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NEW STANDARDS OF HEAD, CHEST AND ABDOMEN CIRCUMFERENCES FOR CZECH CHILDREN

ABSTRACT — *The 4th National Anthropological Cross-sectional Research of Children and Adolescents covering the 0—18 years age bracket (1, 2, 3) took place in September 1981 in Czechoslovakia. The research linked up with the three preceding ones undertaken in 1951, 1961, and 1971 was based on a representative sample of children. The data obtained were processed separately in Slovakia and in the Czech Provinces under the observance of the same procedures.*

The aim of the research was to ascertain new representative growth standards. The study was focused on the problems of body height, body weight, and circumferences of head, chest and abdomen.

The present paper summarizes the results obtained by measuring the circumferences of heads, chests and abdomens, comparing them with the results of the preceding National Anthropological Researches realized in the years 1961 and 1971. In the year 1951 no circumferential measures were taken. Circumferences of the abdomen were measured for the first time only at the last research in the year 1981. The results thus obtained are presented in the enclosed tables and graphs.

KEY WORDS: *Czech children — Head circumference — Chest circumference — Waist circumference.*

MATERIAL AND METHODS

The sample comprised 4 % of children, i.e. 120,000 individuals from the Czech Provinces selected through a threephase random sampling, proportional to the number of children in the administrative regions, districts and localities. A total of 60,000 children were examined at the age of 0 to 6 years and divided into a greater number of age groups with smaller intervals. Thus a more detailed analysis was ensured at the period of accelerated growth during the preschool age. The same number of children was examined in the 6—18 years age bracket, divided into one-year groups and each sex was processed separately.

Children of pre-school age were examined by pediatricians and their nurses at public health facilities, children of school age and adolescents were measured by their teachers in schools and in training apprentice centres of all types.

All research workers were acquainted in advance and in detail with the uniform methodology at regional briefing courses where they were issued uniform measuring devices, letters for parents and instructions for filling in the questionnaires. The circumferential dimensions were measured by band measure. Orders for the measuring instruments were placed with a single manufacturer, to ensure the comparability of results. In the course of the measurements several random tests were realized to make sure that the agreed methodology was used.

The circumference of the head was measured in the front over the glabella, girthing the greatest vaulting of the skull. On measuring the chest circumference the band measure at the back was below the lower angles of the shoulder-blades, and in the front in boys over the breast nipples, in girls over the point mesosternale. On measuring the abdomen circumference the band measure was put perpendicu-

larly to the trunk over the navel in babies, and over the narrowest place over the crest of the hip bones and in front of the navel in older individuals.

Following the collection the data material was statistically processed, first at the Beroun Computing Centre, and then at the Centre of Mathematical Statistics and Programming of the Prague Institute of Hygiene and Epidemiology.

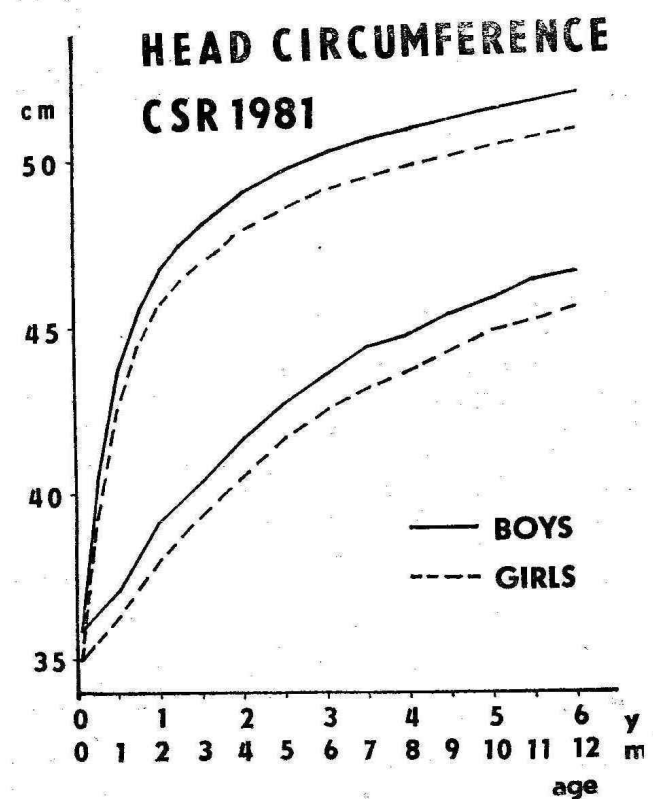
RESULTS

Circumference of the head of boys and girls in the 0-6 years age bracket (Graph No. 1)

The mean circumference of the head in baby boys following birth is 36 cm and of girls 35 cm, at three years of age the boys reach the mean value of 50 cm and girls 49 cm, at 6 years the respective values were 52 cm in boys and 51 cm in girls.

The curves illustrating the development of the maximum circumference of head in boys and girls in the 0-6 years age bracket show a steep rise in both sexes up to the age of 1.5 years, with a subsequent slow-down of the growth. From 4 to 6 years of age the growth is linear. The curves have the same form in both sexes, the difference between mean values being about 1 cm.

The curves from the years 1971 and 1981 up to the age of 1 year overlap and are steeper than the 1961 curve. The difference is about 0.2 of *S.D.* This difference continues to grow so that at the age of 2 years the 1981 curve declines from the 1961 curve and



GRAPH 1. Head circumference of Czech boys and girls from 0 to 6 years.

TABLE 1. Head Circumference of Czech Boys

Age	N	M	S.D.
1 Month	730	37.13	1.63
2 Months	579	39.25	1.70
3 Months	605	40.44	1.54
4 Months	583	41.73	1.39
5 Months	612	42.82	1.56
6 Montht	574	43.71	1.48
7 Months	597	44.49	1.48
8 Months	612	44.90	1.48
9 Months	555	45.51	1.46
10 Months	578	45.96	1.51
11 Months	545	46.46	1.51
1 Year	1,661	46.82	1.53
1.25 Years	1,844	47.58	1.49
1.50 Years	1,784	48.19	1.53
1.75 Years	1,688	48.59	1.57
2 Years	2,770	49.06	1.53
2.50 Years	2,531	49.75	1.50
3 Years	2,214	50.26	1.54
3.50 Years	2,441	50.71	1.46
4 Years	3,972	51.00	1.46
5 Years	2,885	51.56	1.56
6 Years	2,334	52.05	1.51
7 Years	2,349	52.31	1.51
8 Years	2,351	52.79	1.60
9 Years	2,341	53.23	1.59
10 Years	2,257	53.59	1.63
11 Years	2,225	53.94	1.63
12 Years	2,289	54.33	1.64
13 Years	2,435	54.87	1.69
14 Years	2,243	55.48	1.75
15 Years	2,301	56.07	1.67
16 Years	2,543	56.61	1.74
17 Years	2,413	57.00	1.72
18 Years	2,006	57.23	1.68

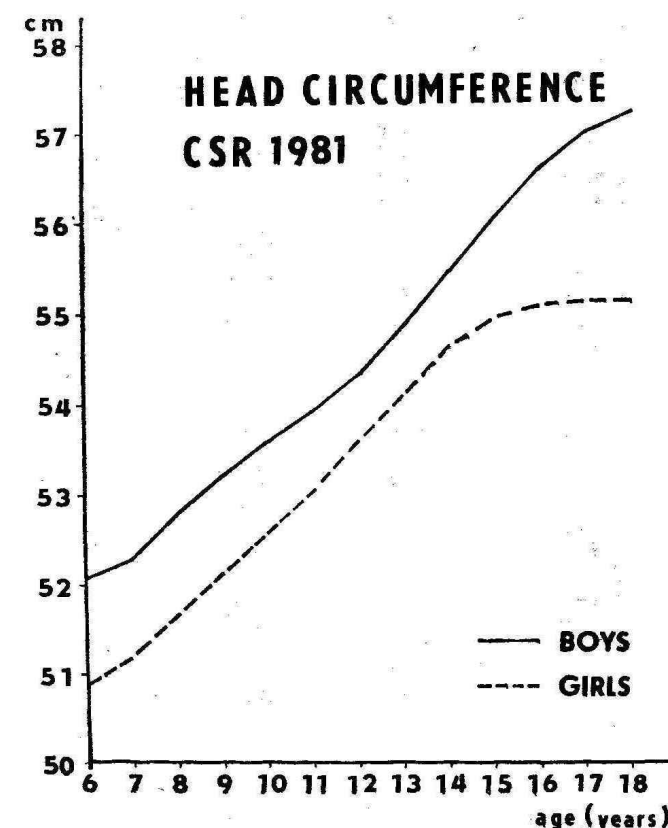
remains steeper. The difference between the values of the years 1981 and 1961 reach $+0.5$ of *S.D.* at 3 years and $+0.6$ *S.D.* at the age of 6 years. In girls the resemblance in age groups from 1971 and 1981 persists up to 6 years. The difference as compared with 1961 reaches $+0.4$ cm at 3 and 6 years corresponding to $+0.3$ of *S.D.*

Circumference of the head in boys and girls from 6 to 18 years (Graph No. 2)

The circumference of the head of boys at the age bracket of 6 to 18 years develops in the form of a moderately concave curve changing in a moderately convex one in the highest age groups after the 15th year. In girls, the mean curve of the circumference of head is rising from 7 to 14 years practically linearly without any deviation, to stop at the value of about 55 cm at about 15 years of their age.

The curves of the circumference of head in boys and girls do not cross in their whole course, reaching the closest approximation between the 12th and 14th year. At the age of 6 years the circumference of the head reaches 52 cm in boys and 51 cm in girls, at 12 years being 54.3 cm in boys and 53.6 cm in girls, the mean circumference of the head in boys reaches 57.3 cm and that of girls 55.1 cm at the age of 18 years.

The difference in mean values of the circumference of head in boys, as compared with the year



GRAPH 2. Head circumference of Czech boys and girls from 6 to 18 years.

TABLE 2. Head Circumference of Czech Girls

Age	N	M	S.D.
1 Month	724	36.27	1.56
2 Months	563	38.01	1.52
3 Months	624	39.33	1.55
4 Months	567	40.51	1.43
5 Months	600	41.65	1.43
6 Months	609	42.46	1.34
7 Months	567	43.23	1.40
8 Months	616	43.73	1.41
9 Months	531	44.33	1.57
10 Months	600	44.93	1.54
11 Months	575	45.22	1.46
1 Year	1,668	45.58	1.52
1.25 Years	1,811	46.37	1.49
1.50 Years	1,872	46.95	1.51
1.75 Years	1,712	47.44	1.47
2 Years	2,826	47.86	1.49
2.50 Years	2,523	48.55	1.57
3 Years	2,203	49.09	1.50
3.50 Years	2,451	49.46	1.51
4 Years	3,975	49.83	1.51
5 Years	2,876	50.38	1.51
6 Years	2,474	50.90	1.44
7 Years	2,266	51.18	1.49
8 Years	2,437	51.68	1.51
9 Years	2,341	52.14	1.55
10 Years	2,269	52.59	1.57
11 Years	2,280	53.03	1.60
12 Years	2,330	53.61	1.60
13 Years	2,485	54.11	1.64
14 Years	2,233	54.64	1.57
15 Years	2,486	54.96	1.54
16 Years	2,832	55.10	1.55
17 Years	2,884	55.15	1.54
18 Years	2,418	55.14	1.50

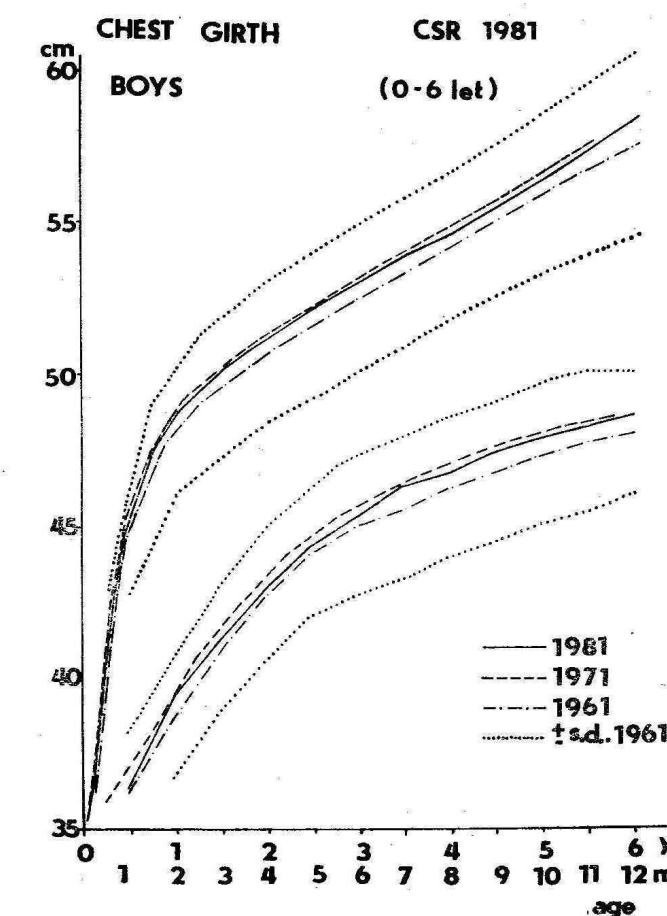
1961, is $+0.8$ cm i.e. $+0.5$ of *S.D.* at 8 years, $+0.9$ cm i.e. again $+0.5$ of *S.D.* at 16 years. This represents a relatively impressive acceleration in the growth of the circumference of head showing thus the highest dynamics in the whole period of growth. In girls the difference in comparison with the year 1961 is $+0.5$ cm i.e. $+0.35$ of *S.D.* at 11 years, $+0.8$ cm i.e. $+0.5$ of *S.D.* at 14 years and $+0.3$ cm i.e. $+0.25$ of *S.D.* at 18 years.

The circumference of chest in boys and girls from 0 to 6 years (Graphs Nos. 3, 4 and 5)

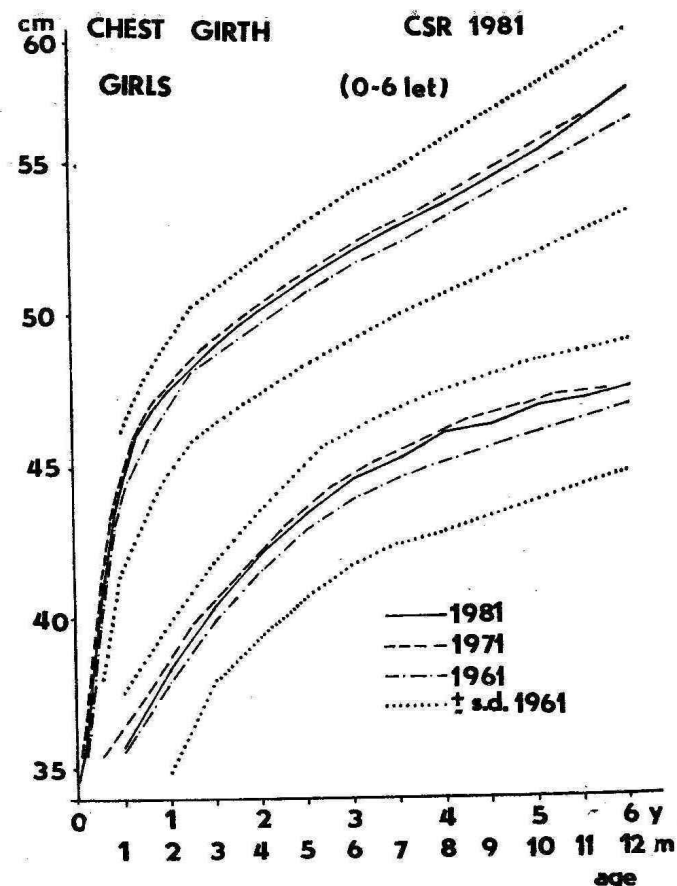
The circumference of the chest in boys presents a continuous convex curve at the period from 0 to 1 year with a transition of the steep increase into a moderate one at about 5 months of age. From the first year up to 6 years the curve shows a gradually rising almost linear course. The curve of girls is similar, with the inflection point at the age of 6 months.

The mean value of the circumference of chest in boys is 35.3 cm and 34.6 cm in girls (read from graphs) after birth. In the first year the mean circumference of chest in boys is 48.7 cm and 47.5 cm in girls, at the age of 3 years it is 53 cm in boys and 52 cm in girls, reaching 58.5 cm in boys and 57.3 cm in girls at 6 years.

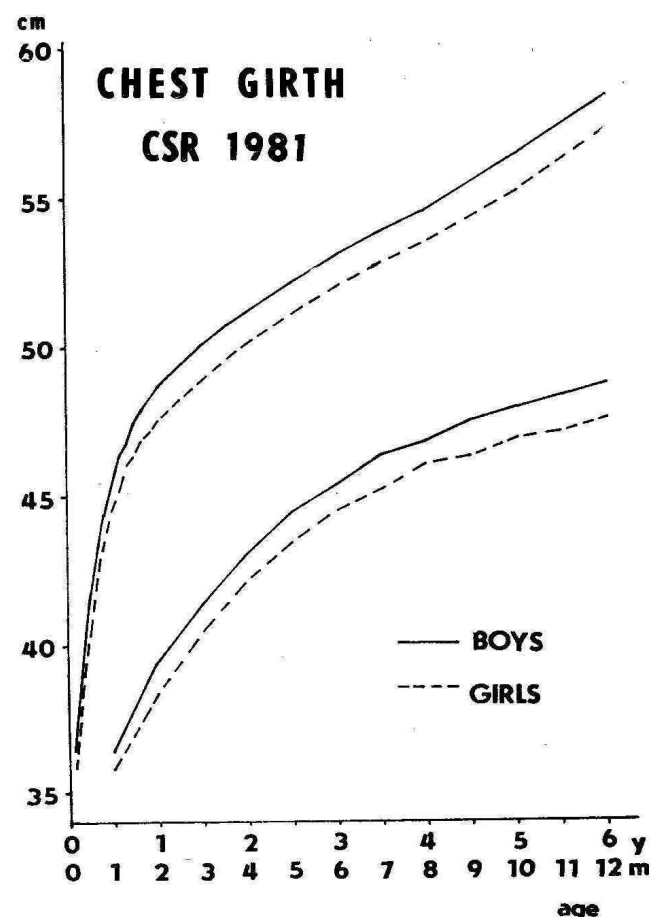
The mean values of circumferences of chest in boys from the year 1981 are to be found between those of the year 1961 and 1971, nearer to those of the



GRAPH 3. Chest circumference of Czech boys from 0 to 6 years.



GRAPH 4. Chest circumference of Czech girls from 0 to 6 years.



GRAPH 5. Chest circumference of Czech boys and girls from 0 to 6 years.

TABLE 3. Chest Circumference of Czech Boys

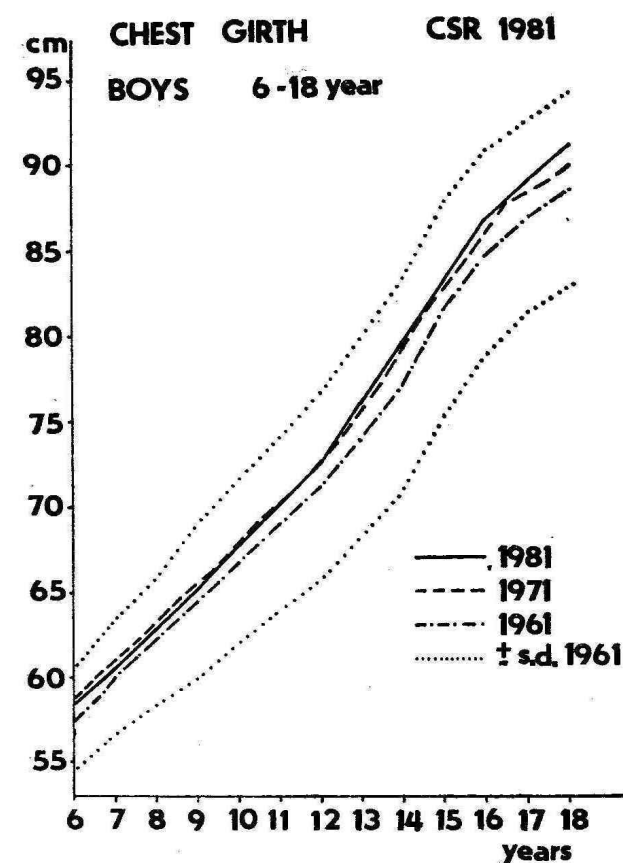
Age	N	M	S.D.
1 Month	730	36.43	2.31
2 Months	579	39.38	2.39
3 Months	605	41.39	5.26
4 Months	583	43.13	2.25
5 Months	612	44.46	2.30
6 Months	574	45.43	2.33
7 Months	597	46.39	2.30
8 Months	612	46.78	2.42
9 Months	555	47.48	2.43
10 Months	578	47.94	2.39
11 Months	545	48.31	2.49
1 Year	1,661	48.72	2.47
1.25 Years	1,844	49.44	2.35
1.50 Years	1,784	50.09	2.41
1.75 Years	1,688	50.72	2.45
2 Years	2,770	51.21	2.46
2.50 Years	2,531	52.16	2.42
3 Years	2,214	53.14	2.51
3.50 Years	2,441	53.86	2.52
4 Years	3,972	54.55	2.66
5 Years	2,885	56.41	2.89
6 Years	2,334	58.46	3.49
7 Years	2,349	60.62	3.66
8 Years	2,351	62.94	4.09
9 Years	2,341	65.21	4.75
10 Years	2,257	67.77	5.37
11 Years	2,225	70.17	5.93
12 Years	2,289	72.64	6.30
13 Years	2,435	76.12	6.90
14 Years	2,243	79.70	6.86
15 Years	2,301	83.36	6.52
16 Years	2,543	86.81	6.41
17 Years	2,413	89.12	6.15
18 Years	2,006	91.18	5.94

year 1971, i.e. they are lower than in the year 1971. The values of the year 1981 differ from the mean value from 1961 at the age of 6 months by +0.6 cm i.e. by +0.3 of *S.D.*, at the age of 3 years by +0.6 cm i.e. by +0.3 of *S.D.* and at the age of 6 years by +1 cm, i.e. by +0.3 of *S.D.* The curves of girls show similar differences compared with the year 1961 as those of boys, i.e. the difference at 6 months being +0.3 of *S.D.* and +0.35 of *S.D.* at 6 years.

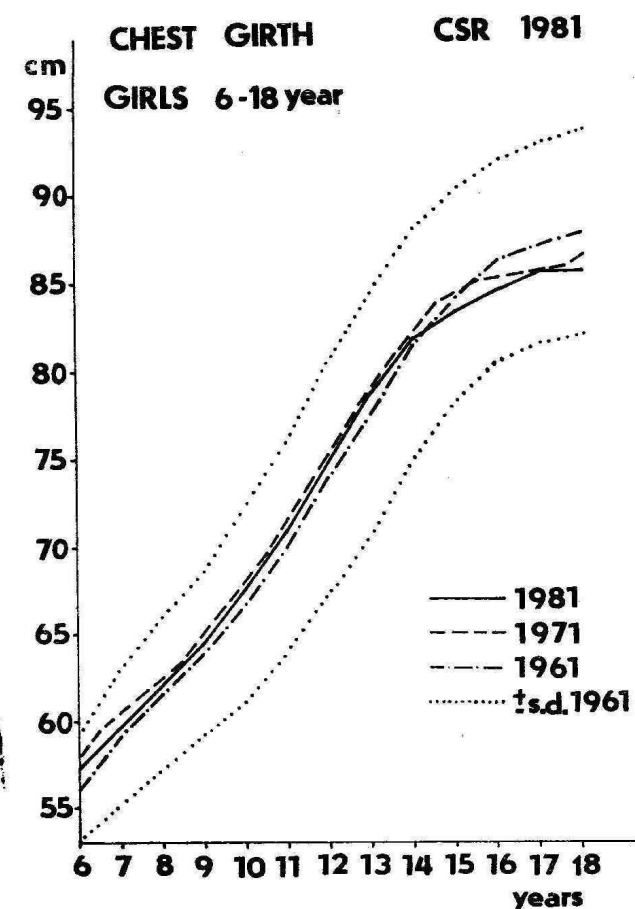
The circumference of chest in boys and girls from 6 to 18 years (Graphs Nos. 6, 7 and 8)

The mean circumference of chest in boys at the age of 6 years is 58.5 cm and in girls 57.2 cm, at 12 years in boys 72.5 cm and in girls 75.0 cm, reaching 91 cm in boys and 85.8 cm in girls at the age of 18 years. The curve of boys and that of girls cross for the first time at the age of 10 years and for the second time at 15 years. Between these two ages the circumferences of chests in girls are larger than those of boys.

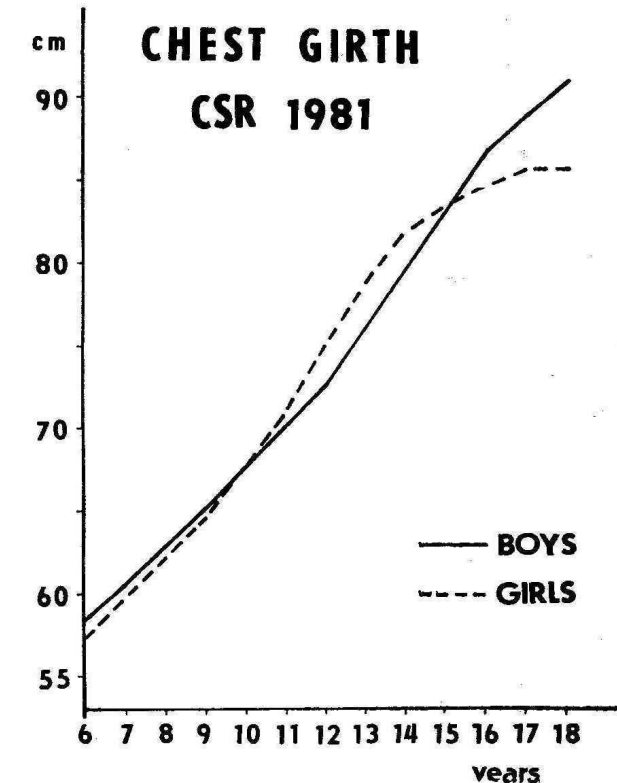
The circumference values of chest of boys in the year 1981 in the 6–12 years age bracket overlap those from the year 1971 or are lower to remain from now on always higher up to 18 years. On the contrary, in girls the mean values are altogether lower than those registered in 1971. At the age of 15 and more years the mean values of girls from 1981 are lower even in comparison with those from 1961. Whereas the course of the boys' curve does not indicate an early stagnation



GRAPH 6. Chest circumference of Czech boys from 6 to 18 years.



GRAPH 7. Chest circumference of Czech girls from 6 to 18 years.



GRAPH 8. Chest circumference of Czech boys and girls from 6 to 18 years.

TABLE 4. Chest Circumference of Czech Girls

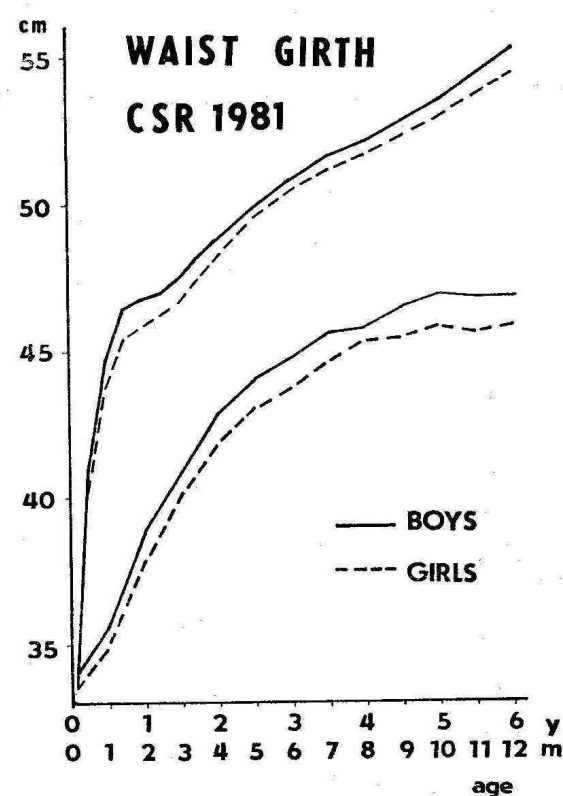
Age	N	M	S.D.
1 Month	724	35.78	2.12
2 Months	563	38.29	2.28
3 Months	624	40.42	2.16
4 Months	567	42.07	2.24
5 Months	600	43.43	2.39
6 Months	609	44.49	2.43
7 Months	567	45.22	2.38
8 Months	616	46.05	2.38
9 Months	531	46.27	2.50
10 Months	600	46.93	2.54
11 Months	575	46.06	2.28
1 Year	1,668	47.48	2.32
1.25 Years	1,811	48.21	2.33
1.50 Years	1,872	48.85	2.38
1.75 Years	1,712	49.46	2.39
2 Years	2,826	50.05	2.46
2.50 Years	2,523	50.06	2.53
3 Years	2,203	52.04	2.62
3.50 Years	2,451	52.75	5.58
4 Years	3,975	53.48	2.74
5 Years	2,876	55.20	3.18
6 Years	2,474	57.32	3.58
7 Years	2,266	59.68	4.14
8 Years	2,437	62.03	4.40
9 Years	2,341	64.45	5.31
10 Years	2,269	67.62	6.06
11 Years	2,280	70.88	6.83
12 Years	2,330	75.04	7.47
13 Years	2,485	78.78	7.35
14 Years	2,233	81.88	6.54
15 Years	2,486	83.51	6.31
16 Years	2,832	84.76	6.16
17 Years	2,884	85.81	6.19
18 Years	2,418	85.82	6.26

of growth after 17 years, that of girls does not change any more after the age of 17 years.

The difference in the circumference of chest in the year 1981 as compared with the year 1961 in boys at 10 years is +0.2, at 12 years +0.25, at 16 years +0.35 and in 18 years +0.45 of *S.D.* In girls the difference in 12 and 14 years is +0.15 of *S.D.* only. At the age of 13 years the mean values from the years 1981 and 1961 coincide and from then on the values of the year 1981 remain lower than in 1961; the difference being -0.3 of the standard deviation at the age of 18 years (about 2 cm).

Circumference of abdomen in boys and girls (from 0 to 6 years) (Graph No. 9)

The curve of the circumferences of abdomen in boys at the age of 6 years shows a sudden slow-down from the 9th month to become well-balanced again after the 18th month. The further course is almost linear with a moderate convexity from 2 to 4 years in both sexes. The course of the curve since birth up to 1 year is continuous, a transition from rapid to



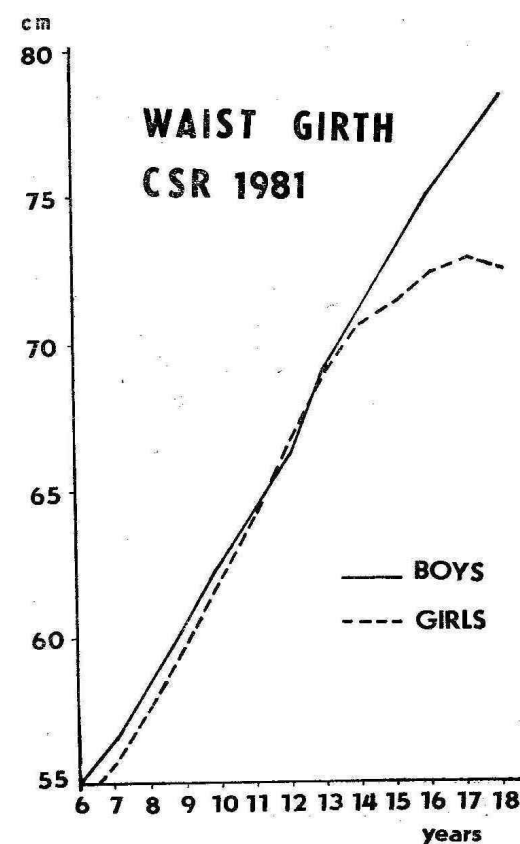
GRAPH 9. Waist circumference of boys and girls from 0 to 6 years.

gradual growth is taking place at about the 15th month of life.

In boys the circumference of abdomen at birth is 34 cm on the average, in girls 33.5 cm, at the age of 1 year roughly 47 cm in boys and 46 cm in girls, at 3 years 51 cm in boys, 50.5 cm in girls and 55.2 cm in boys and 54.3 cm in girls at the age of 6 years (read from graph). The increase from 1 month up to 1 year

TABLE 5. Waist Circumference of Czech Boys

Age	N	M	S.D.
1 Month	730	35.64	3.06
2 Months	579	38.89	3.10
3 Months	605	40.97	3.17
4 Months	583	42.88	3.18
5 Months	612	44.06	3.30
6 Months	574	44.76	3.30
7 Months	597	45.63	3.34
8 Months	612	45.82	3.76
9 Months	555	46.53	3.83
10 Months	578	46.90	3.63
11 Months	545	46.76	3.78
1 Year	1,661	46.81	3.70
1.25 Years	1,844	46.96	3.55
1.50 Years	1,784	47.53	3.48
1.75 Years	1,688	48.20	3.59
2 Years	2,770	48.79	3.43
2.50 Years	2,531	49.86	3.30
3 Years	2,214	50.84	3.34
3.50 Years	2,441	51.62	3.29
4 Years	3,972	52.12	3.46
5 Years	2,885	53.45	3.68
6 Years	2,334	55.04	4.39
7 Years	2,349	56.51	4.74
8 Years	2,351	58.45	5.13
9 Years	2,341	60.38	6.06
10 Years	2,257	62.52	6.54
11 Years	2,225	64.35	7.08
12 Years	2,289	66.19	7.56
13 Years	2,435	69.14	7.87
14 Years	2,243	71.09	7.30
15 Years	2,301	73.07	6.85
16 Years	2,543	75.06	6.70
17 Years	2,413	76.69	6.47
18 Years	2,006	78.36	6.11



GRAPH 10. Waist circumference of boys and girls from 6 to 18 years.

of age in boys and girls is more than 11 cm, from the first year up to 6 years it amounts to 8.5 cm in boys and 8.0 cm in girls.

Circumference of abdomen in boys and girls from 6 to 18 years (Graph No. 10)

The course of boys' curve from 6 to 18 years is in principle linear with noticeable acceleration of growth between the 12th and 13th year of life. The termination of the curve after the 18th year of life, however, does not show any tendency to slowing down the growth of abdomen circumference since that time. The girls' curve shows a different course

TABLE 6. Waist Circumference of Czech Girls

Age	N	M	S.D.
1 Month	724	34.83	2.65
2 Months	563	37.71	2.80
3 Months	624	39.98	2.91
4 Months	567	41.77	3.14
5 Months	600	42.99	3.31
6 Months	609	43.73	3.22
7 Months	567	44.60	3.42
8 Months	616	45.29	3.66
9 Months	531	45.43	3.80
10 Months	600	45.77	3.62
11 Months	575	45.57	3.53
1 Year	1,668	45.75	3.53
1.25 Years	1,811	46.16	3.54
1.50 Years	1,762	46.63	3.47
1.75 Years	1,712	47.42	3.31
2 Years	2,826	48.16	3.46
2.50 Years	2,523	49.53	3.44
3 Years	2,203	50.39	3.43
3.50 Years	2,451	51.07	3.53
4 Years	3,975	51.58	3.67
5 Years	2,876	52.90	4.17
6 Years	2,474	54.34	4.58
7 Years	2,266	55.73	5.14
8 Years	2,437	57.59	5.58
9 Years	2,341	59.72	6.42
10 Years	2,269	61.90	6.92
11 Years	2,280	64.07	7.38
12 Years	2,330	66.65	7.85
13 Years	2,485	69.02	8.15
14 Years	2,233	70.71	7.70
15 Years	2,486	71.36	7.57
16 Years	2,832	72.44	7.56
17 Years	2,884	72.94	7.24
18 Years	2,418	72.55	7.21

after the 13th year of their life when it begins to flatten. Since the 17th year of their life the mean circumference of abdomen in girls does not increase any more and on the contrary a decrease in mean values takes place at the age of 18 years as compared with values registered at 17 years. At the age of 12 years the circumference of abdomen in girls and boys is about 66 cm, at the age of 18 years the mean circumference in boys being 78.5 cm and in girls 73.5 cm.

The curves of boys and girls cross for the first time at 11 years and for the second time at 13 years. During

this period of life the mean circumference of abdomen in girls is higher than that of boys.

DISCUSSION

The results of this research corroborate that the head grows most conspicuously up to 1.5 years of age and in contrast to most other body dimensions the mean values in girls, from birth to maturity, do not surpass the mean values of boys. The maximum approximation of both curves takes place at about the 12th or 13th year.

As compared with the year 1961 we found permanently higher values during the total age period under investigation. With the year 1971 we are able to make comparisons to 6 years only, finding there higher values up to the first year of life, the absolute difference between the year 1971 and 1981 being lesser than the difference with regard to the year 1961. In the period up to 1 year, when we were able to compare the mean values in monthly intervals of age, we found higher values in the year 1971 more often than in 1981 in both sexes.

In the 6 to 18 years age bracket we have found in boys relatively higher acceleration, the values fluctuating in the majority of cases above +0.5 of *S.D.* as compared with the year 1961. In girls the difference with regard to the year 1961 is less than +0.5 of *S.D.* with the exception of the years 14 and 15 when they manifest the highest acceleration. After the 16th year a slow-down of the growth of head circumference up to its stagnation takes place. Thus they deviate from boys as well as from girls from the year 1961 when at that age still positive increase was registered.

On comparing the chest girths measured in the year 1981 with the results of the earlier researches we found that the mean values compared with the year 1961 are always higher in all classes of boys as well as of girls up to the age of 14 years; with regard to the results of the year 1971 the values are lower in both sexes, with the exception of values measured in boys of 1.5 years and above 13 years of age. Thus the daily experience of more consequent obesity control and the actual phenomenon of the younger generation growing more slim have been corroborated. The tendency of growing slimmer is especially conspicuous in the group of girls over the age of 14 years, compared with the year 1961. The two later research studies have registered an impressive average diminution of the circumference of chest. The respective mean values registered in girls in the year 1981 were lower than those found in 1971.

The circumference of the abdomen was measured for the first time in the year 1981, and thus we cannot make any comparisons. This dimension will be used for studying the physical proportionality. The relation between the chest circumference and between abdomen values makes it possible to decide whether excessive weight in some children is due to the prevalence of fat component or of the muscular and skeleton components.

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This research has been coordinated in the State Research Programme by Professor J. Houštěk and L. Pelech. It could have been realized thanks to the understanding of the Ministry of Public Health and of the Ministry of Education of the Czech Socialist Republic and thanks to the successful co-operation of pediatricians and nurses in selected public health facilities and thanks to the help of teachers in schools and apprentice training centres of all types. Our thanks are also due to the specialists of the Beroun Computing Centre and to the team of the Centre of Mathematical Statistics and Programming of the Institute of Hygiene and Epidemiology in Prague, namely to Ing. Z. Roth, CSc., Ing. J. Vígnerová and Dr. M. Josífko.

CONCLUSION

1. The present research of children and adolescents has made it possible to establish new standards for the

circumference of head, chest and abdomen for the needs of public health, physical training and pedagogical practice.

2. It has demonstrated accelerated development of the circumference of head from 2 years in both sexes as compared with the year 1961 and 1971, more impressive in boys. In girls the mean circumference of the head reaches its final value as early as in 17 years of age. In the group of boys a distinct tendency towards the augmentation of the circumference of the head is well perceptible even after reaching the 18th year.

3. The research has revealed an acceleration in the development of the circumference of the chest as compared with the year 1961, as well as a tendency towards slimming compared with the year 1971; the latter trend is more accentuated in girls than in boys and is especially spectacular in girls after reaching the 14th year.

REFERENCES

- FETTER V., PROKOPEC M., SUCHÝ J., ŠOBOVÁ A., 1963: Acceleration of development in youth according to anthropological researches realized in the years 1951 and 1961. (In Czech.) Čs. pediatrie 18, 8: 673—677.
- PROKOPEC M., SUCHÝ J., TITLBACHOVÁ S., 1973: Results of the IIIrd National Research of Youth in 1971. (In Czech.) Čs. pediatrie 28, 7: 341—346.
- PROKOPEC M., TITLBACHOVÁ S., 1983: National anthropological research of children and adolescents in 1981. Czech Countries. Final Report to the Research Task for the Ministry of Health-ČSR Praha.

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