

THE EFFECT OF BIRTH ORDER OF CHILDREN IN THE FAMILY ON THEIR PHYSICAL DEVELOPMENT (HEIGHT)

MIROSLAV PROKOPEC

The existing somatometric studies conducted by a number of authors (in Czechoslovakia Prošek 1925, Lukášová 1947, Kaplan 1962 and others) have revealed that the general sanitary and social conditions of living environment are reflected in the physical conditions of children and that, therefore, the physical development of the youth can be considered to a certain extent as one of the criteria of these conditions, i.e. of the socio-economic and sanitary environment.

In order to be able to draw correct conclusions from the anthropometric investigations it is necessary to try to determine the proportion of the various effects upon the physical development of children. This is not easy. Our task is to answer the question: Is there any difference in physical development (height) between children born as first, second, third, etc.?

We used as basis material from a state-wide growth survey of children in 1951 (V. Fetter and Anthropometric Commission of the Ministry of Health). It is one of the problems studied with this material by the author together with J. Suchý and S. Titlbachová.

METHOD

Data on the height of children and on the birth order of children in family were collected under the guidance of the Anthropological Institute in Prague by teachers of all types of schools in Bohemia and Moravia during September 1951. The investigation covered all regions, but only those districts in the regions indicated by the random selection (about 100 districts).

We expect that the collected data reliably represent the Czech children aged 6 to 14 years at the time of the investigation. As far as young persons aged 14 to 18 years are concerned, we have to take into consideration that the material does not include children who left school. Material elaborated pertained to a total of 55,000 boys and 55,000 girls aged 6 to 18 years. Age was calculated from the date of birth and the date of measurement. Age groups include in the individual years children of

corresponding age with a maximum difference of ± 6 months. The children were divided into 3 groups:

- a) children born as first in the family;
- b) children born as second in the family;
- c) children born as third or subsequent children.

The fourth group is formed by all the three mentioned groups. In our study we did not pay regard to the number of children in the family. Thus e.g. group a) includes first-born children who remained the only children, as well as first-born children from families with several children.

For either sex, for each group and for each age from 6 to 18 years arithmetic means were calculated of the height (x), further the standard error (m), the standard deviation (s) and the variation coefficient (v). Minimum and maximum values were also recorded. The number of cases does not fall in groups a) and b) up to the age of 15 years in any case under 1000 and in group c) under 600. In the 3 highest age groups the number is smaller, but it does not fall under 240. An exception is formed by group c) in 18-years old girls with 141 cases. It should be added that the investigation was carried out 6 years after the end of the war when the food rationing system was still in force.

RESULTS

Results were expressed in tables and graphs (Table 1). *The average heights of children, born as first in the family, are in all age groups higher. Then there follow averages of children born as second, which are almost identical with the total results (with means of children regardless of the order of birth). The lowest mean values were found in children born as third or subsequent children in the family (one group). The order was ascertained both in boys and girls.*

The curves are almost parallel and show curvature which is characteristic for the growth curve. In contrast to girls a growth depression is marked in boys in puberty between the age of 11 and 12 years and in them the adolescent growth acceleration is more pronounced.

TABLE 1

Body height of children by birth
order in the family. *)
(M. Prokopec — 1958)

a = first-born
b = second-born
c = born in 3rd and sub-
sequent order

N = number of cases
 $\bar{x}$ = arithmetic mean
m = standard error (stan-
dard deviation of the
mean)
s = standard deviation
v = variation coefficient

total = total average
min., max. = middle of
interval per 3 cm

BOYS

Age	Group	N	$\bar{x}$	m	s	v	min	max
6	a	1 262	115,0	0,16	5,84	5,38	89,5	137,5
	b	1 328	114,8	0,16	5,63	4,91	98,5	134,5
	c	906	113,1	0,17	5,22	4,62	89,5	134,5
	total	3 515	114,4	0,10	5,60	4,90	89,5	137,5
7	a	1 450	121,2	0,15	5,66	4,67	101,5	140,5
	b	1 355	121,1	0,16	5,70	4,71	101,5	143,5
	c	875	119,3	0,19	5,58	4,67	92,5	140,5
	total	3 702	120,7	0,09	5,72	4,74	92,5	143,5
8	a	1 600	127,1	0,15	5,92	4,64	104,5	146,5
	b	1 290	126,2	0,16	5,68	4,50	104,5	143,5
	c	818	124,8	0,20	5,59	4,47	107,5	143,5
	total	3 734	126,3	0,09	5,78	4,58	104,5	146,5
9	a	1 566	132,7	0,16	6,18	4,66	113,5	173,5
	b	1 142	131,5	0,18	6,01	4,57	110,5	173,5
	c	683	129,7	0,23	6,02	4,64	110,5	173,5
	total	3 409	131,7	0,10	5,99	4,54	110,5	185,5
10	a	1 563	137,1	0,17	6,50	4,75	113,5	176,5
	b	979	136,5	0,20	6,22	4,56	116,5	176,5
	c	680	134,4	0,26	6,45	4,80	107,5	155,5
	total	3 241	136,3	0,12	6,53	4,82	107,5	176,5
11	a	2 901	141,7	0,12	6,69	4,72	113,5	173,5
	b	1 723	140,8	0,15	6,25	4,47	119,5	170,5
	c	1 272	139,4	0,18	6,58	4,73	119,5	167,5
	total	5 905	140,9	0,08	6,48	4,59	113,5	173,5
12	a	3 212	145,8	0,12	7,03	4,82	122,5	176,5
	b	2 074	144,7	0,15	6,90	4,77	113,5	176,5
	c	1 629	143,3	0,17	6,88	4,80	101,5	167,5
	total	6 939	144,9	0,09	7,12	5,17	101,5	176,5
13	a	3 107	151,3	0,15	8,22	5,44	119,5	179,5
	b	2 120	150,4	0,17	7,98	5,31	122,5	179,5
	c	1 592	148,4	0,19	7,67	5,17	119,5	176,5
	total	6 832	150,4	0,10	8,08	5,37	119,5	179,5
14	a	3 156	158,0	0,16	8,99	5,68	122,5	197,5
	b	2 070	157,1	0,20	8,94	5,69	125,5	191,5
	c	1 616	154,8	0,21	8,62	5,57	125,5	185,5
	total	6 857	156,9	0,11	9,04	5,76	122,5	197,5

TAB. 1. continued

Age	Group	N	$\bar{x}$	m	s	v	min	max
15	a	2 231	164,4	0,19	8,86	5,39	122,5	191,5
	b	1 367	163,2	0,24	8,76	5,36	128,5	188,5
	c	1 059	160,5	0,27	8,72	5,43	134,5	185,5
	total	4 672	163,3	0,13	8,98	5,50	122,5	191,5
16	a	1 777	169,6	0,18	7,68	4,53	131,5	191,5
	b	1 089	168,3	0,23	7,68	4,54	140,5	191,5
	c	731	166,8	0,29	7,70	4,62	134,5	191,5
	total	3 613	168,6	0,13	7,79	4,62	131,5	191,5
17	a	1 400	172,8	0,18	6,72	3,89	143,5	194,5
	b	685	171,4	0,26	6,84	3,99	143,5	191,5
	c	466	169,8	0,33	7,07	4,17	143,5	194,5
	total	2 559	171,9	0,14	7,00	4,07	143,5	194,5
18	a	861	173,9	0,21	6,20	3,56	155,5	194,5
	b	402	173,7	0,32	6,56	3,77	149,5	194,5
	c	265	171,7	0,39	6,32	3,69	149,5	191,5
	total	1 532	173,6	0,16	6,35	3,66	149,5	194,5
GIRLS								
6	a	1 442	114,6	0,15	5,51	4,81	95,5	137,5
	b	1 443	113,9	0,14	5,47	4,80	89,5	131,5
	c	1 061	113,0	0,16	5,10	4,54	92,5	137,5
	total	3 950	113,9	0,09	5,38	4,73	89,5	137,5
7	a	1 499	120,9	0,15	5,86	4,85	101,5	140,5
	b	1 357	120,2	0,14	5,27	4,38	101,5	137,5
	c	858	118,9	0,19	5,58	4,70	101,5	140,5
	total	3 716	120,2	0,09	5,58	4,65	101,5	140,5
8	a	1 696	126,3	0,14	5,81	4,60	101,5	143,5
	b	1 231	125,4	0,16	5,66	4,51	110,5	140,5
	c	834	123,9	0,19	5,52	4,46	107,5	140,5
	total	3 762	125,5	0,09	5,71	4,55	101,5	143,5
9	a	1 575	131,4	0,15	5,99	4,57	110,5	152,5
	b	1 068	130,8	0,18	5,96	4,56	113,5	149,5
	c	801	129,3	0,21	5,83	4,51	110,5	149,5
	total	3 447	130,7	0,10	6,02	4,60	110,5	152,5
10	a	1 489	136,5	0,17	6,58	4,82	110,5	158,5
	b	1 014	136,0	0,21	6,56	4,81	110,5	158,5
	c	727	134,0	0,24	6,45	4,80	110,5	158,5
	total	3 230	135,8	0,12	6,72	4,95	110,5	158,5
11	a	3 074	142,6	0,13	7,09	4,97	122,5	167,5
	b	1 853	141,6	0,16	7,06	4,98	113,5	167,5
	c	1 399	139,8	0,19	7,06	5,05	116,5	164,5
	total	6 326	141,7	0,09	7,19	5,08	113,5	167,5
12	a	3 364	147,9	0,13	7,50	5,06	113,5	176,5
	b	2 220	146,8	0,16	7,35	5,01	110,5	167,5
	c	1 704	144,8	0,18	7,60	5,25	113,5	176,5
	total	7 290	146,8	0,09	7,45	5,04	104,5	176,5

Age	Group	N	$\bar{x}$	m	s	v	min	max
13	a	3 358	153,4	0,12	7,22	4,72	116,5	179,5
	b	2 149	152,3	0,16	7,30	4,80	119,5	176,5
	c	1 756	150,9	0,17	7,20	4,77	125,5	170,5
	total	7 266	152,5	0,08	7,25	4,75	116,5	179,5
14	a	3 300	157,3	0,11	6,54	4,16	122,5	182,5
	b	2 171	156,8	0,14	6,52	4,17	125,5	182,5
	c	1 762	154,9	0,16	6,55	4,23	128,5	179,5
	total	7 233	156,4	0,08	6,59	4,22	122,5	182,5
15	a	2 280	159,8	0,13	6,08	3,82	131,5	185,5
	b	1 275	159,1	0,17	6,06	3,81	131,5	188,5
	c	892	157,8	0,20	6,01	3,81	131,5	188,5
	total	4 447	159,2	0,09	6,06	3,81	131,5	188,5
16	a	1 679	161,4	0,14	5,81	3,61	134,5	185,5
	b	857	160,9	0,20	5,84	3,65	134,5	182,5
	c	443	159,8	0,26	5,34	3,35	146,5	176,5
	total	2 980	160,1	0,11	5,79	3,59	134,5	185,5
17	a	1 308	162,4	0,15	5,52	3,40	143,5	182,5
	b	598	161,8	0,23	5,54	3,42	143,5	176,5
	c	243	160,3	0,35	5,44	3,40	146,5	176,5
	total	2 150	162,0	0,12	5,52	3,41	143,5	182,5
18	a	908	162,4	0,18	5,77	3,55	146,5	182,5
	b	371	162,4	0,29	5,56	3,43	146,5	176,5
	c	141	161,4	0,53	6,24	3,87	146,5	182,5
	total	1 420	162,3	0,15	5,78	3,56	146,5	182,5

*) Elaboration of part of the material from Czech regions.
National anthropometric investigation of youth in 1951
(Fetter et al. 1954).

Description of graphs

The upper-most curve represents a connecting line of means of heights of Czech children (girls on the left, boys on the right) born as first regardless of the number of children in the family. In the middle there is a curve of the total results (the thick line) of children born as second (dotted line). Both curves overlap each other. The lowest curve represents the average heights of children born in the third and subsequent order in the family. The difference between the upper-most and under-most curve is relatively stable and amounts to about 3 cm. Differences between the first and second curve, the curve of total results and the lowest curve were confirmed as being statistically significant.

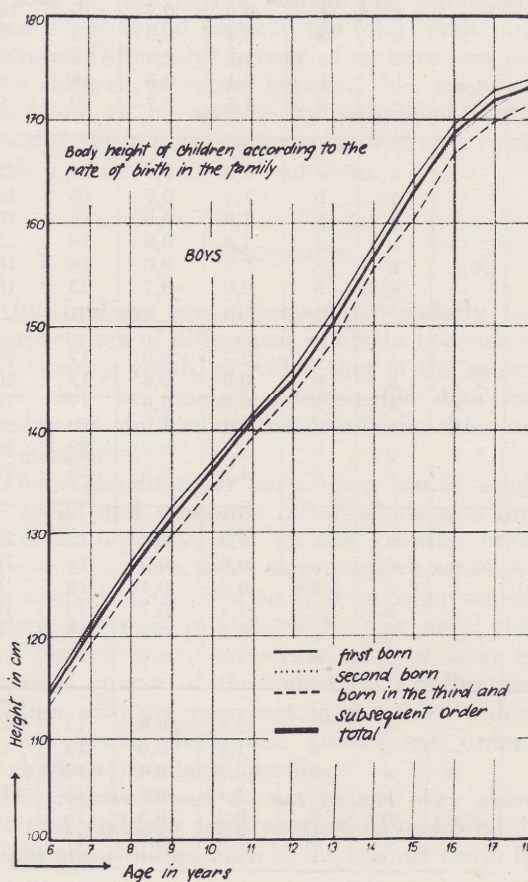
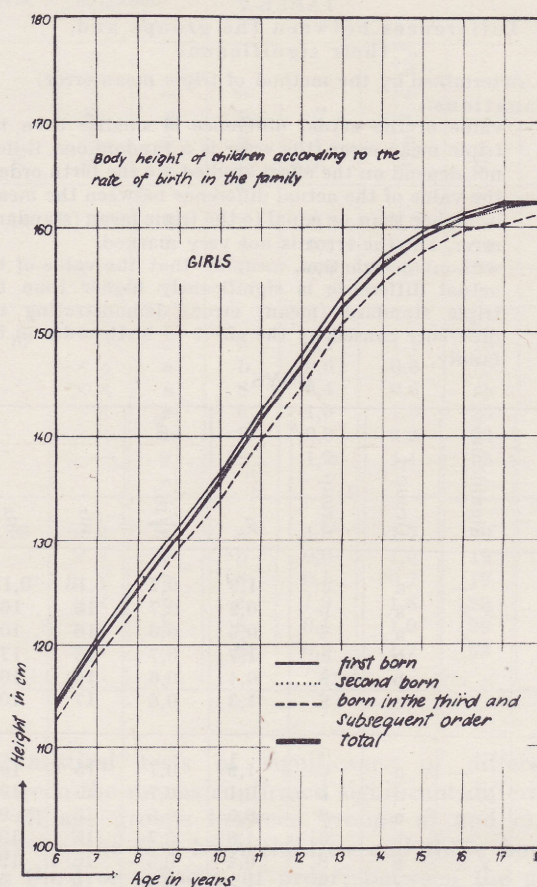


TABLE 2
Differences between the groups and
their significance

(determined by the method of triple mean error)

Explanations:

× × — value of the actual difference is smaller than the triple mean error (the error is a random one, it does not depend on the effect studied, i.e. the birth order).
× — the value of the actual difference between the means is higher than or equal to the triple mean (standard) error, but the error is not very marked.
— — without designation, meaning that the value of the actual difference is significantly higher than the triple standard (mean) error, demonstrating the difference caused by the effect of birth order in the family.

BOYS

Age	Significance	Group 1	Group 2	$\bar{x}_1 - \bar{x}_2$	$3\sqrt{m_1^2 + m_2^2}$	m_1	m_2
6	—	a	c	1,9	0,7	0,16	0,17
	× ×	a	b	0,2	0,7	16	16
	×	a	S	0,6	0,6	16	10
	—	b	c	1,7	0,7	16	17
	× ×	b	S	0,4	0,6	16	10
	—	c	S	1,3	0,6	17	10
7	—	a	c	1,9	0,7	15	19
	× ×	a	b	0,1	0,7	15	19
	×	a	S	0,5	0,5	15	9
	—	b	c	1,8	0,7	16	19
	× ×	b	S	0,4	0,5	16	19
	—	c	S	1,4	0,6	19	9
8	—	a	c	2,3	0,7	15	20
	×	a	b	0,9	0,7	15	16
	×	a	S	0,8	0,5	15	9
	—	b	c	1,4	0,8	16	20
	× ×	b	S	0,1	0,5	16	9
	—	c	S	1,5	0,7	20	9
9	—	a	c	3,0	0,8	16	23
	—	a	b	1,2	0,7	16	18
	—	a	S	1,0	0,6	16	10
	—	b	c	1,8	0,9	18	23
	× ×	b	S	0,2	0,6	18	10
	—	c	S	2,0	0,7	23	10
10	—	a	c	2,7	0,9	17	26
	× ×	a	b	0,6	0,8	17	20
	×	a	S	0,8	0,6	17	12
	—	b	c	2,1	1,0	20	26
	× ×	b	S	0,2	0,7	20	12
	—	c	S	1,9	0,9	26	12
11	—	a	c	2,3	0,6	12	18
	×	a	b	0,9	0,6	12	15
	×	a	S	0,8	0,4	12	8
	—	b	c	1,4	0,7	15	18
	× ×	b	S	0,1	0,5	15	8
	—	c	S	1,5	0,6	18	8
12	—	a	c	2,5	0,6	12	17
	—	a	b	1,1	0,6	12	15
	×	a	S	0,9	0,4	12	9
	—	b	c	1,4	0,7	15	17
	× ×	b	S	0,2	0,5	15	9
	—	c	S	1,6	0,6	17	9

TAB. 2. continued

Age	Significance	Group 1	Group 2	$\bar{x}_1 - \bar{x}_2$	$3\sqrt{m_1^2 + m_2^2}$	m_1	m_2
13	—	a	c	2,9	0,7	15	19
	×	a	b	0,9	0,7	15	17
	×	a	S	0,9	0,5	15	10
	—	b	c	2,0	0,8	17	19
	× ×	b	S	0,0	0,6	17	10
	—	c	S	2,0	0,6	19	10
14	—	a	c	3,2	0,8	16	21
	×	a	b	0,9	0,8	16	20
	—	a	S	1,1	0,6	16	11
	×	b	c	2,3	0,9	20	21
	×	b	S	0,2	0,7	20	11
	—	c	S	2,1	0,7	21	11
15	—	a	c	3,9	1,0	19	27
	—	a	b	1,2	0,9	19	24
	×	a	S	1,1	0,7	19	13
	—	b	c	2,7	1,1	24	27
	× ×	b	S	0,1	0,8	24	13
	—	c	S	2,8	0,9	27	13
16	—	a	c	2,8	1,1	18	29
	—	a	b	1,3	0,9	18	23
	×	a	S	1,0	0,7	18	13
	×	b	c	1,5	1,1	23	29
	× ×	b	S	0,3	0,8	23	13
	—	c	S	1,8	0,9	29	13
17	—	a	c	3,0	1,1	18	33
	—	a	b	1,4	0,9	18	26
	×	a	S	0,9	0,7	18	14
	×	b	c	1,6	1,3	26	33
	× ×	b	S	0,5	0,9	26	14
	—	c	S	2,1	1,1	33	14
18	—	a	c	2,2	1,3	21	39
	× ×	a	b	0,2	1,1	21	32
	×	a	S	0,3	0,8	21	16
	×	b	c	2,0	1,5	32	39
	×	b	S	0,1	1,1	32	16
	—	c	S	1,9	1,3	39	16
GIRLS							
6	—	a	c	1,6	0,7	0,15	0,16
	×	a	b	0,7	0,6	15	14
	×	a	S	0,7	0,5	15	9
	×	b	c	0,9	0,6	14	16
	× ×	b	S	0,0	0,5	14	9
	×	c	S	0,9	0,6	16	9
7	—	a	c	2,0	0,7	15	19
	×	a	b	0,7	0,6	15	14
	×	a	S	0,7	0,5	15	9
	—	b	c	1,3	0,7	14	19
	× ×	b	S	0,0	0,5	14	9
	—	c	S	1,3	0,6	19	9

TAB. 2. continued

Age	Significance	Group 1	Group 2	$\bar{x}_1 - \bar{x}_2$	$3\sqrt{\frac{m_1^2 + m_2^2}{n}}$	m_1	m_2
8	—	a	c	2,4	0,7	14	19
	×	a	b	0,9	0,6	14	16
	×	a	s	0,8	0,5	14	9
	—	b	c	1,5	0,7	16	19
	×	b	s	0,1	0,5	16	9
	—	c	s	1,6	0,6	19	9
9	—	a	c	2,1	0,8	15	21
	×	a	b	0,6	0,7	15	18
	×	a	s	0,7	0,5	15	10
	—	b	c	1,5	0,8	18	21
	×	b	s	0,1	0,6	18	10
	—	c	s	1,4	0,7	21	10
10	—	a	c	2,5	0,9	17	24
	×	a	b	0,5	0,8	17	21
	×	a	s	0,7	0,6	17	12
	—	b	c	2,0	1,0	21	24
	×	b	s	0,2	0,7	21	12
	—	c	s	1,8	0,8	24	12
11	—	a	c	2,8	0,7	13	19
	×	a	b	1,0	0,6	13	16
	×	a	s	0,9	0,5	13	9
	—	b	c	1,8	0,7	16	19
	×	b	s	0,1	0,5	16	9
	—	c	s	1,9	0,6	19	9
12	—	a	c	3,1	0,7	13	18
	×	a	b	1,1	0,6	13	16
	—	a	s	1,1	0,5	13	9
	—	b	c	2,0	0,7	16	18
	×	b	s	0,0	0,5	16	9
	—	c	s	2,0	0,6	18	9
13	—	a	c	2,5	0,6	12	17
	—	a	b	1,1	0,6	12	16
	×	a	s	0,9	0,4	12	8
	—	b	c	1,4	0,7	16	17
	×	b	s	0,2	0,5	16	8
	—	c	s	1,6	0,6	17	8
14	—	a	c	2,4	0,6	11	16
	×	a	b	0,5	0,5	11	14
	×	a	s	0,9	0,4	11	8
	—	b	c	1,9	0,6	14	16
	×	b	s	0,4	0,5	14	8
	—	c	s	1,5	0,5	16	8
15	—	a	c	2,0	0,7	13	20
	×	a	b	0,7	0,6	13	17
	×	a	s	0,6	0,5	13	9
	—	b	c	1,3	0,8	17	20
	×	b	s	0,1	0,6	17	9
	—	c	s	1,4	0,7	20	9
16	—	a	c	1,6	0,9	14	26
	×	a	b	0,5	0,7	14	20
	—	a	s	1,3	0,5	14	11

TAB. 2. continued

Age	Significance	Group 1	Group 2	$\bar{x}_1 - \bar{x}_2$	$3\sqrt{\frac{m_1^2 + m_2^2}{n}}$	m_1	m_2
16	×	b	c	1,1	1,0	20	26
	×	b	s	0,8	0,7	20	11
	×	c	s	0,3	0,8	26	11
17	—	a	c	2,1	1,1	15	35
	×	a	b	0,6	0,8	15	23
	×	a	s	0,4	0,6	15	12
	×	b	c	1,5	1,3	23	35
	×	b	s	0,2	0,8	23	12
	—	c	s	1,7	1,1	35	12
18	×	a	c	1,0	1,7	19	53
	×	a	b	0,0	1,0	19	29
	×	a	s	0,1	0,7	19	15
	×	b	c	1,0	1,8	29	53
	×	b	s	0,1	1,0	29	15
	×	c	s	0,9	1,7	53	15

Statistical tests of significance of differences between the means confirmed significant differences in all age groups between groups a) and c), i.e. between the first-born children and those born in the third or subsequent order; between the group of second-born children and the group of children born in the third or subsequent order, i.e. between b) and c). Further, a statistically significant difference was found between the total results and the group c). Differences between first-born and second-born children, or rather between their heights, were not found to be statistically significant (Table 2). The difference between group a) and c) is relatively stable and amounts to about 3 cm.

DISCUSSION

Our findings are important particularly for the interpretation of differences in height between urban and country youth, provided that at the same time there will be assessed demographic data on the number of children in the family in cities and in the country.

The explanation for our finding can be sought in the social and economic factor which acts through nutrition, heredity, etc. on the growing organism here in a positive, there in a negative sense. A further analysis is needed to find to what extent the highest curve is influenced by the only children who receive much more care, and to what extent the total course of the curve c) is influenced by children who are born not in the third order, but in the fourth, fifth and subsequent order, i.e. by children from large families.

The results found do not in any way show the fact that children born as first have lowest birth-weight and children born in the second, third, fourth

and subsequent order are born with an average weight which is steadily increasing (Fraccaro 1958).

There is no doubt, that the described fact is, together with other factors, responsible for accelerated growth in Czech children and for higher average stature in adulthood, which has been observed in the course of the last three generations. The increase of average adult stature and acceleration of growth and maturation went in the Czech population hand in hand with the diminishing of number of children in families. This phenomenon started earlier and is more pronounced in the town population than in the country population.

The findings described and discussed in this paper reflect the situation in a Middle-European country and may differ from conclusions of similar studies performed in some West-European countries or in the USA. If it is not found in future, it will be possible to consider it as a sign, that the socio-economic conditions of the families with greater number of children had improved.

CONCLUSION

Elaboration of material of 55,000 records about the height and birth order of Czech boys and of the same number of records in respects of Czech girls aged 6 to 18 years, collected by school teachers from selected districts in the course of a national anthropometric investigation in 1951 has revealed that

1. children born as first in the family are on the average tallest,
2. children born as second correspond more or less to the general average,
3. children born in the third or subsequent order (1 group) are in comparison with the above mentioned groups on the average smallest.

The difference between the group of first-born children and the group of children born in the third and subsequent order is relatively stable and amounts approximately to 3 cm. Differences between the means of the first and third group, the

second and third group, and the total results and the third group were confirmed as statistically significant.

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Dr. M. Prokopec, DrSc, Ústav hygieny,
Praha 10, Šrobánova 48.