

# THE 6<sup>TH</sup> NATIONWIDE ANTHROPOLOGICAL SURVEY OF CHILDREN AND ADOLESCENTS IN THE CZECH REPUBLIC IN 2001

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## SUMMARY

The 6<sup>th</sup> nationwide anthropological survey (NAS) of children and adolescents was carried out in the Czech Republic in 2001 to continue the series of surveys repeated at 10-year intervals since 1951 (with the participation of the Slovak Republic up to 1991). The major objective was to find out the following body measurements of children and adolescents: body height and weight, and head, arm, waist and hip circumferences. Questionnaires were used to find out the body measurements of parents (body height and weight) and some socio-economic characteristics of the child's family (number of siblings, education of parents, breast feeding duration, birth weight and length, child's physical activities, TV watching time, computer gaming time, etc.). A school children questionnaire focused on eating habits was also part of the survey in 2001. A total of 59,000 children aged 0.00 to 18.99 years, i.e. about 3 % of the population of the same age range, were enrolled in the survey in 2001. The results obtained presented in diagrammatic and tabular forms are reference standards for monitoring growth of the Czech children and adolescents from birth to the age of 19 years.

The survey revealed a substantial slowdown in the long-term trend in body height increase for both boys and girls. The most marked increase in the mean body height is currently recorded in boys at the prepubescent age while the pubescent girls show a practically zero increase for this parameter. A more marked increase in body height at the adult age is not expected any more, but the increase in body height and weight at the prepubescent age is likely to continue for some time. The 6<sup>th</sup> NAS showed a marked slow down to a stop in the trend in the mean body weight increase. No increase in the mean body weight has been recorded in pubescent girls since the 1970's and in pubescent and postpubescent boys since 1991. Nevertheless, the younger age groups, namely those of preschool and primary school children, continue to show increase in the mean body weight. The secular trend in body weight has been less pronounced compared to that in body height. The rates of overweight and obese children (as assessed by body mass index, BMI) have risen in most age groups of school children compared to those reported in 1991. In contrast, a slight decrease in the rate of overweight children can be seen in boys starting from the age of 16 years and in girls starting from the age of 13 years. The obesity prevalence rate is significantly higher in boys than girls.

Statistical analysis confirmed a correlation between the BMI values in children and education of parents (the higher the education, the lower the rate of overweight children) and between the BMI values and the population size of the community where the child lives (the higher the population, the lower the prevalence rates of overweight and obesity). Single children suffer more frequently from overweight and obesity than those with siblings.

**Key words:** body height, body weight, overweight, obesity, secular trend, growth charts

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## INTRODUCTION

### History of Surveys

The 6<sup>th</sup> nationwide anthropological survey (NAS) of children and adolescents was carried out in the Czech Republic in 2001 to continue the series of surveys repeated at 10-year intervals since 1951 (with the participation of the Slovak Republic up to 1991). The objective of the first survey was to monitor body growth of children and adolescents in relation to the health and nutrition status after the World War II. Body height, body weight and family history were recorded. The ensuing surveys

also included measurements of head, arm, waist and hip circumferences and foot length. In addition, questionnaires were used to find out the parents' body measurements (body height and weight) and some socio-economic characteristics of the child's family (number of siblings, education of parents, breast feeding duration, birth weight and length, child's and parents' physical activities, TV watching time, computer gaming time, etc.). A questionnaire focused on eating habits of school children was part of the survey in 2001.

The first extensive anthropological survey of children in the Czech Lands was carried out in 1895 by J. Matiegka, a physician

and anthropologist (6). Within the survey, biology teachers measured about 100 000 children aged from 6 to 15 years. The nationwide surveys carried out in the second half of the 20<sup>th</sup> century collected anthropometric data on 90 000 to 120 000 individuals aged from 0.00 to 18.99 years (i.e. 3–4 % of the Czech population of the same age range).

### Significance

Six nationwide anthropological surveys provided the reference data for body height and weight and other parameters of the Czech population aged from birth to 18 years. The positive secular trend in body height increase could be analyzed, including data on parents' body heights. Thanks to the questionnaires used during the last three surveys, the child's socio-economic status and family background could be rated and factors influencing growth could be identified. In addition, objective data on the incidence of obesity among children and adolescents in the Czech Republic could be collected. The results obtained and presented in diagrammatic and tabular forms are the reference standards for the monitoring of growth of the Czech children and adolescents. They are of relevance not only to pediatricians but also to other specialists who need to know the basic physical measurements, i.e. mainly body height and weight.

At present, the major results of the surveys are growth or percentile developmental charts of the relevant physical measurements (body height and weight, BMI, head, arm, waist and hip circumferences). Growth is a sensitive indicator of child's health and can be simply evaluated by monitoring the basic physical characteristics. The growth charts may not only provide guidance to the parents themselves but are of relevance to pediatricians who can diagnose any inadequacy in the development of the child's body (short stature, too small or too large head circumference in children under three years of age, child's overweight or underweight, etc.) and refer the child to a respective specialist if needed. The growth charts provide valuable guidance in both establishment of diagnosis and treatment efficacy evaluation.

The body mass index (BMI) percentile charts are of use in evaluating obesity, overweight or underweight. The BMI is the ratio of weight (in kg) to height (in meters) square. BMI values above the 97<sup>th</sup> percentile are considered as obesity, those between the 90<sup>th</sup> and 97<sup>th</sup> percentile as overweight and those below the 10<sup>th</sup> percentile as underweight. This categorization is used for evaluation of population groups in epidemiological studies. Nevertheless, additional body parameters are to be taken into account in individual evaluation.

The growth charts have been issued for the needs of physicians and have become a part of the child's and adolescent's health and vaccination record cards. These cards are given to each child at birth. Both the parents and physicians can use the charts during the child's growth period.

The survey results enable general evaluation of the health and nutrition status of the Czech children population, data comparison at an international level and, based on analysis of physical characteristics and socio-economic factors, identification of possible risk factors for the child's healthy development.

### Survey objectives:

- to analyze the development of the secular trends in body height and weight increase,

- to provide the reference growth standards for the population aged 0.00 to 18.99 years,
- to provide objective data on the prevalence of overweight and obesity in Czech adolescents,
- to analyze effect of some child's family socio-economic factors on its growth.

## MATERIAL AND METHODS

The 6<sup>th</sup> nationwide anthropological survey was carried out in 2001 and at the beginning of 2002 in randomly selected schools and health care facilities all over the Czech Republic. Altogether, 59,000 children aged from birth to 19 years, i.e. 2.9 % of the Czech population of this age range, were measured. Measurements of preschool children were performed by pediatricians, school children were measured by trained teachers and pregraduate students in anthropology. Altogether 186 public health centres and 310 schools (i.e. nursery, primary, secondary and technical schools) took part in the survey.

The following anthropometric parameters were recorded: body height, body weight and head, arm, waist and hip circumferences. Anthropometry was carried out according to Martin-Saller (5). A questionnaire was also part of the anthropological survey. It was focused on the child's eating habits and physical activities. His/her parents had to fill in their body weight and height, physical activities, education, number of children in the family, and child's breast feeding and health status data.

The data analysis was based on the standard procedures, i.e.  $\chi^2$  (software Epi-Info), t-test (software Statistica), calculation of Z-score based on the WHO reference data (software WHO Anthro)

## RESULTS

### Body Height

Since 1895 when the first extensive survey of physical characteristics of school children (6) was carried out, it has been found in every and each ensuing nationwide anthropological survey that the mean body height progressively increased in all age groups of the Czech population. The highest increase in the mean body height is recorded in adolescents. This can be explained by the fact that the puberty period characterized by accelerated growth starts earlier. The last NAS 2001 showed a substantial slowdown in this long-term trend in children body height increase and its complete stop in girls of some age groups (puberty period). The long-term trend in body height increase is evident from Figs 1a and 1b where the mean body height of Czech children and adolescents is expressed by Z score in comparison with the WHO reference data (3). Connecting lines between the points show deviations of the mean body height from the reference data (x) for different age groups. The charts represent Z-scores of the mean body height for boys and girls in 1895, 1951, 1971, 1991 and 2001. The parent's education and size of the community where the child lives are currently the most important of the socio-economic factors influencing the child's growth. Both factors are certainly interconnected and will be further analyzed.

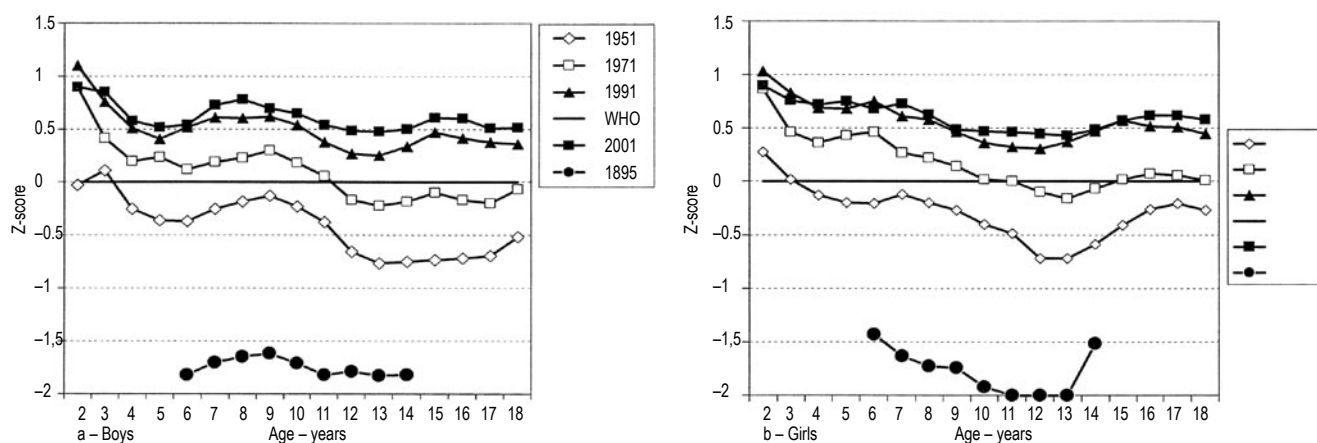


Fig. 1. Body height. Z-score according to WHO reference values.

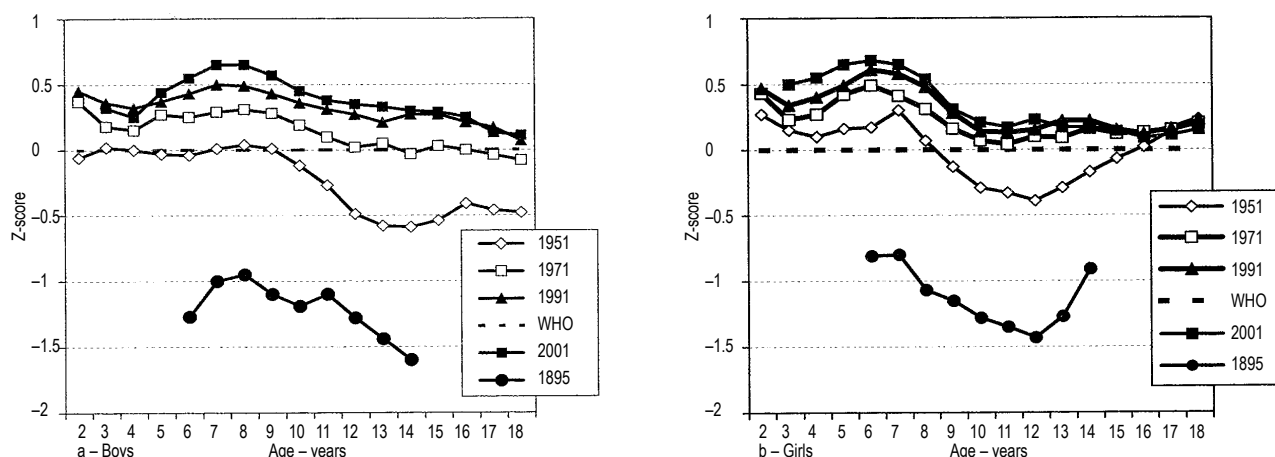


Fig. 2. Body weight. Z-score according to WHO reference values.

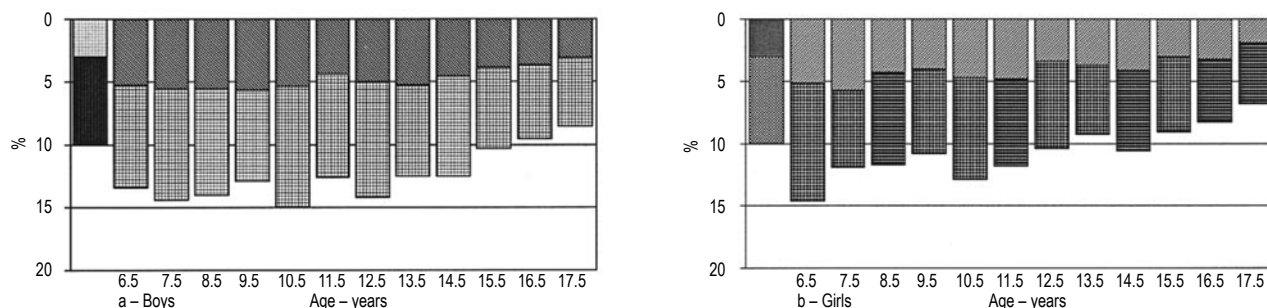


Fig. 3. Ratio of children in BMI categories. Comparison with the 5<sup>th</sup> Nationwide Anthropological Survey 1991. Age 6.00–17.99 years. Overweight and obesity.

## Body Weight

The development in the body weight is more complicated. It differs between preschool and younger school children and adolescents. The orienting limits are 12 years of age in girls and 14 years of age in boys. While in children under the limit of age the body weight increases every 10 years (with each following NAS), those aged over this age limit have not shown such increase for girls since the 1970's and for boys since the 1990's. Boys aged over 14 years showed comparable body weight in 2001 and 1991 or in some age groups even lower body weight in 2001 compared to 1991. The girls aged over 12 years had comparable body weight in 2001 and 1971–1991 while those aged over 15 years had lower body weight in 2001 compared to 1971–1991. Z-score based comparison of the mean body weights (with the WHO reference data) is presented in Figs. 2a and 2b.

## Body Mass Index (BMI)

The body mass index, i.e. the ratio of weight (in kg) to height (in meters) square, is better indicator of the population nutrition status than body weight alone. There are justified fears of the increase in number of obese individuals. Higher percentages of overweight and obese individuals were recorded in 2001 compared to 1991. Nevertheless, not all age groups and not both genders show the same increases in these parameters. Lower percentages of girls aged over 13 years and boys aged over 16 years are overweight (Figs. 3a and 3b). Figs 4a and 4b illustrate changes in percentages of underweight (very low BMI, under the 10<sup>th</sup> percentile) individuals. Compared to 1991 (column 1 of the chart), the percentage of individuals with very low BMI clearly decreased among younger school children while showing a sharp rise in the pubescent period. Data on underweight children indirectly

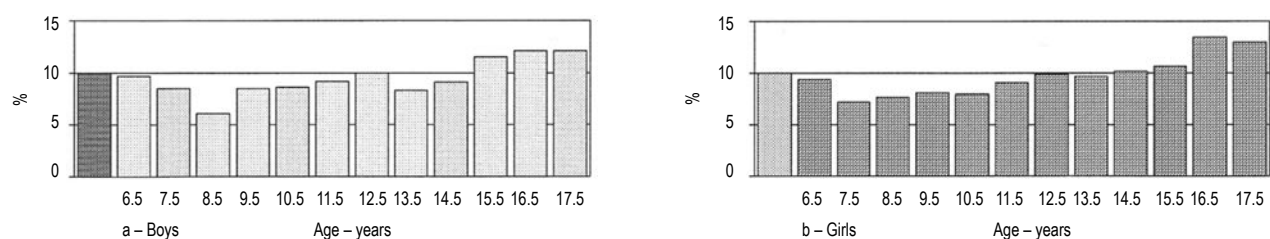


Fig. 4. Ratio of children in BMI categories. Comparison with the 5<sup>th</sup> Nationwide Anthropological Survey 1991. Age 6.00–17.99 years. Underweight.

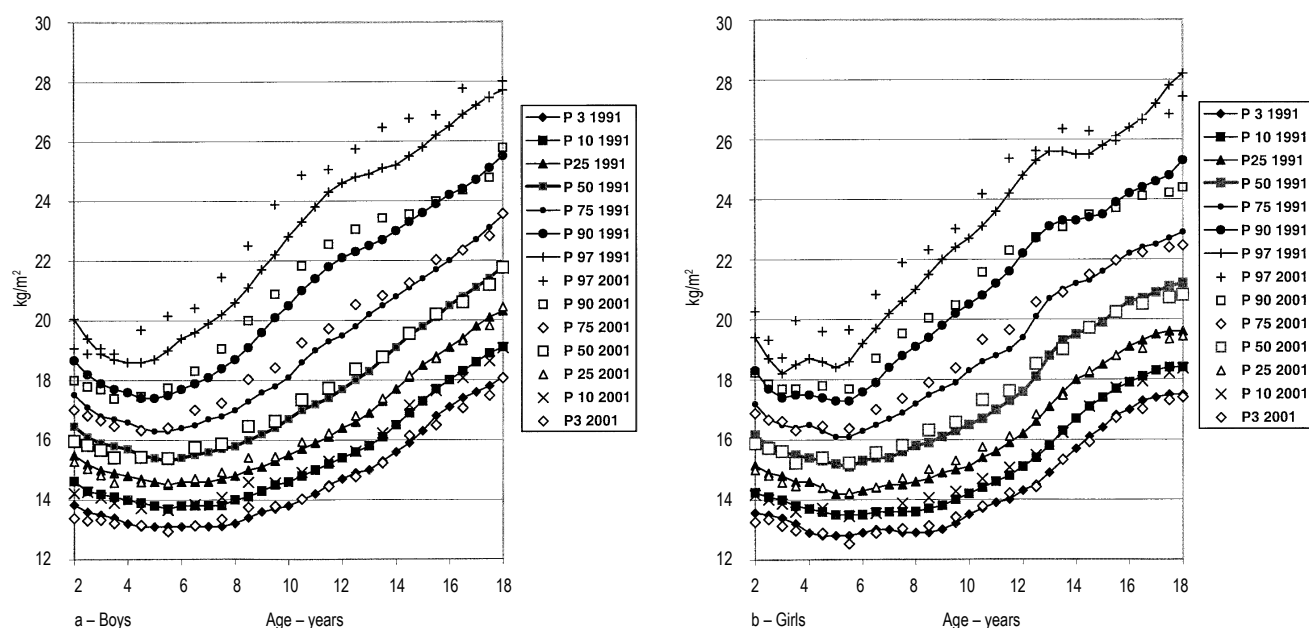


Fig. 5. BMI, empirical centile charts, comparison 2001, 1991. P – percentile

correlate to those on overweight children in the given age groups. The increasing percentage of children with very low BMIs in the puberty period is likewise as negative phenomenon as the increase in the percentage of obese individuals in the population. It reflects facts such as insufficient nutrition due to dieting attempting to reach the ideal of excessive slimness as dictated by fashion and possibly resulting in mental anorexia, reported with increasing frequency in pubescent and adolescent girls. The BMI empirical percentile charts in Figs. 5a and 5b show marked shifts towards higher values for the almost whole age range at the 97<sup>th</sup> percentile, while the shift at the 90<sup>th</sup> and lower percentiles are detectable in younger school children. A shift in the opposite direction towards lower values is evident in girls aged 14–15 years.

Obesity in the Czech school children aged from 6 to 18 years expressed in percentages varies as documented in Table 1. According to standards from 1991, the percentage of obese children increased, mainly in boys, while the percentage of overweight children did not show any marked change.

The percentages of overweight, underweight and obese children aged between 7 and 11 years – this age range being decisive for developing obesity at the adult age according to the WHO Technical Report Series, 2000 (7), are compared with the reference data for the Czech population from 1991 in Table 2. The percentages of obese children are almost twice as high as expected, reaching 5.6 % in boys and 4.7 % in girls against 3 %

expected. The percentage of overweight boys slightly increased (to 8.5 % compared to 7 % expected). Nevertheless, if the Czech population is assessed according to the WHO recommended reference BMI values, the percentages of obese children appear to be clearly lower (3.5 % of boys and 3.0 % of girls aged between 7 and 11 years).

Analysis of factors influencing the BMI values in children showed unambiguously the major role of their parents' BMI values and education. Both relations are statistically significant.

## DISCUSSION

The 5<sup>th</sup> NAS and other studies (1) suggested a slow down in the secular trend in body height, particularly in higher age groups. Similarly, body weight, particularly in girls, was not increasing at the same pace as in previous decades and practically stopped

Table 1. The overweight and obesity rate, age 6.00–17.99 years

	Boys (%)	Girls (%)
Obesity	4.7	3.7
Overweight	7.5	6.4

**Table 2.** Distribution of BMI values among children in 2001 compared to 1991

Children aged 7.00 years to 10.99 years			
	1991	2001 boys n=5,156	2001 girls n=5,174
Obesity (97 <sup>th</sup> percentile <)	3 %	5.6% (3.5%)*	4.7 (3.0%)*
Overweight (90 <sup>th</sup> to 97 <sup>th</sup> percentile)	7 %	8.5% (13.3) %*	7.2 (13.9) %*
Underweight (< 10 <sup>th</sup> percentile)	10%	8.0%	7.8

\* According to the internationally recommended standards

increasing in the highest age groups. The same was found in other extensive studies carried out in the 1990's by the same team as the last 6<sup>th</sup> NAS in different regions of the Czech Republic – 1995–96, 1997–1999 and 1999–2000 (1, 2, 8, 9). This slowdown to complete stop of the secular trends in body height and weight increase had been therefore expected and was confirmed, but not for all age groups. The most marked differences compared to 1991 were found for younger school children. This can be explained by the progressive shift of the fastest growth period towards lower age groups. Owing to good socio-economic conditions, the adult population already reaches the optimum of genetic possibilities. Any marked increase in body height is not expected at the adult age, but the pubescent and prepubescent children are likely to continue to show increases in their body height and weight for some time.

The high incidence of overweight and obesity in the industrialized countries poses a health problem. Unfortunately, in the Czech Republic, the rates of overweight and obesity increased particularly in school children aged 6 to 15 years in 2001 compared to 1991. Only boys aged 16 years and more show a slightly decreased percentages of overweight and obesity while markedly decreased percentages of overweight and obesity were found in girls aged 15 years and more. This can be interpreted as a positive effect of the targeted sensitization and fashion trends with the highest impact just on this age group. Nevertheless, since the percentages of underweight individuals (BMI < 10 percentile) markedly rised in the same age groups, more detailed analysis would be needed to study this phenomenon not sufficiently studied to date.

Statistical analysis confirmed correlation between the child's BMI and his/her parents' education (the higher the parents' education, the lower the risk of overweight) and between the child's BMI and the size of the community where he/she lives (the larger the community population, the lower the prevalence of overweight and obesity). Single children suffer more frequently from overweight and obesity compared to those with siblings.

## CONCLUSIONS

The 6<sup>th</sup> NAS revealed a substantial slowdown in the long-term trend in body height increase for both boys and girls. The most marked increase in the mean body height is currently recorded in boys at the prepubescent age while the pubescent girls show a practically zero increase for this parameter.

A marked slow down to stop in the trend in the mean body weight increase was also found. No increase in the mean body weight has been recorded in pubescent girls since the 1970's and in pubescent and postpubescent boys since 1991. Nevertheless,

the younger age groups, namely those of preschool and primary school children, continue to show increase in the mean body weight.

The rates of overweight and obese children have risen in most age groups compared to those reported in 1991. In contrast, a slight decrease in the rate of overweight children can be seen in boys starting from the age of 16 years and in girls starting from the age of 13 years.

In the age range from 6 to 18 years, the obesity prevalence rate is significantly higher in boys than girls.

The incidence of overweight and obesity among children is significantly associated with their parents' BMIs and education and less significantly associated with the population size of the community where the child lives.

## Acknowledgement

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## REFERENCES

1. Bláha P, Vignerová J, Paulová M, Riedlová J, Kobzová J, Krejčovský L: Development of anthropometric characteristics in Czech children and adolescents aimed at head circumference (0–16 years). Volume I, II. Praha, Státní zdravotní ústav, 1999. (In Czech.)
2. Bláha P, Kobzová J, Krejčovský L, Riedlová J, Vignerová J: Percentile figures and tables. In: Bláha P, Vignerová J, (eds.): Investigation of the growth of Czech children and adolescents. Normal, underweight, overweight. Praha, National Institute of Public Health, 2002, pp. 27 – 73.
3. Dibley MJ, Goldsby JB, Staehling NW: Development of normalized curved for the international growth reference: historical and technical considerations. *Am J Clin Nutr*, 1987; 46: 736–48.
4. Lhotská L, Bláha P, Vignerová J, Roth Z, Prokopec M: The 5<sup>th</sup> Nationwide anthropological survey of children and adolescents, Czech Republic, Anthropometric characteristics. Praha, SZÚ, 1993. (In Czech.)
5. Martin R, Saller K: Text-book of anthropology. Stuttgart, G. Fischer, 1957. (In German.)
6. Matiegka J: Somatology of schoolchildren. Praha, ČAVU, 1927. (In Czech.)
7. Obesity: Preventing and managing the global epidemic. WHO Technical Report Series, Geneva, World Health Organization, 2000.
8. Vignerová J, Bláha P, Kobzová J, Krejčovský L, Paulová M, Riedlová J: Growth and development of school children. *Cent Eur J Publ Health*, 8, 2000, 1: 21–23.
9. Vignerová J, Ošancová K, Kovářová M, Bláha P (2002): Prevalence of excessive and low body weight in the contemporary Czech child population, lifestyle and dietary habits of children. In: Bláha P, Vignerová J, eds. Investigation of the growth of Czech children and adolescents. Normal, underweight, overweight. Praha, National Institute of Public Health, 2002: 102–112.

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