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Overweight and Obesity in Slovak High School Students

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Abstract

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Childhood and adolescent overweight and obesity are important public health concerns. Common definitions of paediatric overweight and obesity are based on BMI (Going et al., 2011). Slovakia is one of the few countries with national BMI standards that take into consideration dietary habits and local genotypes. The purpose of this study was to determine the prevalence of overweight and obesity among adolescents of Prešov region in Slovakia. A non-randomized cross-sectional study was used to determine incidence of obesity in adolescents living in the region of Prešov. Research sample consisted of 1,015 participants (550 girls; 465 boys) aged between 15 and 18 years. BMI values in particular age groups of both genders were assessed according to Slovak National Reference Standards. Results: For both genders, mean values of body height and body weight and mean BMI values across all age categories fell between 50th and 75th percentile. In total, 6.4% of boys and 6.8% of girls were overweight, and 9.4% of boys and 8.2% of girls were obese. The highest prevalence of overweight was found for 18-year-old boys and for 17-year-old girls, and the highest prevalence of obesity was found for both 15-year-old boys and girls. The comparison of our findings with available data from National Anthropometric Survey on physical development of Slovak youth in 2001 showed lower prevalence of overweight, but higher percent prevalence of obesity in girls and boys.

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Keywords: Body weight; body height; BMI; Slovak National Reference Standards; prevalence.

1. Introduction

Growth and development of an individual are determined by genetic and environmental factors including lifestyle and socioeconomic conditions. These factors may have either a positive or negative effect on genetic developmental dispositions (Nováková, Hamade, & Ševčíková, 2004). Growth spurt and secular trend over the past few decades are evidence of how changing life conditions affect growth parameters of children and youth. Monitoring basic somatic parameters of children and adolescents is



an important assessment tool used to determine actual health and nutritional status. Slovakia is one of the countries where experts thoroughly investigate growth characteristics of child population, which allows for acquiring comprehensive knowledge about developmental trends of Slovak children and youth. At the same time, Slovakia is one of the few countries with national standards for the assessment of body height, body weight and BMI. Thanks to National Anthropometric Survey (NAS) conducted at 10-year intervals, tools to monitor and assess current situation in this field are available. Over the past 50 years, the analysis of somatic development of Slovak children has confirmed that Slovak children and youth demonstrate both growth acceleration and moderate increase in overweight and obesity. The analysis of available NAS data from 2001 revealed that 10.7% of girls and 11.3% of boys were overweight, and 6.4% of girls and 6.7% of boys were obese (Nováková, Kajaba, & Salkayová, 2014).

Worldwide, childhood and adolescence overweight and obesity represent a serious health concern. Their continually increasing prevalence is induced by imbalance between energy intake and energy expenditure caused by poor dietary habits and lack of physical activity (Kožuchová & Bašková, 2013). From the perspective of health risks, childhood obesity is more serious than adulthood obesity. In addition to serious health problems such as dyslipidaemia, type 2 diabetes, arterial hypertension, atherosclerosis, or metabolic syndrome, childhood obesity affects children's experience, state of mind and intimacy leading to frustration, depression, social discrimination, which manifest especially during this age period (Hlavatá, 2007).

With respect to the risk factors associated with childhood obesity, early detection of obesity is crucial. Childhood age is specific in terms of determining overweight and obesity. In addition to examining body weight itself, which naturally increases during the growth and developmental period, body weight should be assessed relative to body height. Worldwide, the most applied and the simplest body index used to assess overweight and obesity is the body mass index (BMI), which takes into consideration the relation between body weight and body height. In children, BMI values are significantly age-dependent.

High BMI values during childhood and adolescence are associated with increased probability of adulthood obesity. As much as 80% of obese children tend to remain obese in adulthood as well (Lisá, 2004). In Slovakia, girls and boys under 18 years of age are assessed according to BMI percentile charts, which allows for comparing children BMI with respect to age and gender against reference norms for a given population. The assessment of BMI based on a percentile chart is considered to be a valid assessment tool. Children are classified as overweight or obese when their BMI exceeds 90th percentile or 97th percentile, respectively. BMI values ranging from 25th to 75th percentile indicate normal weight, while BMI values below 25th percentile indicate underweight. BMI between 75th and 90th percentile is indicative of above-normal weight (Hlavatá & Rajteková, 2008).

This paper, which was supported by the Slovak Research and Development Agency pursuant to contract no. APVV-0768-1, provides findings related to the incidence of overweight and obesity of contemporary high school students living in Prešov region.

The purpose of this study was to determine the prevalence of overweight and obesity among adolescents of Prešov region in Slovakia.

2. Materials and methods

A non-randomized cross-sectional study was used to describe selected indicators of body composition as predictors of health risks in high school students from the Prešov region, with respect to gender differences.

The sample consisted of 1,015 high school students aged 15 to 18 years (boys $n = 465$; girls $n = 550$). At the time of measurement, mean decimal age of students (mean \pm SD) was 17.2 ± 1.2 years. The study was conducted between October and December 2013. The sample consisted of students attending 14 schools that differed in the orientation of the teaching process (college-preparatory schools, high schools of art, vocational high schools). Schools were selected using random, stratified sampling in the respective districts, with one school per district. Subsequently, classes from 1st through 4th grade were randomly selected, one class per grade.

Participants took part in basic measurement of anthropometric parameters. Body height was measured using a portable stadiometer (SECA 217, Hamburg, Germany) to the nearest 0.1 cm. Body weight measured to the nearest 0.1 kg was determined using direct segmental multi-frequency bioelectric impedance analysis (DSM-BIA) device InBody 230 (Biospace Co., Ltd.; Seoul, Korea). BMI value was calculated using a standard equation, according to Keys et al. (1972).

Somatic development expressed by body height, body weight and BMI of both female and male students was assessed by comparing their values against reference values, according to Slovak National Reference Standards based on National anthropometric survey from 2001 and 2011 (NAS, 2001, 2011), which provide data about dietary habits and local genotypes. Participants were assessed according to their age and changes in the degree of obesity (BMI value). The students were assigned into age categories according to the rules of decimal age division devised by World Health Organization.

The assignment of students into particular subsamples in relation to somatic development zones was based on percentile charts. Students whose body height values were below 25th percentile of reference values were classified as short, and those with body height falling into 25th and 75th percentile were classified to be of medium height. Students whose body height values equalled or exceeded 90th percentile were classified as tall and very tall, respectively.

Incidence of obesity was determined according to BMI. Data were analysed to determine overweight and obesity rates, using the NAS 2001 reference data for BMI for age. BMI values between 25th and 75th percentile, between 75th and 90th percentile, over 90th percentile and over 97th percentile indicate normal weight, above-normal weight, overweight, and obesity, respectively. Students with BMI values under 25th percentile were not assessed separately, but were assigned to the health weight group.

Legal guardians of participants (when children were younger than 18 years) or/and participants (when children were older than 18 years) received a verbal description of the study procedures before testing and completed a written informed consent that was approved by the ethical committee of Prešov University in Prešov. Measurements were performed according to the ethical standards of the Helsinki Declaration (Harriss & Atkinson, 2011).

3. Results

The trend in physical growth and development of high school youth living in Prešov region was assessed according to growth charts by comparing data against results of VI and VII Slovak nationwide anthropometric cross-sectional surveys conducted in 2001 and 2011, respectively, on representative samples of both boys and girls across all age groups.

Tables 1 and 2 provide descriptive characteristics of anthropometric parameters for both genders and their comparison with national standards of VII. nationwide anthropometric survey conducted in 2011. Mean values of body height, body weight and BMI for boys and girls across particular age groups fell between 50th and 75th percentile, which indicates medium body height and normal body weight. For boys, mean values of investigated parameters increased with age. The most significant increase in body weight equalling 2.7 kg was found particularly between 17th and 18th year of life.

Table 1. Descriptive characteristics of anthropometric parameters for boys

Age	Parameter	Mean	Standard deviation	Minimal value	Maximal value	NAS 2011	
						Mean	Standard deviation
15 years (n = 84)	BH (cm)	175.3	6.5	158.4	190.7	175.8	7.6
	BW (kg)	64.8	12.3	45.1	100.3	66.0	12.9
	BMI (kg.m ⁻²)	21.0	3.4	16.4	30.7	21.3	3.5
16 years (n = 153)	BH (cm)	176.6	6.5	162.2	194.8	177.6	7.1
	BW (kg)	67.6	11.8	46.9	110.0	69.2	12.6
	BMI (kg.m ⁻²)	21.6	3.4	15.5	34.6	21.9	3.6
17 years (n = 94)	BH (cm)	177.1	6.3	160.5	192.8	178.4	7.1
	BW (kg)	68.7	11.3	50.2	97.1	72.1	13.0
	BMI (kg.m ⁻²)	21.9	3.3	17.1	31.5	22.6	3.6
18 years (n = 134)	BH (cm)	177.6	6.9	160.8	198.1	179.3	6.7
	BW (kg)	71.7	11.8	46.7	119.9	74.1	12.2
	BMI (kg.m ⁻²)	22.7	3.3	16.0	33.1	23.1	3.6

Note. n = number of participants; BH – body height; BW – body weight; BMI – body mass index; NAS 2011 – national anthropometric survey 2011

For girls, body height increased by 1.1 cm between 16th and 17th year of life, while mean values of body weight and BMI increased with age, but at a slower rate compared to boys.

Table 2. Descriptive characteristics of anthropometric parameters for girls

Age	Parameter	Mean	Standard deviation	Minimal value	Maximal value	NAS 2011	
						Mean	Standard deviation
15 years (n = 114)	BH (cm)	164.4	5.6	147.0	177.0	164.6	6.1
	BW (kg)	56.8	9.9	37.2	88.8	57.5	10.2
	BMI (kg.m ⁻²)	21.0	3.2	14.6	31.7	21.2	3.6
16 years (n = 143)	BH (cm)	164.3	5.8	150.9	179.1	164.8	6.6
	BW (kg)	57.4	10.8	41.7	100.2	57.7	10.5
	BMI (kg.m ⁻²)	21.2	3.6	15.3	36.1	21.2	3.4

17 years (n = 124)	BH (cm)	165.4	5.7	147.4	181.6	165.1	6.4
	BW (kg)	58.4	9.7	42.7	91.9	58.2	9.1
	BMI (kg.m ⁻²)	21.3	3.2	15.8	34.0	21.3	3.1
18 years (n = 169)	BH (cm)	165.3	6.1	147.5	178.4	165.4	6.5
	BW (kg)	59.4	10.3	40.5	89.4	59.3	11.1
	BMI (kg.m ⁻²)	21.7	3.4	13.9	32.4	21.7	3.7

Note. n = number of participants; BH – body height; BW – body weight; BMI – body mass index; NAS 2011 – national anthropometric survey 2011

Comparison with results of VII nationwide anthropometric survey conducted in 2011 has shown that mean values of anthropometric parameters for boys in particular age categories are lower than reference values, while those for girls are approximately at the same level. However, mean body weight of 15-year-old girls is lower by 0.7 kg.

Intra-individual analysis based on using percentile charts showed that the largest number of high school students fell into the medium body height zone (25th to 75th percentile), i.e. 51.5% of boys and 49.7% of girls (Fig. 1). Overall, 34.9% of boys and 37.4% of girls fell into the below-average body height zone (below 25th percentile). The lowest number, 13.6% of boys and 12.9% of girls were identified to be tall or very tall (75th to 95th percentile).

Unlike body height, which is significantly genetically determined, body weight is an unstable somatic parameter that may be influenced particularly by physical activity and diet. Body weight assessment of participants showed that 42.0% of boys and 44.7% of girls had normal weight (25th to 75th percentile) (Fig. 2). Further, 28.2% of boys and 30.1% of girls were classified as underweight (below 25th percentile). Increased body weight (75th to 90th percentile), overweight (90th to 97th percentile) and obesity (over 97th percentile), was found for 15.3% of boys and 13.1% of girls, 9.6% of boys and 8.2% of girls, and 4.9% of boys and 3.9% of girls, respectively.

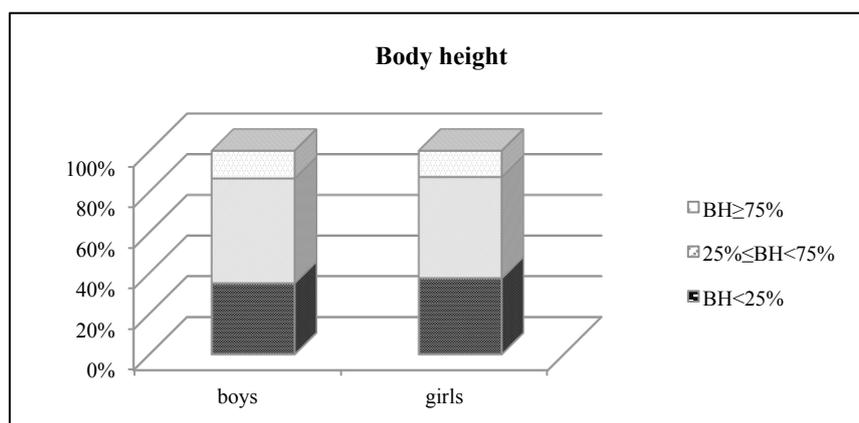


Fig. 1. Percentages of boys and girls in percentile zones according to body height

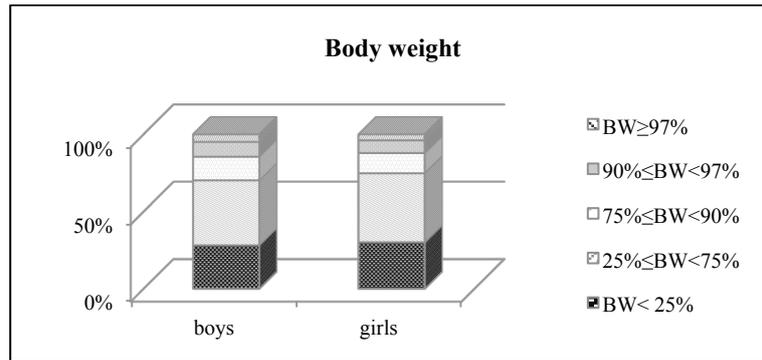


Fig. 2. Percentages for boys and girls in percentile zones according to body weight

Body height and body weight are indicators which if assessed separately do not have as high information value as a frequently used weight-height ratio expressed by BMI (Tománková, Matejovičová, & Tatko, 2010).

Figure 3 shows percentages for boys in particular percentile zones according to their BMI. BMI analysis showed that approximately half of boys in each of the age categories were found to have normal body weight (25th to 75th percentile). The highest percentage and the lowest percentage of boys with normal weight were found for 57.9% of 17-year-olds and 48.5% of 18-year-olds, respectively (Fig. 4). Almost one fifth of boys across all age groups fell into the underweight category (below 25th percentile). For boys, above-normal weight (75th to 90th percentile) was found for 5.3% of 17-year-olds, 13.5% of 16-year-olds and 16.7% of 18-year-olds. The overweight rate (between 90th and 97th percentile) ranged from 5.6% of 15-year-olds to 7.6% of 18-year-olds. The highest obesity rate (above 97th percentile) was found for 15-year-old boys (12.2%), while obesity rate in the remaining age categories gradually decreased from 8.8% for 16-year-olds to 8.3% for 18-year-olds.

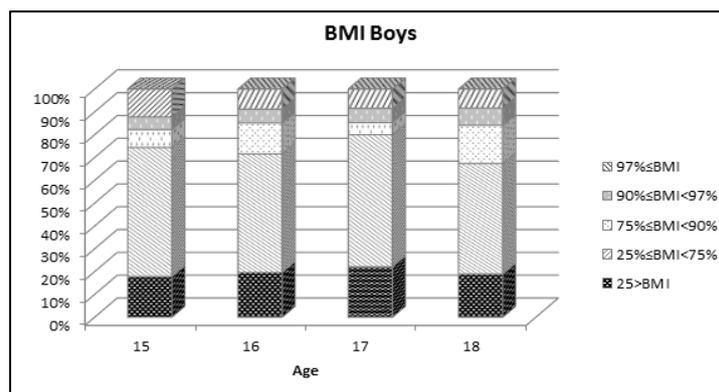


Fig. 3. Percentages for boys in percentile zones according to BMI

Overall, 6.4% and 9.4% of boys were overweight or obese, respectively. Overweight moderately and gradually increased with age, whereas obesity rate for boys decreased. At onset of adolescence, 5.6% of 15-year-old boys were overweight and 12.2% of boys were obese. At the beginning of adulthood, in the 18-year-olds, 7.6% of boys were overweight and 8.3% were obese.

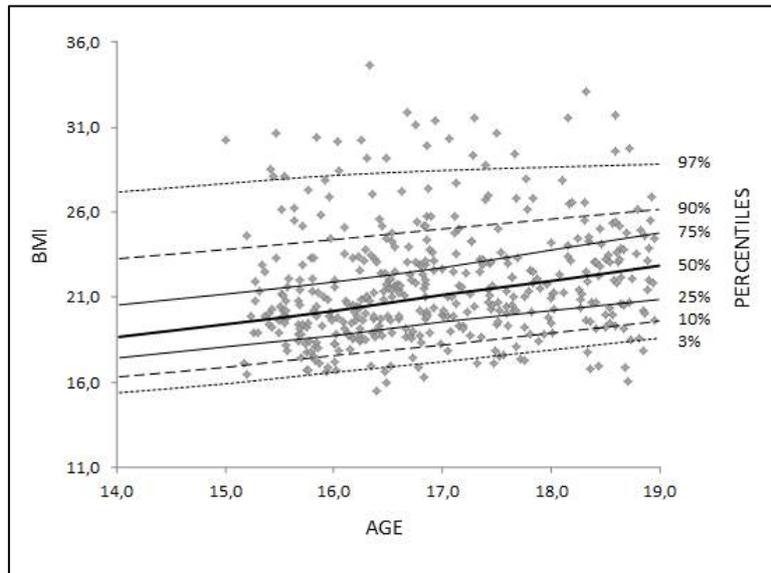


Fig. 4. Distribution of BMI values in the percentile chart for boys

Figure 5 shows percentages for girls in particular percentile zones according to their BMI. BMI analysis showed that approximately half of girls in each of the age categories fell into the normal weight zone (25th to 75th percentile). The highest percentage of normal weight girls was found for 55.0% of 16-year-olds and 46.1% of 18-year-olds (Fig. 6). Underweight was found for 20.0% to 25.0% of girls, depending on the age category. Above-normal weight was lowest for 16-year-old girls, 6.6%, and highest incidence of above-normal weight (75th to 90th percentile) was recorded identically for 11.2% of 15- and 17-year-old girls. The largest percentage of girls with above-normal weight equalling 16.2% was found for 18-year-olds. The lowest and the highest number of overweight girls (90th to 97th percentile) was found for 15-year-olds (5.2%) and 17-year-olds (8.6%), respectively. The highest and the lowest obesity (above 97th percentile) percentage rate equalling 10.3% and 6.9% was found for 15-year-old and 17-year-old girls, respectively.

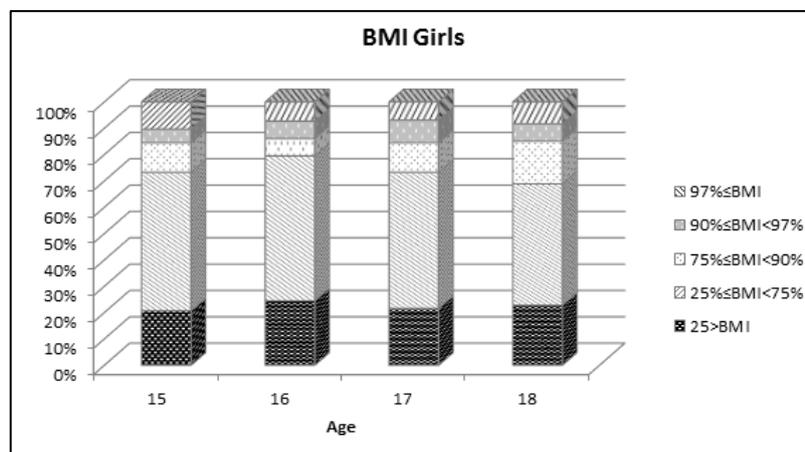


Fig. 5. Percentages of girls in percentile zones according to BMI

Of girls, 6.8% were identified as overweight and 8.2% as obese. Unlike their male counterparts, percentage of overweight girls increased gradually with age. The number of obese girls decreased in 15-year-olds and 17-year-olds only. At the beginning of adolescence, 5.2% of 15-year-old girls were overweight and 10.3% of 15-year-old girls were obese. At the onset of adulthood, 6.6% and 8.4% of 18-year-old girls were overweight or obese, respectively.

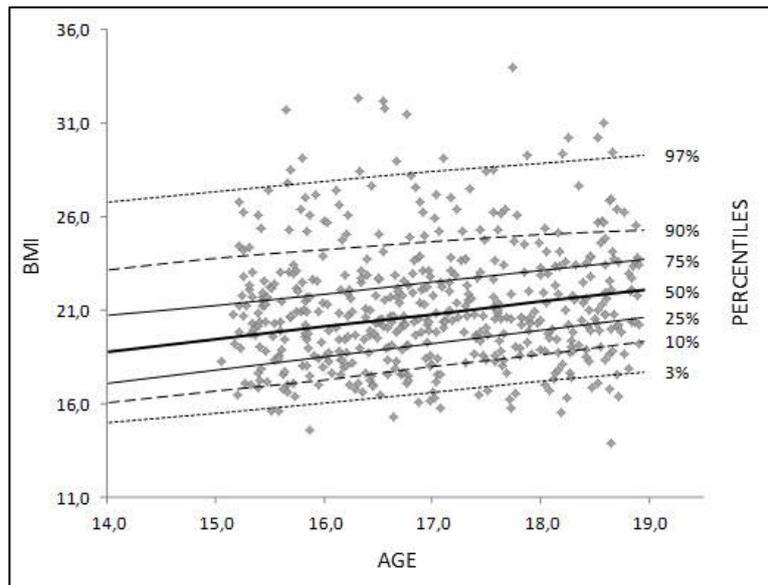


Fig. 6. Distribution of BMI values in the percentile chart for girls

Gender comparison has shown that at the onset of adulthood, at the age of 18, boys are taller by 12.3 cm and heavier by 12.3 kg than girls, and their BMI is higher by 1.0 kg.m⁻² compared to that of girls. With respect to incidence of overweight and obesity in the subsamples, higher rate of overweight was found for 16- and 17-year-old girls, however lower obesity rate was found for 15- and 17-year-old girls compared to their male counterparts. The largest percentage of overweight girls and boys were 17 years old (8.6%) and 18 years old (7.6%), respectively. The highest percentages of both obese boys and girls were found for 15-year-olds (12.2% of boys and 10.3% of girls). The lowest obesity rate was found for 8.3% of 18-year-old boys and 6.9% of 17-year-old girls. These findings have shown that obesity rate decreases with age for both genders, whereas overweight rate increases.

4. Discussions and conclusions

The assessment of somatic development should take into consideration two basic anthropometric parameters, i.e. body height and body weight, which significantly underlie somatic development. Body height is determined by both genetic and constitution factors, however body weight manifests lower rate of developmental stability and is affected mainly by external factors such as nutrition, physical activity, or their relationship expressed as ratio of energy intake to energy expenditure.

The comparison of data collected during VI and VII Slovak nationwide anthropometric surveys conducted in 2001 and 2011 shows that at present the acceleration stimuli and secular trend in body height of adolescents has stopped. Over the past decade, mean values of body height decreased for 16- to 18-year-old boys and for 15- to 18-year-old girls. Stagnation of growth after 16th year of life has been evident since 1991 (Ševčíková et al., 2014). Unlike body height, unfavourable trend in increasing mean body weight for both female and male adolescents is continuing, with more significant increase in boys. Compared to results from 2001, statistically significant increase in body weight was found for adolescents across all age groups, except 16-year-old girls. Body weight increased by 2.9 kg to 3.9 kg for boys and by 0.4 kg to 1.7 kg for girls. A both interesting and unfavourable finding is that at the onset of adulthood mean values of body height increased more significantly compared to the previous decade between 1991 and 2001. In 2001, 18-year-old boys were 0.6 kg heavier compared to their counterparts in 1991, however boys in 2011 were 3.8 kg heavier than their counterparts in 2001. A similar although less significant trend was found for 18-year-old girls. In 2001, 18-year-old girls were 0.15 kg heavier compared to their counterparts in 1991, however, in 2011, their mean body weight was 1.7 kg higher compared to that in 2001. With stagnating body height, increase in body weight resulted in increased mean BMI values, which at present is a basic parameter used to determine the incidence of overweight and obesity. Changes in BMI values correspond to changes in body weight (Ševčíková et al., 2008). During the decade between 2001 and 2011, mean BMI values increased significantly across all age groups for both genders. In 2011, mean BMI values at the onset of adulthood were 23.1 kg.m⁻² for boys and 21.7 kg.m⁻² for girls, whereas in 2001, mean BMI values for boys and girls were 21.8 kg.m⁻² and 21.0 kg.m⁻², respectively. Most significant differences between genders were found for 17- and 18-year-olds, where higher values were recorded for boys. Compared to 2001, mean BMI value increased by 1.27 kg.m⁻² for boys and by 0.64 kg.m⁻² for girls. Between 1991 and 2001, mean BMI values of 13- to 18-year-old girls decreased significantly indicating slenderness, which was not confirmed in 2011.

The analysis of BMI values from 2001 showed that of girls and boys aged 7 to 18 years, 10.2 to 14.5% of girls and 10.0% to 17.5% of boys were overweight and 5.3% to 8.9% of girls and 5.7% to 9.8% of boys were obese. However, different types of associations between overweight and obesity and age were found for both genders. For girls, prevalence of overweight and obesity was found at a younger age. Prevalence of overweight and obesity gradually decreased, with moderate increase at 14 years of age. These findings have revealed that, with onset of puberty and adolescence, girls begin caring more about their looks, change their dietary habits and monitor their body weight more often. However, for boys, the prevalence of overweight and obesity increased from 7 to 12 years of age and then decreased up to 18 years of age. The analysis of anthropometric survey conducted in 2001 showed that during adolescence 10.7% of girls and 11.3% of boys were overweight and 6.4% of girls and 6.7% of boys were obese (Nováková, Kajaba, & Salkayová, 2014).

To determine trends in overweight and obesity rates of Slovak adolescents over the past few decades, we should take into account data from 1991, which were not processed, and data from the most recent VII nationwide anthropometric survey are not available yet.

With regard to external conditions, ethnic and genetic relatedness, Slovak children are fairly similar to children and adolescents from Czech Republic. Anthropometric survey conducted in 1991 showed that, in each of the age categories, 7.0% of children were overweight and 3% of children were obese. However, in 2001, the number of overweight boys and girls increased by 1.9% and by 1.5%, respectively. The percentage of obese children in 2001 equalled 6.6% for boys and 2.6% for girls, and compared to data from 1991, the obesity rate increased by 3.6% for boys and by 2.6% for girls, especially in the younger age groups (Lisá et al., 2008). As reported by Hlavatá (2007), in former Czechoslovakia 13.0% of boys and 12.0% of girls were overweight and 6.0% of boys and 5.6% of girls were obese.

Nationwide anthropometric surveys conducted on Slovak children and adolescents at 10-year intervals have shown that both growth acceleration and secular trend related to body height are diminishing. The unfavourable trend showing increase in body weight of Slovak children and youth over the past few decades, which corresponds to BMI increase, is similar to that present in other economically developed European countries and other countries around the world. Overweight and obesity rates in Slovak adolescents range from 10.5% to 11.5% and from 5.0% to 6.0%, respectively, and do not reach epidemic proportions.

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