INTRODUCTION

Over the past three decades, overweight and obesity in children has been one of the main public health issues in many countries worldwide (1–3). Child overweight (including obesity) has numerous consequences for physical, mental and social health in children and adolescents (4, 5). Moreover, obese children are more likely to remain obese in adulthood since around 80% of obese adolescents will still be obese in adulthood (6). Childhood obesity also determines healthcare costs occurring in adulthood; therefore, reducing child obesity could have a substantial impact on reducing future health care costs (7). Trends in the prevalence of childhood overweight and obesity represent an important health indicator used in various national policies aiming at overweight and obesity prevention and reduction.

Globally, the proportion of children and adolescents with overweight and obesity increased substantially from 1980 in both developed and developing countries (8). Increasing prevalence of overweight in children has also been reported in many Eastern European countries since 2002 (9). Additionally, rising trends in the prevalence of more severe forms of obesity were reported in Australia or the United States (10, 11). Moreover, no national success stories have been reported in the past 33 years in terms of reducing obesity and the probability of meeting the global obesity target is virtually zero (12).

On the other hand, van Jaarsveld and Gulliford (13), who used primary care electronic health records in England, reported stabilization in the prevalence of overweight and obesity in children between 2004 and 2013 in the UK. Another study by Keane et al. (14) also suggested that overweight and obesity in the Republic of Ireland reached a plateau and may start to fall. Stabilization of obesity rates in schoolchildren was also observed in urban Sweden (15). In contrary to this, a current literature review by Visscher et al. (16) concluded that the recent break in the obesity epidemic needs to be interpreted with caution and that the public health issue of obesity is still increasing.

In the Czech Republic, only few long-term studies dealing with child and adolescent overweight and obesity were published. Kunešová et al. (17) report an increasing prevalence of overweight and obesity in 7-year-old Czech children since 1951 and adds that since 2001 prevalence has plateaued with the exception of boys. Another study aimed at preschool children also confirmed an insignificant increase in the obesity level between 2005 and 2015 (18). An increasing percentage

SUMMARY

Objective: Overweight and obesity in adolescents is associated with many health risks and considerable direct and indirect healthcare costs. The purpose of this study is to examine trends in the prevalence of overweight and obesity in 11-, 13- and 15-year-old adolescents in the Czech Republic from 1998 to 2014.

Methods: Data from five self-reported survey rounds (1998, 2002, 2006, 2010, and 2014) of the Health Behaviour in School-aged Children Study (HBSC) were used to assess trends in overweight and obesity among Czech adolescents. The total sample consisted of 19,103 adolescents (51.2% girls). A logistic regression analysis was used to assess trends in different age and gender categories.

Results: From 1998 to 2014 a significant increase in the prevalence of overweight and obesity was observed among boys in all age categories (11 years old 22.2%–28.3% · 13 years old 17.9%–26.7% · 15 years old 9.8%–20.8%). None of the age and gender categories showed an overall decrease over the 16-year period. In boys, the prevalence of overweight was significantly higher with steeper negative trends compared with girls. However, stabilization in overweight rates was observed between 2010 and 2014 in all age and gender groups.

Conclusion: Nationally representative self-reported data show a significant increase in overweight (including obesity) prevalence among children from 1998 to 2014 in the Czech Republic. The results also suggest stabilization in overweight prevalence between 2010 and 2014. Continuing research is needed to determine future trends while interventions aimed at reducing overweight and obesity in children should be implemented on different levels of public policy.

Key words: adolescents, body mass index, HBSC, time trends, prevalence

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of obesity or overweight was reported between 2002 and 2014 in adolescents (19, 20).


MATERIALS AND METHODS

The present study follows the standardized international HBSC research protocol (21). The HBSC study is a WHO collaborative cross-sectional school-based study focusing on health and health behaviour of school-aged children. The study was conducted in the Czech Republic from 1998 to 2014 in 4-year cycles. Each survey round was approved by the Ethical Committee of the Faculty of Physical Culture or the National Institute of Public Health and followed all ethical and legal requirements for this type of study in each survey round. Completion of the HBSC questionnaire by children was voluntary and anonymity and confidentiality were ensured. No incentives were provided in return for participation. Data cleaning was performed by the International Databank, University of Bergen, Norway, in compliance with the international HBSC standards (22).

Sample

Self-reported HBSC data from the Czech Republic collected during April, May and June from 1998 to 2014 were analysed. The response rate varied from 87.0% in 2010 to 89.8% in 1998. Finally, data from 23,740 pupils were obtained. As a result of some unlikely responses and missing values in children’s weight and height, 713 questionnaires were excluded from the analysis. Furthermore, according to the HBSC-protocol only 11-, 13- and 15-year-old adolescents were selected for the analysis. The age category of 11 years included children aged 11.0–11.99 years, the age category of 13 years included children aged 13.0–13.99 years and children aged 15.0–15.99 years were regarded as the age category of 15 years old. The final sample consisted of 19,103 (51.2% of girls) adolescents aged 11, 13 and 15 years (Table 1).

Survey Items

Weight Status

In the present study, data on body height and weight were obtained via a self-report questionnaire with an accuracy of 0.5 cm and 0.1 kg. Body mass index (BMI) (kg/m²) was calculated as body weight (kg) divided by body height (m) squared. Sex- and age-specific cut-off values for weight status based on the World Health Organization percentile BMI charts for 5- to 19-year-old children were used to classify obese, overweight and normal body mass (23). Overweight and obesity were represented by 85–97% and > 97%, respectively, on age-differentiated BMI charts (23). Chronological age of adolescents used to compute age-differentiated BMI was calculated as the difference between the date of application of the HBSC questionnaire and the self-reported month and year of the respondent’s birth.

Statistical Analyses

All data were analysed using IBM SPSS (Version 22). First of all, the composition of the sample, age and gender categories according to each survey round were described. To determine the trends, a logistic regression analysis (Enter method) was used with a dependent variable – overweight and obesity and an independent categorical variable, which was the year that the survey was completed, i.e. 1998, 2002, 2006, 2010, or 2014. To describe the differences in overweight and obesity by gender and age categories in more detail, the Analysis of Variance approach was applied with a dependent variable – overweight and obesity and independent variables of gender (boys, girls) and age categories (11-, 13- and 15-year old). The Levene’s test to assess the equality of variances for an average in BMI was used and the t-test for equality of means was used to assess the statistical significance in average BMI with increasing age between 1998 and 2014.

RESULTS

Table 2 presents the proportions of school-aged overweight children by age and gender. The trends over the 1998–2014 period were, however, generally similar for adolescents of all ages. From 1998 to 2014 a significant increase in the prevalence of overweight

| Table 1. Descriptive characteristics of the samples, HBSC study, Czech Republic 1998–2014 (N = 19,103) |
|---------------------------------------------------------------|---------------------------------------------------------------|
| Boys (n = 9,317) | Girls (n = 9,786) |
| Survey year | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| 1998 (n = 2,979) | 477 | 32.6 | 515 | 35.2 | 471 | 32.2 | 510 | 33.6 | 524 | 34.6 | 482 | 31.8 | 656 | 34.3 | 610 | 32.0 | 643 | 33.7 | 715 | 35.5 | 720 | 33.7 | 701 | 32.8 | 672 | 32.1 | 702 | 33.5 | 720 | 34.4 | 651 | 32.1 | 680 | 33.5 | 699 | 34.4 |
| 2002 (n = 4,045) | 656 | 34.3 | 610 | 32.0 | 643 | 33.7 | 715 | 35.5 | 720 | 33.7 | 701 | 32.8 | 656 | 32.1 | 702 | 33.5 | 720 | 34.4 | 651 | 32.1 | 680 | 33.5 | 699 | 34.4 | 622 | 33.9 | 573 | 31.2 | 642 | 34.9 | 610 | 30.6 | 702 | 35.2 | 684 | 34.2 |
| 2006 (n = 4,124) | 672 | 32.1 | 702 | 33.5 | 720 | 34.4 | 651 | 32.1 | 680 | 33.5 | 699 | 34.4 | 622 | 33.9 | 573 | 31.2 | 642 | 34.9 | 610 | 30.6 | 702 | 35.2 | 684 | 34.2 | 607 | 30.1 | 682 | 33.9 | 725 | 36.0 | 650 | 30.8 | 737 | 35.0 | 721 | 34.2 |
| 2010 (n = 3,833) | 622 | 33.9 | 573 | 31.2 | 642 | 34.9 | 610 | 30.6 | 702 | 35.2 | 684 | 34.2 | 607 | 30.1 | 682 | 33.9 | 725 | 36.0 | 650 | 30.8 | 737 | 35.0 | 721 | 34.2 | 3,034 | 32.6 | 3,082 | 33.1 | 3,201 | 34.3 | 3,136 | 32.0 | 3,363 | 34.4 | 3,287 | 33.6 |
and obesity was observed among boys in all age categories (11 years old 22.2%–28.3%, 13 years old 17.9%–26.7%, 15 years old 9.8%–20.8%) and among 15-year-old girls (6.0%–10.9%). None of the age and gender categories showed an overall decrease over the 16-year period. In boys, the prevalence of overweight was significantly higher with steeper negative trends compared with girls. However, stabilization in overweight rates was observed between 2010 and 2014 in all age and gender groups.

Differences in weight by survey year in boys and girls are displayed in Figures 1 and 2. In boys, the proportion of obese individuals significantly increased from 1998 to 2014 in the age category of 11-year olds from 6.3 to 9.9% (p ≤ 0.05) and 15-year olds from 0.8 to 5.0% (p ≤ 0.001). In girls, the proportion of obese individuals changed significantly only in 15-year olds from 1.0 to 3.7% (p ≤ 0.05) between 1998 and 2014.

Changes in average BMI values in boys and girls in different age categories from 1998 to 2014 are shown in Figures 3 and 4.

DISCUSSION

The present study investigated trends in the prevalence of overweight and obesity in 11-, 13- and 15-year-old adolescents in the Czech Republic from 1998 to 2014. The study revealed a significant increase in the prevalence of overweight (including obesity) in Czech boys in all age categories and in girls at the age of 15. However, the results also imply stabilization in

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<td>13–13.99 years</td>
<td>8.4</td>
<td>9.2</td>
<td>15.0</td>
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<td>11.1</td>
<td>1.37</td>
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<td>15–15.99 years</td>
<td>6.0</td>
<td>6.6</td>
<td>11.9</td>
<td>10.5</td>
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<td>1.86**</td>
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Table 2. Trends in the prevalence of overweight and obesity, HBSC study, Czech Republic 1998–2014

Results of logistic regression; % percentage of participants who are overweight or obese; OR: odds ratio (cohorts from 1998 are reference groups); CI: 95% confidence interval; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001

A clear significant negative trend can be seen in 15-year-old boys and girls. In boys, an average BMI increase from 20.2 in 1998 to 21.1 in 2014 (p ≤ 0.001) was observed, while in girls, an average BMI increase was from 20.1 in 1998 to 20.5 in 2014 (p ≤ 0.05). A significant negative trend was also observed in 13-year-old boys (increase from 19.0 in 1998 to 19.7 in 2014; p ≤ 0.001). Changes in average BMI over time in other age and gender groups were not significant.
overweight rates between 2010 and 2014 in all age and gender groups. The present study extends the results of our previously published studies (19, 20) and is in line with international results demonstrating stabilization of overweight in the same age groups in boys and girls (9, 24).

Stabilization in BMI was also confirmed in different age categories in school-aged children in the Czech Republic (19, 20) as well as internationally in different countries across the globe (25–27).

On the other hand, Skinner et. al. (28), who focuses on obesity in the US, point out that despite substantial clinical and policy efforts targeting the issue of overweight and obesity in children, there is no evidence of a positive change in obesity prevalence in any age group. A current review of literature by Visscher et al. (16) also concludes that trend data based on waist circumference suggest an overall increase and the public health problem of obesity is still increasing. In addition, other studies highlight that the prevalence of overweight and obesity in children remains high and should be highlighted as an important public health issue (12, 28).

**Strength and Limitations**

The present study has several strength and limitations. Firstly, the investigation only included available representative data from the Czech Republic concerning young adolescents from 1998 to 2014. With the respect to all requirements of the standardized HBSC study protocol (21), the same methodology was used in all survey rounds. However, the authors of the present study used self-reported data of weight and height, which might lead to underestimation of the results, especially in girls (29). In contrast to this, the trend analysis was based on the same methodology approach, thus the underestimation of the results of the present study is not likely to influence the overall picture of the study. In studies assessing BMI in children, high numbers of missing values might also lead to incorrect conclusions. However, the excellent response rate in the Czech Republic (> 87.0% in all survey rounds) eliminates this constraint. Lastly, overweight and obesity were calculated on age-differentiated BMI charts according to the WHO standards (23). Using different standards to classify child overweight and obesity might lead to slightly different findings but should not influence the trends.

**CONCLUSIONS**

Czech nationally representative self-reported data from the Health Behaviour in School-aged Children Study show a significant increase in overweight (including obesity) prevalence among children from 1998 to 2014 with signs of stabilization in overweight prevalence between 2010 and 2014. Further research is needed to assess future trends in the prevalence of child overweight in the Czech Republic as well as interventions to decrease the proportion of overweight and obese children. Czech national health promoting strategies and policies such as the Czech National Strategy for Health Protection and Promotion and Disease Prevention – Health 2020 should be accompanied and supported by actions at national, regional and municipal level and should be linked to the budget of key stakeholders in this area.

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**Conflict of Interests**

None declared

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