

# DIETARY INTAKES, PHYSICAL ACTIVITY, AND PREDICTORS OF CHILD OBESITY AMONG 4-6th GRADERS IN THE CZECH REPUBLIC

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## SUMMARY

The prevalence of child obesity in the Czech Republic has increased in the last several years, especially among school-aged children. While obesity trends are closely monitored in the Czech Republic, very little is known about the dietary habits and exercise behaviors of Czech children. The purpose of this study was to evaluate nutrient intakes and physical activity, as well as identify predictors of BMI-for-age in a sample of Czech school-aged children. Ninety-seven fourth, fifth and sixth graders and their parents from two large Czech cities participated in the study. Two 24-hour recalls provided total amount of energy, fat, percentage of energy derived from fat, dietary fiber, and servings of fruits and vegetables. Physical activity was measured by the Self-administered Physical Activity Checklist (SAPAC). Children consumed less energy and dietary fiber than suggested by Czech dietary recommendations. The proportion of energy that children consumed from fat was 28.5%. Children consumed 1.4 cups of fruit and 1.2 cups of vegetables. Children's physical activity levels fell within the current recommendations. Age was the only significant predictor of higher BMI-for-age. Poor dietary quality may be responsible for increasing rates of child obesity in the Czech Republic. Nutritional professionals in the Czech Republic should focus on increasing consumption of fruits, vegetables, and other high-fiber foods in order to reduce the risk for overweight among Czech children.

*Key words:* child obesity, Czech Republic, dietary habits, physical activity, BMI-for-age

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## INTRODUCTION

Child obesity has become a serious public health problem in many developed countries over the last several decades (1). The recent increases in child obesity rates are alarming because studies demonstrated that the majority of overweight children remain overweight or obese in their adult years (2-4). It is estimated that up to 40% of 7-year-old and 80% of 10 to 15-year-old obese children remain obese as adults, which substantially increases their risk of developing a chronic disease (2-5). Previous research identified a wide range of factors that may be contributing to increased body weight and adiposity among children. Excessive intakes of energy and fat, increased consumption of sweetened beverages, and low intakes of fruits and vegetables are often associated with higher Body Mass Indexes (BMI) among young children (6, 7). Lack of physical activity and increased sedentary behaviors have also been linked to child obesity (7). In fact, physical inactivity has been identified as one of the strongest correlates of child obesity, with television watching being linked to decreased energy expenditure and increased appetite among children (8). Because children develop their dietary habits and exercise behaviors early in life, parents play a crucial role in the reduction and prevention of obesity (9). The strong influence of parents on children's food choices within the family environment is reflected in the fact that high parental BMI, low parental education, and lack of available healthy foods in the home were found to be strongly associated with obesity among children in several countries (10, 11).

While the United States has one of the highest rates of overweight among children in the world (22% overweight) (12), a trend toward increased obesity rates has been observed among children in several European countries (10, 13). For example, Kromeyer-Hauschild et al. (14) found that the proportion of overweight German girls increased from 11.7% in 1975 to 20.7% in 1995. The prevalence of obesity among children from Central and Eastern European countries, including the former Czechoslovakia, is generally lower than the U.S. and Western Europe (15). However, recent findings from the Czech Republic suggest that the proportion of overweight and obese children has recently increased (16).

Findings from the 1991 and 2001 Czech National Anthropological Surveys revealed that child obesity rates increased in the age group that is most predictive of adult adiposity (ages 7–11). In 1991, 3% of Czech children were obese; by 2001, 5.6% of boys and 4.7% of girls were obese (16). A 1999–2000 study measured 7 to 11 year old children in 38 public schools in the Czech Republic (17). The findings revealed that 13.1% of boys and 11.9% of girls were overweight or obese in 1999 compared to 10% in 1991 (17). These studies provide evidence that, despite relatively low child obesity rates in relation to other countries, the prevalence of overweight and obesity is rising among elementary school-aged Czech children.

The Czech traditional diet is characterized by large amounts of meat and saturated fats, and by lower amounts of fruits and vegetables (18). Czech 10-year-old children were found to con-

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sume almost 35% of energy from fat while adolescents' intakes of vitamin C, vitamin A and calcium were below the recommended amounts (19, 20). The nutritional status of Czech children has also been influenced by significant economic and social changes in the last several years. While the influx of Western culture has brought several positive nutritional trends into the country, children are increasingly exposed to negative dietary and lifestyle trends, such as an increase in fast food consumption and a decrease in physical activity (20, 21).

While obesity rates among Czech children have been closely monitored in the last several decades, there is very limited knowledge about the dietary habits and physical activity of Czech school-aged children (20). Understanding important predictors of obesity is crucial for developing comprehensive and effective obesity prevention programs for Czech children. The purposes of our study were to determine dietary intakes in terms of energy, fat, and fiber intakes, and fruit and vegetable servings; evaluate the amount and intensity of physical activity; and identify important predictors of BMI in a sample of Czech fourth, fifth and sixth grade children.

## MATERIAL AND METHODS

The study was based on a cross-sectional, correlational study, with a pilot study conducted one year prior to data collection. The target population was elementary school children in grades four, five, and six in two Czech cities (Pilsen and Prague). The schools were randomly selected using a cluster sampling technique and one school in Prague was selected using convenience sampling. Sample size estimation was based on  $R^2$  of 0.3 and power of 0.8 using ten independent variables in a regression model at  $p = 0.05$  (22). The study was approved by the Institutional Review Board at Oklahoma State University and the Ethical Institute of Charles University in Prague, Czech Republic.

Informed written consent was obtained from the principals at each of the selected schools. Parents were informed about the study during a parent meeting or a detailed description of the study was sent home through their children. The parents who agreed to participate were asked to sign written consent and complete the Parent Questionnaire. The questionnaire requested demographic, socioeconomic, and anthropometric information. Self-reported height and weight of parents were used to calculate parental BMI as  $\text{kg}/\text{m}^2$  (overweight: BMI of  $\geq 25$ ; obese: BMI of  $\geq 30$ ). Monthly household income (in Czech Crowns) was reported by parents in five categories:  $\leq 10,000$ , 11,000–20,000, 20,000–30,000, 30,000–40,000, and  $> 40,000$ . Parents reported education level in four categories: elementary, vocational, high-school, and university education.

Two school visits, at least two days apart, were scheduled with children. Children were asked for assent to take part in the study prior to data collection. Information collected from children included demographics, height, weight, dietary intakes and physical activity. Children completed one multiple-pass 24-hour recall (23) and a modified Self-administered Physical Activity Checklist (SAPAC) (24) with the help of the primary investigator or a research assistant. The use of a 24-hour recall was shown to be a valid method of estimating energy and macronutrient intakes of children aged 8 and older in previous research (25). Plastic food

models, real food examples, bean bags and household measuring tools were used to improve the quality of the 24-hour recall.

Dietary intakes were analyzed using the nutrient analysis software Food Processor 8.4. Children's energy, fat, and fiber intakes were estimated as 2-day averages of kilocalories, grams of fat, percentage of energy from fat, and grams of dietary fiber. The average numbers of cups of fruits and vegetables were estimated using the MyPyramid of the United States Department of Agriculture (26). A calculation of fruit and vegetable servings based on the Food Guide Pyramid was shown to be a valid measure of children's fruit and vegetable intake in previous studies (27). Because the original dietary recommendations for children in the Czech Republic have not been updated since late 1980's, children's intakes were compared to the MyPyramid recommendations in addition to the Czech dietary standards (28). The children's intakes were compared to the MyPyramid recommendations based on their age, gender and physical activity level. Dietary fiber intakes were compared to the Adequate Intake for children aged 9 to 13 (29).

Children were also asked to recall the activities they engaged in on the previous day using the modified SAPAC (24). The SAPAC has been validated in previous studies that showed its moderate correlation with both heart rate index and accelerometer scores (24). The original SAPAC was self-administered and included a total of 25 physical activities and two sedentary activities. The questionnaire was administered by the investigators in order to increase the accuracy and validity of the collected data.

Metabolic equivalents (METs) were assigned to all of the physical activities reported by children based on the updated Compendium of Physical Activities developed by Ainsworth et al. (30). One metabolic equivalent is defined as the ratio of the work metabolic rate to the resting metabolic rate, which is equal to the amount of oxygen per kilogram of body weight per minutes that is consumed when sitting quietly (3.5 ml/kg/min or 1 kcal/kg/hour) (30). Moderate activity was defined as any physical activity during which children expended 3-6 METs and vigorous activity was defined as any activity with METs of greater than 6 (30). A two-day average of estimated METs, the average number of minutes spent in moderate and vigorous activities, and the amount of time spent in moderate and vigorous activity combined was estimated for each child.

The height and weight of children were measured in the morning hours at each school. Weight was measured using an electronic scale (Taylor Precision Performance, Oak Brook, Illinois, USA) with a stable weighing platform. Height was measured using the Frankfort Plane technique while their head, back, and buttocks touched a vertical wall behind them. Height and weight measurements were used to calculate children's BMI as  $\text{kg}/\text{m}^2$ . The prevalence of overweight was assessed using the 1991 Czech reference values (31). Children were classified as underweight ( $<10$ th percentile), normal weight (10-90th percentile), overweight ( $>90$ th percentile), or obese ( $>97$ th percentile). The 2000 CDC reference values were used to identify children at risk for overweight by BMI-for-age of  $\geq 85$ th to  $<95$ th percentile, and overweight children by BMI-for-age of  $>95$ th percentile (32). Z-scores that represent the deviations of the value for an individual child from the mean value of the reference population divided by the standard deviation were also calculated using the statistical package Epi Info 2005.

One sample t-tests, independent t-tests,  $\chi$ -square test, bivariate correlation and a linear regression model were used to analyze children's dietary intakes and physical activity, and to identify significant predictors of their BMI. Parental BMI, education, income, children's age, energy intake, percent energy from fat, time (minutes) spent in moderate and vigorous activity, and fruit and vegetable intake were included in the model as independent variables. The Statistical Package for Social Sciences (SPSS 12.0, 2003) was used to conduct statistical analysis in this study. The level of significance was set at 0.05.

## RESULTS

Ninety seven children and their parents participated in the study. The descriptive characteristics of the subjects are summarized in Table 1. The mean parental BMI of  $22.8 \pm 3.9$  fell within a healthy range which is defined by internationally recognized standards as BMI of 18.5 to 24.99. The prevalence of overweight and obesity among children using the Czech reference cutoffs and the 2000 CDC reference cutoffs is presented in Table 2. Four children in the sample were identified as obese using both the Czech standards and the 2000 CDC cutoff values (Table 2). The overall prevalence of overweight and obesity in the sample

**Table 1.** Demographic and anthropometric characteristics of parents and children

Category		n	%	Mean + SD
<b>Children</b>				
Age (years)		97	100.0	11.0 $\pm$ 1.03
BMI (kg/m <sup>2</sup> )		95	95.0	18.4 $\pm$ 2.52
Grade	4th grade	27	28.0	-
	5th grade	43	44.0	-
	6th grade	27	28.0	-
Gender	Males	42	43.0	-
	Females	55	57.0	-
<b>Parents</b>				
Age (years)		92	95.0	37.3 $\pm$ 5.25
Gender	Males	4	4.0	-
	Females	94	96.0	-
BMI (kg/m <sup>2</sup> )	<18.5	92	95.0	22.8 $\pm$ 3.48
	18.5-24.99	5	5.2	-
	25-29.99	66	68.0	-
	30-34.99	18	18.6	-
	>35	3	3.1	-
Education	elementary	0	0.0	-
	vocational	20	20.6	-
	high-school	55	56.7	-
	university	18	18.6	-
Monthly income	<10,000	2	2.1	-
	11,000-20,000	36	37.1	-
	20,000-30,000	28	28.9	-
	30,000-40,000	15	15.5	-
	>40,000	6	6.2	-

**Table 2.** Child obesity prevalence as defined by the 2000 CDC and the Czech reference values

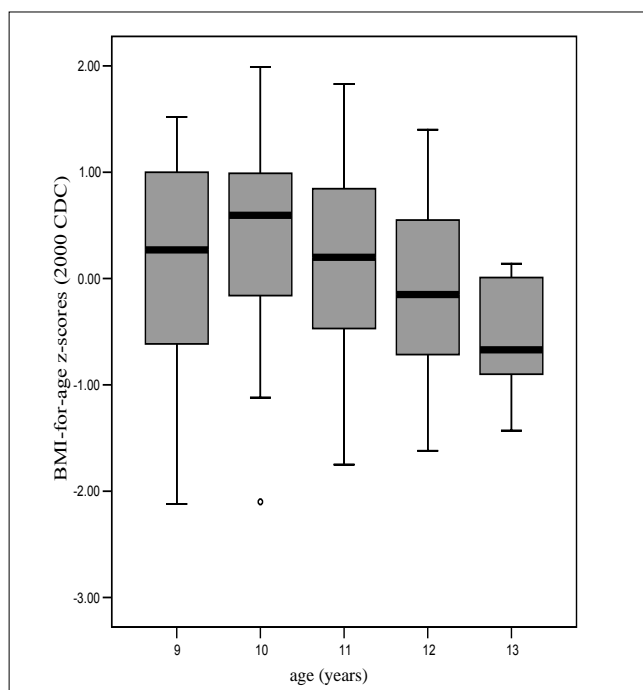
Reference Values	Obesity Prevalence	
	n	%
<b>2000 CDC Reference Values<sup>1</sup></b>		
At risk for overweight ( $\geq$ 85th- $<$ 95th percentile)	10	10.3
Males	5	11.9
Females	5	9.1
Overweight ( $\geq$ 95th percentile)	4	4.1
Males	2	4.8
Females	2	3.6
At risk or overweight ( $\geq$ 85th percentile)	14	14.4
<b>Czech Reference Values<sup>2</sup></b>		
Overweight (90th-97th percentile)	7	7.2
Males	3	7.1
Females	4	7.3
Obese ( $>$ 97th percentile)	4	4.1
Males	2	4.8
Females	2	3.6
Overweight or obese ( $>$ 90th percentile)	11	11.3

<sup>1</sup> Kuczmarksi et al., 2002

<sup>2</sup> Lhotská et al., 1993

was 11.3% based on the Czech standards and 14.4% based on the 2000 CDC reference values.

Gender differences in the prevalence of overweight were evident based on the CDC standards but not the Czech reference values (Table 2). While the sample size did not allow for a statistical analysis based on age groups, children aged 10 appeared to have the highest mean z-score for BMI-for-age in the sample while 13-year-old children tended to have the lowest BMI-for-age z-scores (Fig. 1).



**Fig. 1.** Box plots of children's z-scores for BMI-for-age.

**Table 3.** Differences in dietary intakes of children by gender

	Total (n = 97)	Males (n = 42)	Females (n = 55)	P-value
Energy (kcal)	1416±374	1460±403	1383±350	0.321
Fat (g)	45.5±15.3	48.8±14.4	43.0±15.6	0.064
Fat (% energy)	28.5±5.8	30.3±5.9	27.2±5.4	0.009**
Carbohydrates (% energy)	57.4±7.2	54.9±6.9	59.2±6.9	0.003**
Protein (% energy)	14.1±3.48	14.8±3.8	13.6±3.1	0.090
Fiber (g)	11.9±6.6	10.9±3.8	12.7±8.0	0.164
Fruit (cups)	1.4±1.1	1.1±1.1	1.6±1.2	0.064
Vegetables (cups)	1.2±.9	1.1±.7	1.3±.9	0.294

\*\* p < 0.01

Several trends were identified in children's diets (Table 3). Overall, children consumed 28.5% of their total daily energy from fat. Boys consumed a significantly higher proportion of energy derived from fat and girls consumed significantly more energy from carbohydrates (Table 3;  $p < 0.01$ ). The daily fiber intake was similar in both genders with the mean fiber intake of 11.9±6.6 g. Children consumed approximately 1.4±1.1 cups of fruit and 1.2±0.9 cups of vegetables daily with no significant differences by gender (Table 3). However, girls tended to consume slightly more fruits than boys (Table 3;  $p = 0.064$ ).

The summary of findings related to physical activity is presented in Table 4. Children expended about 495±259 metabolic equivalents (METs) on two days, with boys tending to be slightly more active than girls (Table 4). Children spent approximately one hour watching television and 8 minutes using a computer a day (Table 4). Most children were engaged in at least one moderate or vigorous activity on the two days. Boys engaged in vigorous activities for a significantly longer period of time than girls (Table 4).

Bivariate correlations revealed a significant negative relation between children's age and z-scores for BMI ( $r = -0.29$ ;  $p < 0.01$ ). Children's energy intakes and their BMI z-scores tended to be negatively related ( $r = -0.18$ ;  $p = 0.08$ ). A linear regression model with z-scores for BMI as the dependent variable revealed that children's younger age was the only significant predictor of higher z-scores for BMI ( $R^2 = 0.144$ ;  $p < 0.05$ ). None of the parental, dietary or physical activity variables were found to be significant predictors of children's weight.

## DISCUSSION

Even though the prevalence of overweight among Czech children remains lower than the rates of overweight in the U.S. and other Western countries, Czech children have been getting heavier in the last two decades (16, 17). Because of the negative trend in child obesity, it is essential to evaluate children's dietary intakes and physical activity and identify major factors that influence children's body weight so effective interventions can be developed for Czech children.

Our study examined current dietary intakes and physical activity behaviors in a sample of Czech fourth, fifth, and sixth

**Table 4.** Differences in minutes of physical activity and sedentary behaviors of children by gender

Activity	Total (n = 95)	Males (n = 41)	Females (n = 54)	P-value
Moderate	84.8±104.9	67.7±47.7	97.8±132.0	0.167
Vigorous	23.9±36.5	36.4±38.3	14.5±14.7	0.003**
Moderate & vigorous	96.7±50.7	104.1±48.9	91.0±51.6	0.213
TV/DVD	57.5±43.6	62.6±42.6	53.7±44.5	0.327
Computer	8.3±19.5	14.1±26.3	3.8±10.4	0.009**

\*\* p < 0.01

graders. Analysis of the 24-hour recalls revealed that most children consumed less energy than is recommended based on both the Czech and the MyPyramid dietary recommendations (26, 28). While the use of a multiple-pass 24-hour recall may have contributed to underreporting of energy and nutrient intakes among children, this finding is consistent with a study by Šoltysová and Bellisle (19) in which 10-year-old children consumed 10% less energy than recommended by the Czech dietary standards (28). Low intakes of energy have been also observed among children from other transitional countries, such as Hungary (33). The total amount of energy derived from fat was 28.5% which was within the suggested range of 25–35% of energy from fat for children aged 4 to 18 (34). The children's relatively low dietary intake of fat in our sample may be attributed to the economic and political changes occurring in the Czech Republic since the late 1980's (20, 35). The shift from a centrally planned economy to a free market economy has caused a 300% increase in the price of beef and even larger increases in the price of milk, which may be responsible for children consuming less fat (20, 35).

Children in our sample consumed only 1.4 and 1.2 cups of fruits and vegetables, which is lower than the MyPyramid recommendation for 9-year-old sedentary girls (26). Our finding was consistent with the results of several studies in other Eastern European countries. For instance, a study on dietary habits of children from Moscow revealed that they did not consume adequate amounts of fruit, fruit juice or vegetables on a regular basis (36). The children's low consumption of fruit and vegetables was also reflected in their poor intakes of dietary fiber. Compared to the Czech recommendations, that are significantly lower than the U.S. recommendations (30), the consumption of 11.9 g of dietary fiber was not sufficient (28). A qualitative analysis of the 24-hour recalls indicated that only a few children in the sample consumed some type of whole grain breads or cereal. Low consumption of fruits and vegetables as well as rare consumption of whole wheat breads and cereals is likely responsible for such low fiber intakes. One of the limitations of our study was related to the evaluation of children's dietary intakes. While a multiple-pass 24-hour recall was shown to be a valid method for evaluating children's dietary intakes (23), it is important to note that the analysis of children's diet was limited by the use of only two 24-hour recalls. This limitation was caused by the efforts of the investigators to minimize interference with children's instruction during the study.

Previous research showed that sedentary behaviors significantly contribute to the development of obesity among children (37).

In our study, children watched television for about one hour and engaged in approximately 90 minutes of either moderate or vigorous physical activity a day. While no specific recommendation for physical activity for children exists in the Czech Republic, most children met and some children exceeded the recommendation of at least 60 minutes of physical activity that is recommended by the Dietary Guidelines for Americans (34).

Even though our sample of children was not nationally representative, our study was consistent with the results of a study by Kobzova et al. (16) suggesting that there is a trend towards increased obesity rates among Czech elementary school-aged children. The prevalence of both overweight and obese children combined was estimated between 11.3% and 14.4%, depending on which reference values were used for the analysis. Thus, the overweight and obesity rates in our sample were higher than the prevalence of 10% that was reported in the 1991 National Anthropological Survey (31). The obesity rates alone among boys and girls were also higher compared to the 3% obesity prevalence in 1991 (31). Boys in our study were found to be at higher risk for obesity than girls which is consistent with previous studies (16).

As child obesity rates continue to rise in the Czech Republic, it is important to carefully examine current dietary behaviors and exercise habits of children. Our findings identified important trends in the dietary intakes and physical activity of Czech school-aged children. The role of fruits and vegetables in children's diets and their benefits in terms of obesity prevention has been emphasized in previous research. Regular intake of fruits and vegetables significantly influence satiety and energy intake which in turn may directly affect BMI of children. Despite obvious benefits of fruits and vegetables, children in the Czech Republic do not consume adequate amounts of them on a regular basis. While a future study on dietary habits and physical activity with a nationally representative sample of Czech children is warranted, our study contributes to the existing literature on Czech children's dietary intakes and physical activity. Based on the findings of our study, nutritional professionals in the Czech Republic should focus on improving the dietary habits among school-aged children and address the inadequate consumption of fruit, vegetables, and fiber in future nutrition interventions.

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