

GROWTH STANDARDS OF LJUBLJANA SCHOOL CHILDREN

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Abstract: In the years from 1974 to 1982 an anthropological longitudinal research of the physical development and the growth of stature and weight was performed in Ljubljana. Children were measured in one years intervals from the age of 7 to 14. For the final analysis 125 girls and 116 boys remained. The data were analysed with respect to sexual dimorphism, environmental factors and secular trend. Growth standards for height and weight were compiled.

Key words: Growth standards, Secular trend, Ljubljana children.

Introduction

Stature and weight are measurements which give us basic and most important data and information for evaluation of growth and development. They are the best indicators of health and nutrition state of individuals and of population in the research period (Tanner 1978, van Wieringen 1978, Rhoede-van Wieringen 1985).

As we wished to examine in detail the lows of changes in growth of both parameters we used the longitudinal method of work. We have worked out the growth standars and diagrams for the Ljubljana children. It is necessary to evaluate the growth of individuals in curative as well as in preventive medicine and also for anthropologists to study the changes in time and space. Physical growth is a sensitive indicator of a child overall condition. A deviation of a child's growth pattern may manifest itself before symptoms of the underlying disease or mental stress occur.

Growth standards composed at time intervals may reveal changes in growth. Such changes over period of time defined as secular shift or trend comprises changes in growth velocities, the age at which the adolescent spurt starts and stops, development of secondary sex characteristics.

The first longitudinal survey in the city of Ljubljana was carried out in the years 1954–1965 by the Health Protection Service for School Children and Youth at the Institute of Public Health (Skerget). Two cross-sectional survey were carried out in Ljubljana in the years 1939/40 by Institute of Biology (Škerlj) and in years 1969/70 by University Institute of Public Health (Dovecar).

The aim of our studies is to analyse dynamics of growth on the longitudinal data. We analysed individual differences in growth on the basis of centile values and also the data of height and weight according to socio-economic status and studie the secular trend in the city of Ljubljana.

Material and Methods

The measurements of height and weight of Ljubljana school children from the ages of 7 to 14 were taken by the Institute of Biology, University of Ljubljana in the period between 1974 and 1982. The programme was realised on 13 elementary schools in Ljubljana. There we selected out those children who reached their age of 7 between 15th September 1974 and 15th July 1975. The selected children were observed and measured

at intervals of one year on their birthday with the tolerance of ± 30 days. From the original number of 314 children (149 boys and 165 girls) we managed to keep due to migration and moving to other schools only 241 (116 boys and 125 girls). We performed the measurement every two months. Children were measured barefoot and in light underwear.

Standing height was measured by Martin's anthropometer with the child's head in Frankfort plane and the heels together. The child was encouraged to stretch itself actively. The step scale was used for the weighing and was checked before each session. Both parameters were measured all the time by the same person.

Basic statistics were calculated on DEC-SYSTEM-10 and results tested with HEWLETT PACKARD 9820 A.

As we already had the longitudinal data we wanted to study the diagram of personal growth and development. We calculated centile values: $C_3, C_{10}, C_{25}, C_{50}, C_{75}, C_{90}$ and C_{97} . To analyse the harmonical growth of both parameters in the same time, we draw 241 individual diagrams on the growth centile standards.

Children were grouped to three socio-economic groups according to occupational status of father. Variation in height and weight was tested for average values.

Results

We have calculated for stature and weight the centile values which are separately for boys and girls shown on the Table 1. The growth diagrams – centile standards are shown on the Fig. 1 for boys and Fig. 2 for girls.

Table 1. Standards values of height and weight of Ljubljana boys and girls

Age (years)	C_3	C_{10}	C_{25}	C_{50}	C_{75}	C_{90}	C_{97}
Boys							
Height (cm)							
7	115.18	119.16	121.81	124.37	127.63	130.97	135.77
9	127.24	129.25	132.78	135.86	138.88	141.72	147.93
11	135.04	138.14	142.66	146.74	149.18	153.64	158.70
14	151.05	154.78	161.52	166.93	172.17	175.66	180.53
Weight (kg)							
7	19.89	21.79	23.55	25.06	27.42	31.24	35.72
9	24.85	26.82	28.59	30.99	33.94	39.96	47.31
11	28.59	31.62	33.33	37.09	41.88	50.37	58.64
14	38.29	43.07	49.57	55.84	61.54	70.26	82.01
Girls							
Height (cm)							
7	113.96	118.69	121.35	123.90	127.86	131.11	134.34
9	125.33	129.72	133.02	135.98	139.92	144.21	147.34
11	137.66	140.48	144.29	148.09	153.26	126.52	161.00
14	152.19	156.46	160.12	164.14	166.93	171.12	174.34
Weight (kg)							
7	19.80	20.80	22.91	25.05	28.06	31.67	35.18
9	24.58	25.91	28.59	32.07	35.81	41.97	47.70
11	29.00	31.55	35.38	39.83	44.96	50.37	60.48
14	43.98	47.17	50.82	55.84	62.91	67.34	80.22

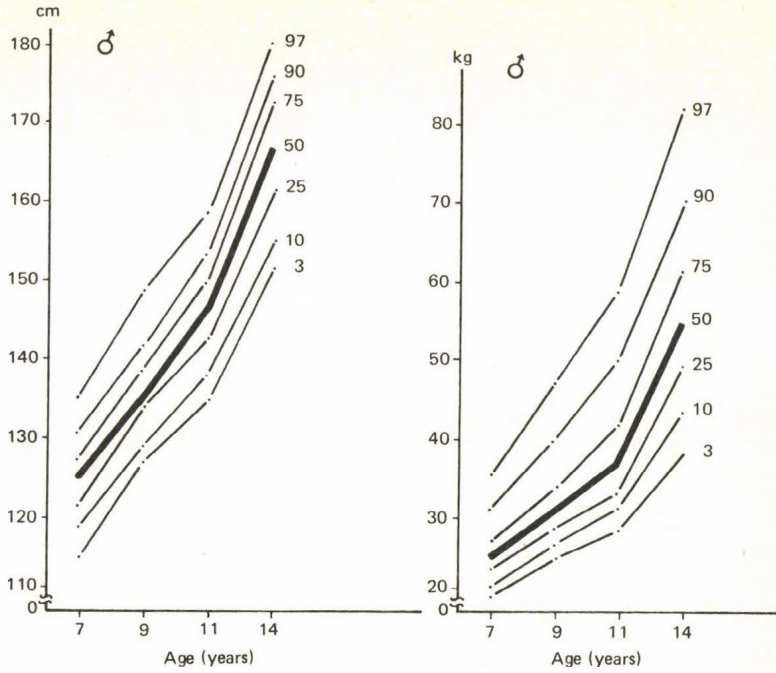


Fig. 1: Centile values of height and weight – Boys

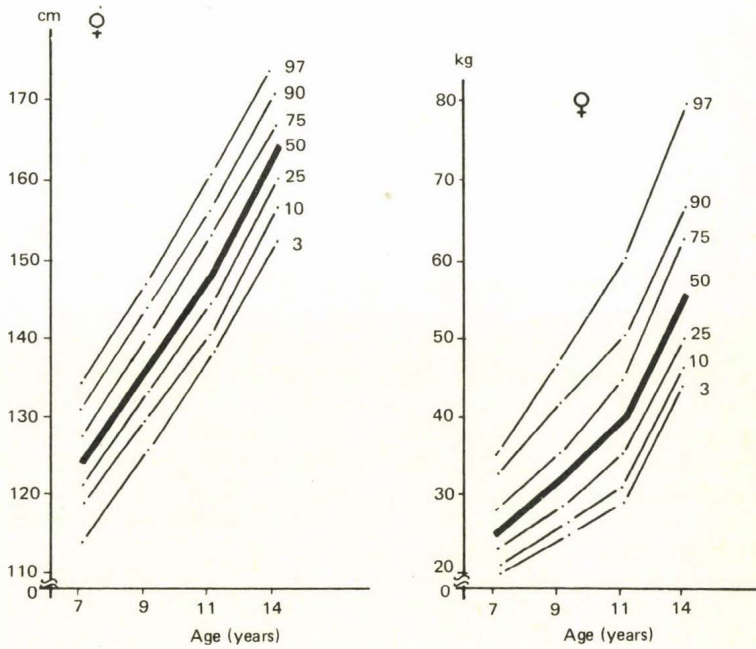


Fig. 2: Centile values of height and weight – Girls

With regard to advantage of our longitudinal data, we have drawn all the 241 particular individual growth curves separately in the centile standards, regarding sex, both for stature and weight. We wanted to establish harmony in the growth of both measurements.

We have classified all the 241 sets of the individual development curves into two groups regarding the conditions at the age of 14:

Group A: Both parameters have values in the same centile ranges. This groups was divided into three subgroups with regard to the position of the stature and weight in the centile net as follows: (1) Stature and weight are in the centile range between $C_{7.5}$ and $C_{2.5}$; (2) Stature and weight are in the centile range above $C_{5.0}$; (3) Stature and weight are in the centile range under $C_{5.0}$.

Group B: Stature and weight in different centile ranges. This group was divided into two subgroups: (1) Stature in the centile range above $C_{5.0}$, weight in the centile range under $C_{5.0}$; (2) Stature in the centile range under $C_{5.0}$, weight in the centile range above $C_{5.0}$.

The analysis of the distribution of children investigated (Table 2) has proved that Ljubljana boys and girls predominate a harmonious development. In one third of the cases their stature and weight are about the mean values, between $C_{2.5}$ and $C_{7.5}$ (boys 37.1%, girls 33.6%). Such a case is shown in Fig. 3. The stature and weight the boy No. 141 were very near to the limits of $C_{5.0}$ during his primary school career, i.e. in the limits of the calculated mean values.

Table 2. Position of individual height (H) and weight (W) in centile standards

Position	Boys		Girls	
	N	%	N	%
Group A				
1. H and W from $C_{2.5}$ to $C_{7.5}$	43	37.1	42	33.6
2. H and W over $C_{5.0}$	31	26.7	32	25.6
3. H and W below $C_{5.0}$	33	28.4	31	24.8
Group B				
1. H over $C_{5.0}$, W below $C_{5.0}$	5	4.3	9	7.2
2. H below $C_{5.0}$, W over $C_{5.0}$	4	3.5	11	8.8
Total	116	100.0	125	100.0

There were 26.7% of taller and at the same time heavier boys and 24.8% of girls. Such a case was boy No. 181 (Fig 4). His stature was at about $C_{9.0}$ during the period investigated. His weight was above $C_{9.7}$ at 7, 9 and 11, but at 14 little under this centile.

In the group of children with low values of stature and weight there were 28.7% boys and 24.8% girls. The boy No. 147 (Fig. 5) had his stature at 7, 9 and 11 between $C_{2.5}$ and $C_{1.0}$ and at 14 even under C_3 . His weight moved at 7, 9 and 11 between $C_{2.5}$ and $C_{1.0}$, and at 14 it was on the same way as his stature, reached C_3 .

Unharmonious development and different position of stature and weight was established only with small number of children. There were 4.3% of tall and proportionally light boys and 7.2% those of girls. The girl No. 20 (Fig. 6) was tall and light during her measuring period. Her stature was all the time between $C_{7.5}$ and $C_{9.7}$ but her weight between $C_{1.0}$ and $C_{5.0}$. At 14 this girl was 174 cm tall ($\bar{x} = 163.7$ cm) and weighted only 49.0 kg ($\bar{x} = 57.1$ kg).

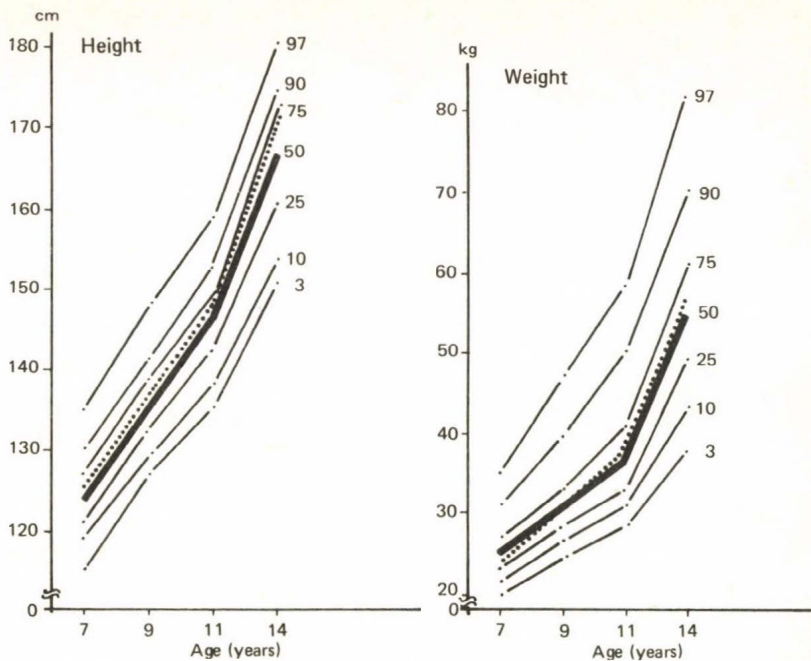


Fig. 3: Growth in height and weight of Boy No 141

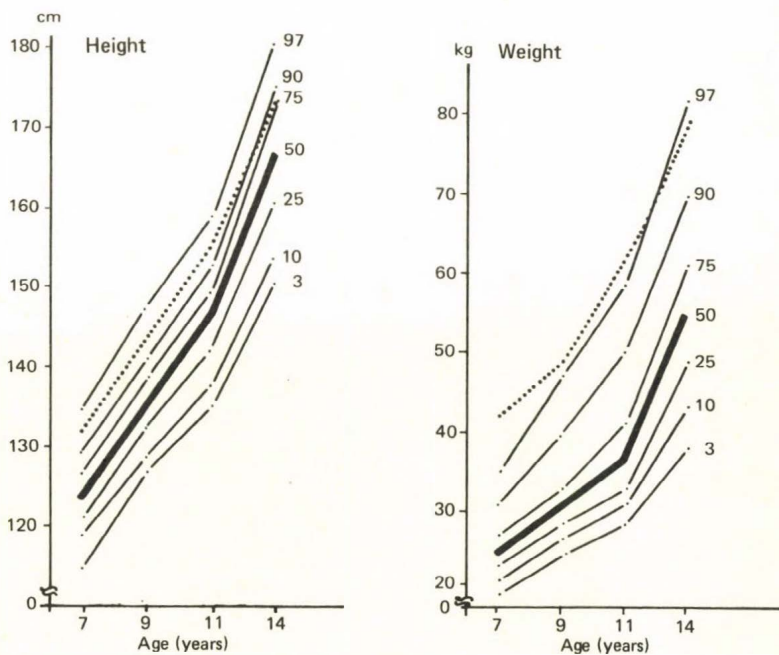


Fig. 4: Growth in height and weight of Boy No 181

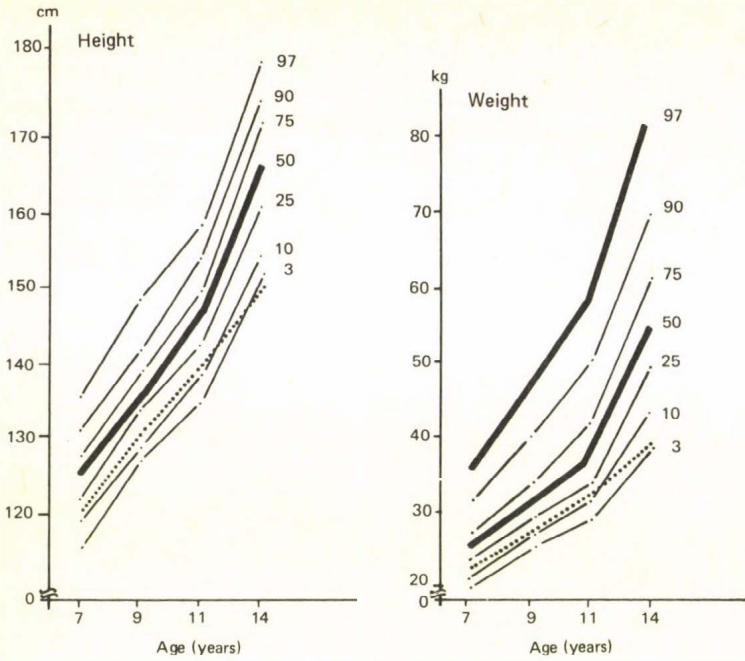


Fig. 5: Growth in height and weight of Boy No 147

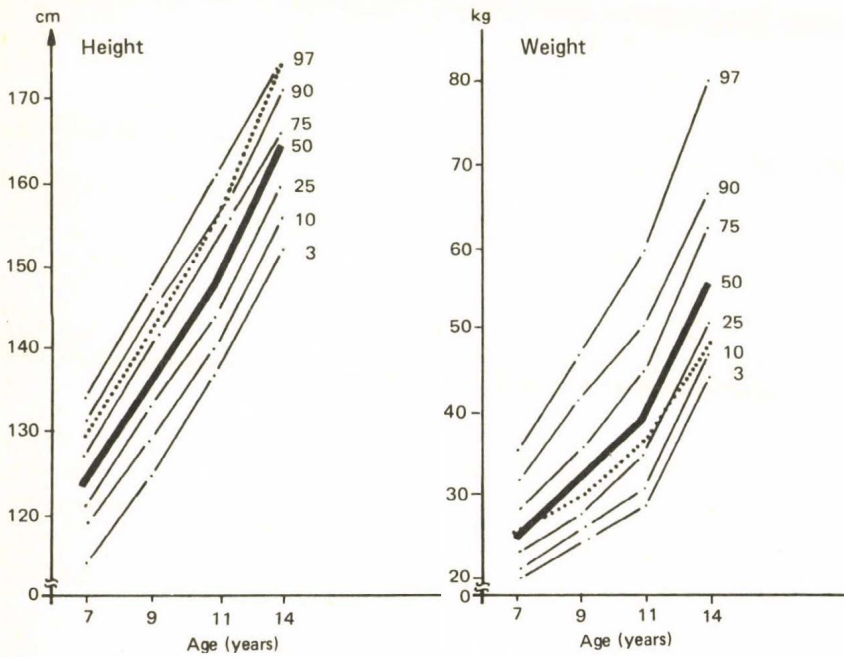


Fig. 6: Growth in height and weight of Girl No 20

Lower stature and higher weight was found in 3.5% of boys and in 8.8% of girls. The girl no. 90 (Fig. 7) from 7 till 14 had her stature on $C_{2.5}$ and her weight was at these ages above $C_{9.0}$. At 14, this girl was 161.7 cm high ($\bar{x} + 163.7$ cm) and weighed 73.0 kg ($\bar{x} = 57.1$ kg).

There were more girls than boys in the groups with different stature and weight. It is possible that the girls in both studied parameters were more variable than boys.

Discussion

We evaluated our longitudinal study in the frame of comparative studies made also in Ljubljana and carried out with the same methods. Series which suited our need were: longitudinal series made in Ljubljana in the years 1954 to 1965 (Skerget 1965) and cross-sectional series from the years 1939/40 (Škerlj 1950) and 1969/70 (Dovečar 1973). The comparison of mean values is shown in the Table 3.

Table 3. Mean height and weight of Ljubljana school children

Age (year)	sex	1939/40		1954/65		1969/70		1974/82	
		N	\bar{x}	N	\bar{x}	N	\bar{x}	N	\bar{x}
Height									
7	♂	—	—	46	124.9	103	123.7	115	124.6
	♀	—	—	43	125.0	110	133.6	125	124.6
9	♂	—	—	55	135.9	101	134.6	116	136.0
	♀	—	—	58	135.0	104	133.3	125	136.6
11	♂	75	139.6	48	146.4	103	144.8	111	146.1
	♀	94	141.3	52	147.9	104	147.1	117	148.5
14	♂	147	154.5	38	164.7	127	161.0	116	166.5
	♀	260	154.8	46	162.3	108	161.4	125	163.7
Weight									
7	♂	—	—	45	25.3	103	25.1	115	25.9
	♀	—	—	43	24.0	110	24.6	112	25.8
9	♂	—	—	54	30.5	101	30.6	116	32.1
	♀	—	—	59	29.9	104	29.4	125	32.6
11	♂	75	32.5	47	38.3	103	37.7	111	38.8
	♀	94	33.1	53	39.1	104	39.1	117	40.7
14	♂	147	43.7	37	52.9	127	51.7	116	56.3
	♀	260	45.9	46	55.3	108	53.6	125	57.1

Comparing of all the four series, we certainly have to take into account the difference in years of research. During these years changes in quality of life occurred and, of course, essential raising of living standard. From the previous studies we already knew the changes of stature and weight during the last decades, established and acknowledged the secular trend (Brodar 1974, Dovečar—Arko 1975, Dovečar 1978, Tomazo-Ravnik 1981). This phenomenon of quicker development in physical and psychical aspect is observed in most countries all over the world in all categories of inhabitants (Wolański 1973, Tanner 1978, van Wieringen 1978, Rhoede—van Wieringen 1985).

The results of the longitudinal study in the years 1954–1965 in comparison with our series, show, there are no statistically significant differences between the average values

of the stature in girls. Boys are significantly higher only at 14 when the difference is 1.8 cm ($P = 0.05$). In weight the differences are significant on the level $P = 0.05$ in 14 year-old boys and in girls at 7 and 9. In spite of all mentioned differences these are in contrary to our expectation quite small. The reason for this is first of all the small number (between 20 and 50) of children measured in the old serie.

We were interested also in time and age, respectively, when in girls overtake boys in physical development. In the old series this overtaking in stature occurred at age of 11. The sex difference to the advantage of girls in 1.5 cm. In our series girls overtake the boys in stature already at 9. The difference at 11 is 2.5 cm. In weight the girls of our series overtake the boys at the age of 9, in the old series comes to crossing of the curves at the age of 10.

The comparison of our data to the results of the series of children measured in the years 1939/40 is possible only at the age of 11 and 14 years. As we expected, the difference between the average values of stature as well as of weight at both ages are high and statistically significant. The rise of stature after the 1940s in 14 year-old boys is 12.0 cm and in 14 year-old girls 8.9 cm. The high increase of average values is probably conditioned by a better state of health and a better quality of food. The weight followed these increases, too. In case of 14 year-old children during 40 years the average weight increased by 12.6 kg in boys and 11.2 kg in girls, respectively.

The changed nutrition is one of the essential reasons for acceleration or retardation of growth. The data show that the acceleration highly declined due to shortage in the first and the second world wars. Where the condition due to shortage were very bad and nutrition troubles very long lasting, it came to interruption of acceleration or even to retardation. During the war time the acceleration was not interrupted only because of bad nutrition but also have to take into account psychical factors like stress, fear, etc. Between the two world wars and especially after the second world war the acceleration attended again very much (van Wieringen 1978, Brodar 1974).

The second cross-section series of Ljubljana's children were measured in the years 1969/70. Compared our data to this series of measurements – which are older for about 10 years than ours – we can see that the average values in our series are higher. The differences in boys are significantly higher only at the age of 14. They are 5.5 cm in stature and 4.6 kg in weight. Our girls are significantly higher than the girls of the older series. The difference at 9 year of age is 3.2 cm and at 14 year of age it is 2.3 cm. While significant differences in boys' weight occur only at 14, the girls of our series are significantly heavier than their counterparts before 10 years. The differences were at 7 year of age 1.2 kg, at 9 3.2 kg and at 14 3.5 kg. The girls of 1969/70 series overtake the boys in stature at 11 year of age when they were higher by 2.3 cm and in weight as well as at 11 when they were heavier by 1.9 kg (Figures 8 and 9).

Similar results about secular trend has achieved also Prebeg when comparing the series of children and youth of Zagreb (Prebeg 1978, 1984). Series of children and youth from the years 1951, 1964, 1973 and 1982 were compared. The increase of average values of stature and weight during the last decades in Yugoslavia was described also by Ivanović (1985) for the area of Titograd and by Gavrilović et al. (1983) for the area of Vršac.

In our future research we would therefore wish to study these problems in such a way that we would take into account more information on the way of life, on the income of a family members, nutrition, education and similar factors influencing growth and development.

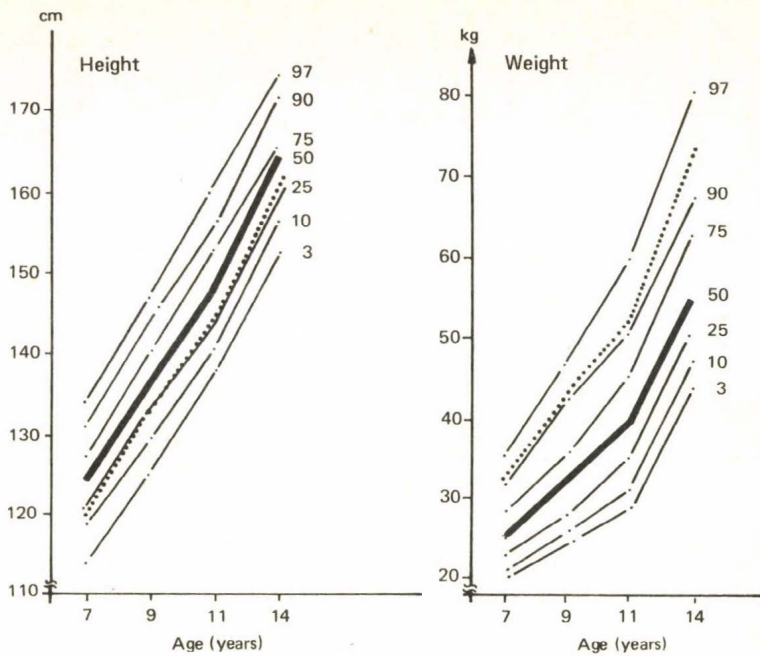


Fig. 7: Growth in height and weight of Girl No 90

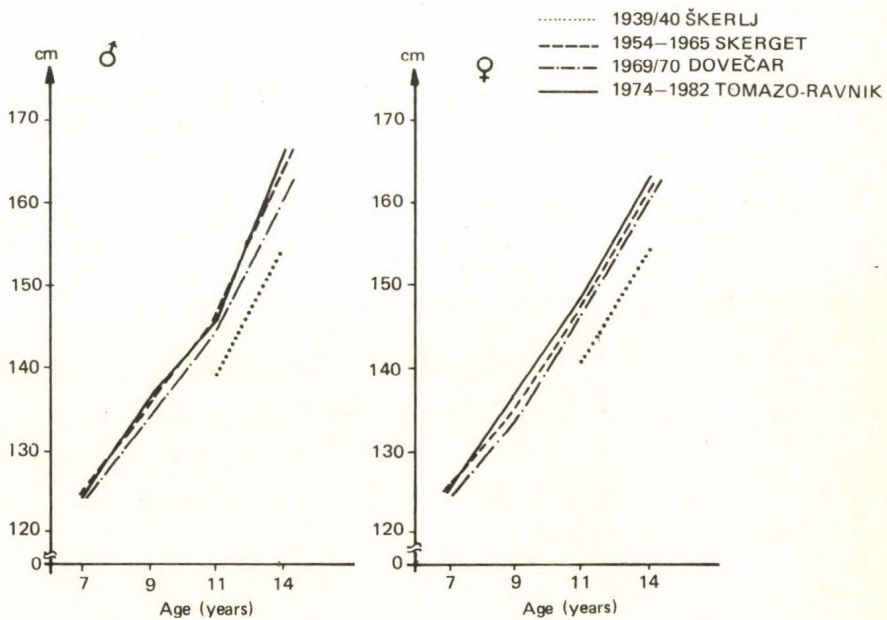


Fig. 8: Comparison of mean height values of Ljubljana series

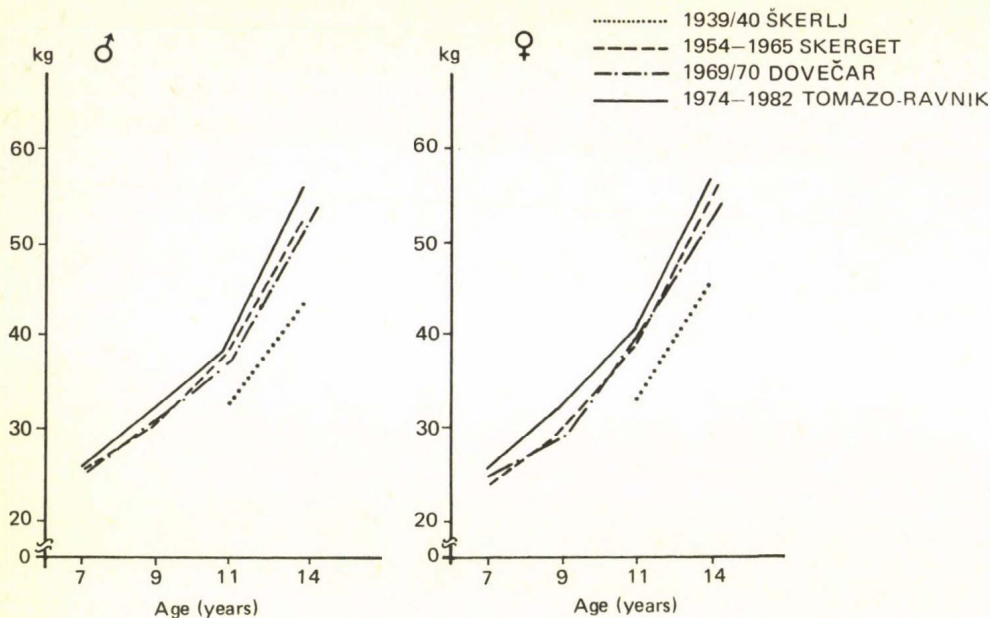


Fig. 9: Comparison of mean weight values of Ljubljana series

Summary

Based on longitudinal growth data of stature and weight of Ljubljana primary school-children in the age of 7–14, we elaborated centile standards. The work was done in the years 1974–1982.

The analysis of individual data drawn in centile standards shows that in our series overwhelming majority of children shows a convenient growth of stature and weight (92.2% of boys and 84.0% of girls). There are more cases of inconsistent development of both parameters with girls.

We established the secular changes between our series and the series of Ljubljana's children measured in the years 1939/40, 1954–1965, and 1969/70. Socio-economic differences in primary school population in the period 1974/82 have not essentially influence the values of stature and weight.

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