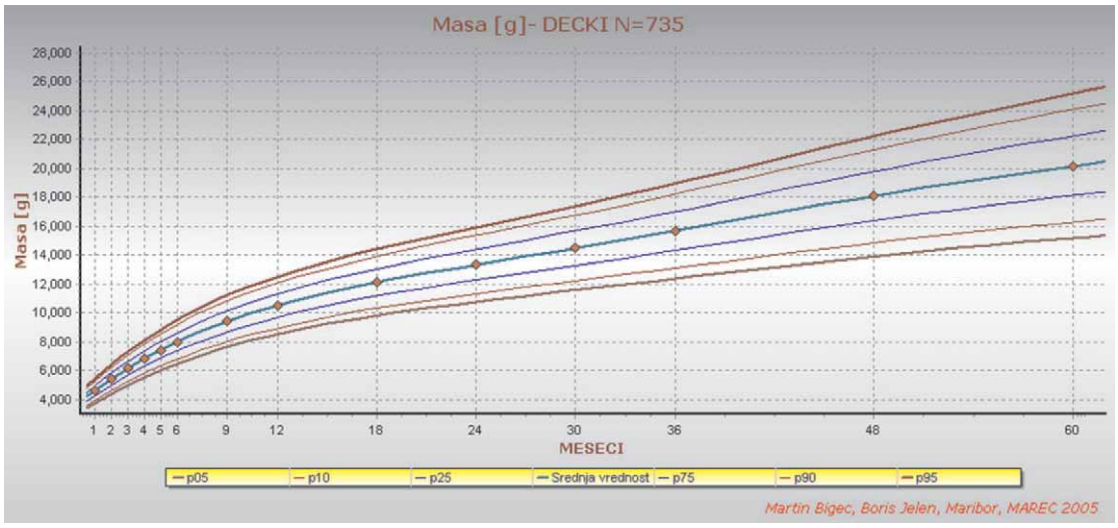

Fig. 1. Body weight – boys

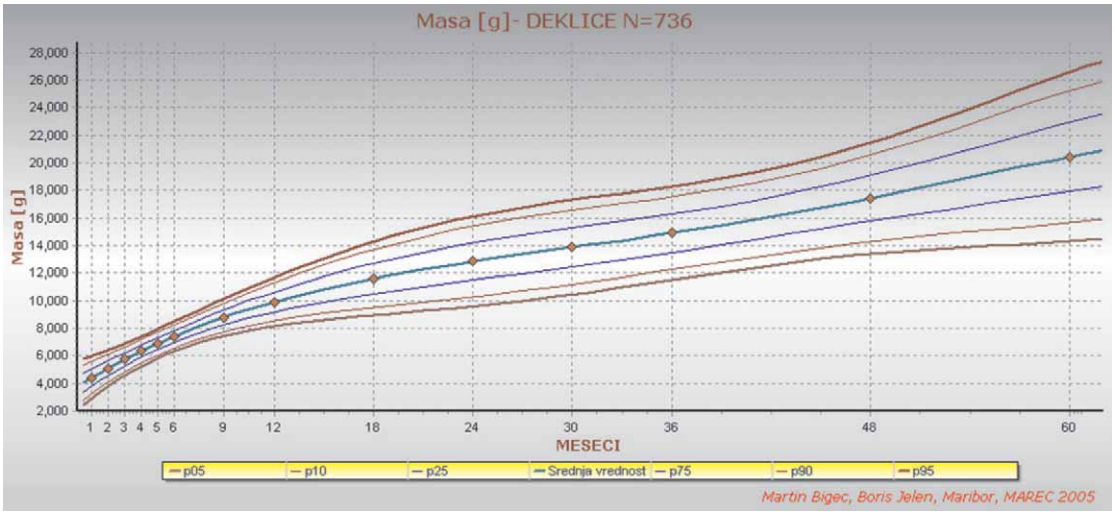

Fig. 2. Body weight - girls

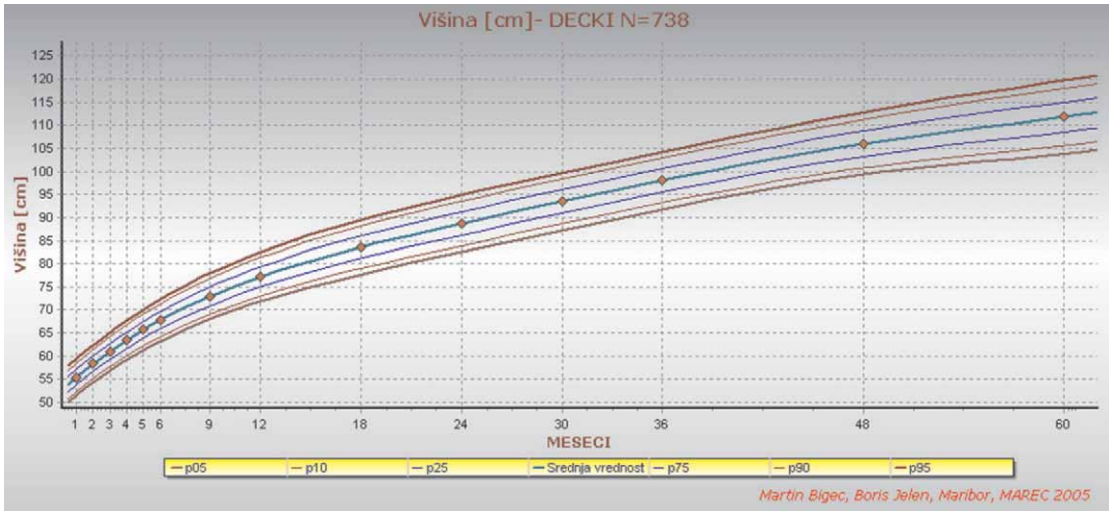

Fig. 3. Body height – boys.

Fig. 4. Body height – girls.

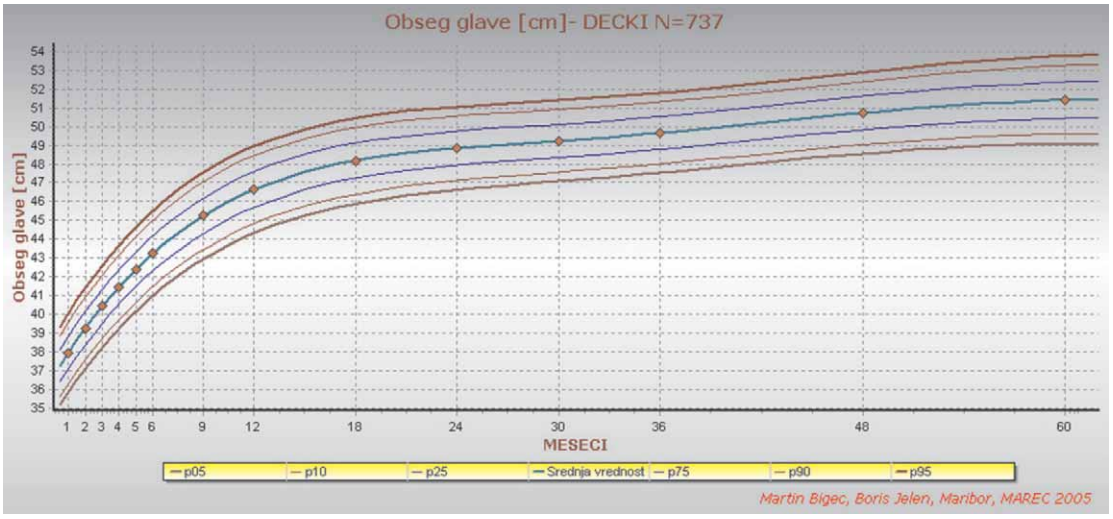

Fig. 5. Head circumference – boys.

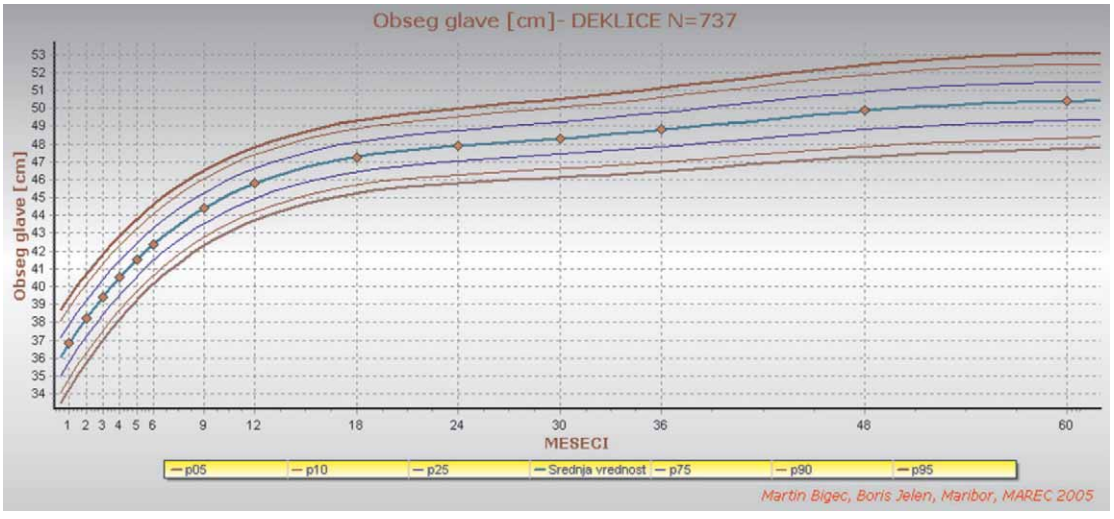

Fig. 6. Head circumference – girls.

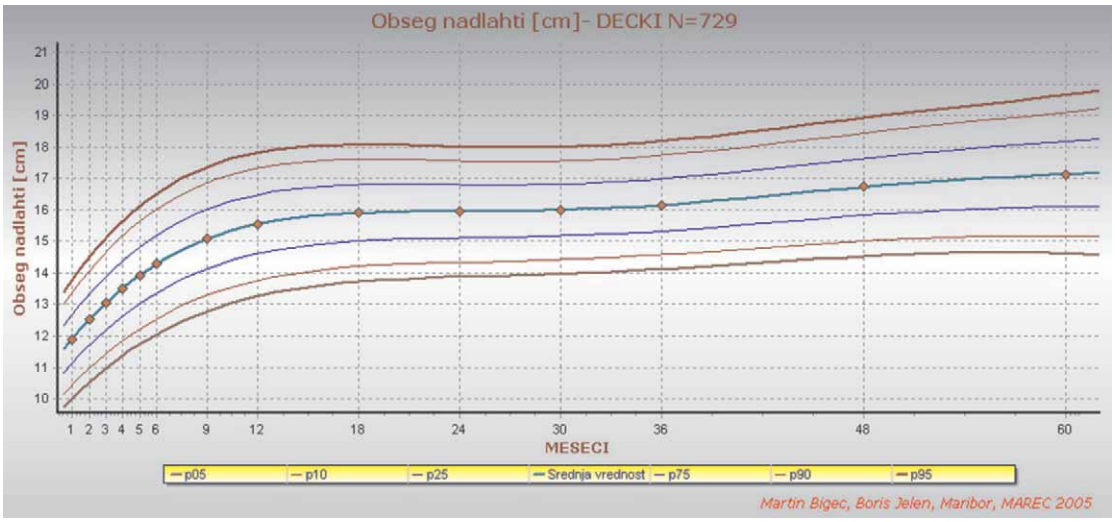

Fig. 7. Middle - upper arm circumference – boys.

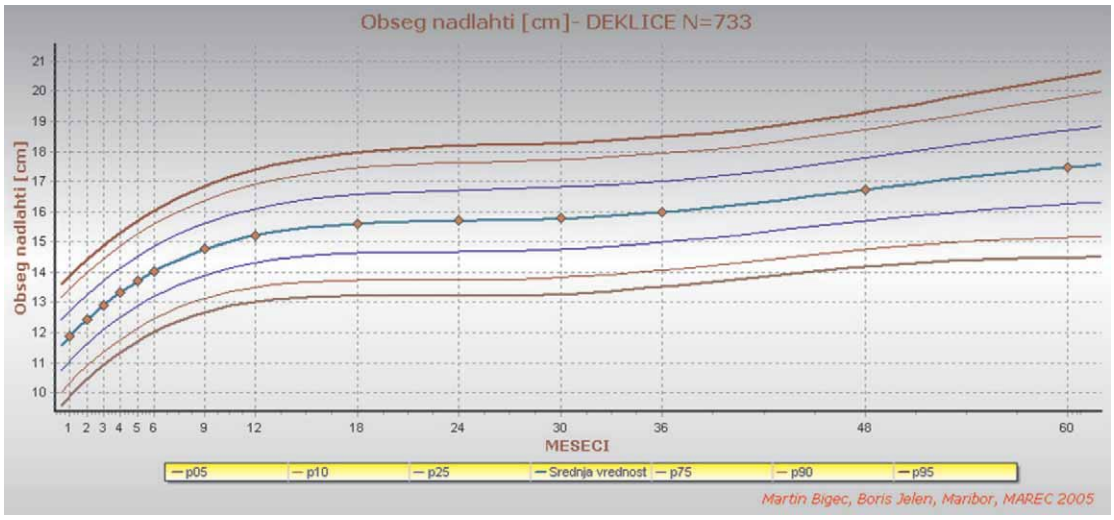

Fig. 8. Upper arm middle circumference girls.

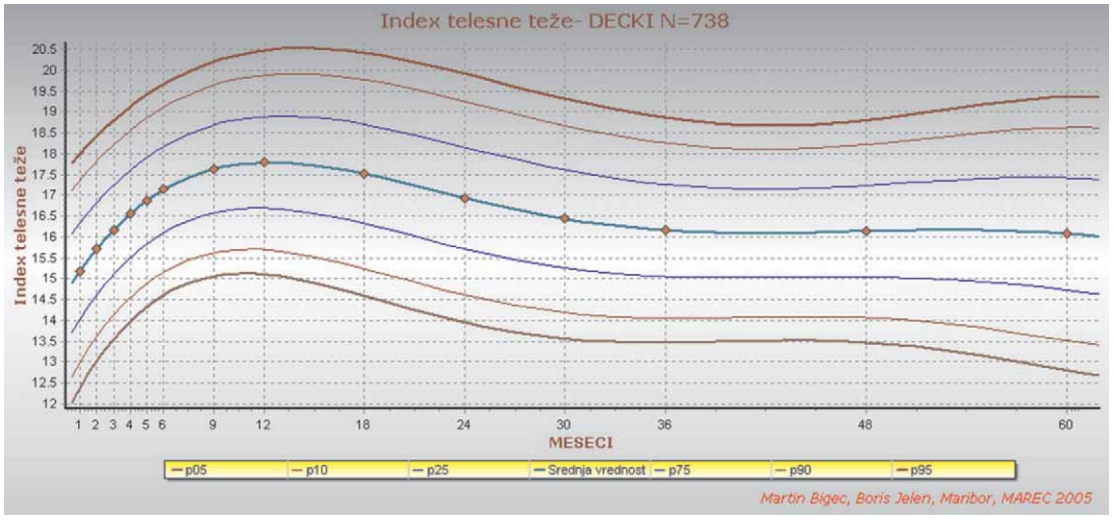

Fig. 9. Body mass index – boys.

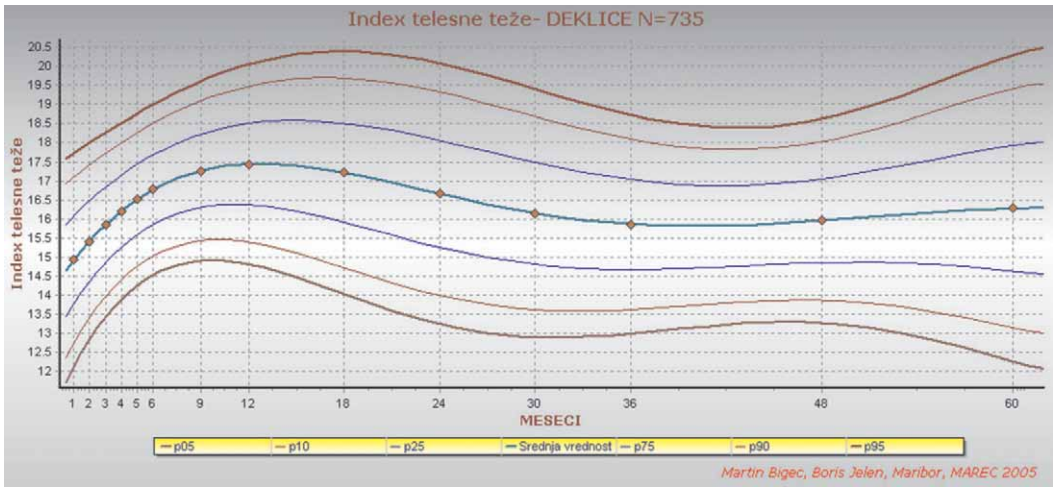

Fig. 10. Body mass index – girls.

Fig. 11. Speed of gaining weight in boys.

Anthropometric measures in 5-year old boys, with no differences between 1996 and 1966 generation:

sternal height, tight circumference, bitrochantric diameter, chest sagittal diameter, chest transversal diameter, head circumference, ankle diameter, chest circumference, wrist breadth, face height, head breadth, upper arm middle circumference.

Anthropometric measures in 6-year-old boys, with differences were higher in favor of 1996 generation:

1. error likelihood is less than 0.001: leg length, head length, upper arm skin fold, subscapular skin fold, arm length, dactylon to dactylon, thigh-femur skinfold, body height, supra iliac skinfold, body mass, sternal height, tight circumference, bitrochantric diameter, chest sagittal diameter, transversechest diameter.

Anthropometric measures in 6-year old boys, when measures between generations were lower in 1996 generation than in 1966 generation:

1. error likelihood is less than 0.001: knee breadth, sitting height, elbow breadth, shoulder breadth-biacromial diameter, face breadth, head breadth;

2. error likelihood is less than 0.05: wrist breadth.

Anthropometric measures in 6-year old boys, with no differences between 1966 and 1996 generation: head circumference, ankle diameter, chest circumference, face height, upper arm middle circumference, abdomen/waste circumference.

Anthropometric measures in 5-year-old girls, when measures between generations were higher in favor of 1996 generation:

1. error likelihood is less than 0.001: leg length, head length, ankle diameter, upper arm skinfold, body mass, dactylon to dactylon, body height, subscapular skinfold, chest sagittal diameter, bitrochantric diameter, sternal height, supra iliac skinfold;

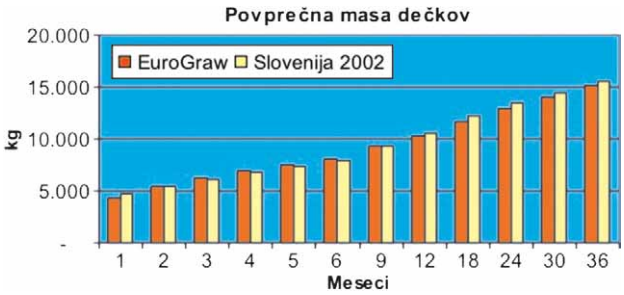

Fig. 12. Body weight comparison between Eurgrowth 2000 and Slovenia 2002 – boys.

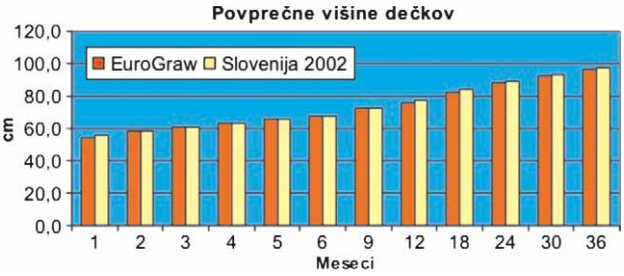

Fig. 13. Body height comparison between Eurgrowth 2000 and Slovenia 2002 – boys.

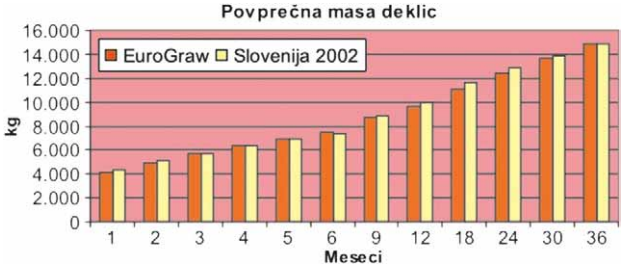

Fig. 14. Body weight comparison: Eurgrowth 2000 - Slovenia 2002 – girls.

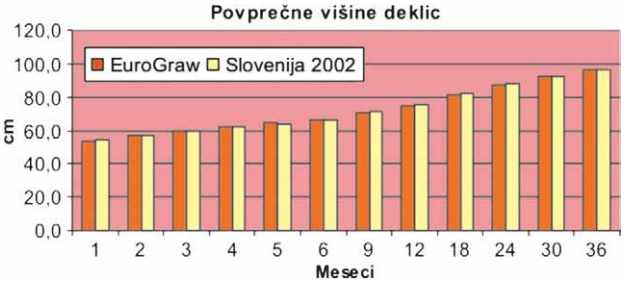

Fig. 15. Body height comparison: Eurgrowth 2000 - Slovenia 2002 – girls.

2. error likelihood is less than 0.05: thigh circumference.

Anthropometric measures in 5-year old girls, when measures were lower in 1996 generation than in 1996 generation:

1. error likelihood is less than 0.001: elbow breadth, face breadth, shoulder breadth-biacromial diameter, sitting height;

2. error likelihood is less than 0.05: head circumference.

Anthropometric measures in 5-year old boys, with no differences between 1966 and 1996 generation: wrist breadth, arm length, chest circumference, chest transversal diameter, thigh-femur skin fold, abdomen/waste circumference, upper arm middle circumference, head breadth, face height, knee breadth.

Anthropometric measures in 6-year old girls, when measures between the generation born in 1966 were higher in favor of 1996 generation

1. error likelihood is less than 0.001: leg length, head length, ankle diameter, upper arm skin fold, body mass, dactylon to dactylon, body height, subscapular skinfold, chest sagittal diameter, bitrochantric diameter, sternal height, arm length, chest circumference;

2. error likelihood is less than 0.05: wrist breadth.

Anthropometric measures in 6-year old girls, when measures between generation born in 1966 were lower in 1996 generation:

1. error likelihood is less than 0.001: elbow breadth, face breadth, shoulder breadth-biacromial diameter, sitting height;

2. error likelihood is less than 0.05: head circumference.

Anthropometric measures in 6-year old girls, with no differences between 1966 and 1996 generation: suprailiac skinfold, tight circumference, chest transversal diameter, thigh-femur skinfold, abdomen/waste circumference, upper arm middle circumference, head breadth, face height, knee breadth.

By comparing our values calculated in 2002 and Eurogrowth data we did not find reliable differences, as it can be seen from Table 3 and diagrams, where girls' and boys' body height and body mass were compared in both studies. A comparison is possible only within the period of 1–36 months of a child's age. The Eurogrowth study is longitudinal and it is still running. They have published only the results for the first 36 months of a child's age. We can compare only body mass, length and upper arm middle circumference. Other measurements are not included into Eurogrowth study.

Conclusion

With time, children and youth are changing in their body growth. Changes are influenced by changed lifestyle, better nourishment, less contagious diseases and mortality caused by immunization, less manual labor, migration and genetic mixing, and other factors. Because of all the mentioned factors and especially because of a higher rate of obese children, standards should be controlled and renewed more often[26]. Physical measures on

5- and 6- year old children were measured in 1966 and 1996 and differences analyzed. There were no other data available to assess the secular trend. In all children 32 measurements were carried out. Each measurement was taken three times. Collected data contain 96 measurement notes and some other identification notes. We created a database with more than 140000 notes. We used the data published in 1968 for children measured in the year 1966, including 608 children from Maribor from 0–7 years of age.

Data analysis showed the physical characteristics of 5 and 6-year old children. Only those developing physical measures with positive trends were defined. We considered the differences higher than in peers in 1966 with the likelihood error less than 0.001, and those with the same error likelihood lower than in the 1966 generation. There are also measures with standard error lower than 0.05, which are higher in 1966 generation, as well as lower than in that generation. In the third group there are measures, where no differences between generations were found.

We have also established that the majority of the measured measurements are not in accordance with those from the year 1966. Those are measures, which are routinely observed in consulting rooms for infants and during the systematic check-ups of pre-school children. Therefore it is urgent to eliminate the old and start using the new anthropomeric standards.

In the year 2002, within the standardization of the developmental test DENVER II measurements and testing of children were completed. The obtained anthropometrical measurements were statistically calculated and compared with the EUROGROWTH study. We could compare only values for 1–36 months old children. We found out that our results do not differ from the Eurogrowth study. Therefore, we did not have to re-arrange statistically for clinical usage[27,28]. In our opinion, our results of anthropometrical measurements in the form of tables and diagrams are convenient for everyday paediatric practice, before all for checking-up of babies and pre-school children.

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REFERENCES

1. TANNER JM. Foetus into man (Open Books, London, 1978). — 2. FLÜGEL B, GREIL H, SOMMER K, Anthropologischer Atlas: Grundlagen und Daten. (Verlag Tribine Berlin, Berlin, 1986). — 3. Anthropometry. Available from: URL: http://en.wikipedia.org/wiki/. — 4. DE ONIS M, Am J Clin Nutr, 64 (1996). — 5. CAMERON N, The methods of auxological antropometry. In: Human Growth 2: Postnatal Growth (Plenum Press, New York, 1988). — 6. MALINA RM, Anthropol Anz,48 (1990). — 7. FRISANCHO AR. Antropometric standards for the assessment of growth and nutritional status, (The University of Michigan Press, Ann Arbor, 1996). — 8. GORSTEIN J, World Health Stat Q, 41 (1988). — 9. HARLAN WR, Am J Epidemiol, 128 (1988). — 10. HAUSPIE RC, Acta Paediatr, 423 (1997). — 11. WEBER G, Ann Hum Biol, 22 (1995). — 12. TSUZAKI S, Helv Paediatr Acta, 42, (1987). — 13. STOLARCZYK H, MALINOWSKI A, Morphol Anthropol, 81 (1996). — 14. BRODAR V. Biol Vestn, 36 (1988). — 15. TANNER JM, Acta Paediatrica Japonica, 29 (1987). — 16. MACAROL-HITI M, Ocena telesne rasti in razvoja otrok v starosti 0-5 let na osnovi antropometrijskih meritev v SR Sloveniji. In: Poročilo o opravljenem programu dela za leto 1986.Univerzitetni zavod za zdravstveno in socialno varstvo Ljubljana, (1986). — 17. AVČIN M, Zdrav Vestn, 37 (1968). — 18. ANON, Antropometrijski standardi otrok v Sloveniji 1966–67. In: Katedra za pediatrijo pri Medicinski fakulteti v Ljubljani, Ljubljana, 1967). — 19. WEINER JS, LOURIE JA. A guide to fields methods. In: Human biology, International Biological Programme Handbook No9, Burgers and Son, London, 1969). — 20. Delovna skupina za restandardizacijo, usposabljanje in aplikacijo DENVER II presajalnega testa v Sloveniji, Novi DENVER II razvojni presejalni test In: Antropometrični instrumentarij in merjenja, (Zdravstveni dom Maribor, Maribor, 2000). — 21. WHO Expert Committee on Physical Status. Infant and children. In: WHO Expert Committee on Physical Status: The use and interpretation of anthropometry, (World Health Organization, Geneva 1995). — 22. VAN'T HOF MA, HASCHKE F, J Pediatr Gastroenterol Nutr, 31 (2000). — 23. WHO Expert Committee on Physical Status. Technical framwork. In: The WHO Expert Committee on Physical Status: Use and interpretation of antropometry (World Health Organization, Geneva, 1995). — 24. Available from: URL: http://198.246.96.2/nchs/about/major/nhanes/growthcharts/clinical_charts.htm. — 25. NCHS&CDC National health and nutrition examination survey III, 1988 – 94. CD-ROM series 11. U.S. Department of health and human services, April 1998, CD – ROM No 2A. — 26. DE ONIS M, Pediatrics, 100 (1997). — 27. RIGBY RA, STASINOPOULOS DM, Stat Med, 23 (2004). — 28. GUO SS, ROCHE AF, CHUMLEA WC, JOHNSON C, KUCZMARSKI RJ, CURTIN R, Am J Hum Biol, 12 (2000).

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GENERACIJSKE PROMJENE U RASTI MARIBORSKE I SLOVENSKE DJECE

S A Ž E T A K

Ishodišta. Među brojnim čimbenicima koji utječu na rast i razvoj djece nalaze se i čimbenici mijenjajućeg se socijalno-ekonomskog okoliša i način života. Njihov utjecaj se također očituje pri promjeni tjelesne rasti djece. Za vrednovanje tih promjena smo u prve dvije generacije petogodišnje i šestogodišnje mariborske djece obaju spolova ocjenjivali stanje tjelesne rasti, utvrđivali sekularne promjene te određivali usklađene standarde, značajne za mariborsku dječju populaciju. Na reprezentativnom uzorku (po spolu i dobi) 1 461 mariborsko dijete iz godine 1996. godine, te uzorku od 608 mariborske djece, izmjerene 1966. godine, uspoređivali smo 28 tjelesnih značajki pri svakoj proučavanoj skupini. Tako dobivena obilježja (varijable) smo statistički obradili i epidemiološko ocjenili, a rezultate provjerili pomoću z-testa. Razlike su značajne u slijedećim antropometrijskim značajkama: kod dječaka u dobi od pet godina, mjere koje su u generaciji 1996. statistički značajno veće od onih iz 1966. godine jesu: dužina noge, dužina glave, kožni nabor na lopatici, dužina ruke, promjer ruke, kožni nabor stegna, tjelesna visina, kožni nabor na trbuhu, tjelesna težina; mjere koje su manje: opseg trbuha, širina koljena, sjedeća visina, širina lakta, širina ramena, širina obraza. Pri šestogodišnjim dječacima se tome pridružuju još i slijedeće mjere: veće od 1966.: visina sternale, opseg stegna, širina bokova, sagitalni promjer prsnog koša; mjere koje su manje: visina obraza, širina glave. Pri petogodišnjim djevojčicama: mjere koje su u generaciji 1996. bile veće od onih iz 1966. jesu: dužina noge, dužina glave, širina gležnja, kožni nabor na nadlaktici, tjelesna težina, promjer ruke, tjelesna visina, kožni nabor na lopatici, sagitalni promjer prsnoga koša, širina bokova, visina sternale, kožni nabor na trbuhu; mjere koje su manje: opseg glave, širina lakta, širina obraza, širina ramena, sjedeća visina. Kod šestogodišnjakinja se tim mjerama pridružuju još: širina zapešća, dužina ruke i opseg prsnoga koša. Trendovi promjena ukazuju na povećanu tendenciju povećavanja ili smanjivanja mjera u većini izmjerenih tjelesnih mjera. U svakodnevnoj praksi najčešće koristimo tjelesnu masu, opseg glave, tjelesnu dužinu kod dojenčadi i tjelesnu visinu kod predškolske djece. U svim tim mjerama smo s vjerojatnošću pogreške $p=0.001$, dokazali da se mjere djece izmjerene godine 1966, i dijagrami iz njih, koji se koriste u dnevnoj praksi, značajno razlikuju od ovih izmjerenih 30 godina kasnije. U drugom djelu članka prikazujemo dio studije antropometrijskih mjerenja djece u okviru standardizacije razvojnoga testa DENVER II. U promatranje je bilo uključeno 1 596 zdrave slovenske djece, u dobi od 0 do šest i pol godina iz Maribora, Kopra, Velenja i Ljubljane. Prema standardiziranoj metodi mjerenja po Cameronu i statističkoj obradi podataka izračunali smo i iscrtali dijagrame za slijedeće tjelesne mjere: tjelesna masa, tjelesna visina, opseg glave, opseg nadlaktice, opseg stegna i indeks tjelesne mase. Poredbenom analizom sa studijom Eurogrowth došli smo do zaključka da se naši rezultati podudaraju s izračunatim europskim standardom, stoga ih predlažemo za korištenje pri preventivnim pregledima, i u svakodnevnoj pedijatrijskoj praksi.