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EvidenceSynthesis

THE INFLUENCE OF SCHOOL FOOD POLICIES ON FRUIT AND VEGETABLE INTAKE AND BODY WEIGHT

FEBRUARY 2015

OVERVIEW

Overweight and obesity is a growing public health concern among children and youth in Canada (1). The Canadian Health Measures Survey (2009-2011) indicates that 16.5% of children and youth aged 6 to 17 years are overweight (CI 11.9-21.4%) and 9.6% are obese (CI 7.3-12.6%) (2). Childhood obesity is associated with adverse health outcomes, including difficulty breathing, hypertension, and insulin resistance (1). Overweight and obese children, in turn, have an increased risk of becoming overweight or obese as adults, with a higher likelihood of adulthood disability and premature death.

Overweight and obesity are associated with consumption of energy dense and nutrient poor foods and progressively inactive lifestyles (3). At the population level, widespread access to and availability of unhealthy food and beverages in a variety of settings, including schools (4), has contributed to this imbalance and made it challenging for many young people to maintain a healthy body weight (5).

Public policy is an important tool for creating food environments that support healthy behaviours. The development of healthy school food policies, in particular, represents a promising area to focus efforts, considering the large amount of time young people spend at school, as well as the significant amount of food they consume in this setting. In the 2010/2011 school year, approximately five million Canadian children consumed one-third of their daily calories in the school environment (6, 7).

School food policies consist of standards, guidelines, and/or programs that aim to alter food environments in the school setting. The World Health Organization (WHO) recommends several school food policy options for interventions to combat obesity and overweight in its *School Policy Framework: Implementation of the WHO Global Strategy on Diet, Physical Activity and Health* (8). These include diet-focused health education, nutrition standards and subsidies, maintaining convenient and welcoming food service areas, regulating the marketing of unhealthy food products, and communication and outreach with food vendors near schools (8). However, despite such recommendations, many schools have yet to implement healthy school food policies, and many school food policies have not been researched or evaluated.

This evidence synthesis examines the impact of school food policies and interventions on 1) students' fruit and vegetable intake and 2) students' body mass index (BMI) or body weight outcomes.

METHODS

Review of Evidence. This evidence synthesis involved the collection of systematic reviews and meta-analyses from three databases (Ovid Medline, CINAHL, and Ovid ERIC) and a web search (Google Scholar). The inclusion criteria for screening included: 1) French or English systematic reviews or meta-analyses published between 2003 and May 20, 2014 in a peer reviewed publication; 2) target population of kindergarten to high school students; 3) exposure of at least one school food policy or related intervention; 4) outcome measure of dietary intake of fruits and vegetables and/or BMI or weight outcomes. The first and second level screenings consisted of reviewing article titles and abstracts. If abstracts were unavailable or insufficiently detailed, full articles were retrieved. After the first and second screenings, twenty-four review articles were screened by one researcher. The four review articles slated for final inclusion were independently assessed by two researchers to ascertain the relevance of included studies.

SYNTHESIS OF EVIDENCE

Characteristics of Systematic Reviews. Three systematic reviews and one meta-analysis met the inclusion criteria for this evidence synthesis (9-12). Reviews evaluated a number of different school food policies/interventions and outcomes. Policies and interventions included in the reviews targeted a range of populations from preschool to high school students, although the preschool student population was beyond the scope off this synthesis (9-12). Primary students were the most prominent study population across the four reviews (9-12) and interventions on high school students were not evaluated in one review (12).

The review by Chriqui et al. (9) examined twenty-four studies on the influence of United States state and district competitive food and beverage policies. In this review, competitive food and beverage policies focus on restrictions and nutrition standards for food sold outside of the U.S federal school meal program, which is often energy-dense and high in sugar, sodium, and fat (9). Outcomes evaluated in this review include impacts on availability and access in schools, students' purchases, consumption and dietary intake, and students' BMI or weight (9). Jaime and Lock (10) reviewed eighteen studies, which explored the impact of nutrition guidelines, regulations restricting unhealthy foods and beverages, and price interventions for healthy food affordability. The outcomes Jaime and Lock (10) evaluated include

students' intake and/or BMI, composition of school menus, and availability or sales of food and beverages in schools. Williams et al. (12) evaluated the impact of policies relating to diet, physical activity, and diet combined with physical activity across the available measures of body weight status in twenty-one studies. Finally, Van Cauwenberghe et al. (11) explored the impact of school food policies and interventions on students' dietary behaviours and changes in body composition across forty-two studies, including educational, environmental, and multi-component interventions.

All four reviews were assessed for quality purposes using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR) criteria (13). In accordance with the AMSTAR ranking proposed by Mikton et al. (14) and adopted by Melchiors et al. (15), the reviews were assigned a rating of low (0-4), moderate (5-8), or high quality (9-11). The AMSTAR rankings assigned to the reviews were five (9), six (10), and seven (11, 12), indicating moderate quality overall. See Table 1 for further characteristics of reviews.

This evidence synthesis reports only on school food policies and interventions relevant to the outcomes of interest (students' fruit and vegetable intake and students' BMI or weight outcomes). School food policies or interventions singly focused on education were not reported, due to their widespread implementation in the school setting. In two reviews that did not consistently report the fruit and vegetable intake outcome, studies were individually retrieved and examined to assess the impact of those policies or interventions on fruit and vegetable intake among a larger suite of dietary behaviours outcomes (9, 11).

Ultimately, after examining the four reviews, forty-three studies were included as presenting relevant information (9-12). The included studies took place across ten countries, with the highest proportion of articles reporting on interventions in the United States (n=23) and the United Kingdom (n=8).

IMPACT OF SCHOOL FOOD POLICIES AND INTERVENTIONS ON STUDENTS' FRUIT AND VEGETABLE INTAKE AND BMI OR WEIGHT OUTCOMES

Overall. Across the four reviews, the relevant school food policies and/or interventions included fruit and vegetable subscription/distribution programs, nutrition guidelines, competitive food and beverage policies, school meal programs, and student engagement initiatives (9-12). Taken together, the number of studies evaluating the impact of school food policies and interventions on students' fruit and vegetable intake and BMI or weight outcomes is somewhat limited. However, synthesis of the evidence suggests that nutritional guidelines and subscription/distribution programs, particularly when paired with an educational component, may represent promising school food policy options to increase students' intake of fruit and vegetables and improve dietary behaviour overall (10, 11). In terms of

students' BMI or weight outcomes, findings from the reviews provide mixed and limited evidence that school food policies can have a positive impact (9-12). However, Williams et al. (12) states that nutrition guidelines are effective in improving student's weight outcomes when included in multi-component interventions aimed at promoting a healthy diet and increasing physical activity.

Subscription/Distribution Programs. Van Cauwenberghe et al. (11) and Jaime and Lock (10) examined the impact of fruit and vegetable subscription/distribution programs on students' fruit and vegetable intake.

Fruit and Vegetable Intake. In total, the reviews reported on three single interventions that examined the impact of fruit and vegetable subscription/distribution programs alone, and eight multi-component interventions that examined these programs primarily combined with nutrition education (10, 11). The single intervention studies, which reported on programs aimed at providing either a piece of fruit or vegetables each day, resulted in improved intake of fruits and/or vegetables in all cases (10, 11, 16, 17). However, only one of the studies reported a sustained effect over the long term (10, 16). In terms of multi-component interventions, seven out of eight studies reported a positive impact on fruit and vegetable intake (18-20), with four studies reporting long-term effects (10, 11, 21-24).

Overall, the Jaime and Lock review (10) concluded that subscription/distribution programs, which promote fruits and vegetables by providing them for free or at a subsidized rate, were effective in improving students' dietary intake. Van Cauwenberghe et al. (11), in contrast, concluded that subscription/distribution interventions alone have limited effectiveness, due to a lack of sustained effect over the long term. However, the authors of that review did state that such programs comprise a more effective intervention for improving children's fruit and vegetable intake when paired with education (11).

Nutrition Guidelines. Van Cauwenberghe et al. (11), Jaime and Lock (10), and Williams et al. (12) examined the impact of nutrition guidelines alone and nutrition guidelines combined with education or physical activity policies, across twelve studies. Three of the twelve studies focused on students' fruit and vegetable intake, and nine studies focused on BMI or weight outcomes (10-12).

Fruit and Vegetable Intake. Findings from Van Cauwenberghe et al. (11) and Jaime and Lock (10) suggest that nutrition guidelines aimed at promoting healthy food and combined with education may have a positive impact on fruit and vegetable intake (10, 11). For example, two studies in the Jaime and Lock (10) review found that multi-component interventions, involving nutrition guideline and education, increased fruit and vegetable intake, with increases ranging from +0.30 servings/day to +0.37 servings/day in intervention schools. Additionally, one study in the Van Cauwenberghe et al. (11) review

reported greater consumption of healthy snacks and meals, which included fresh fruit, in schools with nutrition guidelines aimed at improving the nutritional quality of food and beverage offerings (11, 25). Ultimately, Jaime and Lock (10) recommend nutrition guidelines and education focused on promoting healthier food as an effective policy option for improving the school food environment and students' dietary intake.

BMI or Weight Outcomes. For BMI or weight outcomes, the nine studies included across the reviews consisted of seven studies combining nutrition guidelines with physical activity policies and two studies of nutrition guideline interventions alone (10, 12). According to Williams et al. (12), three of the seven studies, which involved nutrition guidelines paired with physical activity, reported positive impacts on students' BMI or weight outcomes. These interventions included Healthy Living Cambridge Kids (26), the Gold Medal School program (27), and the Annapolis Valley Health Promoting School Program (28), all of which aimed to improve school nutrition in combination with improving opportunities for physical activity (12). Notably, the Annapolis Valley intervention in Nova Scotia, Canada was associated with significantly reduced odds of overweight and obesity (12, 28).

Two of the nine studies, which focused on nutrition guidelines alone, provided inconclusive evidence of positive impacts, with the pooled result of a small but non-significant reduction in students' BMI or weight outcomes (12). The first study involved an intervention placing limits on the amount of fat, sodium, and sugar in school foods and beverages in Philadelphia schools (12, 29). The second study conducted a meta-analysis across 287 schools in the United States of whether the greater availability of fruits and vegetables versus low-nutrient energy dense foods impacted students' BMI (12, 30). Overall, Williams et al. (12) conclude that nutrition guidelines had the most positive impact on students' BMI or weight outcomes when part of multi-component interventions involving physical activity policies aimed at improving the quality and variety of physical activity in schools (26-28).

Competitive Food and Beverage Policies. Chriqui et al. (9) examined the impact of competitive food and beverage policies in eleven studies, with seven studies focusing on overall dietary intake and four studies on BMI or weight outcomes. As described previously, competitive food and beverage policies focus on restrictions and nutrition standards for food sold outside of the U.S federal school meal program, which is often energy-dense and high in sugar, sodium, and fat (9).

Fruit and Vegetable Intake. The Chriqui et al. (9) review reported that competitive food and beverage policies had a positive impact on students' overall dietary intake in three out of seven studies. However, four of the seven studies reviewed a single policy (the Texas Public School Nutrition Policy) and closer review of the individual studies indicated that impact on fruit and vegetable intake was somewhat mixed (9). For example, two out of the four studies on implementing the Texas Public School Nutrition Policy

(which reduced sugar, limited fat, and restricted the size of sugar sweetened beverages in schools) reported that students increased fruit and vegetable intake from lunch menus (9, 31, 32). However, the other two Texas Public School Nutrition Policy studies found no significant differences in students' dietary intake of fruits and vegetables across school food categories before and after implementation of the policy (9, 33, 34).

BMI or Weight Outcomes. The Chriqui et al. (9) review included four studies examining the impact of competitive food and beverage policies on students' BMI or weight outcomes, reporting positive findings in two studies and insignificant or mixed positive and negative results in two studies. Notably, one of the studies with positive results reported not on an individual intervention, but on a longitudinal evaluation of competitive food and beverage laws at the middle school level across 40 states (9, 35). Further, one of the studies with mixed results, which evaluated state laws and district policies in California and Los Angeles, respectively, was somewhat promising in that it reported reduced odds of overweight and obesity, but only in some subgroups (9, 36). Additionally, the second study with mixed results found that across the United States, passage of competitive food and beverage regulations was significantly associated with levels of overweight and obesity (9, 37). However, the study authors concluded that this result may have been due to the high prevalence of child overweight and obesity prior to the laws coming into effect (37). Chriqui et al. (9) argued that mixed results for the impact of competitive food and beverage regulation on students' BMI or weight status may be due to a lack of rigor in study designs, which collected cross-sectional or post-intervention data, and employed very short times to follow-up.

School Meal Programs. Williams et al. (12) and Van Cauwenberghe et al. (11) reviewed nine studies on school programs providing breakfast or lunch meals. In terms of outcomes, one study examined fruit and vegetable intake and eight studies examined BMI or weight outcomes.

Fruit and Vegetable Intake. Van Cauwenberghe et al. (11) reviewed one study, which examined the impact of a school breakfast program combined with nutrition education on improving adolescent students' dietary behaviour and school performance (38). The study found that among students who were given breakfast with a serving of fruit over four months, dietary intake improved (38). However, evidence of effect could not be established due to the study's limited statistical power (11, 38).

BMI or Weight Outcomes. Taken together, the Williams et al. (12) and Van Cauwenberghe et al. (11) reviews included eight studies that evaluated the impact of school meal programs at breakfast or lunch on students' BMI or weight outcomes. Two of the studies provided evidence for both lunch and breakfast programs, so that this evidence synthesis reports on ten results of the studies in total (11, 12). School lunch studies presented a small, non-significant increase in students' BMI or weight outcomes in

meta-analysis across four studies (12, 39-42). In contrast, studies on school breakfast programs presented overall improvements in students' BMI and weight outcomes in meta-analysis across five studies (12, 39, 42-45). Ultimately, Williams et al. (12) advised caution in interpreting school meal program findings, due to the heterogeneous nature of studies evaluating these policies or interventions. Further, Van Cauwenberghe et al. (11), who reviewed a single study, reported non-significant associations between school breakfast programs, which included an educational component, and BMI or weight outcomes (38).

Student Engagement Initiatives. Van Cauwenberghe et al. (11) reviewed two multi-component studies that reported on student engagement initiatives to improve students' intake of healthy foods, including fruits and vegetables.

Fruit and Vegetable Intake. According to Van Cauwenberghe et al (11), one study involving the distribution of healthy food including fruits and vegetables to students by their peers was found to be inconclusive, presenting no association with students' healthy food intake (11, 46). In the other study, school food groups were formed by staff, caterers, and health professionals in the school to engage students and link nutrition education to improved nutritional quality of available food and beverages (11, 47). This study provided mixed results, with significant increases in healthy food intake in some, but not all, of the intervention schools (11, 47). Overall, Van Cauwenberghe et al. (11) did not find evidence for the sustained impacts of student engagement initiatives on healthy food intake in either study.

LIMITATIONS OF REVIEWS

A number of factors have limited the strength of conclusions that can be drawn from the evidence included in this synthesis. First, many school food policies or interventions have not been thoroughly examined in the research literature. While there were forty three studies included across the four reviews, only a nominal portion of this evidence applied to each individual school food policy (9-12). Moreover, there was not an extensive set of findings available to evaluate the overall effectiveness of school food policies on the specific outcomes of interest examined in this synthesis (9-12). Indeed, while evaluating dietary intake of fruits and vegetables helps quantify nutritional quality in a school food environment, it is a relatively narrow outcome measure. For two of the reviews, it was necessary to examine individual studies in the reviews that reported impacts on students' dietary intake to extract evidence relevant to fruit and vegetable intake (9, 11). As well, BMI or weight outcomes were available in only a small subset of the included studies, apart from the meta-analysis by William et al. (12).

Another limitation pertains to the geographic scope of the evidence, which was derived mainly from developed countries. In contrast, limited evidence was available for low-resource settings, such as the remote regions of northern Canada (9-12). Moreover, although socio-economic status and levels of

community affluence are determinants of healthy diets, less school food policy research was conducted with these populations and in these settings [10, 11]. Considering this issue, it is difficult to assess what adaptations or modification might be needed for school food policies to succeed in improving students' dietary intake of fruits and vegetables and BMI or weight outcomes across these specific contexts.

In addition, a potential limitation of evidence synthesis in this area relates to the study designs. Many of the outcomes were measured through self-report, curbing the objectivity of the reported associations (10, 11). Further, studies in the reviews rarely involved randomized experiments, limiting both the level of evidence and the conclusions to be drawn (9-12). The review authors were careful to qualify this limitation by stating that natural experiments, which provide evidence from real-world settings, are inevitable, and even preferable, in policy research (12). However, all of the authors presented differences in the length of time to follow-up across study designs as a limitation of pooling studies in their reviews (9-12). Williams et al. (12) attempted to address this limitation by incorporating a minimum time to follow-up of six months into their inclusion criteria, in accordance with the United Kingdom's National Institution for Health and Care Excellence obesity guidance. However, throughout the four reviews, the wide range in timelines for school food policy interventions and evaluations might limit the validity of certain cross-study comparisons (9-12).

Finally, two reviews noted the importance of conducting economic analysis of cost-effectiveness to evaluate school food policies (10, 11). These authors argued that although it was little examined across studies, cost-effectiveness is equally important as impacts on students' dietary intake or weight status outcome measures for evaluating school food policies (10, 11).

FUTURE RESEARCH

Further research is needed to establish firm recommendations for implementing the full slate of possible school food policies, such as those recommended in WHO's *School Policy Framework* (8). In the meantime, as Jaime and Lock (10) have argued, more high quality research using comparable study designs will facilitate better understanding of impacts across individual school food policy categories. Moreover, both Jaime and Lock (10) and Van Cauwenberghe et al. (11) have contended that evaluations of school food policies working with socio-economically disadvantaged populations and in low resource settings warrant greater attention.

In terms of study designs, three review authors spoke to the need to establish research infrastructure that supports longitudinal research (9, 10, 12). Further, Williams et al. (12) suggested that for evidence to inform policies, standard timeframes (conducted over a period of years rather than months) would better facilitate cross-study comparisons. Chriqui et al. (9) recommended assigning geographical

identifiers to national data sets to facilitate this longitudinal evaluation of school food policy outcomes. In terms of study designs, Van Cauwenberghe et al. (11) asserted that objective as opposed to self-reported measures should be used in a greater proportion of studies, providing more reliable evidence of impacts on students' dietary behaviours and weight status. Finally, policy analyses should evaluate interventions across cost-effectiveness and other relevant domains, providing evidence to facilitate public policy uptake and implementation beyond the research context (10, 11, 48).

CONCLUSIONS

This evidence synthesis illustrates that although further research is required to evaluate the impact of school food policies, certain policies and/or interventions have demonstrated promising impacts on students' dietary intake of fruits and vegetables and BMI or weight outcomes. Please see Table 2 for an overview of findings and conclusions from the reviews. Based on available evidence, three of the four reviews have advanced a hypothesis that multi-component interventions with broader health promotion mandates are the most effective school food policies across both dietary behaviours (including intake of fruits and vegetables) and BMI or weight outcomes (10-12).

Table 1. Characteristics of Reviews Evaluating the Impact of School Food Policies on Dietary Intake of Fruits and Vegetables and Body Weight Status

Author	Years	Study design	Total Studies/ Articles (n^1/n^2)	Types of studies included	Overlapping Studies (n)	School Food Policy Interventions on Relevant Outcomes (Studies)	Location of Studies	Relevant Outcomes (n^1)	AMSTAR ranking
Chriqui et al. (2014)	2006 to 2012	Descriptive systematic review	24 / 24	Cross-sectional Longitudinal	1	Competitive Food and Beverage Policies (n=11)	United States (n=24)	Dietary intake of fruits and vegetables & BMI or weight outcomes	5/11
Jaime & Lock (2009)	1991 to 2007	Descriptive systematic review	18 / 27	Cluster randomised controlled trial Cross-sectional Non-randomised controlled trial Non-randomised non-controlled trial Randomised controlled trial Randomised controlled crossover trial	4	Subscription/Distribution Programs (n=2) Subscription/Distribution Programs Combined with Education (n=2) Nutrition Guidelines Combined with Education (n=2) Nutrition Guidelines Combined with Physical Activity Policies (n=1)	United States (n=11) United Kingdom (n=3) Belgium (n=1) Denmark (n=1) Norway (n=1) Norway, Netherlands, & Spain (n=1)	Dietary intake of fruits and vegetables & BMI or weight outcomes	6/11
Van Cauwenberghe et al. (2010)	1991 to 2007	Descriptive systematic review	42 / 53	Before-and-after Cluster randomised controlled trial Non-randomised controlled trial	3	Subscription/Distribution Programs (n=2) Subscription/Distribution Programs Combined with Education (n=7) Student Engagement Initiatives (n=2)	United Kingdom (n=20) Norway (n=6) Italy (n=5) Netherlands	Dietary intake of fruits and vegetables & BMI or weight outcomes	7/11

Author	Years	Study design	Total Studies/ Articles (n^1/n^2)	Types of studies included	Overlapping Studies (n)	School Food Policy Interventions on Relevant Outcomes (Studies)	Location of Studies	Relevant Outcomes (n^1)	AMSTAR ranking
				Prospective cohort Randomised controlled trial		Nutrition Guidelines Combined with Education (n=1) School Breakfast Programs Combined with Education (n=1)	(n=4) Denmark (n=2) France (n=2) Belgium (n=1) Norway, Netherlands, & Spain (n=1) Sweden (n=1)		
Williams et al. (2013)	2003 to 2012	Systematic review and meta-analysis	21 / 23	Cohort Controlled before-and-after Cross-sectional Randomised controlled trial	0	Nutrition Guidelines (n=2) Nutrition Guidelines Combined with Physical Activity Policies (n=5) School Breakfast and Lunch Meal Programs (n=7)	United States (n=16) Australia (n=1) Canada (n=1) Italy (n=1) Mexico (n=1) United Kingdom (n=1)	BMI or weight outcomes	7/11

Table 2. Overview of Findings Evaluating the Impact of School Food Policies on Dietary Intake of Fruits and Vegetables and Body Weight Status

School Food Policy	Relevant Reviews	Summary of Evidence	Conclusions
Subscription/Distribution Programs	Jaime and Lock (2009) Van Cauwenberghe et al. (2010)	Three studies on subscription/distribution programs alone reported positive evidence of impacts on fruit and vegetable intake (16, 17, 49). Seven out of eight studies on multi-component interventions (subscription/ distribution programs combined with education) reported positive evidence of impacts on fruit and vegetable intake (18-24, 49).	This synthesis found limited evidence that subscription/distribution programs alone improved students' dietary intake of fruits and vegetables. This synthesis found good evidence that subscription/ distribution programs combined with educational interventions improved students' dietary intake of fruits and vegetables.
Nutrition Guidelines	Jaime & Lock (2009) Van Cauwenberghe et al. (2010) Williams et al. (2013)	Three out of three studies on nutrition guidelines combined with education reported positive evidence of impacts on fruit and vegetable intake (25, 50-52). Three out of seven studies on nutrition guidelines combined with a physical activity component reported positive evidence of impacts on BMI or weight outcomes (26-28).	This synthesis found limited evidence that nutrition guidelines combined with education improved students' dietary intake of fruit and vegetables. This synthesis found limited evidence that nutrition guidelines combined with physical activity policies improved students' BMI or weight outcomes.
Competitive Food and Beverage Policies	Chriqui et al. (2014)	Three out of seven studies on competitive food and beverage polices reported positive impacts outcomes relevant to fruit and vegetable intake (31, 32, 53). Two out of four studies on competitive food and beverage policies reported positive evidence of impacts on BMI or weight outcomes (54, 55).	This synthesis found limited evidence that competitive food and beverage policies improved students' dietary intake of fruits and vegetables or BMI or weight outcomes.

School Food Policy	Relevant Reviews	Summary of Evidence	Conclusions
School Meal Programs	Williams et al. (2013) Van Cauwenberghe et al. (2010)	A single study on a school breakfast program combined with education reported inconclusive evidence on outcomes relevant to fruit and vegetable intake (38). Meta-analysis of eight studies on school breakfast and lunch meal programs reported inconclusive evidence of impacts on BMI or weight outcomes (39-45).	This synthesis found inconclusive evidence that school meal programs improved students' dietary intake of fruit and vegetables or BMI or weight outcomes.
Student Engagement Initiatives	Van Cauwenberghe et al. (2010)	Two out of two studies on student engagement initiatives reported inconclusive evidence of impacts on fruit and vegetable intake (46, 47)	This synthesis found inconclusive evidence that student engagement initiatives improved students' dietary intake of fruits and vegetables.

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