Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns

I. Janssen[1,2], P. T. Katzmarzyk[1,2], W. F. Boyce[1,3], C. Vereecken[4], C. Mulvihill[5], C. Roberts[6], C. Currie[7], W. Pickett[1,8] and The Health Behaviour in School-Aged Children Obesity Working Group*

[1]Department of Community Health and Epidemiology, Queen's University, Kingston, Canada; [2]School of Physical and Health Education, Queen's University, Kingston, Canada; [3]Social Program Evaluation Group, Faculty of Education, Queen's University, Kingston, Canada; [4]Department of Public Health, Ghent University, Ghent, Belgium; [5]Health Development Agency, Holborn Gate, London, England; [6]Research and Evaluation Branch, Health Promotion Division, Welsh Assembly Government, Cardiff, Wales; [7]Child & Adolescent Health Research Unit, Moray House School of Education, University of Edinburgh, Edinburgh, Scotland; [8]Department of Emergency Medicine, Queen's University, Kingston, Canada

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Address reprint requests to: I Janssen, School of Physical and Health Education, Queen's University, Kingston, Ontario, Canada, K7L 3N6. E-mail: janssen@post.queensu.ca

Summary

The purposes of this systematic review were to present and compare recent estimates of the prevalence of overweight and obesity in school-aged youth from 34 countries and to examine associations between overweight and selected dietary and physical activity patterns. Data consisted of a cross-sectional survey of 137 593 youth (10–16 years) from the 34 (primarily European) participating countries of the 2001–2002 *Health Behaviour in School-Aged Children Study.* The prevalence of overweight and obesity was determined based on self-reported height and weight and the international child body mass index standards. Logistic regression was employed to examine associations between overweight status with selected dietary and physical activity patterns. The two countries with the highest prevalence of overweight (pre-obese + obese) and obese youth were Malta (25.4% and 7.9%) and the United States (25.1% and 6.8%) while the two countries with the lowest prevalence were Lithuania (5.1% and 0.4%) and Latvia (5.9% and 0.5%). Overweight and obesity prevalence was particularly high in countries located in North America, Great Britain, and south-western Europe. Within most countries physical activity levels were lower and television viewing times were higher in overweight compared to normal weight youth. In 91% of the countries examined, the frequency of sweets intake was lower in overweight than normal weight youth. Overweight status was not associated with the intake of fruits, vegetables, and soft drinks or time spent on the computer. In conclusion, the adolescent obesity epidemic is a global issue. Increasing physical activity participation and decreasing television viewing should be the focus of strategies aimed at preventing and treating overweight and obesity in youth.

Keywords: Adolescent health, body mass index.

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Introduction

Countries throughout the world experienced a marked increase in the prevalence of overweight and obese children and adolescents from the 1980s to 1990s (1–12) and evidence from the United States suggests that this upward trend has continued into the 21st century (13). The results from these and numerous other recent studies have broadened our knowledge of the increasing and global impact that obesity has on public health. Nonetheless, international epidemiological information is still lacking. Specifically,

*The Health Behaviour in School-Aged Children Obesity Working Group: Á. Ńemeth, K. Ojala, U. Ravens-Sieberer, J. Todd and B. Woynarowska.

the magnitude of the obesity epidemic in young persons remains unknown for many countries. Further, cross-national comparisons of overweight and obesity prevalence in youth have been problematic because of the use of non-representative samples in many countries and because of differences in study designs (1,9). These differences include the means by which height and weight were obtained, the classification system employed to determine which youth were overweight, and differences in the gender and ages of the youth studied. Further, because of the rapid increase in childhood obesity, even recent cross-national comparisons performed on surveys from the 1990s may be outdated.

There is no clear explanation of the primary cause of overweight and obesity in adolescents, although dietary and/or physical activity patterns must be important factors. Thus, the particular associations between various dietary and physical activity variables with paediatric overweight need to be determined. The establishment of consistent trends in the associations between overweight with dietary and physical activity patterns across countries with different cultures would provide strong evidence of a common aetiology for these relationships. A clearer understanding of the factors that contribute to obesity in youth from different countries may aid in the development of optimal preventive and treatment measures for overweight and obesity in young persons.

The purposes of this study were to present and compare recent estimates of the prevalence of overweight and obesity in school-aged youth from 34 countries and to examine associations between overweight and selected dietary habits and physical activity patterns. These results are based on the 2001–2002 *Health Behaviour in School-Aged Children Study* (HBSC), an international study conducted in collaboration with the World Health Organization Regional Office for Europe (14).

Methods

Description of survey and study population

The 2001–2002 HBSC is a cross-sectional survey from 34 countries (14). The goal of the HBSC is to identify youth health indicators and the factors that influence them. The HBSC represents a coherent set of indicators that provide a valid representation of the health and lifestyle of adolescents in industrialized countries. In each country the sample was based on a cluster design with the school class being the basic cluster (14). Schools and classes were selected to be representative by age and geography. All national samples were selected to be nationally representative, but were self-weighting. The three age groups sampled represented the onset of adolescence – age 11; the challenge of physical and emotional change – age 13; and the time when important life and career decisions are beginning to be made – age 15 (14). In all countries the data were collected through self-completed questionnaires administered in the classroom.

The HBSC survey was approved by ethics review boards in each country. Within each country consent was solicited from the participating school boards and individual schools, and student participation was voluntary.

Survey methods

The HBSC survey consisted of a questionnaire that was administered in the classroom setting. The international HBSC questionnaire was devised through cooperative research between members of the HBSC research network representing all member countries. All questionnaire items were piloted within HBSC countries. The standard English version of the international questionnaire was translated for the specific national language(s) and cultural contexts of the 34 participating countries. The questionnaire was designed so that it could be completed by the participating students in approximately 45 min.

Body mass index (BMI) measurement and overweight classification

Height and body weight were based on self-reports. BMI was calculated as weight/height^2 (kg/m^2). The international age- and gender-specific child BMI cut-points were used to define overweight and obesity (15). These cut-points were derived in a large international sample using regression techniques by passing a line through the health-related adult cut-points at 18 years. Youth with BMI values corresponding to an adult BMI of <25.0 kg m^{-2} were classified as normal weight and youth with BMI values corresponding to an adult BMI of ≥ 25.0 kg m^{-2} were classified as overweight. Thus, in this study overweight youth included those who were obese. The overweight youth were further subdivided into pre-obese (BMI corresponding to adult value of 25.0–29.9 kg m^{-2}) and obese (BMI corresponding to adult value of ≥ 30.0 kg m^{-2}) groups.

Dietary variables

The subjects were asked how many times in a typical week they consumed fruits, vegetables, sweets (candy, chocolate), and non-diet soft drinks. The possible responses were never, less than once a week, once a week, 2–4 d a week, 5–6 d a week, once a day, and more than once a day. Subjects were grouped according to these response categories. Food frequency questionnaires are useful for ranking of individuals for specific food items so that characteristics of those with high and low intakes can be compared (16). However, quantification of total intake based on frequency alone may be inaccurate because of the absence of information on portion sizes (16).

Physical activity and sedentary behaviours

After being provided with a definition (physical activity is any activity that increases your heart rate and makes you get out of breath some of the time) and examples of common physical activities, the subjects were asked how many days in the past week and in a typical week they were physically active (cumulative activity including sports, school activities, playing with friends, and walking to school) for 60 min or more. These questions were based on the moderate-to-vigorous physical activity measure developed by Prochaska and colleagues (17). As suggested by these authors (17), the average number of days from the past week and typical week were used as an index of physical activity participation. Physical activity data were not collected in Belgium (French).

The subjects were asked how many hours they watched television (including videos) and used a computer (for playing games, emailing, chatting, or surfing the Internet) in their free time in a typical weekday and weekend. The possible responses were none, about 0.5, 1, 2, 3, 4, 5, 6, or ≥7 h per day. Subjects were grouped according to these response categories for weekday television watching and computer use. Although not presented, the associations for weekend television watching and computer use were comparable to those presented here for the weekday. Computer use data were not collected in Ireland. Because there are many sedentary behaviours other than television watching and computer use, these measures do not represent total time being sedentary.

Non-respondents

To determine whether the youth who did not report their height and weight were comparable to those who did, we compared weight loss attempts and body image perceptions between these groups. In regards to weight loss, subjects were asked if they were presently dieting or doing something to lose weight. The possible responses were: no, my weight is fine; no, but I should lose weight; no, because I need to put on weight; or yes. In regards to body image, subjects were asked if they thought their body was much too thin, a bit too thin, about the right size, a bit too fat, or much too fat. Similar percentages of those who reported, vs. those who did not report, height and weight, indicated that they were either trying to lose weight or that they should do something to lose weight (33% vs. 36%) and that they perceived themselves to be either a bit or much too fat (28% vs. 31%).

Statistical analysis

Data management and computations of descriptive statistics and prevalence were performed using SPSS version 11 (SPSS Inc., Chicago, IL, USA). Regression analyses were performed using HLM version 5 (Scientific Software International, Lincolnwood, IL, USA). A *P*-value of 0.05 was used to determine significance. The overweight and obesity prevalence was calculated and ranked across the 34 countries. Logistic regression was used to examine associations between dietary and physical activity variables (lifestyle variables) and BMI classification (normal weight vs. overweight), with the lifestyle variables acting as the independent variable. Dummy variables were created to compute odds ratios (OR) for these factors. The lifestyle variables were included in the regression models as continuous factored variables and the OR and associated 95% confidence interval were computed for each unit increase in the lifestyle variable in comparison with the lowest (referent) level. *P*-values associated with tests for linear trend in these OR are provided. The OR were adjusted simultaneously for age, gender, presently trying to lose weight (yes or no), and each of the other lifestyle variables.

Results

A total of 162 305 youth from 34 countries completed the survey. Of these, 1329 did not have adequate data to calculate age in months and 14.5% of the remaining subjects did not report their height and weight. Thus, a total of 137 593 subjects aged 10–16 years were considered for the present study. Although all samples were nationally representative, there was a variation between countries in the percentage of subjects reporting height and weight, with a minimum of 39.7% (Ireland), median of 88.5% (Portugal), and maximum of 99.6% (Czech Republic) (Table 1). The subjects (respondents) from each country were similar with respect to mean age (range 12.7 ± 1.6–14.2 ± 1.7) and gender (range 46.7% boys to 52.9% boys).

Figure 1 illustrates the ranking of the countries according to the prevalence of overweight. The three countries with the highest prevalence of overweight youth were Malta (25.4%), the United States (25.1%), and Wales (21.2%). The countries with the highest prevalence of obesity were Malta (7.9%), the United States (6.8%), and England (5.1%). The three countries with the lowest prevalence of overweight and obese youth were Lithuania (5.1% and 0.4%), Russia (5.9% and 0.6%), and Latvia (5.9% and 0.5%).

Inspection of Fig. 2 reveals that there were regional differences in the national overweight prevalence. The prevalence of overweight youth was >15% in the North American countries (Canada, United States), the countries in Great Britain (England, Scotland, Wales), and the five countries in the southern portion of western Europe (Greece, Italy, Malta, Portugal, Spain). By comparison, the prevalence of overweight youth was between 10% and 15% in the Nordic countries (Denmark, Finland, Norway, Sweden), for most of the countries within the central por-

Table 1 Number of survey respondents

Country	Number (absolute) [% of total surveyed]
Austria	3994 [89.3]
Belgium (Flemish)	5876 [93.4]
Belgium (French)	3066 [70.9]
Canada	3543 [81.2]
Croatia	4145 [94.3]
Czech Republic	4990 [99.6]
Denmark	4009 [85.8]
England	3601 [59.2]
Estonia	3752 [94.3]
Finland	5205 [96.6]
France	7624 [93.1]
Germany	4878 [86.3]
Greece	3584 [94.1]
Greenland	558 [62.6]
Hungary	3845 [92.3]
Ireland	1140 [39.7]
Israel	4200 [74.2]
Italy	4095 [93.4]
Latvia	3091 [88.8]
Lithuania	4194 [74.3]
Macedonia	3596 [86.4]
Malta	1065 [53.8]
Netherlands	3860 [90.4]
Norway	4415 [87.9]
Poland	5909 [92.6]
Portugal	2602 [88.5]
Russia	7450 [92.7]
Scotland	2133 [48.4]
Slovenia	3769 [95.3]
Spain	4445 [76.3]
Sweden	3507 [89.3]
Switzerland	4190 [89.5]
Ukraine	3645 [89.1]
United States	4447 [88.5]
Wales	3170 [81.6]

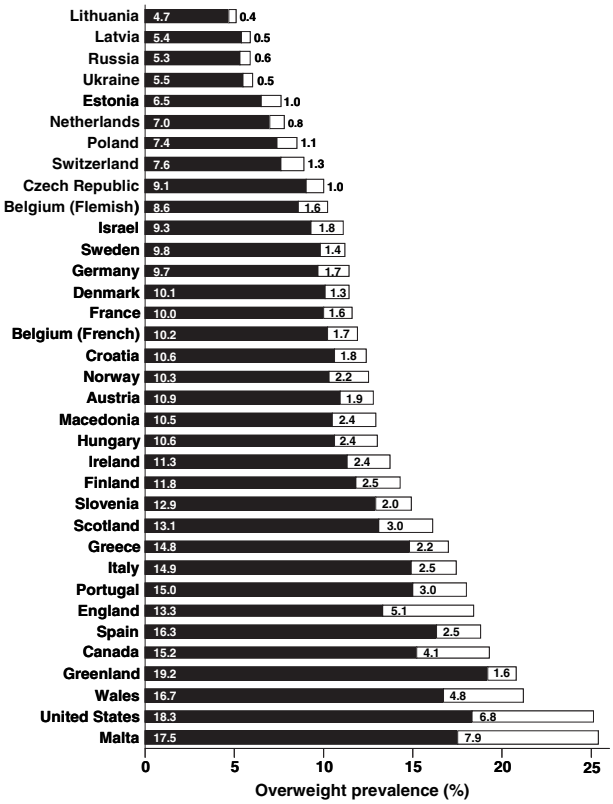

Figure 1 Ranking of the 34 (primarily European) countries according to the prevalence of overweight youth (aged 10–16 years) in 2001–2002. The contribution of the pre-obese and obese children to the total overweight prevalence are represented by the closed (■) and open (□) bars respectively.

tion of western Europe (Austria, Belgium, France, Germany, Netherlands, Switzerland), and the four countries in the south-west corner of eastern Europe (Croatia, Hungary, Macedonia, Slovenia). The prevalence of overweight youth was <10% in the remaining seven eastern European countries (Czech Republic, Estonia, Latvia, Lithuania, Poland, Russia, Ukraine).

Table 2 describes the dietary and physical activity patterns according to country. There was large variation between countries in the percentage of study participants who were high consumers (once per day or more often) of fruit (20.1% in Estonia to 51.5% in Israel), vegetables (11.0% in Spain to 52.5% in Belgium-Flemish), sweets (8.9% in Finland to 48.7% in Ireland), and soft drinks (7.6% in Finland to 53.1% in Israel). The percentage of study participants who were physically active for 60 or more minutes on 5 or more days per week ranged from 19.3% in France to 49.5% in the United States. There was also a large variation between countries in the percentage of students who watched 3 or more hours of television on the average week day (24.0% in Switzerland to 66.2% in Israel) and used a computer in their free time for 2 or more hours on the average week day (15.7% in Switzerland to 47.9% in Israel).

There were no consistent patterns and few significant findings for the relationships between fruit, vegetable, and soft drink intake with overweight (Table 3). There was a significant ($P < 0.05$) negative relationship between the intake of sweets (candy, chocolate) and BMI classification in 31 out of the 34 countries (91%) such that higher sweets intake was associated with a lower odds of overweight (Table 3).

There was a significant ($P < 0.05$) negative relationship between physical activity participation and BMI classification in 29 out of the 33 countries (88%) such that greater physical activity participation was associated with a lower odds of overweight (Table 4). There was a significant ($P < 0.05$) positive relationship between television viewing time and BMI classification in 22 out of the 34 countries (65%) such that with greater television-viewing time there was a greater odds of overweight (Table 4). There were no consistent patterns and few significant findings for the rela-

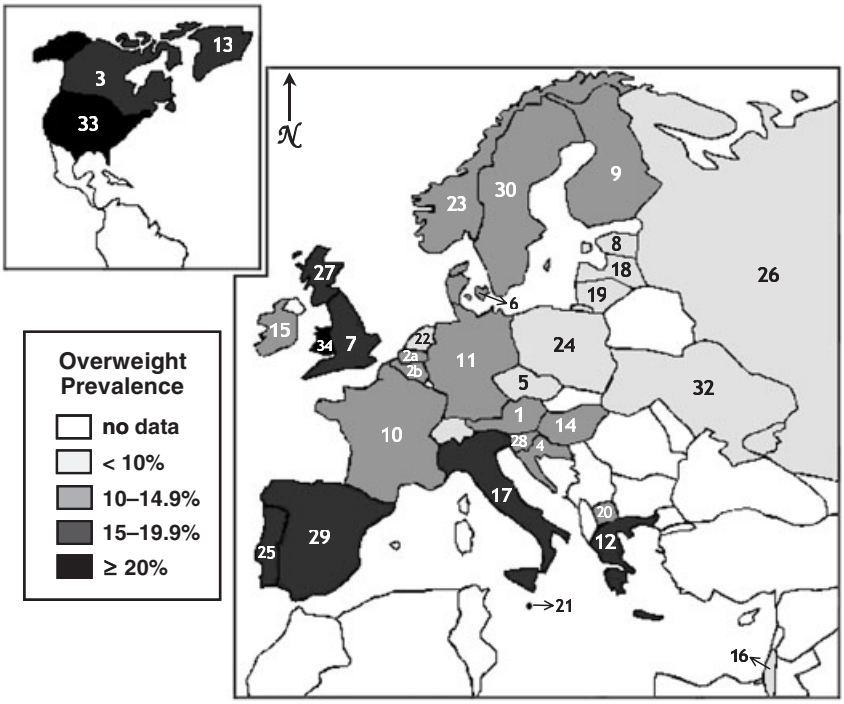

Figure 2 Prevalence of overweight youth (10–16 years olds) in 34 countries. 1 = Austria, 2a = Belgium Flemish, 2b = Belgium French, 3 = Canada, 4 = Croatia, 5 = Czech Republic, 6 = Denmark, 7 = England, 8 = Estonia, 9 = Finland, 10 = France, 11 = Germany, 12 = Greece, 13 = Greenland, 14 = Hungary, 15 = Ireland, 16 = Israel, 17 = Italy, 18 = Latvia, 19 = Lithuania, 20 = Macedonia, 21 = Malta, 22 = Netherlands, 23 = Norway, 24 = Poland, 25 = Portugal, 26 = Russia, 27 = Scotland, 28 = Slovenia, 29 = Spain, 30 = Sweden, 31 = Switzerland, 32 = Ukraine, 33 = United States, 34 = Wales.

tionships between time spent on the computer and overweight (Table 4).

The results presented in Tables 3 and 4 were obtained from multiple logistic regression models in which the OR for each of the dietary and physical activity variables were adjusted for age, gender, presently trying to lose weight (yes or no), and each of the other dietary and physical activity variables. For each of the dietary and physical activity variables examined, similar patterns of associations were obtained using crude logistic regression models and the sizes of the observed effects were similar (data not shown), indicating that the results were not biased because of confounding or colinearity.

Discussion

There were large variations in the prevalence of overweight (5.1–25.4%) and obese (0.4–7.9%) school-aged youth across the 34 countries. However, the overweight and obesity prevalence was quite high in many countries, particularly those in North America, Great Britain, and the southern portion of western Europe. Within most countries lower physical activity participation and higher television viewing were associated with a greater likelihood of being overweight after controlling for known dietary predictors, implying that physical inactivity and television viewing are important determinants of overweight in youth throughout the industrialized world.

Few studies have performed cross-national comparisons of overweight and obesity among school-aged children and adolescents. Lobstein and Frelut (11) provided estimates of childhood overweight and obesity based on measured heights and weights from nationally representative survey data conducted in 21 European countries during the 1990s. In that study overweight and obesity were defined according to the same international childhood BMI standards that were employed in the current study (15). In adolescents aged 14–17 years, the prevalence of overweight ranged from 8% in Slovenia to 23% in Greece. As with the present study, these authors noted a tendency for high prevalence of overweight youth among countries in south-western Europe. However, these cross-national comparisons were limited given the different age ranges of the subjects and the years that the surveys were conducted for each country. Using data from the 1997–1999 HBSC survey, Lissau and colleagues (12) determined the prevalence of overweight and obese youth from 15 countries using the 85th and 95th age- and gender-specific BMI percentiles respectively. By comparison to this earlier HBSC report, the present study provides updated data (2001–2002 survey), data for a larger number ($n = 34$) of countries, and employed the international BMI standards for children.

Our data and that of previous studies demonstrate that, while there is a considerable range in national prevalence of overweight and obesity in children and adolescents, these conditions are common in many parts of the world. In 77% of the countries examined here at least 10% of the youth were overweight and in 20% of the countries at least 3% of the youth were obese. The prevalence of overweight and obese youth was particularly high in countries in North

Table 2 Description of food intake and physical activity variables by country

Country	High fruit intake*	High vegetable intake*	High sweets intake*	High soft drink intake*	Physically active†	High TV viewers‡	High computer users§
Austria	38.1	16.4	21.4	20.4	41.6	31.0	24.7
Belgium (Flemish)	26.5	52.5	28.6	39.3	21.2	40.0	25.7
Belgium (French)	38.3	45.1	42.7	37.7	NA	34.2	22.3
Canada	38.3	40.7	22.2	21.8	44.9	43.2	38.0
Croatia	35.1	25.5	34.3	32.4	33.0	52.8	19.9
Czech Republic	42.5	27.9	25.2	28.6	42.4	47.0	26.1
Denmark	32.5	28.7	11.5	9.8	33.7	44.6	29.1
England	27.1	28.6	31.6	38.1	41.8	51.9	37.2
Estonia	20.1	15.4	28.4	9.8	25.2	63.0	32.4
Finland	21.5	21.9	8.9	7.6	34.1	39.8	23.0
France	34.3	43.4	28.5	29.0	19.3	34.1	16.1
Germany	42.7	32.2	27.4	29.8	26.0	38.5	24.6
Greece	38.0	21.4	15.5	18.3	35.5	37.9	20.7
Greenland	21.4	29.4	38.1	34.8	41.3	40.6	26.8
Hungary	31.7	15.1	34.1	32.5	29.3	39.1	22.8
Ireland	33.0	39.4	48.7	36.7	47.2	38.4	NA
Israel	51.5	48.9	40.6	53.1	30.4	66.2	47.9
Italy	38.1	21.7	38.0	24.4	25.6	42.7	19.5
Latvia	24.0	28.7	27.6	15.6	30.1	62.6	26.7
Lithuania	22.2	30.1	18.9	10.2	42.7	57.3	23.3
Macedonia	43.2	32.5	42.1	34.3	28.8	48.1	26.1
Malta	38.1	21.7	38.0	24.4	25.6	42.7	19.5
Netherlands	28.3	40.7	43.2	43.6	39.9	45.0	30.9
Norway	29.0	22.0	15.8	20.5	25.6	48.0	30.9
Poland	46.1	36.3	36.4	25.4	35.3	52.5	31.8
Portugal	48.8	26.9	22.5	33.5	25.4	52.8	25.4
Russia	27.2	36.0	25.2	21.8	31.2	55.5	29.6
Scotland	34.2	33.4	45.1	46.9	39.9	50.1	38.8
Slovenia	39.0	25.7	26.4	39.6	40.8	39.6	22.7
Spain	36.9	11.0	23.4	29.8	32.8	42.9	20.3
Sweden	27.3	30.2	13.2	12.7	33.7	36.6	32.0
Switzerland	35.4	33.7	27.5	32.6	33.3	24.0	15.7
Ukraine	24.1	46.2	35.5	16.9	32.9	66.2	17.1
United States	27.5	29.9	33.1	42.4	49.5	46.7	30.8
Wales	23.0	21.1	26.7	36.5	36.5	53.0	32.8

*Percentage of study participants who reported consuming food item once per day or more often.
†Percentage of study participants who reported participating in 60 or more minutes of cumulative physical activity on 5 or more days per week (average of last week and typical week).
‡Percentage of study participants who reported watching 3 or more hours of television during the average week day.
§Percentage of study participants who reported using the computer for 2 or more hours in their free time during the average weekday.
NA, data not available for that country.

America, Great Britain, and south-western Europe, a finding consistent with those for adults (1), and one that implies that campaigns aimed at preventing and reducing obesity are of particular importance in these regions. The regional differences in overweight and obesity could be explained by a number of factors including differences in socio-economic status and the availability and preferences of food and leisure-time physical activities (18). Additional research is required to clarify why these regional differences exist.

The high prevalence of overweight and obesity in youth could be explained by any of the factors that influence energy intake or expenditure. A change in dietary patterns in recent decades, including an increased consumption of soft drinks and candy and a decreased consumption of fruits and vegetables in many countries, has been implicated in the increase in childhood and adolescent obesity (19,20). Despite these implications, we observed no consistent patterns surrounding the associations between overweight with the intake of fruits, vegetables, and non-diet soft drinks. In fact, in 31 out of the 34 countries examined (91%) there was a significant *negative* relationship between the intake of sweets and BMI classification such that with increasing sweets intake there was a decreased likelihood

Table 3 Odds ratios for overweight using prediction models with food items

Country	Fruit intake OR (95% CI)*	Vegetable intake OR (95% CI)*	Sweets intake OR (95% CI)*	Soft drink intake OR (95% CI)*
Austria	0.98 (0.91–1.05)	1.02 (0.95–1.09)	0.85 (0.80–0.91)‡	1.02 (0.96–1.08)
Belgium (Flemish)	1.07 (1.00–1.13)†	0.96 (0.89–1.04)	0.87 (0.81–0.92)‡	0.93 (0.88–0.98)‡
Belgium (French)	1.06 (0.99–1.13)	1.03 (0.96–1.11)	0.85 (0.79–0.91)‡	0.95 (0.89–1.02)
Canada	0.95 (0.88–1.03)	1.07 (0.99–1.16)	0.87 (0.82–0.93)‡	1.01 (0.95–1.08)
Croatia	1.00 (0.93–1.08)	1.07 (1.00–1.15)	0.83 (0.78–0.89)‡	1.04 (0.98–1.10)
Czech Republic	0.93 (0.85–1.00)	1.06 (0.99–1.14)	0.81 (0.76–0.87)‡	1.02 (0.96–1.09)
Denmark	0.97 (0.90–1.05)	1.06 (0.99–1.15)	0.83 (0.78–0.89)‡	0.99 (0.93–1.04)
England	1.02 (0.95–1.09)	0.97 (0.91–1.04)	0.88 (0.82–0.95)‡	1.04 (0.99–1.09)
Estonia	1.09 (0.99–1.20)	0.96 (0.87–1.07)	0.80 (0.73–0.88)‡	0.97 (0.88–1.06)
Finland	0.96 (0.89–1.03)	0.94 (0.88–1.00)	0.88 (0.81–0.95)‡	0.95 (0.89–1.02)
France	0.99 (0.94–1.03)	1.08 (1.02–1.14)†	0.90 (0.86–0.94)‡	0.96 (0.92–1.01)
Germany	1.01 (0.93–1.10)	1.04 (0.95–1.13)	0.78 (0.70–0.86)‡	0.99 (0.91–1.07)
Greece	0.91 (0.86–0.97)‡	0.98 (0.92–1.04)	0.92 (0.86–0.98)‡	0.99 (0.94–1.05)
Greenland	0.98 (0.86–1.12)	0.88 (0.77–1.02)	0.78 (0.66–0.92)‡	1.09 (0.93–1.27)
Hungary	1.09 (1.03–1.16)†	1.03 (0.97–1.10)	0.77 (0.72–0.82)‡	1.00 (0.94–1.06)
Ireland	0.91 (0.81–1.04)	1.04 (0.93–1.17)	0.98 (0.87–1.11)	0.93 (0.84–1.03)
Israel	1.02 (0.96–1.10)	1.06 (0.99–1.13)	0.93 (0.88–0.98)‡	0.94 (0.89–0.99)‡
Italy	0.96 (0.91–1.01)	1.00 (0.95–1.06)	0.86 (0.81–0.92)‡	0.97 (0.91–1.02)
Latvia	1.03 (0.92–1.15)	0.95 (0.86–1.05)	0.85 (0.77–0.94)‡	0.94 (0.86–1.04)
Lithuania	0.90 (0.79–1.03)	1.02 (0.89–1.17)	0.85 (0.76–0.96)‡	0.96 (0.86–1.07)
Macedonia	1.04 (0.96–1.13)	1.01 (0.94–1.09)	0.87 (0.81–0.94)‡	1.02 (0.96–1.08)
Malta	1.00 (0.91–1.10)	0.96 (0.87–1.05)	1.02 (0.95–1.09)	1.04 (0.95–1.13)
Netherlands	1.01 (0.93–1.10)	1.06 (0.94–1.09)	0.85 (0.78–0.92)‡	0.98 (0.91–1.06)
Norway	1.09 (1.02–1.17)†	1.01 (0.94–1.08)	0.90 (0.83–0.98)‡	0.97 (0.89–1.05)
Poland	1.01 (0.93–1.10)	1.04 (0.98–1.11)	0.90 (0.85–0.96)‡	1.04 (0.98–1.10)
Portugal	1.04 (0.97–1.11)	0.93 (0.87–1.00)‡	0.87 (0.81–0.92)‡	1.01 (0.96–1.08)
Russia	1.10 (1.02–1.18)†	0.96 (0.90–1.02)	0.90 (0.85–0.96)‡	0.95 (0.89–1.02)
Scotland	0.99 (0.91–1.07)	1.02 (0.94–1.11)	0.86 (0.79–0.95)‡	0.99 (0.91–1.08)
Slovenia	1.02 (0.95–1.10)	1.03 (0.96–1.10)	0.81 (0.76–0.87)‡	0.99 (0.94–1.04)
Spain	0.96 (0.91–1.01)	1.02 (0.96–1.09)	0.89 (0.85–0.93)‡	1.03 (0.99–1.09)
Sweden	1.03 (0.97–1.10)	1.04 (0.96–1.13)	0.72 (0.66–0.79)‡	1.10 (0.99–1.21)
Switzerland	0.98 (0.90–1.06)	1.03 (0.95–1.12)	0.82 (0.76–0.89)‡	0.96 (0.90–1.02)
Ukraine	1.00 (0.91–1.10)	1.01 (0.92–1.11)	0.90 (0.81–1.00)	1.13 (1.03–1.24)†
United States	0.97 (0.92–1.02)	1.00 (0.95–1.05)	0.90 (0.85–0.94)‡	1.04 (0.99–1.08)
Wales	1.01 (0.95–1.08)	1.00 (0.93–1.08)	0.83 (0.77–0.89)‡	1.08 (1.02–1.14)†

*Odds ratios (95% confidence intervals). Food items were included in the regression model as continuous variables and the OR for overweight were computed for each unit increase the food items (See Methods). The OR were adjusted for age, gender, presently trying to lose weight (yes or no), and each of the other dietary and physical activity variables.

†Significant *positive* relationship ($P < 0.05$).

‡Significant *negative* relationship ($P < 0.05$).

of overweight. Because we statistically controlled for being on a weight loss diet, it is unlikely that weight loss practices explain this finding. However, it is possible that overweight children may deliberately restrict their intake of sweets in order to control weight. Another possible explanation is that overweight individuals are more likely than normal weight individuals to under-report unhealthy food intake (21,22). Another possibility is that the youth who were eating sweets, which are primarily carbohydrate based energy sources, were eating fewer fatty foods such as potato chips and pastries. Thus, because the caloric density of carbohydrates is less than half of that of fats (4 kcal g^{-1} vs. 9 kcal g^{-1}), the total caloric intake may have been reduced in those reporting a high sweets intake. Finally, because we only have data on the frequency of food consumption, it is possible that the overweight youth ate greater portion sizes and thus consumed comparable or greater amounts of sweets even though they consumed sweets less often.

In the past few decades physical activity patterns in adolescents have changed as a result of an increase in time spent watching television, the advent of the household computer, and a decrease in opportunities for physical activity in schools and communities (19,23). We observed that the likelihood of being overweight was significantly lower in a dose-response manner with higher physical

Table 4 Odds ratios for overweight using prediction models with physical activity variables

Country	Physical activity level OR (95% CI)*	TV viewing time OR (95% CI)*	Computer use OR (95% CI)*
Austria	0.80 (0.76–0.85)†	1.24 (1.16–1.33)‡	0.97 (0.91–1.04)
Belgium (Flemish)	0.82 (0.78–0.87)†	1.15 (1.09–1.21)‡	1.06 (1.00–1.13)‡
Belgium (French)	NA	1.11 (1.03–1.20)‡	0.95 (0.88–1.03)
Canada	0.87 (0.84–0.91)†	1.15 (1.09–1.21)‡	0.95 (0.90–1.00)
Croatia	0.85 (0.81–0.91)†	1.00 (0.94–1.06)	1.02 (0.96–1.09)
Czech Republic	0.88 (0.84–0.93)†	1.09 (1.03–1.16)‡	1.03 (0.96–1.10)
Denmark	0.99 (0.94–1.06)	1.17 (1.09–1.26)‡	0.99 (0.92–1.06)
England	0.91 (0.86–0.96)†	1.11 (1.05–1.16)‡	0.97 (0.91–1.03)
Estonia	0.90 (0.83–0.98)†	1.10 (1.03–1.16)‡	1.05 (0.99–1.12)
Finland	0.91 (0.87–0.95)†	1.17 (1.11–1.24)‡	1.10 (1.04–1.16)‡
France	0.89 (0.85–0.93)†	1.12 (1.07–1.17)‡	0.97 (0.92–1.02)
Germany	0.99 (0.93–1.05)	1.17 (1.10–1.24)‡	1.00 (0.94–1.07)
Greece	0.95 (0.90–1.00)†	1.12 (1.06–1.18)‡	1.00 (0.95–1.06)
Greenland	0.85 (0.76–0.95)†	1.10 (0.98–1.24)	1.05 (0.92–1.26)
Hungary	0.87 (0.82–0.93)†	1.13 (1.07–1.20)‡	1.00 (0.95–1.06)
Ireland	0.82 (0.75–0.89)†	1.02 (0.90–1.15)	NA
Israel	0.88 (0.84–0.93)†	1.09 (1.02–1.16)‡	1.00 (0.94–1.07)
Italy	0.89 (0.85–0.94)†	1.09 (1.03–1.14)‡	1.03 (0.96–1.10)
Latvia	0.96 (0.88–1.05)	0.96 (0.88–1.04)	1.05 (0.95–1.16)
Lithuania	0.94 (0.87–1.02)†	1.04 (0.96–1.13)	1.06 (0.96–1.18)
Macedonia	0.94 (0.89–0.99)†	1.03 (0.97–1.06)	1.06 (1.00–1.13)‡
Malta	0.84 (0.79–0.90)†	1.04 (0.96–1.14)	0.93 (0.86–1.00)†
Netherlands	0.88 (0.82–0.94)†	1.17 (1.10–1.26)‡	0.94 (0.87–1.01)
Norway	0.81 (0.77–0.86)†	1.14 (1.08–1.20)‡	0.99 (0.93–1.05)
Poland	0.86 (0.82–0.90)†	1.01 (0.94–1.08)	1.04 (0.99–1.09)
Portugal	0.93 (0.87–0.99)†	1.03 (0.96–1.09)	0.95 (0.89–1.03)
Russia	0.96 (0.91–1.01)	1.09 (1.02–1.15)‡	0.94 (0.89–1.00)
Scotland	0.87 (0.81–0.94)†	1.09 (1.02–1.17)‡	0.97 (0.90–1.04)
Slovenia	0.88 (0.84–0.93)†	1.08 (1.01–1.15)‡	0.99 (0.93–1.06)
Spain	0.90 (0.86–0.94)†	1.09 (1.04–1.15)‡	0.94 (0.90–0.99)†
Sweden	0.86 (0.81–0.92)†	1.02 (0.95–1.10)	0.96 (0.89–1.02)
Switzerland	0.88 (0.82–0.94)†	1.19 (1.10–1.29)‡	1.00 (0.92–1.08)
Ukraine	0.92 (0.85–0.99)†	0.99 (0.92–1.06)	0.93 (0.84–1.02)
United States	0.90 (0.87–0.94)†	1.13 (1.08–1.17)‡	0.95 (0.91–0.99)†
Wales	0.88 (0.84–0.92)†	1.04 (0.99–1.09)	1.06 (1.01–1.13)‡

*Odds ratios (95% confidence intervals). Leisure-time activities were included in the regression model as continuous variables and the OR for overweight were computed for each unit increase in the leisure-time activity variables (see Methods). The OR were adjusted for age, gender, presently trying to lose weight (yes or no), and each of the other dietary and physical activity variables.

†Significant *negative* relationship ($P < 0.05$).

‡Significant *positive* relationship ($P < 0.05$).

NA, data not available for that country.

activity participation in 29 out of the 33 countries examined (88%). The fact that similar associations were found across countries and cultures demonstrates the robustness of this finding, although because this was a cross-sectional study the temporality of the relation between physical activity and overweight is uncertain. American guidelines recommend that youth engage in 30–60 min of physical activity on most or all days of the week (24,25), guidelines developed in Great Britain recommend that youth engage in at least 60 min of daily physical activity at least 5 d a week (26), and Canadian guidelines recommend that all adolescents, regardless of their current activity level, gradually increase their daily physical activity participation by 90 min (27). Our observations indicate that physical activity interventions should be a fundamental component of health campaigns aimed at reducing the global obesity epidemic. Along this line, presenting more opportunities for physical activity in the school and community can reduce sedentary behaviours in youth (19,28).

Consistent with the observations for physical activity participation, we observed risk gradients indicating higher degrees of overweight with greater television viewing time in 22 out of the 34 countries examined (65%). These results support a growing body of evidence implicating

television viewing as a leading factor associated with adolescent obesity (29–31). Our cross-sectional observations are consistent with prospective (31) and intervention (29) studies that found a cause and effect relationship between television viewing and obesity in young persons. The mechanisms linking television viewing with overweight and obesity in youth include an increased caloric intake from eating during viewing or from the effects of food advertising, and reduced energy expenditure from television viewing displacing physical activity (30).

The primary limitation of this study was that the body weights and heights were self-reported. Although this raises questions about the accuracy of the BMI values and the applicability of the overweight cut-points, which may be further compounded by selected biases across the various countries examined, others have shown that self-reported heights and weights are fairly reliable (32,33). For instance, in a nationally representative sample of American youth it was reported that 94% of the subjects were correctly classified as obese or non-obese based on self-reported height and body weight (32). Given the magnitude and direction of the biases observed in these studies (32,33), it is likely that the overweight and obesity prevalence presented in the current study were slightly underestimated. A second limitation was that 14% of the youth surveyed did not report their height and weight. However, we found that the body images and weight loss practices were similar in youth who reported, vs. those who did not report, their height and weight, suggesting that the degree of adiposity was similar in these groups. A third limitation of our study was that the dietary patterns and physical activity variables were also self-reported, and information was only obtained on the frequency and not the total volume for these variables. A final limitation of this study was that the associations observed between overweight status with dietary and physical activity patterns were based on cross-sectional data and therefore causal inferences cannot be implied.

In conclusion, the prevention and treatment of overweight in school-aged youth requires increased efforts and partnerships at all levels, including regional and national governments and international agencies. All of these groups should be responsible for promoting physical activity, healthy diets, and healthy body weights. The importance of national governments in countries where the prevalence of overweight youth is particularly high such as those in Malta, the United States, and Great Britain is clear. However, because obesity in young persons is a global phenomenon, it would be natural and timely for the World Health Organization (WHO) to take a leadership role. Although the WHO has recently published guidelines on preventing and managing the global obesity epidemic (1), these guidelines focused on adults and there is a need for the publication and endorsement of guidelines specific for children and adolescents.

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