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GROWTH AND DEVELOPMENT OF PUPILS IN DEBRECEN (EAST HUNGARY) BASED ON CROSS-SECTIONAL AND LONGITUDINAL STUDIES

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Abstract: The authors performed a cross-sectional growth study on nearly 8500 pupils aged 7–18 of primary and secondary schools in Debrecen between 1973–76. 524 of them were 7–8 year old, repeatedly measured until they became 18. The mean values of body measurements (height, weight, chest circumference in normal position, in inspiration and expiration, upper arm circumference, hand strength and vital capacity) of the longitudinal study were compared to those of the original cross-sectional study. The differences were described. Percentiles of the values characteristics of children growing up at the present time in Debrecen, obtained in the longitudinal study are reported.
Key words: Longitudinal growth study, Body measurements, Functional characteristics.

Introduction

Debrecen is a town with 200 000 inhabitants. We have been observing the pupils' growth with repeated cross-sectional and two longitudinal studies in this town. Our first cross-sectional examination (Cs1) was performed 20 years ago, between 1966–69 and it was carried out on over 6000 school children aged 7–16 years (Szöllősi et al. 1970, Szöllősi–Jókay 1978, Szöllősi 1981a). The 7–8 year-old pupils were then examined by being remeasured till their age of 18 (L1). Comparing the data obtained in such a way, a great acceleration of the growth was found. In the boys: stature +10 cm, weight +8 kg, chest circumference +8 cm at the age of 16. In the girls' stature and weight, significant differences formed only from the age of 13 and 14 and they represented only 1–3 cm and 1.5–1.8 kg, respectively. In their chest circumference, however, a remarkable shift forward in development could be observed already from the age of 9. The greatest difference was at the age of 12: nearly 6 cm. The results of the comparison were demonstrated at the EUSUHM Congresses held in Amsterdam (Szöllősi 1981b) and in Budapest (Szöllősi–Jókay 1985).

Having obtained these findings we were interested in how long the strong rise of growth lasts?

Material and Methods

Between 1973–76 we performed a second cross-sectional study (Cs2) on nearly 8500 pupils of Debrecen aged 7–18 by Martin's technics (Martin–Saller 1957–66). The 7–8 year-olds (259 girls and 265 boys) were then followed by being remeasured till the age of 18. Now we demonstrate the differences comparing the findings of these two studies.

Results and Discussion

The *boys* followed in our second longitudinal study (L2) got somewhat shorter *stature* at the age of 10 and 12 and taller for 17–18 than those in Cs2. Their *weight* is less

($p < 5\%$) from 9 to 12, but from 15, it is more than that of the ones in Cs2 ($p < 1$ and 0.1%, respectively) (Fig. 1). The *chest circumference* hardly differs from the Cs2 till the age of 14 but from 15 it is significantly bigger except at the age of 17. The vital capacity is lower till the age of 14 and from 15 it is significantly higher than in Cs2 ($p < 5$, 1, and 0.1%) (Fig. 2). The chest circumference in maximal inspiration is larger between 12–16, finally, however, it is nearly identical with that of the Cs2. The reason for the vital capacity growing higher is that the chest circumference in expiration became smaller at 17–18 (Fig. 3). In such a way the breathing deviation of the chest grew larger and consequently their breathing technics improved (strengthening of the expiratory muscles).

In the *upper arm circumference* no significant change was brought about and the *hand strength* was measured only in the L2 study. Therefore only the L2 data are demonstrated in Fig. 4. The upper arm circumference grows at a strong rate between 8–17, however, the hand strength runs parallel with it only to the age of 14. From now on its growth rate is strongly left behind. Boys aged from 14–18 are secondary school pupils, most of whom give up regular sport activities during this time. Thus the muscles lack training. It is a functional cause of the lag of the hand strength since their body weight grows at a maximum intensity between 13–16 (see Fig. 1) and it should also mean the gain in the muscular mass of the body.

The *girls' height* is practically the same till the age of 14 then they have become significantly taller than the ones in Cs2 ($p < 2$ or 1%). The *weight* is less between 11–14, from 15, however, it became significantly greater than that of the ones in the Cs2 sample (Fig. 1). The *chest circumference* is significantly bigger between 14–16 but later on it hardly differs from the values observed in Cs2. Here the point is only the shifting of the intensive development of the chest to an earlier age. At the age of 13 the vital capacity is still lower but from 15 it increased to a much higher value ($p < 0.1\%$). It can be seen that it intensively rises after the decreased development of the chest, too (Fig. 2). A shifting forward of the development could be experienced in both the *inspiration* and *expiration* evaluations of the chest as well and similarly to the case of boys the breathing deviation grew here, too (Fig. 3). Till the age of 14, in the same manner as in the case of boys, the enhancement of the girls' *hand strength* follows the growth of the *upper arm circumference*. From this age on, however, a decrease is evident (Fig. 4). It is due to the lack of training as well as to the fact that during this period the increase of subcutaneous fat in girls plays a major role in the increase of the upper arm circumference (Jókay–Szöllősi 1985).

Our cross-sectional and longitudinal studies have produced a lot of information. From them, figures 1–4 manifest that in the case of the L2 study – in contradiction to the L1 – significant deviations were found only in the boys' latter years, in comparison to the Cs2 investigation, in both the body measurements and vital capacity. The differences are not so great at all, unlike those between the Cs1 and L1. In girls the process in the same except in the case of chest circumference, where the development occures at the earlier ages.

It is evident from the comparison of the above data as well as the results of our other observations that the intensified acceleration of the pupils' body development occurred in the period between the two Cs studies performed by us and this intensity has slowed down recently. Therefore it has become possible to state the regularities and norms of the development of the new generation. Tables 1 and 2 demonstrate the percentile values obtained.

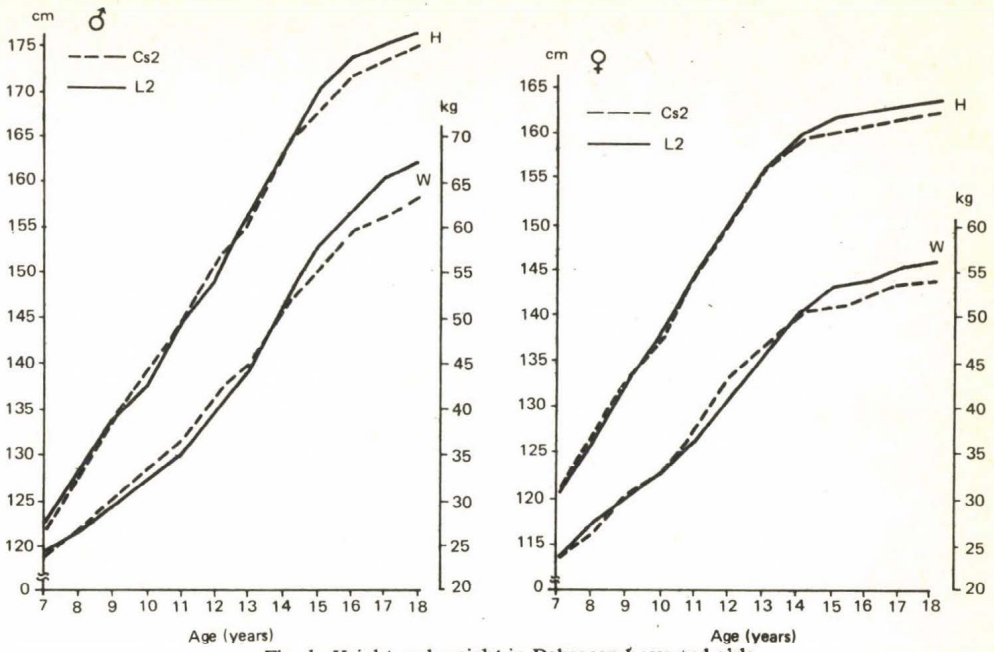

Fig. 1: Height and weight in Debrecen boys and girls

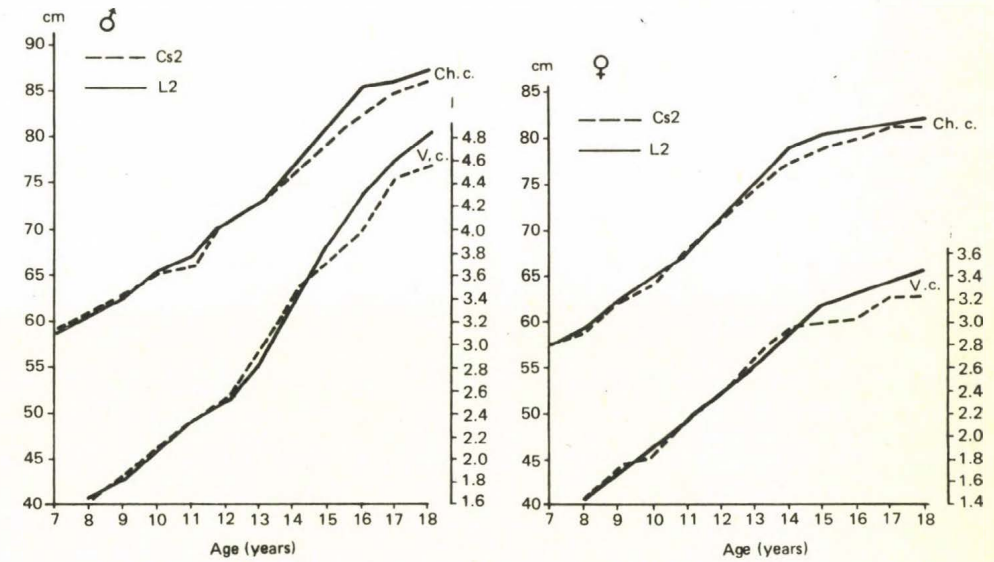

Fig. 2: Chest circumference and vital capacity in Debrecen boys and girls

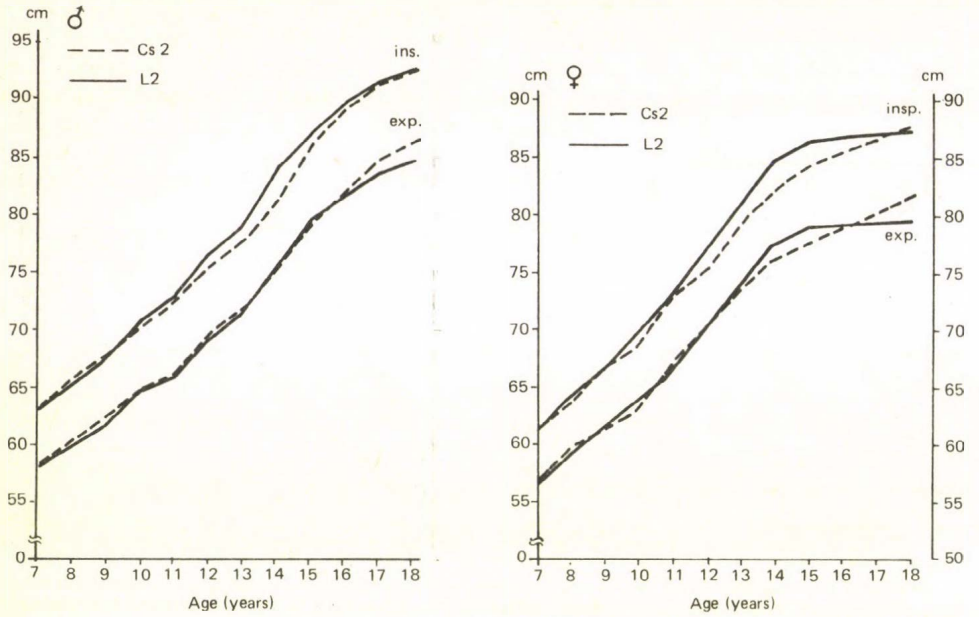

Fig. 3: Chest circumference in maximal inspiration and exspiration in Debrecen boys and girls

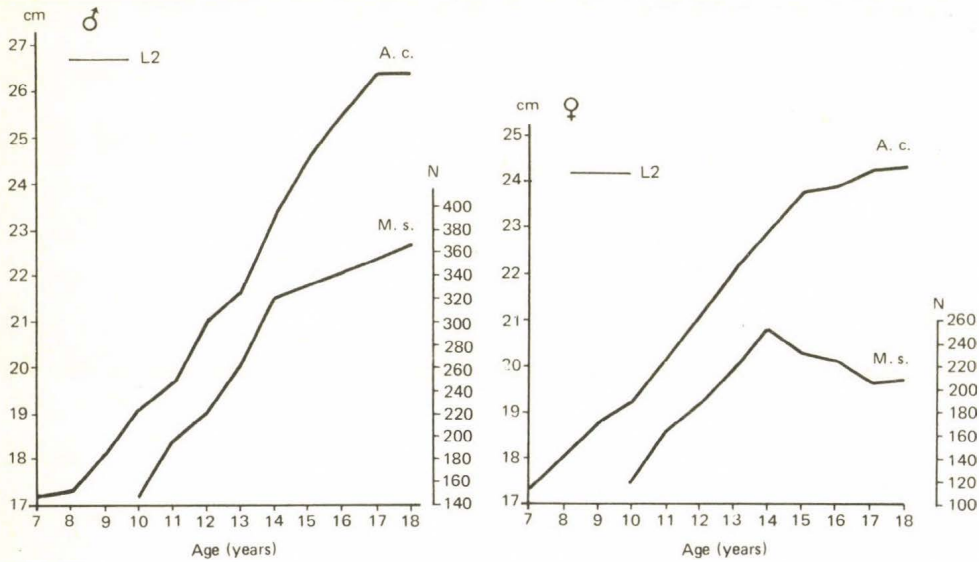

Fig. 4: Upper arm circumference and hand strength in Debrecen boys and girls

Table 1. Percentile values of height (cm) and weight (kg) of Debrecen boys and girls

Boys							Age (year)	Girls						
p3	p10	p25	p50	p75	p90	p97		p3	p10	p25	p50	p75	p90	p97
113.5	115.5	119.0	122.0	126.5	130.5	135.0	7	111.5	113.5	116.0	119.5	123.5	128.0	131.0
117.5	121.0	124.7	127.2	131.5	135.5	140.2	8	115.5	120.0	123.0	127.0	130.5	134.5	137.0
124.0	127.5	129.5	133.0	136.5	141.0	144.0	9	124.0	126.5	129.0	132.0	136.5	140.5	143.0
127.5	131.0	133.2	137.5	141.5	145.5	150.0	10	126.0	129.0	133.5	137.5	142.5	146.0	149.5
132.0	136.0	139.0	142.5	147.0	152.5	157.5	11	132.0	135.0	139.5	144.0	150.0	154.0	156.0
136.0	139.5	144.0	149.0	153.5	160.0	163.0	12	137.5	141.0	146.5	150.5	155.5	159.5	164.0
141.0	146.5	151.5	155.5	161.0	166.5	170.5	13	144.0	148.0	151.0	156.5	161.5	164.0	168.0
144.5	153.0	158.5	164.0	168.5	175.0	179.5	14	147.0	150.0	155.0	160.5	164.0	167.5	172.0
151.0	159.5	164.7	169.5	174.5	179.5	182.5	15	150.5	154.0	158.0	161.0	165.5	169.0	174.0
158.0	163.5	168.5	173.5	177.5	182.0	185.5	16	151.8	154.7	159.0	162.0	166.5	169.5	173.7
161.3	166.0	170.5	175.0	179.2	183.5	187.0	17	151.5	154.5	159.5	162.5	166.5	170.5	174.0
164.0	167.2	172.2	176.5	180.5	185.0	188.5	18	151.8	154.8	159.5	163.0	167.8	171.5	175.5
19.0	20.0	22.0	24.0	25.0	28.0	34.5	7	17.5	19.0	21.0	22.5	25.0	27.0	29.5
19.5	21.5	23.5	26.0	29.2	32.0	34.0	8	19.0	21.0	23.5	26.0	30.0	33.0	38.0
23.0	25.0	26.0	29.0	31.5	33.5	38.0	9	21.5	24.0	25.5	29.0	32.0	37.0	40.0
24.5	25.0	28.0	31.0	35.0	41.0	46.5	10	23.5	25.0	28.0	32.0	36.5	40.5	45.0
26.0	28.5	30.5	34.0	38.0	44.5	48.0	11	25.0	27.0	30.5	34.5	42.0	47.5	51.0
28.0	30.0	34.0	38.0	43.0	51.5	59.0	12	28.5	30.0	35.0	40.0	46.0	52.5	59.0
32.0	34.0	37.0	42.0	47.0	55.0	63.0	13	33.0	35.0	39.0	44.0	50.5	57.0	65.0
34.0	39.0	44.0	50.5	60.0	65.0	73.5	14	35.0	40.0	44.0	50.0	55.0	61.0	66.0
41.0	45.0	50.0	57.0	62.0	69.0	81.0	15	41.0	43.5	48.0	52.0	58.0	63.0	66.0
46.0	51.0	55.0	61.0	67.0	74.0	84.5	16	41.0	45.0	48.5	52.5	58.0	64.0	68.0
49.0	54.0	58.5	64.5	70.0	76.0	86.0	17	44.0	47.0	50.0	54.0	59.0	66.0	69.0
52.0	57.0	60.5	66.0	72.0	79.0	87.0	18	43.0	47.5	50.5	55.0	60.0	66.0	73.0

Table 2. Percentile values of chest circumference (cm) and vital capacity (lit.) of Debrecen boys and girls

Boys							Age (year)	Girls						
p3	p10	p25	p50	p75	p90	p97		p3	p10	p25	p50	p75	p90	p97
54.0	55.0	56.0	58.0	60.0	62.0	69.0	7	52.0	54.0	55.0	57.0	59.0	61.0	66.0
54.0	56.0	58.0	60.0	63.0	65.0	66.0	8	53.0	55.0	57.0	59.0	62.0	67.0	72.0
57.0	58.0	60.0	62.0	65.0	67.0	69.0	9	55.0	57.0	59.0	61.0	64.0	69.0	71.0
58.5	60.0	62.0	65.0	68.0	72.0	80.0	10	57.0	58.0	60.0	64.0	67.0	72.0	79.0
60.0	62.0	64.0	66.2	69.5	73.0	77.0	11	58.5	60.0	63.0	66.0	70.5	76.0	80.0
62.0	63.0	67.0	69.0	74.0	80.0	86.0	12	61.0	64.0	67.0	71.0	75.0	80.0	85.0
63.0	66.0	69.0	71.0	75.0	81.0	87.0	13	64.0	67.0	71.0	74.0	79.0	83.0	91.0
65.0	69.0	73.0	76.0	81.0	88.0	91.0	14	68.0	71.0	75.0	78.5	82.0	86.0	93.0
69.0	72.0	77.0	80.5	85.0	89.0	96.0	15	72.0	74.0	77.0	80.0	83.0	87.0	94.0
73.5	76.0	80.0	83.0	87.0	91.0	97.0	16	72.0	75.0	77.0	80.0	84.0	89.0	96.0
75.0	79.5	81.0	86.0	89.0	93.0	99.0	17	73.0	76.0	78.0	81.0	84.0	88.0	92.0
77.0	80.0	83.0	86.0	90.5	94.0	100.0	18	73.0	76.0	78.0	81.0	84.0	89.0	94.0
1.13	1.27	1.46	1.60	1.83	2.03	2.30	8	1.00	1.07	1.29	1.44	1.70	1.84	1.93
1.20	1.45	1.62	1.79	2.02	2.23	2.48	9	1.27	1.36	1.54	1.71	1.86	2.07	2.22
1.51	1.66	1.87	2.05	2.30	2.50	2.71	10	1.33	1.43	1.64	1.88	2.02	2.21	2.55
1.74	1.89	2.06	2.29	2.51	2.78	3.06	11	1.38	1.75	1.93	2.11	2.41	2.66	2.84
1.69	1.96	2.19	2.47	2.83	3.10	3.33	12	1.40	1.68	2.07	2.31	2.69	2.98	3.22
2.06	2.28	2.48	2.72	3.18	3.57	4.02	13	1.79	2.01	2.29	2.55	2.82	3.23	3.39
2.16	2.41	2.83	3.26	3.84	4.43	4.68	14	1.96	2.15	2.50	2.94	3.26	3.48	3.67
2.48	2.96	3.39	3.83	4.37	4.88	5.29	15	2.31	2.51	2.84	3.12	3.46	3.72	4.16
3.02	3.39	3.90	4.26	4.69	5.26	5.70	16	2.49	2.68	2.97	3.26	3.60	3.86	4.16
3.16	3.70	4.09	4.59	5.04	5.51	6.03	17	2.50	2.80	3.02	3.36	3.70	4.03	4.46
3.51	3.94	4.30	4.78	5.27	5.70	6.36	18	2.57	2.80	3.11	3.44	3.81	4.10	4.50

Summary

In their former investigations of the Debrecen children, the authors had found that the pupils' growth had accelerated at a great rate. They therefore performed a new corss-sectional study on more than 6000 pupils from the town aged 7–18 years in 1973–76. They then investigated the 7–8 year-old boys and girls (524 pupils) by remeasurings till their age of 18. Comparing the data of the pupils followed longitudinally to those of the ones in the latter cross-sectional study they observed a decrease of the highly accelerated development.

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