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The impact of a population-level school food and nutrition policy on dietary intake and body weights of Canadian children

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ABSTRACT

Objective. The objective of this study is to assess population-level trends in children's dietary intake and weight status before and after the implementation of a provincial school nutrition policy in the province of Nova Scotia, Canada.

Method. Self-reported dietary behavior and nutrient intake and measured body mass index were collected as part of a population-level study with grade 5 students in 2003 (n = 5215) and 2011 (5508), prior to and following implementation of the policy. We applied random effects regression methods to assess the effect of the policy on dietary and health outcomes.

Results. In 2011, students reported consuming more milk products, while there was no difference in mean consumption of vegetables and fruits in adjusted models. Adjusted regression analysis revealed a statistically significant decrease in sugar-sweetened beverage consumption. Despite significant temporal decreases in dietary energy intake and increases in diet quality, prevalence rates of overweight and obesity continued to increase.

Conclusion. This population-level intervention research suggests a positive influence of school nutrition policies on diet quality, energy intake and healthy beverage consumption, and that more action beyond schools is needed to curb the increases in the prevalence of childhood obesity.

Introduction

Public policy is a critical component of population health interventions (Hawe and Potvin, 2009) and offers an important opportunity to address the rising public health concerns of child and adolescent obesity (Story et al., 2009b). Rates of overweight and obesity have increased over the last two decades (Shields, 2006a; Tremblay and Willms, 2000; Willms et al., 2003) and have significant health (Whitaker et al., 1997; Must et al., 1999; Rocchini, 2002; Biddle et al., 2004) and economic implications (Kirk et al., 2011; Kuhle et al., 2011; Tran et al., 2013). Current evidence suggests the need for comprehensive, sustainable initiatives to stimulate the changes necessary to produce a population-level change in childhood weight status (Hobbs, 2008); however, there is a relative paucity of population-level intervention research to help inform this important public health issue (Sanson-Fisher et al., 2008). Schools are an important partner in population-level obesity prevention, particularly through supporting early development of healthy behaviors, including promoting healthy eating and physical activity (Stone et al., 1998; Story et al., 2009a; Wechsler et al., 2000). Over the past ten years, many school jurisdictions have developed and implemented nutrition policies and guidelines as part of a broader strategy to address childhood obesity (Boehmer et al., 2007; Foster et al., 2008).

In Canada, there is no national/federal school nutrition policy or school feeding program; rather provincial/territorial jurisdictions are responsible for developing policies to regulate and manage school food. Research and policy activity in the Canadian province of Nova Scotia (NS) provide a timely opportunity to explore the relative impact of a nutrition policy on children's health behaviors and weight status over time (McIsaac et al., 2012). Provincial results from the 2003 Children's Lifestyle and School Performance Study I (CLASS I) (Veugelers and Fitzgerald, 2005b; Veugelers et al., 2005) helped to inform new policies and investments related to school health over the past decade in NS. The *Food and Nutrition Policy for Nova Scotia Public Schools* was introduced in 2006, with full implementation expected in all public (state) schools by 2009. This policy included all three categories defined in an earlier systematic review, including nutritional guidelines, regulation of food and beverages available and price interventions (Jaime and

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Table 1
Nova Scotia Nutrition Policy 2006: Summary of directives.

Directives	Description
1. Food and Beverages Served and Sold in School	1.1 During the school day when students are present, food and beverages served and sold in school will be consistent with the Food and Beverage Standards for Nova Scotia Public Schools. This includes cafeterias, canteens, vending machines, and lunch, breakfast, and snack programs. 1.2 The policy and food and beverage standards are also in effect during evening programs for students provided by the school. (Refer to Directives 5 and 6 for considerations for Fundraising and Special Functions.) 1.3 Schools will ensure that the majority of choices available are from food and beverages of Maximum Nutrition, recognizing that they are more nutritious than those of Moderate Nutrition. 1.4 Schools will serve or sell only milk (white, chocolate, flavored, and nutritional alternatives to milk, e.g., soy), 100% juice, and water as beverages as per the Food and Beverage Standards for Nova Scotia Public Schools. 1.5 Schools will not use deep fat fryers to prepare food.
2. Clean Drinking Water	2.1 Schools will ensure that students and staff have access to clean drinking water during the school day. 2.2 Teachers and administrators will encourage students to drink water, especially during periods of hot weather or increased physical activity. This may be facilitated by allowing water bottles into the classroom.
3. Programming	3.1 It is expected that all schools will participate in the Nova Scotia Department of Agriculture's School Milk Program.
4. Pricing	4.1 To ensure that healthy food and beverage choices are accessible to the majority of students, schools will make affordability the primary consideration when setting prices or profit margins. Meal programs, in particular, will be priced with this in mind.
5. Fundraising	5.1 Fundraising with food and beverages organized by and through schools will center only on items of Maximum or Moderate Nutrition.
6. Special Functions	6.1 Food and beverages of Maximum and Moderate Nutrition will be offered during Special Functions. However, Special Functions may include items from the Minimum Nutrition list. Special Functions are events that may occur once or twice a month and include special occasions and in-school celebrations (e.g., parent–teacher night, Remembrance Day, school bazaar, Spring Fling, Halloween, Christmas bake sales).
7. Promotion and Advertising	Schools will work to develop a culture that promotes health by 7.1 promoting healthy food and beverage choices that emphasize and are consistent with the Maximum Nutrition and Moderate Nutrition lists. 7.2 giving priority space to healthy food and beverages as defined by the Maximum Nutrition list (e.g., counter-top refrigerators, placement of fruits and vegetables at student eye level).
8. Food as a Reinforcer	8.1 School staff and volunteers will not offer food as a reinforcer or withhold food from students as a consequence, except in cases where a program planning team is using applied behavioral analysis to implement an individual program plan for a student.
9. Students Who May Be Vulnerable	9.1 Schools will ensure that students and parents are aware of breakfast, lunch, and snack programs that are offered in or through the school at minimal or no cost and are accessible to all students. 9.2 Schools must ensure that any food programs are made available to students in a non-stigmatizing manner. 9.3 Schools will work with parents to ensure that staff/volunteers are aware of food allergies and guidelines for supporting children with food-related chronic diseases (e.g., diabetes, celiac disease). 9.4 Schools will ensure that any food and beverages served and sold from those listed in the Food and Beverage Standards for Nova Scotia Public Schools are in alignment with school board anaphylaxis policy, Canadian School Boards Association Anaphylaxis Guidelines, or Peanut Aware policies and guidelines.
10. Portion Sizes	10.1 Schools will serve and sell appropriate portions of food and beverages. Super-sized portions are not appropriate to serve or sell in schools. Refer to Canada's Food Guide to Healthy Eating for information related to portion sizes.
11. Food Safety	11.1 Schools are required to prepare and serve foods in accordance with food safety standards and training guidelines as outlined by the Health Protection Act of the Nova Scotia Department of Agriculture. This may require the need for a Food Establishment Permit, food safety training, and Workplace Hazardous Materials Information System (WHMIS) training. 11.2 Schools will emphasize and promote cleanliness. Placemats or disinfectant wipes are encouraged if students are to eat at their desks. 11.3 Schools will ensure that students are aware of the importance of hand washing and will provide students with the opportunity to wash their hands before consuming meals.
12. Nutrition Education	12.1 The Department of Education will work with partners to ensure continued development and currency of high-quality, evidence-based health education curriculum that includes food and nutrition outcomes. 12.2 The Department of Education will work with partners to ensure continued development and currency of high-quality, evidence-based family studies curriculum that includes food and nutrition studies. 12.3 When possible, schools should integrate nutrition education into other subject areas and activities beyond the classroom. 12.4 The Department of Education will work with partners to enhance pre-service and in-service teacher education regarding nutrition. 12.5 The Department of Education will work with partners to ensure that opportunities for ongoing professional development are made available to teachers to support food and nutrition education. 12.6 The Department of Education will work with partners to ensure that teachers and students have access to the resources they need to address food and nutrition curriculum outcomes.

Lock, 2009). Briefly, the Nova Scotia Nutrition Policy (NSNP) is intended to increase access to and enjoyment of health-promoting, safe, and affordable food and beverages served and sold in public schools, with the objective of helping to make the healthy food and beverage choice the easy choice in the school setting. The policy mandates standards for foods and beverages served and sold in schools and provides directives for various school eating practices (including pricing, programming and advertising) and guidelines that encourage schools to foster community partnerships and support local food products (Government of Nova Scotia, 2008). A summary of the policy directives and guidelines is provided in Table 1. Following policy implementation, a subsequent data collection cycle in 2011 (CLASS II) provided an opportunity to explore how changes in school food practices as a result of the NSNP may have affected changes in student behavior, if at all. The objective of this study is therefore to assess population-level trends in children's nutritional intake and weight status from 2003 to 2011 as they relate to the potential impact of the NSNP.

Methods

Study design

CLASS is a large, cross-sectional, provincial study that has investigated the relationship between nutrition, physical activity, mental health and school performance of grade 5 students in Nova Scotia across two time points (2003 and 2011). The vast majority of the grade 5 student population in Nova Scotia attends

public schools; all public schools were invited to participate in both data collection cycles. In 2003, 282 of 291 schools (96.9%) agreed to participate and 5517 parents provided their consent, resulting in an average response rate of 51.1% per school. The 2011 cycle of data collection provides a comparable sample with 269 of 286 schools (94.1%) and informed consent from 5913 parents. The higher response rate in 2011 (67.7%) may be reflective of the support we received from school jurisdictions and stakeholders interested in the CLASS research. On each occasion, trained research assistants visited the schools to administer the surveys to students and to complete anthropometric measurements. Standing height was measured to the nearest 0.1 cm after students had removed their shoes and body weight to the nearest 0.1 kg on calibrated digital scales. The surveys were similar in both cycles (some items were slightly modified or added in 2011) and included the Harvard Youth Adolescent Food Frequency Questionnaire (YAQ) adapted for Canadian settings (used in both 2003 and 2011) to gather information on usual dietary intake and habits pertaining to mealtime behaviors (Rockett et al., 1995). The survey for students included mostly validated questions on physical and sedentary activities, mental health, self-efficacy and body image, and measurements of height and weight. Parents also completed a survey to collect information on socio-demographic factors and the home environment. Principals completed surveys that provided information on school characteristics and implementation of school policies. Ethics approval for this study was obtained from the Health Research Ethics Boards at the University of Alberta and Dalhousie University. Permission for data collection was also granted from participating school boards.

Outcomes

Dietary behavior and nutrient intake

Student's diet quality, nutrient intake, and caloric intake were assessed using the YAQ and Canadian Nutrient File (Health Canada, 2007). Overall diet quality was measured using the Diet Quality Index — International (DQI) score, a composite measure of diet quality ranging from 0 to 100 that includes aspects of diet adequacy, variety, balance and moderation (Kim et al., 2003). Sugar-sweetened beverages (SSB) were defined as consumption of non-diet soda, fruit drinks and sweetened iced tea drinks, based on the YAQ. Nutrient intakes were compared with the Dietary Reference Intakes (DRIs) (Institute of Medicine, 2011) where intakes of carbohydrate, protein and fat were compared with the Acceptable Macronutrient Distribution Range (AMDR). Intake of calcium, folate, iron, zinc and vitamins A, C, and D was compared with the Estimated Average Requirement (EAR). As an EAR is not available for total fiber, comparisons were made with the Adequate Intake (AI), which is a value that is observed to be adequate in healthy populations (Institute of Medicine, 2011). Levels of sodium intake were compared with the Upper Limit (UL). The lower range of the DRI reference values was used to determine the prevalence of nutrient inadequacy. There were 5195 and 5491 students who completed the FFQ in 2003 and 2011 respectively. Of these students, we excluded 368 (3.4%) students with reported average energy intakes of less than 500 kcal or greater than 5000 kcal per day from the analyses pertaining to dietary outcomes, following established criteria for outlying observations (Willett, 1998). *Eating Well with Canada's Food Guide* (Health Canada, 2008) also provided guidelines for healthy eating according to recommended number of servings for the four food groups: vegetables and fruit, milk and alternatives (yogurt, cheese), grain products (e.g., bread, pasta, cereal) and meat and alternatives (e.g., tofu, beans, eggs). Dietary behaviors and intakes from each of the four food groups were determined from the YAQ.

Weight status

Measured body mass index (BMI) was used to define weight status based on the age- and gender-specific cut-off points of the International Obesity Task Force (Cole et al., 2000). Students without height and weight measurements were excluded from the analyses related to weight status.

Covariates

Parents completed home surveys that included information on parental education attainment levels (secondary or less, college, university or above) and household income levels (< $20,000; $20,001–$40,000; $40,001–$60,000; >$60,001). Place of residency (urban/rural) was determined using postal codes collected from parent surveys.

Statistical analysis

All statistical analyses were weighted for non-response bias and represent provincial estimates of the grade 5 student population in public schools across NS. Response weights were calculated based on average household incomes according to postal code data from the 2001 and 2011 census for participants and non-participants, to account for non-response bias due to lower participation rates in residential areas with lower household incomes (Veugelers and Fitzgerald, 2005b). Unadjusted differences between pre- and post-policy implementation for dietary outcomes and weight status were assessed using the Rao–Scott-Chi-square (Rao and Scott, 1981, 1984) or t-test as appropriate. These changes were considered to act as proxies of policy effect.

We applied random effects regression methods to account for the clustering of students within schools that are embedded within school boards. Missing values were considered as separate covariate categories but are not presented. Students from schools that did not take part in both years of the study were excluded from the regression analysis. Considering the cross-sectional study design, prevalence ratios (PRs) and 95% confidence intervals (CI) were estimated from Poisson random effects regression models with robust variance (Barros and Hirakata, 2003) for the following binary outcomes: eat breakfast, bring a prepared lunch from home, buy lunch at school, eat supper at table with others, eat supper in front of the TV, eat at fast food restaurant, overweight and obesity. Regression coefficients (β) and 95% CI were derived from linear random effects regression models for the following continuous outcomes: mean servings of fruits and vegetables per day, mean servings of grain products per day, mean servings of milk products per day, mean servings of meat and alternatives per day, mean non-diet soda intake, mean dietary energy intake, and mean DQI score. The number of servings consumed from each food group was standardized by assuming a caloric intake of 2000 kcal per day. Furthermore, the analyses were adjusted for the potential confounding effects of gender, household income, parental education and place of residency. Dietary outcomes were further adjusted for energy intake.

Results

The characteristics of 5215 grade 5 students attending public schools who participated in CLASS I and 5508 students who participated in CLASS II are shown in Table 2. Parents of grade 5 students in 2011 had significantly higher levels of education and higher overall household income than parents of students in 2003. In terms of adequacy of nutritional intake, the mean percentage of total energy intake that

Table 2
Characteristics of grade 5 students attending public schools[a] in the Canadian province of Nova Scotia in 2003 and 2011.

Independent variable	2003	2011	*P*[b]
Gender			0.278
Girls	51.0	52.1	
Boys	49.0	47.9	
Parental education			<0.001
Secondary or less	30.0	19.3	
College	38.0	43.0	
University or above	32.0	37.7	
Household income			<0.001
Less than $20,000	12.2	8.5	
$20,001–$40,000	22.4	17.7	
$40,001–$60,000	25.6	17.6	
>$60,000	39.8	56.1	
Place of residency			0.398
Urban	68.0	64.3	
Rural	32.0	35.7	
Overweight[c] (excluding obese)	23.1	22.6	0.625
Obesity[c]	9.8	10.9	0.172

Note: CLASS = Children's Lifestyle and School-Performance Study; DQI = Diet Quality Index.

[a] Findings based on 5215 students from CLASS I and 5508 students from CLASS II attending public schools in Nova Scotia, Canada. Results are adjusted for non-response and represent provincial estimates of students attending public schools.

[b] *P*-values derived using the Rao–Scott Chi-square which examine differences in weighted estimates by adjusting for the design effect.

[c] Excludes students without height and weight measurements for BMI calculations.

Table 3
Dietary Reference Intakes (DRIs) and observed nutrient intakes among grade 5 students attending public schools in the Canadian province of Nova Scotia in 2003 and 2011.

Nutrient	DRI category[a]	Reference value	Mean ± SE			Effect size[b]	Prevalence of inadequacy	
			2003	2011	*P*-value		2003	2011
Carbohydrate								
(%)	AMDR	45–65	55.6 ± 0.1	56.5 ± 0.1	<0.001	0.11	2.5%	2.0%
(g/d)	EAR[c]	100	299.7 ± 2.4	267.1 ± 2.2	<0.001	−0.18	1.7%	2.3%
Protein								
(%)	AMDR	10–30	14.8 ± 0.1	15.9 ± 0.1	<0.001	0.22	3.4%	1.7%
(g/kg/d)	EAR	0.76	1.94 ± 0.02	1.84 ± 0.02	<0.001	−0.09	6.5%	7.6%
Fat								
(%)	AMDR	25–35	30.7 ± 0.1	28.7 ± 0.1	<0.001	−0.25	7.4%	19.6%
(g)	EAR	ND	73.4 ± 0.6	60.2 ± 0.5	<0.001	−0.25	–	–
Vitamin C (mg)	EAR	39	163.5 ± 1.7	125.8 ± 1.5	<0.001	−0.26	5.4%	11.7%
Folate	EAR	250	363.8 ± 2.8	335.2 ± 2.5	<0.001	−0.15	27.7%	33.5%
Vitamin A (ug RAE/d)								
Males	EAR	445	918.7 ± 12.6	898.5 ± 10.9	0.22	−0.03	16.7%	18.9%
Females	EAR	420	901.1 ± 12.7	881.8 ± 10.6	0.25	−0.03	15.3%	16.0%
Iron (mg)								
Males	EAR	5.9	12.1 ± 0.1	12.5 ± 0.1	0.03	0.06	8.7%	8.1%
Females	EAR	5.7	11.1 ± 0.1	11.5 ± 0.1	0.03	0.06	10.6%	8.5%
Zinc (mg)	EAR	7	10.2 ± 0.1	9.5 ± 0.1	<0.001	−0.12	24.6%	30.5%
Calcium (mg)	EAR	1100	1181.9 ± 9.7	1110.0 ± 9.6	<0.001	−0.10	48.5%	55.3%
Vitamin D (IU)	EAR	400	251.5 ± 2.7	245.2 ± 2.7	0.10	−0.03	80.7%	81.4%
Total fiber (g)								
Males	AI	31	16.2 ± 0.2	15.6 ± 0.2	0.01	−0.08	–	–
Females	AI	26	15.6 ± 0.2	15.1 ± 0.2	0.03	−0.06	–	–
Sodium (mg)	UL	2200	2615.1 ± 20.6	2404.8 ± 18.7	<0.001	−0.14	–	–

[a] AMDR = Acceptable Macronutrient Distribution Range; EAR = Estimated Average Requirement; ND = Not Determined; AI = Adequate Intake; UL = Upper Limit.
[b] Effect size is mean 2003 − mean 2011 / SD.
[c] EAR is the value that is estimated to meet the requirements of 50% of healthy individuals. AI is used in the absence of definitive data on which to base an EAR. The prevalence of inadequacy cannot be determined with values below an AI because lower values may be adequate. EAR is not available for total fat intake. Sodium intake levels were compared with the Upper Limit (UL) values above which potential adverse effect may occur (i.e. high blood pressure). Only the UL was used for sodium because health concerns pertain primarily to the excess consumption of sodium and sodium deficiencies are extremely rare in Canada.

was attributable to carbohydrate and protein increased in 2011 from 2003 and this decreased for percentage of total energy intake attributable to fat (Table 3). The average sodium intake significantly decreased from 2615 mg in 2003 to 2405 mg in 2011. Average intake of vitamin C, folate, vitamin A, zinc and calcium exceeded EAR values in 2003 and 2011. However, the average intake of these micronutrients decreased over the years and rates of inadequate levels among respondents increased. In particular, inadequate levels of calcium increased from 48.5% in 2003 to 55.3% in 2011. Average intake levels of vitamin D were below reference values in 2003 and 2011, with over 80% of respondents having inadequate intakes. Intake of total fiber decreased in both boys and girls and these levels were below reference values for AI. In relation to dietary behaviors and intake, in both 2003 and 2011, 95% of grade 5 students reported they usually ate breakfast either at home or at school (Table 4). After adjusting for potential confounders, students were 33% more likely to bring a lunch prepared from home (PR = 1.33, 95% CI = 1.19, 1.50) and 33% less likely to buy lunch at school in 2011 relative to 2003 (PR = 0.67, 95% CI = 0.48, 0.92). Students in 2011 compared to students in 2003 were also 13% more likely to eat supper in front of the TV and less likely to eat supper at the table with others, although this was not significant after adjusting for confounders. Moreover, we observed a statistically significant 16% decrease in the likelihood of students reporting eating at a fast food restaurant in 2011 relative to 2003. In 2011 relative to 2003, students reported consuming 0.26 serving per day more milk products, while no difference in mean consumption of fruits and vegetables was observed in adjusted models. Adjusted regression analysis also revealed a decrease of 0.20 can or glass per day in SSB consumption, which included a 0.09 can or glass per day decrease in soda consumption. Significant decreases in dietary energy intake along with increases in diet quality as measured by the DQI were also observed over time. The prevalence of overweight (excluding obesity) remained relatively unchanged at 23.1% in 2003 compared with 22.6% in 2011, whereas the prevalence of obesity increased slightly from 9.8% to 10.9% over the same time period.

Discussion

This study involved a large population-based comparison of grade 5 students in Nova Scotia in 2003 and 2011, which represents the timeframe before and after the implementation of the NSNP. This policy began influencing changes in school food in Nova Scotia from 2006 with full implementation expected by 2009. As this study observes trends from 2003 to 2011, we can examine population differences before and after policy implementation, although without a comparison group, it is not possible to disentangle any effects of the policy from wider societal changes. Nonetheless, this study provides "real world" evidence of the impact of a population-level (province-wide) intervention to promote healthy eating in schools. Thus far, the majority of research has focused on shorter term (one to three years) nutrition-related changes using an experimental or cross-section design in relation to state or district-wide implementation of a nutrition policy (Jaime and Lock, 2009). As very few studies have assessed changes at a population level (Mullally et al., 2010), our study contributes important population-level context and adds to the limited evidence of the long-term, organic changes observed following nutrition policy implementation. Similar to other studies, we observed positive trends in diet quality (Cullen and Watson, 2009; Cullen et al., 2008) and energy intake (Mendoza et al., 2010) following the implementation of the NSNP, but we did not find statistically significant increases in consumption of vegetables and fruit that have been reported by others. A decline in SSB consumption over the timeframe observed in this study is consistent with other research following the implementation of a school-based nutrition policy (Blum et al., 2008; Johnson et al., 2009; Jones et al., 2010); however, different from earlier work, we did not differentiate between beverages consumed at home and at school.

Typically, school nutrition policies focus on foods available at school, rather than the food provided at home. The focus on improving school food is important for NS as earlier research (CLASS I) found that students who purchased lunch at school (compared to those who brought

Table 4
Effect of the Nova Scotia Food and Nutrition Policy on dietary behaviors, dietary intakes, and weight status among grade 5 students attending public schools between 2003 and 2011.[a]

Outcome	2003	2011	P[b]	Unadjusted change[c]	Adjusted change[d]
Dietary behaviors				PR (95% CI)	PR (95% CI)
Eat breakfast	95.3%	94.9%	0.400	0.99 (0.99, 1.00)	**0.99** (0.98, 1.00)
Bring a prepared lunch from home	59.1%	79.3%	<0.001	**1.35** (1.20, 1.52)	**1.33** (1.19, 1.50)
Buy lunch at school	17.3%	12.8%	0.003	**0.69** (0.58, 0.82)	**0.67** (0.48, 0.92)
Supper at table with others	72.4%	73.0%	0.618	1.00 (0.98, 1.03)	0.98 (0.96, 1.01)
Supper in front of the TV	56.1%	60.9%	<0.001	**1.10** (1.05, 1.15)	**1.13** (1.07, 1.18)
Eat at fast food restaurant	49.6%	40.8%	<0.001	**0.84** (0.76, 0.91)	**0.84** (0.77, 0.92)
Dietary intakes				β (95% CI)	β (95% CI)
Mean servings of fruits & vegetables per day	5.20	5.23	0.596	0.01 (−0.16, 0.18)	−0.08 (−0.27, 0.19)
Mean servings of grain products per day	4.68	4.99	<0.001	**0.29** (0.19, 0.39)	**0.26** (0.17, 0.34)
Mean servings of milk products per day	3.23	3.54	<0.001	**0.31** (0.25, 0.37)	**0.24** (0.18, 0.31)
Mean servings of meat & alternatives per day	1.52	1.59	<0.001	**0.06** (0.03, 0.09)	**0.06** (0.03, 0.09)
Mean soda intake (cans or glasses/day)	0.44	0.27	<0.001	**−0.16** (−0.19, −0.13)	**−0.09** (−0.11, −0.06)
Mean sugar-sweetened beverages (non-diet soda, fruit juices, and sweetened tea cans or glasses/day)	0.99	0.62	<0.001	**−0.34** (−0.41, −0.26)	**−0.20** (−0.27, −0.12)
Mean dietary energy intake (kcal) per day	2151	1887	<0.001	**−267.15** (−323.62, −210.69)	**−248.52** (−301.21, −195.83)
Mean DQI score	62.0	63.0	<0.001	**0.71** (0.39, 1.04)	**1.80** (1.33, 2.27)
Weight status				PR (95% CI)	PR (95% CI)
Overweight (excl obese)[e]	23.1	22.6	0.625	1.01 (0.92, 1.09)	1.03 (0.94, 1.12)
Obese[f]	9.8	10.9	0.020	1.15 (0.95, 1.39)	**1.26** (1.08, 1.48)

[a] Multilevel models with clustering of students within schools within school boards.
[b] *P*-values derived using the Rao–Scott Chi-square or t-test where appropriate.
[c] Change in public schools over time between 2003 and 2011/significant results highlighted in bold font.
[d] Models adjusting for the potential confounding effects of gender, household income, parental education, and place of residency. Students from public schools that did not participate in both years of the study were excluded from the regression analysis. Dietary outcomes were further adjusted for energy intake. Prevalence ratio (PR) from Poisson random effect models with robust variance assessing the effect of FNP on binary outcomes (i.e. dietary behaviors and weight status) and β coefficients are derived from linear random effect models assessing the effect of FNP on continuous outcomes (i.e. dietary intake and DQI score).
[e] Overweight (excluding obese) compared to normal weight. Students without height and weight measurements for BMI calculations were excluded from the analysis.
[f] Obese compared to normal weight. Students without height and weight measurements for BMI calculations were excluded from the analysis.

lunch from home) had poorer diets and were more likely to be overweight and obese (Veugelers and Fitzgerald, 2005b). Food served during school lunch should now follow the NSNP but the frequency with which options are available varies according to the capacity and interest of the school to manage a lunch program. Notably, the results of this study found that students were more likely to bring a lunch prepared from home and less likely to buy lunch at school following the implementation of the NSNP. The decrease in school lunch participation is an important area of investigation considering unintended negative consequences following nutrition policy implementation that have been reported in other studies. For example, Cullen et al. (2006) reported that students might compensate for lack of access to 'banned' foods by buying other processed foods. Although unfounded in research (Wharton et al., 2008), schools often report difficult obstacles in creating healthier food options such as the fear that profits will be negatively influenced. Free fruit and vegetable programs (Bere et al., 2007; Coyle et al., 2009) and price reductions in healthy food options (Blum et al., 2008; Gonzalez et al., 2009; Johnson et al., 2009; Jones et al., 2010) are school strategies that have also demonstrated improvements in children's diet quality and provide an opportunity to support families and strengthen school policies related to nutrition.

National surveys have suggested a leveling of childhood overweight and obesity rates. The 2004 Canadian Community Health Survey and the 2009–2011 Canadian Health Measures Survey suggest that rates of overweight (excluding obese) among children decreased from 18.1% in 2004 to 16.2% in 2010 whereas obesity remained the same at 8.2% in 2004 and 8.1% in 2010 (Shields, 2006b; Statistics Canada, 2012). Compared to the leveling of national results, this study reported no change in overweight (23.1% to 22.6%) but a slight increase in obesity (9.8% to 10.9%) along a similar time period. It is important to note that lifestyle and poor health are particular challenges to residents of NS (Government of Nova Scotia, 2012); our results suggest that the current conditions that make it difficult for children to acquire nutritious foods and recommended levels of physical activity might have an influence on prevalence rates over time and these factors extend beyond the school gates. Although several studies have reported an impact of nutrition policy on body weight (Foster et al., 2008; Kubik et al., 2005; Sanchez-Vaznaugh et al., 2010), the current study did not find similar effects.

It is possible that the NSNP led to some potential positive effects on nutrition, including a reduction in percentage of energy from saturated fat and a decrease in SSB consumption. However, there was evidence of a negative trend in micronutrient and dietary fiber consumption. There are several reasons for this. First, students in 2011 were less likely to buy their lunch at school and more likely to bring a lunch from home than in 2003, as discussed above. It could also be because of increasing media attention on the healthiness (or not) of school meals internationally over the last decade (Institute of Medicine, 2010) or because the changes brought in by the policy itself may have been perceived more negatively by parents and students. An unintended consequence of this shift to food brought in from home might be to negatively impact overall nutritional quality, since international research comparing school meals and packed lunches in England between 1990 and 2007 showed that mandatory school food standards had widened the nutritional gap between school meals and packed lunches (Evans et al., 2010). The modest changes reported might also be reflective of the complexity of school nutrition policy implementation and the significance of obstructive community-related factors, such as the widespread availability of energy dense, nutrient poor food (Swinburn et al., 2011) and the increasing cost of healthy foods (Nova Scotia Participatory Food Costing Project, 2011; Ricciuto and Tarasuk, 2007). Although we saw a reported reduction in consumption of fast food, this could reflect a number of contributing factors that were beyond the NSNP (e.g., increasing food prices or greater awareness of the negative effects of fast food consumption more broadly). It may also reflect social desirability bias although this is difficult to judge without further exploration. These factors may also explain the lack of change in the rates of overweight and obesity. Although weight status is an outcome, we believe that dietary changes are also the more informative measures for evaluating a policy that targets food and nutrition.

In the current study, nutrition policy implementation occurred across the province in conditions that were not controlled by research. Therefore these results provide significant insight on the potential

real-world effects that result from a population-level policy intervention. Importantly, the NSNP is a comprehensive policy that not only includes regulations and guidelines for school food, but also encourages schools to consider broader factors that contribute to the school food environment. The importance and health benefits of applying a comprehensive approach to school nutrition are well supported in the literature (Van Cauwenberghe et al., 2010; Wang and Stewart, 2012) and have been found to be beneficial to diet quality, active lifestyles, and body weight (Veugelers and Fitzgerald, 2005a). Future research will use a comprehensive model to study the effects of specific school policies and practices on students' health behaviors and body weights. Furthermore, we will explore school-level differences in the school food environment to help us understand how differences in policy implementation (i.e., with respect to reported adherence to policy directives and guidelines as well as the adoption of broader health promotion initiatives) across different schools may have influenced student behaviors. Intervention context has been reported as a key component of evaluations relating to obesity prevention (Waters et al., 2011) and further exploration of this construct through qualitative case studies will provide critical evidence to help interpret the observed outcomes across schools and improve policy and practice in Nova Scotia (Hawe and Potvin, 2009; Wang and Stewart, 2012).

Strengths of our study include the relatively high response rates and reduction of nonresponse bias through the use of weighting. Furthermore, we adjusted for a number of potential confounders, measured participants' height and weight, and applied consistent protocols to survey administration. We also used a validated FFQ which enables consideration of a number of important dietary factors and we have considerable experience with the use of this tool for population level analyses of the type reported here (e.g., Veugelers and Fitzgerald, 2005a, 2005b). Most of the questions included were validated, although self-reported responses, including those in the YAQ, remain subjective and hence may be prone to error. Unfortunately, this remains a limitation of population-based dietary surveys, but has been mitigated by the steps taken above to ensure consistency in data capture. The YAQ may not fully capture newer foods, e.g., energy drinks. FFQs may also overestimate intake (Burrows et al., 2010) although this is less of an issue in our study which uses the same tool over two time points. We also observed that, relative to 2003, parents in 2011 reportedly had higher levels of education and higher incomes. These changes paralleled not only economic growth but also differences in participation rates, and underline the importance that temporal comparisons are adjusted for these socioeconomic differences, as was done in the present study.

In summary, population health approaches that include a focus on healthy school policies are critical in the prevention of childhood obesity. The implementation of the NSNP provides an important opportunity to explore the relative effect of student population trends in nutritional habits and weight status observed before and after policy implementation. Although this study reports improvements in diet quality, energy intake and healthy beverage consumption, no significant effects on overweight or obesity were observed over time. It is clear that more action is needed to curb the increases in the prevalence of childhood obesity. This includes more consistent messaging and support for parents and the community to reinforce healthy school food practices.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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