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SELECTED PROPORTIONAL INDICES IN SOUTH BOHEMIAN CHILDREN

ABSTRACT: *We present in our paper the development of the Rohrer's index (RI), the Waist-Hip ratio (WHR) and subcutaneous fat (measurements of four skinfolds by a Harpenden caliper) in South Bohemian (Czech Republic) schoolchildren. Anthropological research in years 1997–99 (grant IGA MZ CR, #3979–3) showed some differences in body composition and nutritional status in comparison with the reference samples. The differences were also evident in comparison of our sample with that of South Bohemian schoolchildren from years 1995–96. The higher mean values of the Rohrer's index and the sum of four skinfolds (which correspond to the quantity of subcutaneous fat) prove higher nutritional status of our sample. The changes in analyzed parameters during development and their intersexual differences confirm the exploitability of these parameters for the estimation of the nutritional status of schoolchildren.*

KEY WORDS: *Rohrer's index – Subcutaneous fat – Schoolchildren – South Bohemia (Czech Republic)*

INTRODUCTION

According to the WHO there are some 250 million obese subjects in the world. In Europe and South America obese subjects account for almost 50% of the population. The incidence of obesity is increasing even among children (Bláha *et al.* 1999).

We present in our paper the development of the Rohrer's index (RI), the Waist-Hip ratio (WHR) and subcutaneous fat (shown by a Harpenden caliper measurements of four skinfolds) in South Bohemian schoolchildren between 6–15 years of age. Anthropometric data were collected during the investigation „Semi long-term study of the physical development of school youth from the Czech Republic“ (grant IGA MZ CR, # 3979-3) during the years 1997–1999.

We would like to find out whether the phenomenon of fullness and higher values of Rohrer's index and skinfold thicknesses in South Bohemian children is temporary or permanent and assess suitability of using indices and parameters for establishment of nutritional status of schoolchildren.

MATERIALS AND METHODS

The sample from South Bohemia – city of České Budějovice and two small towns Hluboká nad Vltavou and Lišov (file SB, 1997–99) consisted of 588 children (276 boys and 312 girls). The children were measured repeatedly always after 6 months. Sorting of the age categories was made according to the recommendation of the WHO (*Table 1*).

Martin-Saller's method (Martin, Saller 1957) was used. The skinfold thickness was measured by a Harpenden caliper. All skinfolds were taken on the right side of the body. The values of skinfold thickness was read to the nearest 0.1 mm.

We present in our paper:

- 1) the Rohrer's index [RI, Rohrer-Buffon-Bardeen's index; $\text{Body weight (kg)} \cdot 10^5 / \text{Stature (cm)}^3$],
- 2) the Waist-Hip ratio [WHR, also AGR; $\text{Waist circumference (cm)} \cdot 10^2 / \text{Hip circumference (cm)}$],
- 3) the sum of four skinfolds [skinfold thicknesses on the arm above the *musculus biceps brachii*, above the

musculus triceps brachii, on the back below the *angulus scapulae inferior* – subscapular – and above the *spina iliaca anterior superior* – suprailiac – on the abdomen; (mm)],

- 4) percentage of body fat: the consequential values of measurements of the selected skinfolds made the total body fat calculation possible. We used the Durnin's and Rahaman's method (Durnin, Rahaman 1967), modified by Brook (1971).

Our data (SB, 1997–99) were compared with the results of another regional investigation (Kobzová 1999) and the overall Czech Republic surveys (Bláha *et al.* 1999, Bláha *et al.* 2002, Lhotská *et al.* 1995). The investigations are abbreviated as follows: Kobzová, 1995–96 (Kobzová 1999), V.CAV, 1991 (Lhotská *et al.* 1995), Bláha, 1995–96 (Bláha *et al.* 1999), Bláha, 1997–99 (Bláha *et al.* 2002).

Student's t-test on the levels $p=0.05$ (*) respectively $p=0.01$ (**) was used to estimate the statistical significance of the differences between boys and girls in one file and the differences among the files in somatometric and body composition variables.

RESULTS

See Table 2 and Figures 1a, 1b and 2 for the Rohrer's index (RI).

The mean values of the RI for boys decreased till 10 years of their age, then increased for 11- and 12-year-old boys and decreased again till the end of the research period. The values for girls decreased till 11 years of age, then moderately increased for 12- and 13-year-old girls and decreased till the end of the research period.

Table 3 and Figures 2 and 3 show the WHR in our sample.

The mean WHR values for boys very moderately decreased till 10 years of their age, then slightly increased and after 11 years of age moderately decreased again until the peak of puberty, especially from the age of 13 till the end of the research period. The mean WHR values for girls had a different development. The difference between the mean values for 6- and 14-year-old is higher for girls than for boys. The values decreased markedly from 6 to 8 years

of age and then stagnated till 10 years of their age. We can see permanent decrease of the index values about the end of the research period.

See Table 4 and Figure 4 for the sum of four skinfolds (which corresponds to the quantity of subcutaneous fat) and the corresponding body fat percentage. The development of subcutaneous fat in boys has a tendency to increase until the age of 12 and then the values do not increase. Except the decrease between the age of 12 and 13, we can see the permanent increase of these values in girls.

DISCUSSION

RI: The intersexual comparison of the index values for our boys and girls (with higher values) showed statistically significant differences in 9–10-year-old children. The comparison of our sample with the reference ones (Bláha *et al.* 1999, Kobzová 1999, Lhotská *et al.* 1995) showed that the mean values of our sample were in most cases higher. The results were statistically significant in many age categories. The comparison of z-scores showed that the differences of the index values between our sample and the reference one (Bláha *et al.* 1999) were not too high and never exceeded $0.25*SD$.

WHR: The intersexual comparison showed the same trend of the mean index values for children from the age of 6 till the age of 10. From the age category of 10 the values for boys and girls are markedly different. About the end of the research period the values for boys stagnated and the values for girls decreased markedly and permanently. The index values excellently represent intersexual differences from the beginning of puberty. The comparison of z-scores showed higher values of the index in our sample against the reference one (Bláha *et al.* 1999). The values were higher than cca $0.5*SD$ in boys and cca $0.7*SD$ in girls. Nevertheless, we cannot exclude a methodical difference in the measurements of waist circumferences in our sample and the reference one (Bláha *et al.* 1999).

The sum of four skinfolds: The comparison of our boys and girls confirms the well-known fact that the quantity of

TABLE 1. The mean age in age categories (years) – SB, 1997–99.

Age category	Boys			Girls		
	N	Mean	SD	N	Mean	SD
6.00–6.99	65	6.63	0.25	75	6.63	0.23
7.00–7.99	145	7.48	0.29	144	7.50	0.28
8.00–8.99	172	8.50	0.28	193	8.55	0.30
9.00–9.99	123	9.45	0.30	155	9.49	0.28
10.00–10.99	143	10.51	0.29	188	10.53	0.27
11.00–11.99	127	11.49	0.30	141	11.45	0.29
12.00–12.99	163	12.50	0.29	192	12.53	0.28
13.00–13.99	118	13.46	0.29	156	13.49	0.28
14.00–14.99	83	14.44	0.28	111	14.43	0.27

TABLE 2. Rohrer's index (mg/cm³) – a comparison, boys, girls.

BOYS																	
Age category	SB, 1997–99			V. CAV. 1991			Bláha 1995–96			Kobzová 1995–96							
	N	Mean	SD	N	Mean	SD	N	t1	SD	N	Mean	SD	t3				
6.00–6.99	65	1.274	0.180	1450	1.29	0.15	1264	0.706	0.14	1264	1.28	0.14	0.265	158	1.28	0.14	0.240
7.00–7.99	145	1.236	0.170	1923	1.25	0.15	1294	0.964	0.15	1294	1.25	0.15	0.951	126	1.25	0.16	0.698
8.00–8.99	172	1.232	0.149	1903	1.23	0.15	1223	0.168	0.16	1223	1.23	0.16	0.155	100	1.23	0.17	0.101
9.00–9.99	123	1.214	0.132	1959	1.22	0.16	1309	0.482	0.17	1309	1.22	0.17	0.469	108	1.23	0.20	0.707
10.00–10.99	143	1.195	0.140	1933	1.22	0.17	1310	2.028*	0.18	1310	1.21	0.18	1.179	106	1.19	0.20	0.220
11.00–11.99	127	1.219	0.177	1988	1.21	0.17	1247	0.557	0.18	1247	1.20	0.18	1.151	107	1.19	0.17	1.276
12.00–12.99	163	1.223	0.190	2355	1.20	0.17	1217	1.504	0.18	1217	1.18	0.18	2.730**	100	1.18	0.17	1.903
13.00–13.99	118	1.206	0.177	2310	1.18	0.16	1192	1.563	0.19	1192	1.17	0.19	2.093*	113	1.17	0.22	1.367
14.00–14.99	83	1.185	0.204	2456	1.17	0.15	1004	0.664	0.18	1004	1.17	0.18	0.649	118	1.15	0.17	1.281

GIRLS																	
Age category	SB, 1997–99			V. CAV. 1991			Bláha 1995–96			Kobzová 1995–96							
	N	Mean	SD	N	Mean	SD	N	t1	SD	N	Mean	SD	t3				
6.00–6.99	75	1.314	0.136	1624	1.29	0.15	1487	1.487	0.15	1487	1.28	0.15	2.089*	151	1.27	0.14	2.268**
7.00–7.99	144	1.271	0.143	1894	1.26	0.16	1290	0.882	0.16	1290	1.24	0.16	2.437*	126	1.21	0.16	3.283**
8.00–8.99	193	1.257	0.148	1836	1.23	0.17	1263	2.375*	0.17	1263	1.23	0.17	2.312*	105	1.20	0.17	2.891**
9.00–9.99	155	1.254	0.171	1914	1.21	0.17	1423	3.082**	0.18	1423	1.22	0.18	2.338*	109	1.21	0.18	1.996*
10.00–10.99	188	1.230	0.173	1862	1.19	0.17	1459	3.026**	0.19	1459	1.2	0.19	2.212*	112	1.21	0.21	0.851
11.00–11.99	141	1.220	0.190	1964	1.18	0.17	1444	2.431*	0.18	1444	1.19	0.18	1.798	102	1.18	0.18	1.670
12.00–12.99	192	1.226	0.176	2189	1.19	0.18	1329	2.713**	0.19	1329	1.19	0.19	2.622**	111	1.18	0.17	2.240*
13.00–13.99	156	1.230	0.181	2320	1.21	0.17	1341	1.341	0.18	1341	1.21	0.18	1.303	109	1.20	0.19	1.290
14.00–14.99	111	1.222	0.173	2506	1.21	0.16	930	0.717	0.19	930	1.23	0.19	0.456	105	1.22	0.19	0.081

* p ≤ 0.05; ** p ≤ 0.01

* p ≤ 0.05; ** p ≤ 0.01

TABLE 3. Waist-Hip Ratio (i.u.) – SB, 1997–99.

Age category	Boys			Girls			t
	N	Mean	SD	N	Mean	SD	
6.00–6.49	18	91.7	5.8	21	89.0	4.4	0.371 *
6.50–6.99	48	89.7	3.8	55	89.9	4.7	-0.033
7.00–7.49	74	89.8	3.6	65	88.8	3.7	0.194 *
7.50–7.99	73	88.9	4.0	74	87.3	4.3	0.272 **
8.00–8.49	72	88.0	3.3	63	86.6	4.6	0.247 *
8.50–8.99	60	88.4	3.4	66	87.3	3.7	0.219 *
9.00–9.49	54	87.8	3.2	62	87.6	4.4	0.037
9.50–9.99	56	87.7	3.3	77	87.1	4.5	0.108
10.00–10.49	48	87.0	3.1	63	87.1	4.1	-0.019
10.50–10.99	56	88.0	3.4	65	86.4	4.4	0.288 **
11.00–11.49	54	88.2	3.7	68	85.2	5.0	0.482 **
11.50–11.99	59	88.3	4.5	62	85.0	4.7	0.507 **
12.00–12.49	68	87.6	4.2	64	84.2	4.3	0.566 **
12.50–12.99	60	87.6	4.3	78	83.1	4.2	0.749 **
13.00–13.49	58	87.5	4.7	74	82.2	4.5	0.815 **
13.50–13.99	47	86.1	4.9	68	82.2	4.2	0.604 **
14.00–14.49	30	86.4	5.2	41	80.7	4.4	0.837 **

* p ≤ 0.05; ** p ≤ 0.01

TABLE 4. The sum of four skinfold thicknesses (mm) – SB, 1997–99.

Age category	Boys				Girls				t
	N	Mean	SD	% fat	N	Mean	SD	% fat	
6.00–6.49	17	25.18	11.45	15.50%	21	29.50	11.42	21.50%	0.267
6.50–6.99	49	22.37	9.66	13.70%	54	28.95	10.02	21.00%	0.473**
7.00–7.49	71	22.76	9.85	14.30%	66	29.58	11.51	21.50%	0.450**
7.50–7.99	71	24.57	12.30	15.50%	73	32.55	12.16	22.70%	0.461**
8.00–8.49	70	26.45	11.57	15.90%	64	32.20	10.44	22.30%	0.369**
8.50–8.99	55	28.11	10.39	16.70%	69	30.52	9.02	21.90%	0.175
9.00–9.49	49	26.03	11.04	15.90%	74	34.52	13.45	23.50%	0.488**
9.50–9.99	52	29.14	12.98	17.10%	74	36.21	14.27	23.80%	0.367**
10.00–10.49	45	27.99	7.89	16.70%	65	37.43	14.40	24.10%	0.575**
10.50–10.99	55	28.66	11.97	17.10%	64	37.33	15.67	24.10%	0.440**
11.00–11.49	54	27.93	9.13	16.70%	67	39.14	16.54	24.70%	0.593**
11.50–11.99	61	33.99	17.74	19.10%	61	43.14	17.61	25.90%	0.366**
12.00–12.49	66	35.93	20.61	19.90%	66	43.36	18.53	25.90%	0.286**
12.50–12.99	58	35.06	18.29	19.50%	80	39.27	16.10	24.70%	0.173
13.00–13.49	56	33.39	16.47	18.70%	76	38.96	14.54	24.70%	0.254*
13.50–13.99	47	32.43	17.77	18.30%	70	43.15	15.78	25.90%	0.451**
14.00–14.49	31	34.70	19.14	19.50%	42	42.14	14.46	25.60%	0.310**

* p ≤ 0.05; ** p ≤ 0.01

subcutaneous fat is higher for girls in every age category. The differences were lower in the peak of puberty of girls (Table 4). From the age of 13 the intersexual differences were markedly and statistically significant again. The values of South Bohemian subsample of girls were always higher during the research period. The values in our boys were higher against the reference sample (Bláha *et al.* 1999) from the age of 8.

The mean values of our sample and the median values of the reference one (Bláha *et al.* 1999) cannot be compared.

Some interesting information was provided by previous anthropological investigations of South Bohemian schoolchildren. The establishment of somatotypes according to Heath-Carter investigated in 1993 showed some differences in comparison to the overall Czech Republic survey (Lhotská *et al.* 1995). The sample of

the mean value (mg/cm³)

FIGURE 1a. Rohrer's index (mg/cm³) – a comparison, boys.

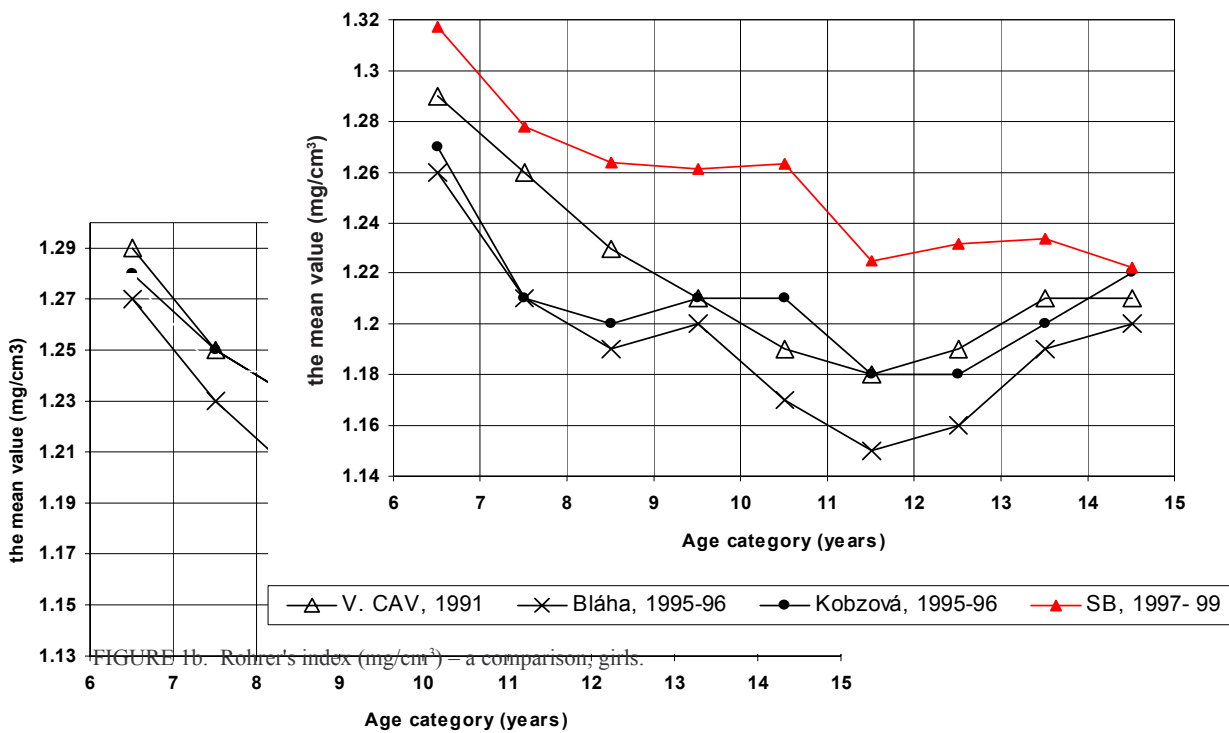


FIGURE 1b. Rohrer's index (mg/cm³) – a comparison, girls.

—△— V.CAV, 1991 —×— Bláha, 1995-96 —●— Kobzová, 1995-96 —▲— SB, 1997-99

schoolchildren from České Budějovice has higher endomorphy and lower mesomorphy (Kobzová 2001a). In addition, the identification of the body composition according to Matiegka showed (compared with the overall Czech Republic survey – Lhotská *et al.* 1995) that the mean values of the muscular fraction are significantly lower and the mean values of the fat fraction are significantly higher in the sample from České Budějovice (Kobzová 2001b).

CONCLUSIONS

Anthropological research in 1997–99 (grant IGA MZ CR, #3979–3) showed some differences in body composition and nutritional status in comparison with the reference samples. The differences were also evident in comparison of our sample with that of South Bohemian schoolchildren from years 1995–96.

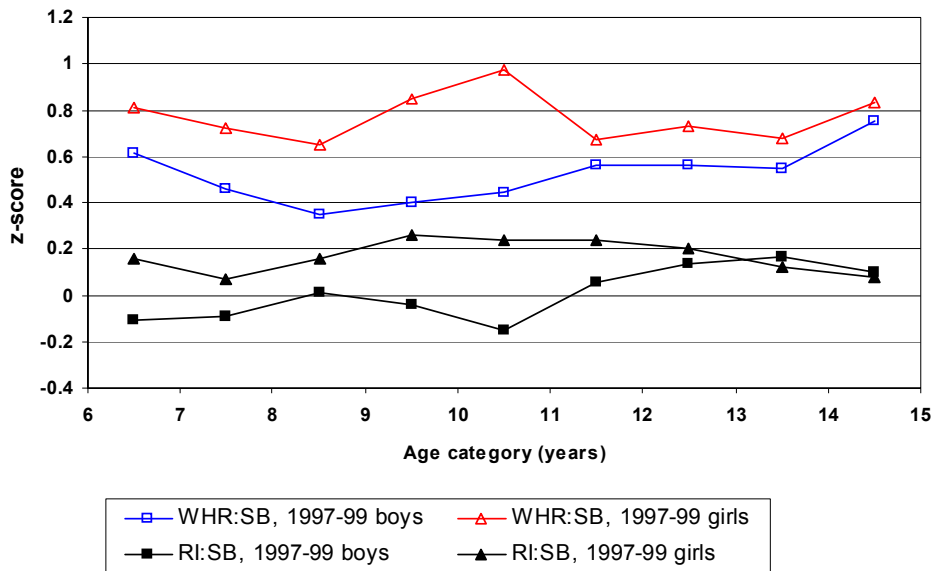


FIGURE 2. Mean values of the RI (g/cm³) and WHR (i.u.) standardized on reference data V.CAV, 1991 (Lhotská *et al.* 1995).

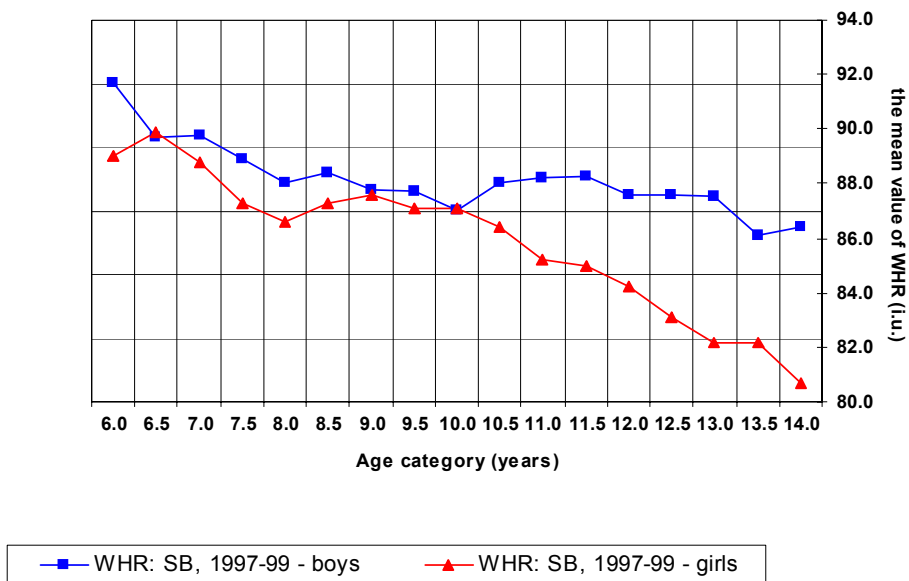


FIGURE 3. WHR (i.u.) – the mean values, file SB, 1997–99.

The higher mean values of the Rohrer's index and the sum of four skinfolds (which corresponds to the quantity of subcutaneous fat) prove higher nutritional status of our sample.

The changes in analyzed parameters during development and their intersexual differences confirm the exploitability of these parameters for the estimation of the nutritional status of schoolchildren.

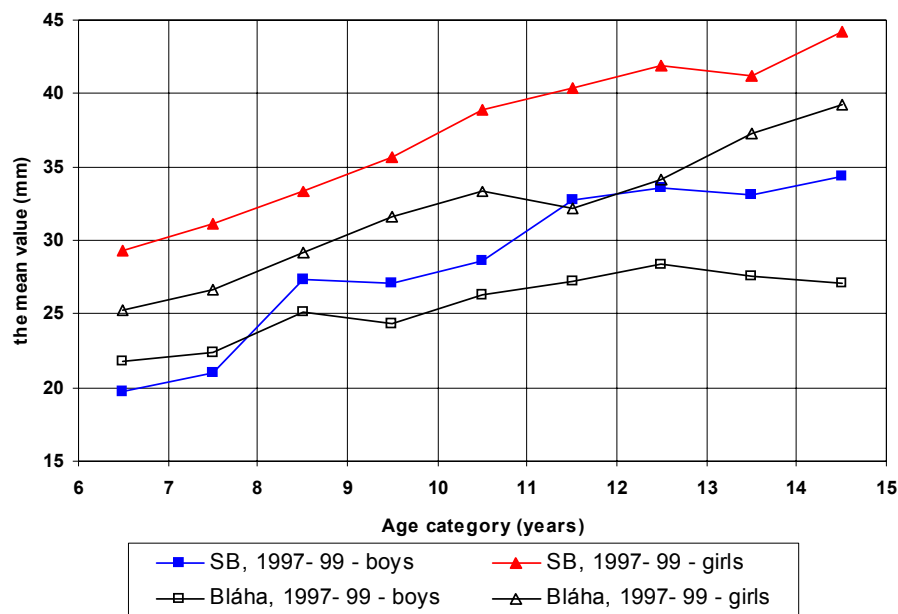


FIGURE 4. The sum of four skinfolds (mm) – a comparison.

REFERENCES

- BLÁHA P., VIGNEROVÁ J., PAULOVÁ M., RIEDLOVÁ J., KOBZOVÁ J., KREJČOVSKÝ L. 1999: *Vývoj tělesných parametrů českých dětí a mládeže se zaměřením na rozměry hlavy (0–16 let)*. (Development of Somatic Parameters of Czech Children and Adolescents Focused on Cephalic Parameters – 0–16 years, in Czech with English translation). National Institute of Public Health, Prague. 182 pp.
- BLÁHA P., KOBZOVÁ J., KREJČOVSKÝ J., RIEDLOVÁ J., VIGNEROVÁ J., 2002: Percentile figures and tables. In: P. Bláha, J. Vignerová (Eds.): *Investigation of Growth of Czech Children and Adolescents*. Pp. 28–73. National Institute of Public Health, Prague.
- BROOK G. G. D., 1971: Determination of body composition of children from skinfold measurements. *Archiv. of Dies. in Childhood*. 46: 182–184.
- DURNIN J. V. G. A., RAHAMAN M. M., 1967: The assessment of the amount of fat in the human body from measurements of skin fold thickness. *Brit. J. of Nutrition*. 21: 681–689.
- KOBZOVÁ J., 1999: *Tělesný vývoj českobudějovických dětí ve věku 6–14 let v regionálním a chronologickém srovnání*. (The body development in schoolchildren from the town of České Budějovice, the regional and the chronological comparison, in Czech with English summary) ms., Dissertation, Faculty of Science, Charles University, Prague. 211 pp.
- KOBZOVÁ J., 2001a: *Somatotypologická studie českobudějovických školních dětí*. (Somatotypological study in children from České Budějovice, in Czech with English summary). In: P. Bláha (Ed.): *Antropologický sborník: Liblice, 1996*. Pp. 44–48. Brno.
- KOBZOVÁ J., 2001b: *Složení těla českobudějovických školních dětí*. (Body composition in children from České Budějovice, in Czech with English summary). In: P. Bláha (Ed.): *Antropologický sborník: Liblice, 1996*. Pp. 49–56. Brno.

- LHOTSKÁ L., BLÁHA P., VIGNEROVÁ J., ROTH Z., PROKOPEČ M., 1995: *V. Celostátní antropologický výzkum dětí a mládeže 1991 (České země)*. Anthropometrické charakteristiky. (5th Nation-wide Anthropological Survey of Children and Adolescents 1991, Czech Republic, Anthropometric characteristics, in Czech with English translation), SZÚ (National Institute of Public Health), Prague, 187 pp.
- MARTIN R., SALLER K., 1957: *Lehrbuch der Anthropologie in systematischer Darstellung*. G. Fischer Verlag, Stuttgart.

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