

Original Article

Stabilization of Overweight and Obesity in Slovenian Adolescents and Increased Risk in Those Entering Non-Grammar Secondary Schools

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Key Words

Overweight · Obesity · Adolescent · Education · Slovenia

Abstract

Background/Aim: To estimate overweight and obesity prevalence trends in Slovenian adolescents entering secondary schools in the years 2004, 2009 and 2014 and differences in the prevalence between different types of secondary schools. **Methods:** Data from 17,538 adolescents entering secondary schools (mean age \pm standard deviation 15.4 \pm 0.5 years) collected during obligatory medical examination in years 2004, 2009 and 2014 was analyzed. Overweight and obesity were defined using International Obesity Task Force criteria. **Results:** In 2004–2009 overweight and obesity prevalence increased, especially in males and stabilized thereafter (2009–2014) in both genders. It was significantly higher ($p < 0.0001$) in those attending secondary vocational and technical/professional versus grammar schools (2009; 28.7 vs. 16.8% overweight females and 31.6 vs. 22.3% overweight males; 2014: 29.7 vs. 17.9% overweight females and 33.6 vs. 20.4% overweight males). **Conclusions:** Overweight and obesity prevalence in Slovenian adolescents entering secondary schools stabilized recently. Adolescents attending secondary vocational and technical/professional schools are at an increased risk of overweight and obesity.

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Introduction

Obese children and adolescents are prone to develop overweight or obesity in adulthood which is often associated with various obesity-related health complications [1, 2]. Significant obesity-related metabolic and non-metabolic complications may however also present in adolescents and even children [1, 3]. Obesity in children represents an important public healthcare problem that will become even more significant in the near future should we not turn the current trends in the prevalence of obesity and its complications [1, 4].

Overweight and obesity prevalence was increasing in both developed and developing countries until recently, when it plateaued at an unacceptably high level [5–7]. Increase in prevalence was also reported in Slovenian children and adolescents [8–10]. Recently prevalence of overweight and obesity stabilized in Slovenian 5-year-old children in the period 2001–2009, and in 7-year-old children in the period 1991–2011 in the city of Ljubljana [11, 12]. In the same time period prevalence of overweight and obesity however continued to increase in Slovenian adolescents [13].

The aim of this study was to estimate trends in the prevalence of overweight and obesity in Slovenian adolescents entering secondary schools in the years 2004, 2009, and 2014. In addition, differences in the prevalence of overweight and obesity according to the type of secondary schools adolescents were entering was investigated in the years 2009 and 2014.

Material and Methods

Subjects

All students entering secondary schools have an obligatory clinical examination. It is performed by a primary care pediatrician at a local healthcare facility. For the purpose of the study, anonymous data was obtained from primary care pediatricians from all regions of Slovenia that were willing to participate in the study. Data was collected from all adolescents that have had an obligatory clinical examination performed by these pediatricians in the years 2004, 2009, and 2014. In 2014, however, 11 subjects were excluded due to missing data (2 gender, 4 height and weight, 5 age). In 2009, 4 subjects were excluded due to missing data (3 height, 1 weight), 1 due to age < 15 years and 51 due to age > 17 years. In 2004, no subjects were excluded.

The adolescents were measured in their underwear in the morning in a fasted state by a trained medical professional. Height and weight were determined by validated stadiometers and electronic digital scales. Both were rounded to the first decimal place. BMI was calculated as weight (kg) divided by squared height (m).

Overweight and obesity prevalence were calculated using the International Obesity Task Force (IOTF) criteria corresponding to adult's BMI cut-offs of 25 and 30 kg/m², respectively, at 18 years of age [14]. These criteria define age- and gender-specific cut-off points from 2- to 18-year-old children.

In 2009 and 2014 data, the type of secondary schools adolescents were entering was also recorded. Adolescents were divided into two groups according to the type of secondary school. Adolescents entering academically oriented grammar secondary schools were included into the first group. Adolescents entering other types of secondary schools – vocational schools and technical/professional secondary schools – were included into the second group. Adolescents with missing data on the type of schooling were excluded from the sub-analysis (N = 1,446 in 2009 and N = 879 in 2014). The effective size of the population of students entering secondary schools in Slovenia was obtained for each of the 12 statistical regions and for each gender [15].

Statistical Analysis

Descriptive statistics were calculated for the three survey time points (2004, 2009, and 2014). The results were reported as the number and proportion of subjects that were overweight (including obese) or obese, with 95% confidence interval (95% CI) separately for males and females.

The gender-specific BMI distributions in consecutive years were compared using quantile-quantile (QQ) plots. QQ plots are scatter plots of the quantiles of one distribution against the quantiles of the second distribution and are useful for the assessment of the similarity between two distributions. If two distributions are similar, the points should be close to the identity line. The BMI distributions were compared using Mann-Whitney test.

To take the sampling scheme into account, the proportion estimates were obtained for each of the statistical regions, and the overall estimate was defined as their weighted average (the weights being the proportion of students effectively enrolled in each region, for each year and gender). To take into account that the sampling fraction was large, a finite population correction was applied; the correction guarantees that the standard errors are estimated correctly when the population is not infinite, and in practice it reduces the standard errors by a factor equal to $\sqrt{((N - n)) / ((N - 1))}$, where n and N are the sizes of the sample and of the population, respectively. Standard errors, 95% CI, and p values were based on hypergeometric distribution for the region-specific estimates and on normal approximation for the overall estimates. Unweighted estimates were also derived. The comparisons between vocational and technical/professional schools versus grammar schools were based on unweighted estimates; the p values were obtained using the chi-square test, and the 95% CI were based on normal approximation.

The R statistical program was used for statistical analysis [16]. The `Sprop` function included in the sampling book R package was used to obtain the results corrected for the finite population.

Results

Altogether 17,538 (8,437 females) adolescents entering secondary schools were included in the study. The prevalence of overweight and obesity in the year 2004 has been reported previously [13]. The sample included 10.1% of all students entering secondary schools in Slovenia in 2004, 31.6% in 2009, and 40.6% in 2014. Descriptive statistics data are presented in table 1.

Trends in Overweight and Obesity Prevalence from 2004 to 2014

There was an increase in the prevalence of overweight in the period 2004–2009, being more profound in males than in females (table 1). It however stabilized in the period 2009–2014, especially in males (table 1). Obesity prevalence increased significantly from 2004 to 2009 for both females and males, and stabilized in the period 2009–2014 (table 1).

Males were more prone to be overweight than females in the years 2009 and 2014: 8.4 (6.4–10.3, $p < 0.001$) versus 5.2 (3.5–7.0, $p < 0.001$) (estimated difference of proportions (95% CI, p value)). In addition, males were also more prone than females to be obese in years the 2009 and 2014: 3.6 (2.4–4.8), $p < 0.001$ versus 3.7 (2.7–3.7, $p < 0.001$).

Similar results were obtained with the unweighted estimates (within 0.5 percentage points for obesity and 1.5 percentage points for overweight, complete data not shown).

Trends in BMI Distribution in Males and Females from 2004 to 2014

In addition to trends in the prevalence of overweight and obesity, we have also investigated the pattern of BMI distribution within the population. Distribution of central BMI values (mean and median) changed modestly in the selected time period (fig. 1). There was however a change towards an increased prevalence of adolescents with very high BMI values from 2004 to 2009 for both females and males and for males from 2009 to 2014, but not for females (fig. 1). Overall, the 2004 and 2009 gender-specific BMI distributions were significantly different ($p < 0.001$ for both genders), while the 2009 and 2014 BMI distributions were not ($p = 0.72$ and 0.91 for females and males, respectively).

Overweight and Obesity Prevalence in Relation to the Type of Secondary School

As presented in table 2, the prevalence of overweight and obesity was higher in both males and females attending vocational and technical/professional secondary schools. All differences (for both obesity and overweight within each gender and year) were significant ($p < 0.0001$).

Table 1. Overweight/obesity prevalence and auxologic data in adolescent females and males in the years 2004, 2009 and 2014

	2004		2009		2014		Δ 2009 – 2004*		Δ 2014 – 2009*	
	females (n = 1,412, 53%) (n = 1,229, 47%)	males (n = 1,229, 47%)	females (n = 3,500, 51%)	males (n = 3,361, 49%)	females (n = 3,525, 44%)	males (n = 4,511, 56%)	females	males	females	males
Age, years	15.66 ± 0.60	15.74 ± 0.68	15.13 ± 0.38	15.16 ± 0.41	15.55 ± 0.49	15.60 ± 0.57				
BMI, kg/m ²	21.34 ± 3.39	21.53 ± 3.35	21.99 ± 3.88	22.40 ± 4.22	22.03 ± 3.88	22.40 ± 4.23				
Overweight prevalence, % (95% CI)	18.6 (16.5–20.7)	20.6 (18.1–23.1)	21.0 (19.8–22.3)	29.4 (27.9–30.9)	23.4 (22.1–24.7)	28.6 (27.5–29.8)	2.4 (0.0–4.9) p = 0.052	8.8 (5.9–11.7) p < 0.001	2.4 (0.6–4.1) p = 0.010	–0.8 (–2.7 to 1.1) p = 0.424
Obesity prevalence, % (95% CI)	3.5 (2.5–4.6)	3.0 (2.1–4.0)	5.7 (5.0–6.5)	9.3 (8.3–10.3)	5.6 (4.9–6.3)	9.2 (8.5–10.0)	2.2 (0.9–3.4) p < 0.001	6.3 (4.9–7.6) p < 0.001	–0.1 (–1.1 to 0.9) p = 0.790	–0.1 (–1.3 to 1.1) p = 0.925

*Estimated difference of proportions (95% CI, p value).

Table 2. Overweight and obesity prevalence in adolescent females and males according to the type of secondary school they are attending in years 2009 and 2014

School	2009		2014		Δ 2009 – 2009*		Δ 2014 – 2014*	
	females	males	females	males	non-grammar - grammar	non-grammar - grammar	non-grammar - grammar	non-grammar - grammar
Overweight	16.8 (14.9–19.0)	28.7 (26.3–31.3)	11.9 (8.6–15.2)	9.3 (5.7–12.9)	11.8 (8.8–14.8) p < 0.001	13.2 (10.0–16.3) p < 0.001	33.6 (31.9–35.3)	8.0 (6.2–9.8) p < 0.001
Obesity	4.2 (3.3–5.5)	8.6 (7.1–10.3)	4.4 (2.4–6.3)	4.4 (2.8–6.1)	4.4 (2.8–6.1) p < 0.001	4.4 (2.8–6.1) p < 0.001	12.0 (10.9–13.3)	8.0 (6.2–9.8) p < 0.001

Overweight and obesity prevalence is expressed as percentage and 95% confidence interval. Non-grammar school includes vocational and technical/professional schools. Δ – difference.

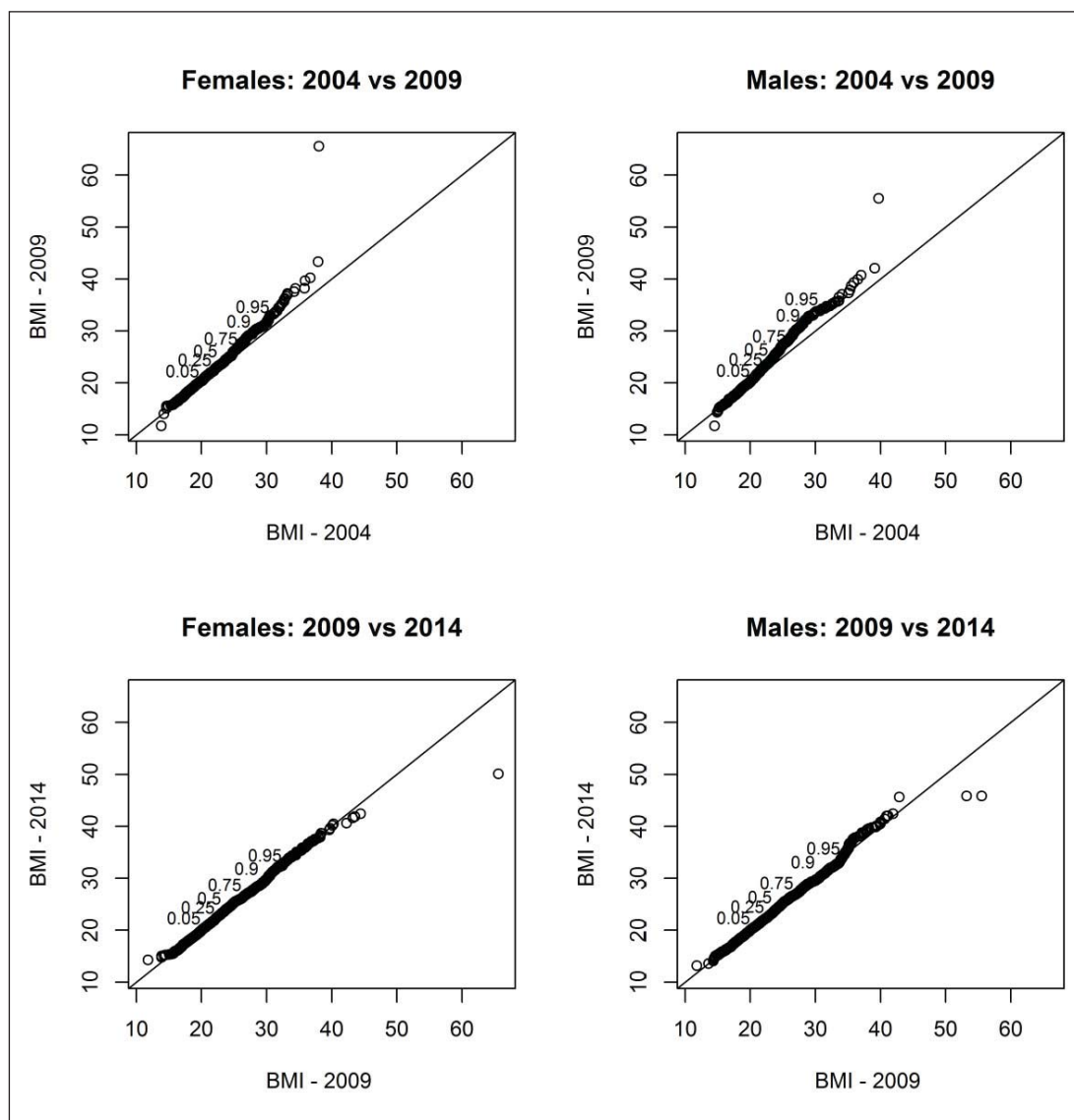


Fig. 1. Quantile to quantile plots of observed BMI in adolescent males and females in the period 2004–2014 (pairwise comparisons). The numbers in the plots indicate the ordinate position of the corresponding quantile of the distribution plotted on the ordinate axis, e.g., in the first plot 0.5 is plotted on the ordinate where the median of the distribution of BMI for year 2004 is 21.3.

Discussion

Trends in overweight and obesity prevalence in Slovenian adolescents entering secondary schools were estimated by analyzing data from 10% of adolescents entering secondary schools in Slovenia in 2004, 32% in 2009, and 41% in 2014 [15]. One of the main findings was that overweight and obesity prevalence increased from 2004 to 2009 (being more profound in males) and then stabilized from 2009 to 2014.

In the time period 2001–2002, Slovenia ranked in the middle of the 34 countries (including several European countries, USA, Canada, and Israel) participating in the Health Behaviour in School-Aged Children (HBSC) survey with an overweight (including obesity) prevalence of

14.9% in 10- to 16-year-old adolescents (girls and boys) which was determined using self-reported data [17]. In 2010, according to the IOTF criteria and based on measured weight, 22.5% of girls and 31.7% of boys aged 10–12 years in Slovenia were overweight or obese, which is similar to our results (table 1) [18]. Also in 2010, it was estimated that 21.2% of boys and 13.5% of girls aged 14 years in the capital city of Ljubljana were overweight according to IOTF criteria [12]. These data are further supported by the data from the HBSC survey performed in the period 2009–2010 where it was estimated that 13% of girls and 23% of boys were overweight or obese. Slovenia ranked in the upper third of countries participating in the study [19].

In the period 2009–2014, however, overweight and obesity prevalence trends in Slovenian adolescents stabilized. Similar trends were recently determined in Germany where overweight and obesity in children/adolescents aged 4–16 years stabilized already in the years 2004 and 2008 [20] and in the USA where obesity in 2- to 19-year-old children remained stable between 2007 and 2008 as well as 2009 and 2010 [21]. In England overweight and obesity prevalence stabilized between 2004 and 2013 in younger children but still increased in 11- to 15-year-old children, although to a lesser extent [22]. Despite the stabilization of overweight and obesity prevalence, Slovenia ranks in the group of countries with the highest prevalence of overweight and obesity in adolescents in Europe [23].

Data on nutritional habits or physical activity of the subjects were unfortunately not collected in the present study. Therefore, we can only speculate on the reasons why the prevalence of overweight and obesity increased in Slovenian adolescents in the period 2004–2009.

Increased energy intake is suspected to be a major cause for the obesity pandemic in children and adolescents, i.e., a diet high in energy, saturated fats, carbohydrates, sugar-sweetened drinks, and low in fiber [24–26]. It was determined that in years 2003–2005 Slovenian adolescents did not meet minimal standards for the intake of vegetables, grains, fish and plant oils, and also fruits in boys [27]. Intake of sugar-sweetened beverages was determined to be extremely high, ranking at the top of international scale of sugar-sweetened beverages intake in 2010 [28]. This was especially evident in boys when compared to girls, possibly explaining the more profound increase in the prevalence of overweight and obesity in adolescent boys when compared to girls in the present study [27, 28]. It was also estimated that Slovenian adolescents, based on food frequency questionnaire and 3-day weighted dietary protocol, consumed excessive amounts of free sugars, especially in liquid form [29]. Some adolescents did tend to underreport and overreport their energy intake but it was assessed that the assessment of the diet of the whole group was valid [30].

In addition only 44% of children had regular breakfast during the working week in this time period, which ranked Slovenian adolescents at the very bottom of the international scale of regular breakfast consumption [28]. Having breakfast is associated with higher diet quality and lower prevalence of adiposity [31].

Recently a stabilization of obesity in 5-year-old children in Slovenia was reported. It was speculated that this might be caused by new national nutritional guidelines for the preparation of meals in kindergartens and schools, with decreased total fat and carbohydrate intake [11]. More than 75% of 5-year-old Slovenian children visit kindergartens, where they receive up to 4 meals per day [11]. A significantly lower percentage of Slovenian adolescents had regular meals in schools in this time period [32].

In addition to unhealthy diet, physical inactivity is also a major contributor to the development of overweight and obesity in children and adolescents [33–35]. Adolescents from Northern and Central Europe tend to be more physically active than those from Southern Europe, where overweight and obesity prevalence is higher [23, 36]. According to self-reported data from the HBSC study there has been a decline in regular physical activity in

Slovenian adolescents in the period 2002–2010 [28]. A decrease in motor abilities in Slovenian 6- to 18-year-old children and adolescents was determined by objectively measured motor abilities [37]. In addition to nutritional causes this could significantly contribute to the increased prevalence of overweight and obesity in Slovenian adolescents.

Our results indicate that not only the prevalence of obesity but also that of adolescents with very high BMI values increased (fig. 1). This change was more evident in adolescent boys than girls. Similar observations were made in North America, several European countries, Australia, and New Zealand [21, 38–40]. A proposed explanation is that children with a genetic predisposition for obesity are especially susceptible to the environmental risk factors causing obesity, with boys being more sensitive than girls [39].

The prevalence of adolescents that drink sugar-sweetened beverages however decreased in the period 2010–2014. The decrease was more significant in adolescent boys – from 48.8% in 2010 to 28% in 2014, than in girls – from 39.2% to 22.7% [28]. This may be attributed to campaigns targeting intake of sugar-sweetened beverages by informing children, parents and educational professionals about negative health effects of sugar-sweetened beverages and advantages of drinking plain water [41]. In addition, the percent of adolescents that regularly eat breakfast increased [28]. Not eating breakfast regularly is associated with higher risk of obesity [31]. On the other side it is possible to decrease this risk by targeted interventions [42]. Regular physical activity plays a prominent role in obesity prevention [35]. In this respect it is important to acknowledge the possible effect of the Healthy Lifestyle Project on the stabilization of overweight and obesity prevalence in Slovenia. This project has been offering children and adolescents aged 6–15 years additional sports activities for several years in all regions of Slovenia [43].

A significantly lower prevalence of overweight and obesity was estimated in adolescents attending grammar schools, compared to those attending secondary vocational and technical/professional schools in the years 2009 and 2014 (table 2). There are limited data on the association between type of school children/adolescents are attending and the overweight and obesity prevalence; however, differences between girls attending secondary grammar schools versus those attending vocational and technical/professional secondary schools were already reported in 2004. At that time girls attending grammar secondary schools were taller, lighter, had smaller skin fold thickness, and achieved better results in motor tests [44]. Children attending secondary vocational schools have poorer academic results when compared to those attending grammar schools. There is a negative association between overweight and obesity prevalence in children and their academic results [45, 46]. Obese adolescents have higher probability of being enrolled in a school with lower level of education [45]. Academic results are associated with socioeconomic status and directly or indirectly with overweight and obesity. Adolescents attending schools with lower socioeconomic status have a higher BMI when compared to those attending schools with higher socioeconomic status, e.g. private schools [47]. Altogether, overweight and obesity prevalence is associated with adolescent's academic results and socioeconomic status. Therefore specifically targeted interventions, taking into account adolescent's academic and socioeconomic status, need to be strictly implemented for adolescents attending secondary vocational and technical/professional schools in Slovenia.

One of the strengths of the presented study is that a large sample of adolescents from all regions of Slovenia was analyzed. This was especially true for samples from 2009 (32%) and 2014 (41%), and thus the main conclusions of the study were derived for the time period 2009–2014. For the sample estimates to be as representative as possible of the population values the proportion estimates were obtained for each of the statistical regions and the overall estimate was defined as their weighted average (the weights being the proportion of students effectively enrolled in each region, for each year and gender). Another strength is

that anthropometric measurements were performed by trained medical professionals using validated stadiometers and electronic digital scales.

Several limitations also have to be acknowledged. The measurements were not limited to one season only, but were performed from September to May of the following year, and this could have an effect on the reported results as it is known that there is a seasonal variability in nutritional status. In addition, data on nutritional and physical activity habits were not collected making a discussion on possible causes of estimated changes and differences in overweight and obesity prevalence speculative. Determination of these causes was however not an aim of the study.

Conclusions

Overweight and obesity prevalence increased in Slovenian adolescents entering secondary schools in the period 2004–2009. Thereafter, prevalence of overweight and obesity stabilized in the period 2009–2014, similarly to several other developed countries. Adolescent boys seem to be at particularly high risk for developing overweight and obesity, when compared to adolescent girls.

Adolescents entering vocational and technical/professional secondary schools are at an increased risk for overweight and obesity when compared to adolescent entering grammar schools. Specifically targeted intervention, such as healthy and regular meals, regular and appropriate physical activity and educational programs about healthy lifestyle provided by the school, should therefore be strictly implemented, especially in this population.

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Disclosure Statement

The authors declare that they have no conflict of interest.

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