A Review of the Effectiveness of School Meal and Snack Programs on Household Food Insecurity, Learning, and Health

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Alberta Health Services

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Executive Summary

Purpose

- This report summarizes the findings of systematic reviews and primary research published from 2010-2015 around the impact of school meal and snack programs (SMSP) on household food insecurity, learning and health outcomes.
- Studies from high income countries that provided food to children in a school setting, during school hours, using both universal and targeted population approaches are included in this report. The literature was reviewed using a comprehensive search strategy and synthesis approach.
- This review considers the evidence and provides recommendations within a Canadian public health context.

Interventions Reviewed

- **76** articles from data base searches, citation lists and expert/colleague sources considered for full text review.
- **41** articles appraised and results synthesized:
- **8 review** articles
- **25 primary** research articles
- **8** cross-sectional articles

Key Findings

Impact on Household Food Insecurity (HFI)

- Most evidence is from the USDA school breakfast and school lunch program (SBP, SLP), plus one study from New Zealand. There were no articles meeting the inclusion criteria that reported on a Canadian SBP or SLP.
- Free and reduced-price meals may free up some household resources in some cases.
- A SMSP may have an impact on the worry and anxiety domain of food insecurity (marginal food insecurity) for households with children participating in the program; but not moderate or severe HFI.
- It is inaccurate to state that a SMSP alleviates household food insecurity.

Impact on Learning (attendance, behaviour, memory, grades, achievement tests).

- Evidence from middle and high income countries is primarily from the USDA SBP and SLP plus three studies from Wales, Denmark and New Zealand. None of the articles meeting the inclusion criteria reported on a Canadian SBP or SLP.
- Quality evidence that a SMSP impacts student learning is lacking. Studies demonstrating an impact have numerous methodological issues.
- School breakfast programs offered in low socioeconomic communities may have a small impact on improving attendance, particularly for frequent program users.

Impact on Health (breakfast consumption, diet quality, fruit and vegetable intake)

- Evidence from high income countries is primarily from the USDA SBP and from the Norwegian School Fruit Program fruit and vegetable (FV) snack program. One article reported on a Canadian snack program.
- A free school FV program positively impacts the FV consumption of program participants.
- A SBP or SLP often does not lead to improved diet quality for program participants.

- A SBP or SLP may reduce inequities in diet quality for children from low socioeconomic status households.
- A SBP does not measurably improve the frequency of breakfast consumption of elementary school children.

Relevance of Findings to Nutrition Services and Implications to Practice
There is some evidence that a free, school-based, universally offered FV snack program has a positive association with a health outcome, namely, increased FV intake. FV provision programs that are free and universally offered to all schools or are offered to all students in schools in disadvantaged communities may have the potential to contribute to positive health outcomes over the long term.

While adequate nutrition, a supportive learning environment, and regular school attendance influence readiness to learn, the evidence does not show that SMSP participation independently influences academic performance, school attendance, or behaviour.

School meal programs are not an effective response to alleviating HFI. At best free meals may reduce some of the anxiety and worry in food insecure households and free up some household resources for other basic needs priorities. HFI (inadequate/ insecure access to food due to financial constraints) is well-recognized in Canada as an issue of material deprivation and inadequate household income. Upstream policy approaches are the actions needed to ensure households have sufficient income to meet basic needs including a basic healthy diet.

Summary and Recommendations
Encourage community stakeholders to:
- Continue to support current Canadian health and social policies and approaches to address key outcomes of interest.
- Support free, universal fruit and vegetable provision programs.

In discussion with community stakeholders consider the following evidence:
- If addressing household food insecurity outcomes, do not consider a school breakfast, lunch or snack program an effective approach.
- If striving to influence academic performance, school attendance, or behavior outcomes, do not consider a school breakfast, lunch or snack program as independently effective.

If engaged in implementation and evaluation opportunities, reinforce that desired outcomes are more likely to be realized when programs:
- Ensure high quality food is offered.
- Have a robust evaluation plan that includes appropriate indicators and evaluation tools for the stated program outcomes.

Abbreviations

AHS	Alberta Health Services
BPI	Behaviour Problems Index
CBA	Controlled before-after study
CCHIP	Community Childhood Hunger Identification Project
CPS-FSS	Current Population Survey - Food Security Supplement (U.S.)
CS	Cross sectional study
CSH	Comprehensive School Health
DR	Descriptive review with systematic search strategy
EPHPP	Effective Public Health Practice Project
FFQ	Food Frequency Questionnaire
FFVP	Fresh Fruit and Vegetable Program (USDA)
FFVS	Free Fruit and Vegetable Snack
FV	Fruit and Vegetable
FVMM	Fruits and Vegetables Make the Marks (Norway)
HFI	Household Food Insecurity
HFIS	Household Food Insecurity Survey (USDA)
HFSSM	Household Food Security Survey Module
ITS	Interrupted-time-series study
LRS	Learning Rating Scale
MA	Meta-analysis
NFFP	Norway Free Fruit Program
NFVPP	Northern Fruit and Vegetable Pilot Program (Canada)
NHANES	National Health and Nutrition Examination Survey (U.S.)
NRCT	Non-randomized controlled trial
NSFP	Norwegian School Fruit Program
NSFS	National School Fruit Scheme (UK)
NSLP	National School Lunch Program (USDA)
PSBI	Primary School Breakfast Initiative (UK)
PSFBI	Primary School Free Breakfast Initiative
SBP	School Breakfast Program
SFSP	Summer Food Service Program (USDA)
SLP	School Lunch Program
SMSP	School Meal/Snack Program
SNDA	School Nutrition Dietary Assessment Study (U.S.)
SR	Systematic review
SVFS	School Vegetable and Fruit Scheme (UK)
USDA	United States Department of Agriculture

Introduction

School meal and snack programs include a range of food provision programs which may be offered to all students (universal program) or to students from low-income households or those living within disadvantaged communities (targeted program). In some countries or jurisdictions, school meal programs are well established. For example, the United States Department of Agriculture (USDA) provides subsidized meals in a school setting through the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). These U.S. programs are offered based on need and are considered part of the U.S. social safety net. In Canada, calls for federal, provincial or municipal action frequently cite SMSP as having a positive outcome on children's learning/school performance, health, or food insecurity status; however, careful thought around the impact of SMSP on these outcomes is warranted to ensure that the potential benefits and possible unintended consequences are addressed within the Canadian context, and that appropriate policy responses to these complex issues are considered.

This report, prepared by Nutrition Services, Population and Public Health, AHS, summarizes the published literature about the effects of school meal and snack programs (SMSP) on household food insecurity, learning and health outcomes. The evidence review focused on interventions from high income countries that were implemented using both universal and targeted population approaches. Appendix A contains a list of definitions used in this report.

The intent of this report is to:
- Consider the evidence with a Canadian public health context.
- Share key findings based on results.
- Provide recommendations for practice and program evaluation.

Scope

The following topics were considered beyond the scope of this review:
- Studies that focused on SMSP processes, implementation strategies, policies, legislation, impact on quality, quality improvement actions, participation rates and school operations. While these studies may provide valuable information on the parameters and indicators for successful implementation of a SMSP, they do not measure the impact of SMSP provision on the outcomes of interest.
- Studies or reports about SMSP as a distribution mechanism for agricultural products and local economic development. Whether or not a SMSP program should be a means to support local food, family farmers and the agricultural sector is an important issue that requires a distinct, dedicated analysis.

- Studies reporting on weight status and change in weight as an outcome measure of a SMSP (studies reporting on outcomes of interest in addition to weight were included; however, weight was not discussed in this review). Healthy weight and weight change are important health markers; however, due to the complexity and inter-relatedness of factors that influence growth in children and adolescents, including genetic, environmental, economic, psychosocial, food consumption, and puberty, underweight and overweight/obesity as a distinct health outcome of a SMSP was not explored. Further review of this topic may be warranted.
- Studies that evaluated the impact of multi-component, whole school approaches due to the difficulty in isolating the impact of a SMSP on the outcomes of interest. It is recognized that these programs involve policies, activities and services provided in a coordinated manner to create healthy school communities and to promote the interdependent health, social and education outcomes that impact students' current and lifelong health.

Methods

A multi-step, systematic process was used for article search, retrieval, selection, critical appraisal and synthesis (Figure 1).

Search Strategy

PubMed, MEDLINE, EMBASE and CINAHL via the OVID Interface were searched for original articles, reports and reviews published between January 1980 and March 2014. The Cochrane Collaboration, the Effective Public Health Practice Project (EPHPP), Health Evidence (McMaster University), the National Institute for Health and Healthcare Evidence, and the Centre for Reviews and Dissemination at York University databases were also searched for pre-processed evidence from 1980 to August 2015. In addition, citations were identified from the reference lists of systematic reviews (SR), narrative reviews and primary research articles, published and unpublished grey literature evaluation reports, and documents such as the USDA Food and Nutrition Service Evaluation Reports, Alberta Food Matters Universal School Food Strategy for Alberta, Food Secure Canada, and the Centre for Science in the Public Interest.

Eligibility Criteria and Study Selection

Articles were reviewed for inclusion/exclusion at the title, abstract and full text reading stages, using defined criteria (Figure 1). A minimum of two reviewers were responsible for screening and determining articles for inclusion at each step in the inclusion/ exclusion process. Articles were categorized into one or more of the three key outcomes areas: food insecurity, learning, or heath.

Articles were included if they reported on interventions providing food to children in a school setting, during school hours, through a meal, snack, or vegetable/fruit provision program and measured the impact of the program on food insecurity, health or learning outcomes. Research that investigated a relationship between any of the outcomes, such as the association between household food insecurity and academic achievement, but did not study the impact of a school meal or snack provision program on these outcomes were excluded. Commentaries, opinion papers, narrative reviews, unpublished evaluation reports, interventions without a school meal or snack provision program, and studies conducted in low income countries or with less than 20 participants, were also excluded.

A total of 1585 potential articles were retrieved from the database search. Additional articles were identified through hand search strategies. A total of 76 articles from both the database and hand search sources were considered for final review and critical appraisal. Of these, 41 articles (8 review articles, 25 primary research articles and 8 cross-sectional studies) met the inclusion criteria. Appendix C contains a list of study designs relevant to this review.

Data Extraction

Data was extracted from all included studies by one reviewer and checked for accuracy and consistency by a second reviewer. Studies are presented in this review by study design, appraisal rating (Figure 1) and by universal or targeted population approach (Tables 1-3) where applicable. Further details around study design, data collection tools, outcomes of interest, indicators, measurements and measurement tools and results were delineated in an internal synthesis report.

Quality Appraisal

Articles were critically appraised using standard public health practice evidence appraisal tools based on the information provided in the study article. Review articles (e.g. systematic reviews and reviews with a systematic search strategy) were appraised with the *Health Evidence Quality Assessment Tool – Review Articles*.[1] Primary research articles (RCT, NRCT, CBA, ITS) were appraised using the *Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies (EPHPP)*.[2] A minimum of two reviewers independently rated each article. Discrepancies in quality assessment ratings were resolved by consensus or by a third reviewer.

Few high quality review or primary research articles were available, so all critically appraised articles meeting the inclusion criteria were included in this evidence review to ensure a more comprehensive scan of the evidence.

Data Synthesis

The body of literature was reviewed to summarize the impact or effectiveness of school meal and snack programs. The findings were synthesized using these indicators: a) household food insecurity; b) learning outcomes (school attendance, behaviour, memory, grades and academic achievement tests; and c) health (breakfast consumption, dietary quality, fruit, and vegetable intake). Stronger weight was given to outcomes presented in systematic reviews and randomized control trials (RCT). Where there are discrepancies between articles, conclusions were weighted in favour of higher quality SR and RCT study designs.

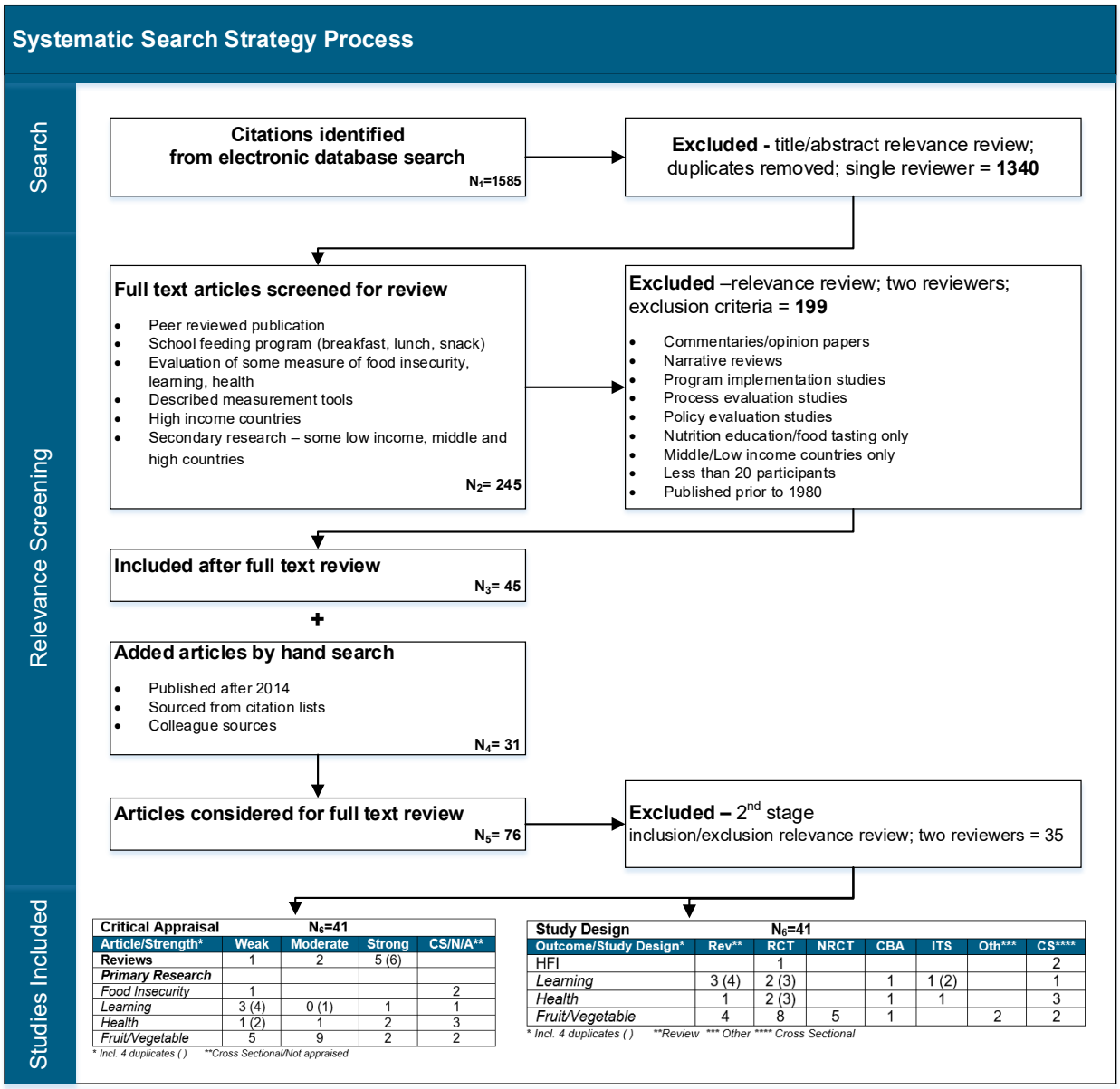
The literature synthesis was reviewed by AHS and external content experts. Reviewer feedback was incorporated into the final report and executive summary.

Limitations

The challenges and limitations experienced while conducting this review included:

- Systematic reviews used various methods to report on the outcomes of interest, such as combining research from high, middle and low income countries, programs using universal and targeted approaches, and using different categories to classify single and multi-component programs.
- Different interventions, outcomes, indicators and measurements, and a range of tools were used in studies (many with no reported validity and reliability testing).
- Many studies had small sample sizes, methodological designs that are subject to selection bias, and statistical tests that failed to account for obvious confounding factors.
- Studies rarely described the nutritional quality of food provided nor did they collect and analyze intake information on both school day intake and entire day intake. The exception to this was most studies of fruit and vegetable programs (FV).
- Difficulty in applying the findings from systematic reviews and primary research studies to the Canadian context, given systemic differences in culture, education, health, economics, and social systems and values.
- No studies were found that investigated the impact of a SMSP on the outcomes of interest compared to other policy responses (e.g. smaller class sizes for learning outcomes, increased funding to households experiencing HFI).

Figure 1. Article Retrieval, Selection, and Quality Appraisal Process



Critical Appraisal	N6=41			
Article/Strength*	Weak	Moderate	Strong	CS/N/A**
Reviews	1	2	5 (6)	
Primary Research				
Food Insecurity	1			2
Learning	3 (4)	0 (1)	1	1
Health	1 (2)	1	2	3
Fruit/Vegetable	5	9	2	2

** Incl. 4 duplicates ( ) **Cross Sectional/Not appraised*

Study Design	N6=41						
Outcome/Study Design*	Rev**	RCT	NRCT	CBA	ITS	Oth***	CS****
HFI		1					2
Learning	3 (4)	2 (3)		1	1 (2)		1
Health	1	2 (3)		1	1		3
Fruit/Vegetable	4	8	5	1		2	2

** Incl. 4 duplicates ( ) **Review *** Other **** Cross Sectional*

A. School Meal and Snack Programs: Impact on Household Food Insecurity (HFI)

Synthesis of the Literature for Household Food Insecurity Outcomes

Description of the Intervention Related to HFI Outcomes

- School meal programs have been promoted as a response to addressing household food insecurity.
- Recent USDA reports frame school meal programs as providing a reliable source of food to vulnerable children living in food insecure households.[3]

Evidence Source

- Evidence from high income countries on the impact of a school meal program on household food insecurity outcomes is primarily from the USDA SBP and SLP, and one cross-over, cluster RCT from New Zealand.
- None of the articles meeting the inclusion criteria for this review reported on a Canadian SBP or SLP.

Published Literature

Overall quality of the literature and limitations:

- Three articles: no reviews; one RCT;[4] two cross-sectional studies.[5,6]
- Food insecurity was described in the included literature as both household food insecurity[4–6] and hunger.[4] Child reports of hunger used measurements of increased fullness (satiety), which is not synonymous with measures of household food insecurity, therefore these results were not included as an impact in this report.
- Most articles described objective data methods for measurement of household food insecurity, using either the full Household Food Security Module or an adapted version of this module.

Impact on HFI Outcomes

- Implementation of a School Breakfast Program in resource poor communities in a high income country did not impact household food insecurity.[4]
- Access to a USDA School Breakfast Program[5] was associated with a lower risk of food insecurity at the marginal level (worry/anxiety domain). This study used multivariate analysis from the U.S. Early Childhood Longitudinal Survey of school breakfast program availability for grade 3 students.
- Access to a USDA School Breakfast Program[5] was not correlated with a lower risk of moderate or severe HFI (quality or quantity domain).
- Seasonal difference in HFI status of low income U.S. families was linked to access to school or summer food programs.[6] Increased childcare costs and/or decreased parent income in the summer were noted by the study authors as potential reasons for this seasonal difference; these potential confounding factors were not controlled for in the study analysis.

Table 1. Household Food Insecurity
Overall Summary of Published Literature Included

	Key Findings	Population Approach	Article Reference
Household Food Insecurity 	• No significant impact *(1 RCT)*	Targeted Approach; Universal Implementation	Ni Mhurchu, 2013[4]
	• Access to a USDA School Breakfast Program *(1 Cross Sectional)* • Linked to lower risk of marginal HFI (worry/anxiety domain) • Not correlated with a lower risk of moderate or severe HFI (quality or quantity domain)	Targeted Approach; Universal Implementation	Bartfeld & Ahn, 2011[5]
	• Seasonal difference in HFI status for low income families linked to access to school or summer food programs *(1 Cross Sectional)* • Authors identified ↑ childcare costs or ↓ parent income in the summer as potential reasons for this seasonal difference (confounding factors not controlled)	Targeted Approach; Universal Implementation	Nord & Romig, 2006[6]

HFI: Grey Literature

The United States Department of Agriculture (USDA), Economic Research Service produced a June 2017 report summarizing research on the effects of USDA child nutrition programs on children's household food insecurity. The USDA child nutrition programs delivered in the school setting include the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). Participating schools receive cash subsidies and donated foods. Students may qualify for free or reduced-priced meals based on participation in other assistance programs or on established income eligibility thresholds.[3]

- Overall, the report found that, where accessible, the USDA free and reduced-price meals can free up some household resources.
- Four of the included studies reported that participation in the NSLP was associated with significantly lower rates of food insecurity for households with children. This finding persisted after controlling for selection bias (the likelihood that program participants were from low income households that were more food insecure).
- Effects of SBP availability were found significant for marginal food insecurity only (worry or anxiety domain).

HFI: Key Findings

- **Free and reduced-price meals may free up some household resources.**
- **A SMSP may have an impact on the worry and anxiety domain of food insecurity (marginal food insecurity) for households with children participating in the program**
- **It is inaccurate to state that a SMSP alleviates household food insecurity.**

Impact on Household Resources

Free and reduced-price meals may free up some household resources; however, it is inaccurate to state that a SMSP alleviates household food insecurity.

- An RCT conducted in resource poor communities in a high income country did not demonstrate an impact of a SBP on household food insecurity.[4]
- Cross sectional and modeling analysis research[3] on the UDSA national school breakfast program (NSBP) and national school lunch program (NSLP) demonstrate an impact of these school meal programs, on marginal household food insecurity and the availability of household resources to allocate to other necessities. These programs are part of the U.S. social safety net.

HFI: Discussion

Canadian Context Considerations

Household food insecurity, the inadequate or insecure access to food due to financial constraints,[7] is well-recognized in Canada as an issue of material deprivation and inadequate household income.[8] Predominant Canadian research demonstrates household food insecurity is sensitive to income-based policy interventions[9–11] and questions the current focus on provision of free food or alternative sources of food acquisition.[12] It is possible that the development and implementation of a school food breakfast or lunch program in Canada could further distract from efforts to address the root causes of household food insecurity, that is, adequate income to afford a healthy diet for all members of the household. Strengthening the ability of families to provide for all members of their household is the desired Canadian response to the issue of HFI.

- Household food insecurity is a household experience and household managed process.[13] While a school meal program may free up some household resources, it is unclear how household dynamics and processes in middle and high income countries are impacted by a program that provides support in the form of school food to a child family member, rather than resource transfer to the entire family.
- Current research and dialogue is lacking on how children who are food insecure experience school meal provision programs and how their experiences relate to those of their family. It is important to acknowledge the interrelationships of children, their caregivers and other family members when considering both the potential benefits and unintended consequences of SMSP programs.[14]
- School food programs are most likely to be implemented in elementary schools, reaching a child member of the household. However, children are the most protected family members from food quality and quantity impacts of food insecurity. Older children (adolescents) and adults are the most impacted household members.[15,16]
- Beliefs about needs held by service providers and those of low-income or food-insecure households are not aligned. Providers view that unhealthy food practices and behaviours are a result of a lack of knowledge or skill. Food insecure households do not report this need, but rather, identify a deficit of fiscal resources.[17,18]
- Research in Canada[19] and the United States[20] has demonstrated positive impacts on food insecurity and nutrition outcomes with small monthly cash benefits.

Implementation Considerations

The evidence favours a targeted population approach (i.e. in schools with a high prevalence of low income households) with universal implementation (the program is provided to all students in the school) where a decision has already been made to implement a SBP or SLP with the intent of impacting marginal HFI.

- This translates to implementing the program in schools servicing low socio-economic status communities, with no restrictions and no “means-testing”/“eligibility-testing” of students to access the program.
- If implementing a program with the intent of impacting household food insecurity, involve target families in both development and implementation. Canadian research highlights the importance of obtaining input from families experiencing food insecurity to ensure that school food programs are not implemented in a paternalistic manner.[21]

Evaluation Considerations

Prior to program implementation, determine the indicator that will measure whether the intervention is effective in impacting household food insecurity.

- The most accurate measure of household food insecurity in Canada is the Household Food Security Survey Module (HFSSM). This 18-item questionnaire measures prevalence and severity of household food insecurity through 10 adult-referenced items and 8-child referenced items. The HFSSM measures the range of HFI, including marginal (concerns about running out of food before there is money to buy more), to moderate (household compromises in the quality and/or quantity of food consumed due to lack of money), to severe (a situation in which eating patterns are disrupted, such as missed meals).[7]
- A measurement of “hunger” is not a measure of household food insecurity and is not recommended as an indicator measure. Hunger is an individual-level physiological condition that may or may not be related or result from food insecurity. Hunger refers to a physical sensation and it influences individual decisions about what, how much and when to eat. Terms such as hunger, appetite, satiety and satiation also have distinct meanings.[22]
- Include a mechanism to capture unintended consequences of the program in the evaluation framework. For example, studies in low income countries indicate that in extremely resource poor households, children receiving free food at school are restricted from food at home (unintended consequence).

B. School Meal and Snack Programs: Impact on Learning

Synthesis of the Literature for Learning Outcomes

Description of the Intervention Related to Learning Outcomes

- School meal provision, particularly school breakfast programs, is often cited as having positive effects on a variety of school learning and performance outcomes, including school attendance, behaviour at school, short-term memory, and academic performance.
- Breakfast consumption, relative to fasting, has been shown to have an impact on specific aspects of learning such as short-term cognition and tasks requiring attention.[23]

Evidence Source

- Evidence from middle and high income countries on the impact of a school meal program on learning outcomes is primarily from the USDA SBP and SLP, and three RCTs from Wales, Denmark and New Zealand. Review articles meeting the inclusion criteria seldom differentiated findings based on country income level.
- None of the articles meeting the inclusion criteria for this review reported on a Canadian SBP or SLP.

Published Literature

Overall quality of the literature and limitations

- Eleven articles: one Cochrane review,[24] three reviews using a systematic search strategy,[23,25,26] three 3RCTs,[4,27,28] 1 CBA,[29] 2 ITS[30,31] and one cross-sectional study[32] reported on the impact of SMSP on learning outcomes in middle and high income countries.
- Learning outcomes measured included: school attendance, (attendance,[4,30] absenteeism,[29,31] tardiness,[29,31] student behaviour,[27,28,32] student cognition/memory,[27] and academic performance, including grades[30,31] and achievement tests.[4,27,28,30] Data methods varied between study and type of learning outcome.
- A Cochrane systematic review and meta-analysis[24] reported methodological, experimental design, or data contamination issues present among their included studies that showed non-significant increases for school attendance, behavioural and academic performance. These particular studies were excluded from this review as they either a small sample size (<20 students) or a pre-1980 date of publication (current review exclusion criteria).
- Methodological limitations persist for the ITS and CBA studies included here: small subsets of students,[30,31] probable bias due to self-selection into the program,[29–31] and expressed limitations, by the study author, that the findings could not be attributed to the SBP.[30]

Impact of breakfast on learning outcomes versus impact of a SBP on learning outcomes

- Breakfast consumption and learning outcomes presented in three review articles[23,25,26] confused the impact of breakfast on learning with the impact of a school breakfast program on learning outcomes. Findings from studies that compared consuming breakfast with no breakfast or the effects of different breakfast composition types are not generalizable to effects of a school breakfast program.

Impact of SBP on school attendance

- One RCT study, conducted with children attending schools in disadvantaged communities in New Zealand[4] reported no significant effect of a free SBP on children's school attendance. However, SBP participation was correlated with greater overall school attendance when subgroup analysis was completed on students who attended the breakfast program more frequently.[4] A small intervention impact was reported for school attendance in three cohort studies, one ITS,[30] and two CBA studies,[31,33] in which students self-selected to a SBP.

Impact of SBP or SLP on behaviour

- Two large RCT studies, conducted using a universal population approach with generally well-nourished children in Wales[27] and Denmark,[28] did not find differences in the outcomes of behaviour[27,28] that could be attributed to the SBP[27] or SLP[28] intervention. No evidence of benefit on student behaviour was identified in a large cross-sectional analysis of the USDA NSLP.[32] Improvements in student behaviour were reported in one CBA study of a USDA free SBP.[31]

Impact of SBP on memory

- The Wales RCT did not find an impact on the outcome of memory that could be attributed to the SBP intervention.[27]

Impact of SBP or SLP on grades and academic achievement tests

- No differences in academic achievement test performance were found in the RCT design studies conducted as either a universal approach SLP program with well-nourished children in Denmark[28] or a targeted approach SBP program in New Zealand.[4] A small, non-significant intervention impact was reported for academic achievement in three studies: as grades in one ITS study[31] and as grades[30] and grades/academic achievement tests[29] in two CBA studies in which students self-selected to an SBP.

Table 2. Learning
Overall Summary of Published Literature Included

Learning Outcome	Key Findings	Population Approach	Article Reference(s)
School Attendance	• No significant improvements, with the exception of increased attendance for a subset of high frequency program participants *(1 RCT)*	Targeted Approach; Universal Implementation	Ni Mhurchu, 2013[4]
	• Improvement in school attendance or tardiness (2CBA, 1 ITS). *(Low quality studies; methodological issues)*	Targeted Approach; Means-tested Implementation	Kleinman, 2002;[30] Meyers, 1989;[29] JM Murphy, 1998[31]
Behaviour	• No significant difference *(2 RCTs)*	Universal Approach; Universal Implementation	S. Murphy, 2011;[27] Sorensen, 2013[28]
	• No significant difference (1 RCT)	Targeted Approach; Universal Implementation	Ni Mhurchu, 2013[4]
	• No significant difference *(1 Cross-sectional) Analysis of NSLP Participation*	Targeted Approach; Means-tested Implementation	Dunifon & Kowaleski-Jones, 2003[32]
Memory	• No significant difference (1 RCT)	Universal Approach; Universal Implementation	S. Murphy, 2011[27]
Grades	• Improvement in grades or specific grade sub-sets e.g. math, language (1CBA, 1 ITS). *(Low quality studies; methodological issues)*	Targeted Approach; Means-tested Implementation	Kleinman, 2002;[30] Murphy, JM 1998[31]
Academic Achievement Tests	• No significant improvements *(1 RCT)* (Small non-significant increase for reading only portion of the test)	Universal Approach; Universal Implementation	Sorensen, 2015[28]
	• No significant improvements *(1 RCTs)*	Targeted Approach; Universal Implementation	Ni Mhurchu, 2013[4]
	• No evidence that USDA NSLP participation impacted achievement test scores *(1 Cross Sectional)*	Targeted Approach; Means –tested Implementation	Dunifon & Kowaleski-Jones, 2003[32]
	• Improvement in total score and language sub-score (1CBA). *(Low quality studies; methodological issues)*	Targeted Approach; Means-tested Implementation	Meyers, 1989[29]

Learning: Grey Literature

Research on the effects of USDA child nutrition programs on children's academic performance was also summarized in the United States Department of Agriculture (USDA), Economic Research Service June 2017 report.[3] The report stated that studies have found child nutrition programs improved academic performance of children in low-income and food insecure households; however, only one study was cited to support this statement in the report.

Learning: Key Findings

- **Quality evidence that a SMSP impacts student behaviour, memory, grades, academic achievement tests and school attendance is lacking. Studies demonstrating an impact have numerous methodological issues.**
- **In low socioeconomic status communities, a SBP may play a role in improving school attendance.**

Impact on Learning Outcomes

Evidence that a SMSP impacts student behaviour, memory, grades, academic achievement tests and school attendance is lacking. Studies demonstrating an impact have numerous methodological issues.

- Quality evidence that a SMSP improves children's memory, concentration, classroom behaviour, school grades or standardized achievement test scores, as either a universal or targeted population approach program in middle and high income countries, is lacking.
- Evidence in middle and high income countries on the impact of a school meal program on any of a variety of learning outcomes is limited. The lack of high quality studies, inconsistent findings between studies and challenges with generalizability of findings was a commonly cited theme in systematic review articles.[23–26]
- RCT[4,27,28] and cross-sectional studies[32] conducted in middle and high income countries reported no significant improvements in learning outcomes attributable to a SMSP intervention. Studies that reported an improvement in grades[30,31] and academic achievement tests[29] have numerous methodological issues.

Impact on Student School Attendance

School breakfast programs offered in low socioeconomic status communities may play a role in improving school attendance, particularly for frequent program users.

- Limited evidence suggests that SBP participation may be correlated with greater overall school attendance for frequent program users. This statement is based on subgroup analysis of a SBP RCT[4] and results of studies in which students self-selected to a SBP.[29–31]

Learning: Discussion

Canadian Context Considerations

It is beyond the scope of this review to assess the most appropriate Canadian policy response to address issues of poor learning outcomes in Canadian schools or to define the specific learning outcomes of priority interest to Canadian educators. In the health field, a Comprehensive School Health (CSH) approach is an Albertan, Canadian and internationally recognized approach for building healthy school communities.[33] This approach builds on the fundamental premise that healthy students are better learners and better educated students are healthier.[33]

Other context considerations:

It is important to acknowledge evidence that adequate nutrition[34] and a non-fasting state impacts academic performance;[24] however, it is inaccurate to use such findings as evidence of impact of a SMSP on learning outcomes.

- Early U.S. arguments for school breakfast programs cite research that linked breakfast to improved dietary status and enhanced school performance,[35] as well as cohort studies included in this review,[29–31] which state that participation in SBPs was associated with increased school attendance, decreased tardiness and improved grades or achievement tests. Recent systematic reviews[22] are careful to distinguish results, separating studies looking at the effects of breakfast consumption on learning outcomes from studies examining the impact of a school food intervention program on these outcomes. Other literature, including Canadian evaluation reports[36] and published articles[37] fail to make these distinctions, and report strong statements of program benefits based on nonexperimental designs.[36]

Regular school attendance is well established as an important contributor to success at school.

- In low income countries, school feeding programs were established to provide targeted families and their children an incentive to attend school. There may be some communities in Canada where this objective of a SBP or SLP likely has applicability.

Many factors influence learning and success at school.

- Given the limited evidence of SMSP on learning impacts, it is important that a school food program does not displace other evidence-based strategies that address regular school attendance, a supportive learning environment for all students and academic achievement, particularly for students in known disadvantaged groups.
- Given the interconnectivity of the many factors that influence learning and health, it remains challenging to isolate the impact of any one component within a CSH approach. Integrated policy, programming and services are recommended to improve student's chances for success.[38]

Implementation Considerations

Where a decision has already been made to implement a SBP or SLP with the intent of impacting student learning outcomes, the evidence favours a targeted population approach (i.e. in schools with a high prevalence of low income households) with universal implementation (the program is provided to all students in the school).

- This translates to implementing the program in schools servicing low socio-economic status communities, with no restrictions and no “means-testing”/“eligibility-testing” of students to access the program.
- Given ongoing fiscal resource constraints, critically assess the best programmatic and policy responses to address an issue of lower academic success at school or poor school attendance.

Evaluation Considerations

Prior to program implementation, determine the indicator(s) that will measure learning outcomes and data collection opportunities.

- Determine the learning outcome indicators and standardized measurement tools to assess learning outcomes potentially impacted by a SMSP. These indicators and measurement tools need to be relevant for the Canadian context. SBP or SLP participation rates compared to learning outcomes are not a good indicator of program impact.
- Include approaches to control for confounding variables. Assess what other factors might influence learning outcomes that may be unrelated to food provision.
- For each agreed upon learning outcome, determine what is an adequate marker of improvement to indicate a successful program. For example, if attendance is considered an indicator, how many days/year of increased school attendance are needed to determine success?

C.School Meal and Snack Programs: Impact on Health

Synthesis of the Literature on Health Outcomes

Description of the Intervention Related to Health Outcomes

- School meal provision, including school breakfast programs, school lunch programs, and vegetable and fruit snack programs, are often cited as having positive effects on a variety of health outcomes, including reduction in breakfast skipping behaviours, improvements in overall diet quality, improvements in diet quality at breakfast, and/or lunch and improvements in vegetable and fruit intake.
- It is important to distinguish between evidence that supports adequate nutrition and breakfast consumption as important to children's health and evidence that a SMSP will impact children's overall diet quality, intake of vegetables and fruit, or breakfast skipping behaviour.

Evidence Source

- Evidence in middle and high income countries on the impact of a school meal or snack program on nutrition outcomes is primarily from the USDA SBP and SLP for overall diet quality and from the Norwegian School Fruit Program for fruit and vegetable snack programs. Vegetable and fruit intake outcome studies include RCT design studies conducted in Norway, as well as RCTs and other study designs from Denmark, Netherlands, UK and the U.S. This primary research data base is supported by four systematic reviews. Evidence on the impact of SMSP on nutrition outcomes other than vegetable and fruit consumption includes studies conducted in Wales, Norway, New Zealand and the US.
- One of the articles meeting the inclusion criteria for this review reported on a Canadian northern fruit and vegetable program.[39]

Published Literature

Overall quality of the literature and limitations

- Ten articles: one review,[24] three RCTs,[4,27,40] one CBS,[41] one ITS,[30] one NRCT,[42] and three cross-sectional studies[43–45] reported on the impact of SMSP on nutrition related health outcomes of diet quality and/or breakfast skipping behaviours in middle and high income countries.
- Four systematic reviews,[46–49] including two reviews with meta-analyses[46,48] focused on school-based interventions designed to encourage FV consumption. Delgado-Noguera et al[46] reported no significant differences for consumption of FV for either multi-component interventions (7 RCTs) or free/subsidized FV interventions (2 RCTs), whereas the Evans et al[48] meta-analysis, and the Van Cauwenberghe et al[49] and de Sa and Lock[47] reviews all reported improvements in FV intake. These review papers used different criteria for original study classification, in particular related to the food provision component, thus, a closer look at the primary research was conducted for this review.

- An additional 18 research articles, including eight cluster RCTs,[39,50–56] five NRCTs,[57–61] two analytical cross-sectional,[62,63] one CBA,[64] and two cross-sectional studies using longitudinal data,[65,66] explored the impact of school FV or school fruit snack on fruit and/or vegetable consumption. These studies investigated the impact of universal approach, school-based FV provision programs on student consumption intakes, both during the intervention and at various time points post intervention. They observed differences between free or paid programs, as well as programs offered as one component of a multi-strategy initiative.
- SBP articles collected and analyzed diet quality information through a variety of methods. Methods used included: 24-hour dietary recalls;[30,42–45] student completed dietary recall questionnaires;[27,40] non-validated food frequency questionnaires;[41] and Healthy Eating Indexes.[41,43]
- Some of the challenges in reviewing the evidence for school FV provision programs included: variations in numerous aspects of study designs, such as, intervention length (five weeks to one school year); measurement tools used for collecting dietary intakes and how dietary intake was collected (e.g. student,[50–54] parent,[58] and student and parent;[52,56,57] differences in how FV intake quantity was reported; and differences in type and frequency of FV snack offerings. Fruit and vegetable intake was most often reported as portions per day, with one portion being equivalent to 80 grams.[50–54,58–60] Other ways of reporting vegetable and fruit intake included: pieces per day;[59,61] number of times per day;[59] grams per day;[61] grams per meal;[59] pieces per week;[62] and portions per week.[56,58–60] Program impact effect was greater for school day intake only versus total day intake.
- Size of impact was also reported using a variety of units (portions/day, servings/day, grams/day, pieces/day, pieces/week) and time frames, including school day only,[64] school day and all day;[50–52,66] all day only;[39,53,55–61,65] and weekly.[54,62] Food intake was reported as fruit intake only,[63] fruit intake and vegetable intake (separately),[57–60] and combined fruit and vegetable intake.[39,50–54,62,65,66]

Impact of SBP on Breakfast Consumption

- No change in breakfast consumption attributable to a SBP was reported in all four studies that used an intervention and control group study design.[4,27,41,42] The three articles that measured breakfast setting all described a shift of breakfast from the home to a school setting.[4,27,42] Ni Mhurchu et al[4] hypothesized that children in the free SBP replaced the practice of eating breakfast at home with eating it at school. Crepinsek et al[42] found that students from universal-free SBP schools were more likely to eat a breakfast both at home and at school, when compared to students from means-tested SBP schools.
- A USA cross-sectional study, looking at the effect of SBP on the likelihood children would eat breakfast everyday[43] did not find a link between the availability of a SBP and improved breakfast consumption frequency, using either simple descriptive analysis or difference-in-difference estimates.

- A decline in breakfast skipping behaviour was observed among students attending more deprived schools and living in lower socioeconomic status households in an inequity modelling analysis completed by Moore et al.[40]
- A cross-sectional study[45] found that most non-SBP participants ate breakfast (81%), with the majority (69%) eating breakfast at home. An ITS study[30] reported that about half (n=44; 45%) of the 97 study participants increased their SBP participation when the program was changed from a means-tested approach to a free program.

Impact of SBP on Dietary Intake

- Three studies reported on the impact of a SBP on both breakfast meal diet quality and quality of the student's total daily intake;[27,41,42] secondary data analysis on the Murphy S et al[40] results was reported for the breakfast meal only.
- Two studies[27,42] examined the impact of a SBP on students' total day dietary intake. Both studies reported dietary quality improvements for breakfast meal intake. However, these improvements were not sustained when the full day's intake (24 hour dietary intakes) was considered.
- Breakfast meal diet quality was more favourable for students from intervention (free SBP) schools. Improved diet quality was reported as: higher intakes of healthy foods;[27] larger increases in consumption of healthy breakfast items for free SBP schools in more deprived areas;[40] increased likelihood of consuming a nutritionally substantive breakfast;[42] and better Healthy Eating Index Scores.
- Potentially negative results were observed for students who ate "two breakfasts" (one at home and one at school) in the USDA Pilot Project. This included: substantially higher energy intakes at breakfast (40% versus 20% of daily energy requirements), which persisted over a 24-hour time period, resulting in an excess of recommended energy allowances (122% for two-breakfast consumers versus 101% for one-breakfast consumers).[42]

Impact of USDA SBP and SLP on Dietary Intake

- The relationship between children's participation in the USDA school meal programs and diet quality was explored using U.S. National Health and Nutrition Examination Survey (NHANES)[43] and School Nutrition Dietary Assessment Study (SNDA-1) data.[44,45]
- Results from studies which measured actual dietary intake and USDA SBP and/or SLP participation[44,45] indicated a positive impact of the USDA program on the adequacy of micronutrient intakes (iron, fibre, potassium, calcium, vitamin A), particularly for disadvantaged students.
- Results from studies which reported on diet quality based on whether or not a student could access a USDA program found an association between the program being available and: a reduced percentage of calories from fat for SBP availability;[43] increased daily caloric and sodium intakes for SLP access;[44] and higher percentage of intake from fat and saturated fat for both SBP and NSLP availability.[45] Actual program participation was not determined in these studies.

- Clark and Fox[44] and Gordon et al[45] reported that improvements in nutrition quality were most pronounced for the high-school aged students participating in school meal programs compared to younger school-aged children. The adolescent cohort was more likely to have inadequate intakes of several vitamins and minerals and excessive intakes of cholesterol and total fat relative to younger children at baseline.[43] However, while participation in school meal programs was associated with an increased likelihood of adequate vitamin and mineral intakes in adolescents, it was also associated with an increase in sodium.[44]

Impact of FV Snack Program on Dietary Intake

- A positive impact on FV intake for school, all day and/or weekly FV consumption was reported during the intervention/treatment arms or groups that included a **free** FV provision component.[51,52,58,60,62] This impact was observed in studies where FV provision was offered: 1) as a free subscription to an existing national school program;[51,52,58] 2) provided free as a provision only intervention; or 3) as part of a multi-component intervention arm.[39,56]
- Impact was greater for school day only analysis versus all day analysis. When both school day and all day FV consumption were factored into the impact determination, a smaller, but still positive impact was reported in most studies.[52]
- In some studies, a significant effect was only reported when specific analyses were completed. For example, Tak et al[61] found a significant effect based on analysis of child reported dietary intakes but not when analysis was based on parents' report of the child's intake. Te Velde et al[56] found that vegetable intake was improved only when ethnic group sub-analysis was completed.
- Minimal or no impact on FV intake were reported when FV provision was offered as a paid or subsidized paid intervention.[51,52,56,57] This included school, all day and/or weekly FV consumption reported for national school FV programs[51,57] and intervention arms that included a paid and subsidized paid FV provision component.[52,56] An increase in disparity in FV intake between program subscribers and non-subscribers was observed when the program offered was a subsidized, paid program.[52]
- Most intervention follow-up studies demonstrated a positive sustained impact of a **free** FV program on daily FV consumption.[50,53,54,56,60] Programs in which students had to pay for the FV snack or were partially subsidized did not report a sustained post-intervention impact.[51] The free subscription Norwegian School Fruit Program[51,53,54] and free Netherlands Schoolgruitn Project[60] continued to report a small net sustained post-intervention impact on daily FV consumption one-year,[51,60] two-years,[56] three-years,[53] and seven-years[54] after a school year intervention period (~ 9 months). Conversely, the free UK National School Fruit Scheme found no sustained effect for students once they were no longer eligible for the program.[62]
- Limited research is published on the impact of a free FV snack program on FV consumption in schools or communities defined as marginalized. The available research indicates that income-related disparities in FV intake frequency may be mitigated through access to school FV and food programs[63–65] but that the impact is not sustained once the

program ends.[63,64] Longitudinal U.S. cohort data,[65] which investigated FV intake by income category, found a gradient relationship in which adolescents in the lowest income category (<$15,000) had higher mean frequency of FV intake if they obtained school food, whereas those in the highest income category (>$150,000) who obtained school food had lower mean FV intake. Both a CBA study conducted in the U.S.[64] and an analytical U.K. cross-sectional study[63] reported an end-of-intervention increased FV intake on snack days when free FV was offered. Neither study observed a sustained intervention impact.[63,64]

Table 3. Health Outcomes
Overall Summary of Literature Included

Health Outcome	Key Findings	Population Approach	Article Reference(s)
Breakfast Consumption	• No significant difference in breakfast skipping behaviour *(1 RCTs, 2 NRCT)*	Universal Approach; Universal Implementation	Murphy S 2011;[27] Ask 2006;[41] Crepinsek 2006[42]
	• Declined for LSES students attending schools in more deprived communities. (*1 RCT*)	Universal Approach; Universal Implementation	Moore 2014[40]
	• No significant difference in breakfast skipping behaviour (*1 RCT*)	Targeted Approach; Universal Implementation	Ni Mhurchu 2013[4]
	• No evidence that availability of a USDA SBP impacted whether or not a child eats breakfast everyday *(1 Cross Sectional)*	Targeted Approach; Means-tested Implementation	Bhattacharya 2006[43]
Diet Quality	• No significant improvement in total daily intake *(2 RCT, 1 NRCT) or improved only for a small subset of students (1 NRCT)*	Universal Approach; Universal Implementation	Moore 2014;[40] Murphy S 2011;[27] Crepinsek 2006;[42] Ask 2006[41]
	• Improvement in diet quality when school day only intake was considered	Universal Approach; Universal Implementation	Moore 2014;[40] Murphy S 2011;[27] Crepinsek 2006[42]
	• Better diet quality for LSES students *(1 RCT)*	Universal Approach; Universal Implementation	Moore 2014[40]
	• Positive impact of **free** FV school snack program on unhealthy snack consumption 7 years post-program. (*1 RCT*)	Universal Approach; Universal Implementation	Øverby 2012[55]
	• Availability of a USDA SBP improved diet quality & nutritional status *(1 Cross Sectional)*	Targeted Approach; Means-tested Implementation	Bhattacharya 2006[43]

Health Outcome	Key Findings	Population Approach	Article Reference(s)
Diet Quality (continued)	• Participation in a USDA SLP or SBP associated with both improvements and declines in intakes of specific nutrients. *(2 Cross Sectional)*	Targeted Approach; Means-tested Implementation	Clark & Fox 2009[44] Gordon 1995[45]
Fruit & Vegetable Intake	• Positive impact of a **free** FV school snack program on both school day and all day FV intake. (*3 RCTs, 3 NRCT, 1 cross-sectional*) • Most studies reported an increase of fruit intake but not vegetable intake. • Range of effect size reported. Highest increases reported ranged from ↑0.2 portions/day to ↑0.6 portions/day; ↑0.5 to 0.6 servings/day, ↑7.5 to 14 pieces/week. • 1 portion defined as 80 grams.	Universal Approach; Universal Implementation	Bere 2005;[52] He 2009;[39] Ransley 2007;[58] Reinaerts 2007;[59] Tak 2007;[61] Te Velde 2008;[56] Fogarty 2007[62]
	• Positive, small impact of **free** FV school snack programs on all day FV intakes when measured 1 year, 3 years and 7 years after the program ended. (*4 RCTs, 1 NRCT*)	Universal Approach; Universal Implementation	Bere 2006a;[50] Bere 2007;[53] Bere 2015;[54] Reinaerts 2008;[60] Te Velde 2008[56]
	• No impact of free FV school snack programs on FV intakes when measured 1 year after program ended. (*1 NRCT*)	Universal Approach; Universal Implementation	Reinaerts 2008[60]
	• Post-program improvements in FV intake with a free FV school snack may be greater for LSES students. (*1 RCT*)	Universal Approach; Universal Implementation	Bere 2015[54]
	• No impact for **paid** or **paid, subsidized** FV school snack program on all day intake at end of intervention or 1 year after program end. (*2 RCTs*) • Increased disparity between program subscribes and non-subscribers (*1 RCT*)	Universal Approach; Universal Implementation	Bere 2006;[51] Bere 2005[52]

Health Outcome	Key Findings	Population Approach	Article Reference(s)
Fruit & Vegetable Intake (continued)	• Increased fruit intake for both subscribers and non-subscribers to a subsidized FV program. (*I NRCT*)	Universal Approach; Universal Implementation	Eriksen 2003[57]
	• Income related disparities in FV intake frequency. Improved during **free** program; not sustained once the program ends. (*1 CBA, 1 Analytic Cross Sectional, 1 Longitudinal Cohort*)	Targeted Approach; Universal Implementation Undisclosed approach & implementation	Jamelske 2012;[64] Wells & Nelson 2005;[63] Longacre 2014[65]

Health: Grey Literature

The United States Department of Agriculture (USDA), Economic Research Service June 2017 report summarized current research on the effects of USDA child nutrition programs on dietary quality.[3]

The report presented data on two studies which examined the role of school meals for children who ate USDA school breakfast and/or school lunch, using NHANES data. The results were consistent with earlier analysis that the NSLP contributed both positively and negatively to diet quality. For example, NSLP participants receiving free or reduced-price lunch were found to consume fewer empty calories and more fibre, milk, fruit, and vegetables compared to income-eligible nonparticipants, both at lunch and during a full 24 hours; participants also consumed less whole grains and more sodium.

The report highlighted that these studies were completed prior to the implementation of robust nutrition standards as outlined in the 2010 Healthy, Hunger-Free Kids Act (HHFKA).

Health: Key Findings

- **A free school fruit and vegetable (FV) program positively impacts the FV consumption behaviour of program participants.**
- **A School Breakfast Program (SBP) or School Lunch Program (SLP) does not always lead to improved diet quality for program participants. A SBP or SLP may reduce inequities in diet quality for children from low socioeconomic status households. Provision of high quality food is essential if these programs are implemented.**
- **A SBP does not measurably improve the frequency of breakfast consumption of elementary school children.**

Free School FV Program: Impact on Vegetable and Fruit Consumption

A free school FV program positively impacts the FV consumption behaviour of program participants.

- Quality evidence exists in high income countries that a free school fruit and vegetable program positively impacts of FV consumption behaviour of program participants while the program is in place. RCT design studies in Norway have demonstrated a possible sustained post-program effect for free school FV snack programs.[50,53,54,56]
- It is important to distinguish findings of impact based on whether the FV provision program is a free, subsidized paid, or paid intervention. Minimal or no impact on FV intake were reported for paid or subsidized paid interventions.[51,52,56,57] Some reviews on this topic do not make this distinction in their analysis.[46–49]
- A free FV provision program may reduce socio-economic differences in FV consumption among children.[53] However, an increase in disparity in FV intake was observed between program subscribers and non-subscribers when the program offered was a subsidized, paid program.[52] Limited research indicates that income-related disparities in FV intake frequency could be mitigated through free access to FV in a school setting.[63–65]
- Evidence for impact is stronger for fruit consumption than vegetable consumption for both RCT design[39,52,56] and non-RCT design studies.[58,59,61,62]

SMSP: Impact on Diet Quality

A School Breakfast Program (SBP) or School Lunch Program (SLP) does not necessarily lead to improved diet quality for program participants. A SBP or SLP may reduce inequities in diet quality for children from low socioeconomic status households. Provision of high quality food is essential if these programs are implemented.

- A SBP or SLP may reduce inequities in diet quality for children from low socioeconomic status households.[43–45] However, these results do not indicate that a school meal program will always provide a nutritional advantage over home prepared school food. In more affluent schools, access to a SBP did not result in higher quality diets.[43] Provision of high quality food is essential for programs to achieve intended diet quality improvement results.
- Relatively few studies have measured and reported on the impact of a SBP and/or a SLP on meal diet quality and quality of student's total daily intake. Studies reporting on improvements in total dietary intake include an RCT conducted in Wales,[27] a CBA conducted in Norway,[41] and four US studies, an ITS and three cross-sectional studies.[43–45]

SBP: Impact on Breakfast Consumption

A SBP does not measurably improve the frequency of breakfast consumption of elementary school children.

- Studies that employed an intervention and control study design did not report a change in student breakfast consumption attributable to a SBP.[4,27,41,42]
- When implemented in lower socioeconomic status communities, a SBP has been linked to a decline in breakfast skipping behaviour that was more pronounced for inequities that may exist for students living in the lowest socioeconomic households.[40]
- It is important to accurately report study findings. For example, a SBP has been demonstrated to change the setting of breakfast consumption from a home to a school setting, thus an increase in breakfast program participation rates cannot be reported as an increased prevalence of breakfast consumption amongst program participants.[4,27,42]

Health Discussion

Canadian Context Considerations

It is beyond the scope of this review to assess the most appropriate Canadian policy and programmatic responses to address issues of poor diet quality among children and adolescents. The predominant discourse supporting implementation of a SMSP is that meals or snacks provided in a school setting have the potential to reach children at a population scale across socio-economic classes and over a considerable period of their lives,[67] thus being an opportunity for the development of healthy and sustainable food behaviours. However the findings from this SMSP review have shown a limited impact of meal programs on children's intake.

From a Canadian perspective, a recent paper that explored Canadian school food programs identified 11 academic articles evaluating programs that provided school food; many implemented with disadvantaged populations or in remote communities. Most program interventions were multicomponent, including school provision plus a variety of policy, education and family and/or community involvement strategies. They reported positive changes in children's food preferences, willingness to try new foods, attitudes and perceptions of healthy eating. While a higher intake of vegetables and fruit was reported for some interventions, similar to the findings of this SMSP review, they did not show the changes being sustained over time.[68]

Consider other options that can be implemented in a school setting to address dietary short-comings in children's food intake:

- Apply an evidence-based framework such as Comprehensive School Health (CSH) to address a priority health issue such as healthy eating. CSH is a well-established multi-component whole school community approach used to build healthy school communities and address health issues[69] Well-being is considered an essential aspect of student

achievement. Multi-component actions are drawn from one or more of the four inter-related components: social and physical environments; teaching and learning; healthy school policy; and partnership and services.[69]

- Examples of effective school-setting approaches for improving primary school children's fruit and vegetable consumption or preferences, in addition to school based fruit and vegetable provision programs, include: computer-based interventions,[46] cross-curricular and quality curriculum interventions,[70] and innovative strategies to engage and motivate children.[71]
- Additional system level actions that have been suggested to address issues of diet quality in the school setting include: additional school time for snack and lunch consumption; a dedicated lunch room space; classroom refrigerators that can safely store milk products and fresh fruits and vegetables.

Implementation Considerations

Evidence favours a free fruit and vegetable snack program as the best universal population approach school program for a potential short term and long term impact on fruit and vegetable intakes in school-aged children.

- Both single component programs (free fruit and vegetable provision only programs) and multiple component programs with free fruit and vegetable provision (free fruit and vegetable provision combined with other components such as nutrition education, curriculum enhancements and parental involvement) are potential implementation options.

High quality food provision in any school based program is imperative to achieve desired outcomes of improvements in diet quality.

- If the choice is to implement a school meal or snack program as a programmatic response to support healthy eating among school aged children, then foods offered in the program need to provide a dietary advantage[72] to foods currently eaten during school hour. Recent Canadian research indicates that a focus on increasing fruit and vegetable intake,[73] increasing milk and milk product intake,[74] and reducing intake of sugar-sweetened beverages[73] are appropriate to address dietary short-comings in Canadian children's food intake during school hours.
- School meal policies that require healthy food provision for all school food access avenues (i.e. meals, snacks, vending machines) support improvements in diet quality for students.[75]
- The quality of vegetable and/or fruit offered also has important implications for improvements to baseline diet quality, program acceptance and program uptake by the student.

Evaluation Considerations

Prior to program implementation, develop an evaluation plan, including identification of indicators and tools to measure the effectiveness of the intervention impact on diet quality.

- School nutrition program guidelines in Canada outline the importance of program evaluation. However, Godin[76] found that evaluation results were often inaccessible or unavailable for school-based breakfast programs in Canada. This is a gap in the ability to assess whether a school breakfast program is actually an effective response to the issue of poor diet quality or of low breakfast consumption prevalence for Canadian children.
- In order to best understand program impacts, the following measures are recommended, to include in a school meal program evaluation:
  - measure both 'during school day' and 'all day' consumption. Both school day and all day dietary consumption measurements are recognized as critical to evaluate impact. However, this is a noted gap, with few Canadian studies assessing the dietary contribution of foods eaten at school (and source of these foods) in relation to foods eaten for the entire day.[74]
  - choose a consistent tool for reporting dietary consumption. Ensure the tool is a validated measure for determining dietary quality of Canadian children and appropriate for the population group completing the tool (e.g. children, parents).
- Determine what level of diet change demonstrates that a school breakfast program, a school lunch program or a school fruit and vegetable provision program is an effective intervention to impact diet quality.

If the program aim is to reduce breakfast skipping in the student population, measure both place of breakfast consumption (i.e. home; school) and breakfast consumption prevalence rates pre-and post-intervention.

- Program participation rates and breakfast availability measures are not accurate indicators of daily breakfast consumption frequency.

Overall Conclusions

This review of the published literature explored the impact of both universal and targeted School Meal Snack Programs (SMSP) on household food insecurity, learning and health in high income countries. It is often hypothesized that giving children breakfast or lunch at school will have favourable impacts on these outcomes; however, this was not supported by the evidence. Alternatively, there is some evidence that a free, school-based, universally offered FV snack program has a positive association with a health outcome, namely, increased FV intake.

The evidence does not support the hypothesis that universal or targeted SMSP independently impacts learning outcomes in a high income country. While there is an association between adequate nutrition, a supportive learning environment, and regular school attendance influencing readiness to learn, the evidence does not demonstrate that

SMSP participation independently influences academic performance, school attendance, or behaviour. The studies that did demonstrate a small impact of a school breakfast program (SBP) on school attendance had numerous methodological design issues.

The impact of SMSP on household food insecurity and diet quality is a complex issue. Some evidence suggests that a SMSP can benefit children who attend school in a socioeconomically disadvantaged community by decreasing the student's worry or anxiety around access to food during the school day, and by potentially improving diet quality. However, to have a positive impact on diet quality, these programs must be governed by a strong nutrition policy that ensures consistent provision of healthy food choices.

There is also the possibility of unintended consequences of a SMSP. For example, a SBP may simply transfer the breakfast setting from home to school or result in the consumption of two breakfasts. In addition, a SMSP may lead to fewer family meals, loss of food skills at home, and decreased parental influence on children's food choices, although these effects are rarely measured or explored in the published literature. Thus, the success of a SMSP cannot be measured simply by program participation.

Several high quality studies have demonstrated that free, single or multi-component school FV snack programs can have a small, positive and potential long-term impact on increased FV intake and decreased unhealthy snack consumption. These programs have also been shown to reduce socio-economic inequities in FV intakes; participating children improve their FV intake and lower socio-economic (SES) participants experience the most significant increases. Furthermore, students do not appear to compensate for increased FV intake at school by reducing their intake at home. Thus, FV provision programs that are free and universally offered to all schools or are offered to all students in schools in disadvantaged communities may have the potential to contribute to positive health outcomes over the long term. Within the Canadian context, a free, universally offered FV program has the most potential to be effectively implemented when factors such as food, delivery, school infrastructure, staff and other implementation costs are considered.

This evidence review revealed a wide variation in the indicators, outcomes and measurements used, as well as how study results were reported and used to inform practice and recommendations. Results and conclusions from studies were often presented as cause- and- effect relationships instead of associations which acknowledge the multiple confounding factors impacting these outcomes. Application of existing SMSP evidence to the Canadian context, including the unique situation of vulnerable populations in Canada, highlights the need for well-defined outcomes and measurement tools when evaluating and researching program responses to complex issues. In addition, when choosing public health responses to address health and food insecurity issues in the school-aged population, consideration of the potential impact of an intervention in the Canadian health and social policy context is needed.

Recommendations for Practice

Encourage community stakeholders to:

- Continue to support current Canadian health and social policies and approaches to address key outcomes of interest.
  - Canadian evidence favours income-based policy approaches to address root causes of household food insecurity.
  - In Alberta and Canada a CSH approach is recognized best practice for building healthy school communities and addressing priority health issues.

- Support free, universal fruit and vegetable provision programs.
  - Evidence favours a free fruit and vegetable snack program as the best universal population approach school program for a potential short term and long term impact on fruit and vegetable intakes in school-aged children.
  - Both single component programs (free fruit and vegetable provision only programs) and multiple component programs with free fruit and vegetable provision (free fruit and vegetable provision combined with other components) options are effective. Examples of other components include nutrition education, curriculum enhancements and parental involvement.
  - Focus on a free fruit and vegetable program provides an opportunity to reach a broad range of students from K-12. It could also create linkages to Alberta agriculture and local producers across the province and have lower implementation costs than a school breakfast or lunch program.

In discussion with community stakeholders consider the following evidence:

- If addressing household food insecurity outcomes, do not consider a school breakfast, lunch or snack program as an effective approach.
  - Household food insecurity (inadequate/insecure access to food due to financial constraints) is an issue well recognized in Canada as one of material deprivation and inadequate household income.
  - A strategy approach that targets only some (child) members versus all members of a household is not recommended. Strategies considered need to measurably reduce financial constraints and positively impact the entire household (family).

- If striving to influence academic performance, school attendance, or behavior outcomes, do not consider a school breakfast, lunch or snack program as independently effective.
  - While adequate nutrition, a supportive learning environment, and regular school attendance may influence readiness to learn, the evidence does not show that SMSP participation independently influences academic performance, school attendance, or behaviour.
  - Given the limited evidence of SMSP on learning impacts, it is important that a school food program does not displace other evidence-based strategies that address regular school attendance, a supportive learning environment for all students and academic achievement, particularly for students in known disadvantaged groups.

If engaged in implementation and evaluation opportunities, reinforce that desired outcomes are more likely to be realized when programs:

- Offer high quality.
  - High quality food provision in any school based food program is imperative to achieve desired outcomes of improvements in quality of students' diets. Strong nutrition policy helps ensure the provision of healthy food choices.
  - The quality of food offered also has important implications for program acceptance and uptake by students.

- Have a robust evaluation plan that includes appropriate indicators and evaluation tools for the stated program outcomes.
  - Choose consistent and validated tools for the Canadian population.
  - Measure both school day and "all day" impacts. For example, measure both school day and all day dietary consumption.
  - Include measures to capture unintended consequences. For example, in a SBP intended to reduce breakfast skipping, measure both place of breakfast consumption (i.e. home; school) and frequency of breakfast consumption pre-and post-intervention.
  - Include measures to capture other factors. For example, consider whether other factors that are not directly related to food consumption, might influence learning outcomes, such as relationship building with school teachers for students participating in a SBP.
  - Determine what level of change demonstrates program effectiveness. For example, if attendance is considered an indicator, how many days/year of increased school attendance are needed to determine success?

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Appendix A: List of Definitions

Term	Definition
High Income	High income country is a country with a high-income economy as defined by the World Bank. Income is measured using gross national income (GNI) per capital, in U.S. dollars, calculated from local currency using the World Bank Atlas method. Other similar but technically different terminology for high income economies include "First World" and "developed country". In this report, the World Bank Economies 2015 document was used to determine studies conducted in high income countries.[77]
Low and Middle Income	Low, low-middle and high-middle income economy groupings are three of the four income groupings as defined by the World Bank. As for the high-income economy grouping, income is measured using gross national income (GNI) per capital in U.S. dollars. The middle income category is divided into lower middle or upper middle. Other terms such as "developing country" and "Third World" are terminology previously used. In this report, the World Bank Economies 2015 document was used to determine studies conducted in developed countries.[77]
Household food insecurity *(also referred to as food insecurity)**	Defined as "the inadequate or insecure access to adequate food due to financial constraints", often referred to as income-related household food insecurity. Household food insecurity exists at a marginal level when a household (including adult(s), with or without children) worries about running out of food and/or experiences income-related barrier(s) to accessing adequate food. Moderate food insecurity occurs when a household must compromise the quality and/or quantity of food consumed due to a lack of money. Severe food insecurity describes a household situation in which eating patterns are disrupted (including missed meals) and food intake is reduced.[7,8]
Household food security *(also referred to as food security)**	A *household* is classified as food secure when financial access to food is adequate. Socioeconomic inequality increases households' vulnerability to food insecurity. "Food security includes, at a minimum, the ready availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in socially respectable ways".[8,78]
Hunger*	"The term hunger is often used colloquially to refer to household food insecurity, but it is not the same. Hunger encompasses the sensations of discomfort, weakness, pain or sickness experienced by an individual that result from an extended period of not having enough to eat. The hunger experienced by an individual is therefore a potential result of food insecurity within a household, and may not be experienced by everyone in that household. The experience of severe food insecurity, missing meals and going without food, has been acknowledged in relation to the great likelihood of physiological involuntary hunger but the measurement of HFI in Canada does not specifically measure hunger."[8] Hunger may be due to voluntary or circumstantial food restrictions or considered a physical cue to recognize whether one is full or not (satiety).
Satiety*	Satiety a feeling or condition of being full after eating food.[79]
School meal and snack program (SMSP)	In this report, SMSP are defined as a free or subsidized breakfast, lunch, snack, or fruit and vegetable provision programs.

Term	Definition
Targeted population approach	Intended to apply to a priority sub-group within the broader, defined population. "Eligibility and access to services are determined by selection criteria, such as income, health status, employment status or neighbourhood".[80] For example, in developed countries, SMSP would operate in schools that are located in geographic areas described as economically marginalized or disadvantaged and/or where the student body is described as predominately low socioeconomic status. Programs may be offered only to those who meet specific criteria (targeted implementation) or to everyone (universal implementation) within a targeted setting.
Universal population approach	Designed to apply to an entire population. "Eligibility and access are based simply on being part of a defined population".[80] For example, a SMSP can be accessed by all children attending school without any household eligibility qualifiers such as income, education, class, race, or parents' employment status.
**For a current discussion of these terms, please see: "Prevalence, Severity and Impact of Household Food Insecurity: A Serious Public Health Issue. Background paper. Dietitians of Canada. August 2016". www.dietitians.ca/foodinsecurity*[8]	

Appendix B: List of Study Designs

Term	Definition
Controlled before-after study (CBA)	A study in which observations are made before and after the implementation of an intervention, both in a group that receives the intervention and in a control group that does not.[81]
Cross sectional study (CS)	A study that collects information on interventions (past or present) and current health outcomes, i.e. restricted to health states, for a group of people at a particular point in time, to examine associations between the outcomes and the exposure to interventions.[81]
Descriptive review with systematic search strategy (DR)	For the purpose of the report, this is defined as a review with the search strategy outlined, although the search may not be as rigorous as that outlined when conducting a systematic review of the literature.
Grey literature	Grey literature consists of documents produced by all levels of government, academics, business and organizations "where publishing is not the primary activity of the producing body".[82] Examples include annual reports, conference proceedings, technical reports, theses, white papers, and even informal communication such as blogs, emails, or social media posts.
Interrupted-time-series study (ITS)	A study that uses observation at multiple time points before and after an intervention (the “interruption”). The design attempts to detect whether the intervention has had an effect significantly greater that any underlying trend over time.[81]
Meta-analysis	A statistical technique to combine the results of multiple studies resulting in a single pooled estimate of effect.[83]
Narrative review	These are evidence overviews or expert commentaries on a given health topic. Unlike systematic reviews, they are not designed to be reproducible as their methodology (e.g. search strategy, inclusion criteria) is usually not described.[83]
Non-randomized controlled trial *or* non-randomized trial (NRCT)	An experimental study in which people are allocated to different interventions using methods that are not random.[81] The most common types of NRCTs in public health are natural experiments where an intervention takes place and an existing group, not receiving the intervention, is used as a control.
Randomized controlled trial *or* randomized trial (RCT)	An experimental study in which people are allocated to different interventions using methods that are random.[81]
Systematic review (SR)	A review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyze data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyze and summarize the results of the included studies.[83]

Appendix C: Systematic Review Tables

Table A. Review Studies: School Meal and Snack Programs and the Impact on Learning and Health Outcomes

Author	Included studies *(years)*	Study design *(definitions in Appendix C)*	Study types	Total studies/ articles *(n1/n2)*	Outcomes reported/number of studies school feeding programs and outcomes	Relevant outcomes *(outcome measured)*	Health evidence rating
Adolphus, 2013 ***Learning***	1950-2013	DR	RCT NRCT Cohort Case-control studies	36/36	**School breakfast program and learning** *academic performance and/or behaviour (15 studies: 7 in developing countries; 8 in developed countries)* **Other outcomes**: *sugar load of breakfast & behaviour; breakfast quality & behaviour or academics; frequency of breakfast & behaviour or academics.*	**Learning** *Academic performance; Behaviour*	Weak
Ells et al, 2008 ***Learning***	Database inception-2005	DR	RCT NRCT	29/29	**Provision of school breakfast clubs and educational outcomes** *(4 studies)* **Other outcomes:** *breakfast consumption vs. fasting; low vs. high-protein breakfast; low vs. high-energy breakfast; habitual breakfast consumption vs. standardized breakfast consumption; sugar intake; fish oil supplementation; vitamin & mineral supplementation.*	**Learning** *Selection of educational outcomes*	Moderate
Hoyland, 2009 ***Learning***	1950-2008	DR	Not specified but not excluded by study quality. Quality assessment done for included studies.	41/45	**School feeding programs and academics or cognitive performance** *(13 studies; 5 in developing countries; 7 in developed countries)* **Other outcomes:** *acute effects of breakfast vs. no breakfast; quality of habitual breakfast intake on cognitive performance.*	**Learning** *Academic performance; Behaviour; Cognitive performance*	Moderate
Kristjansson et al, 2007 ***Learning Health***	Database inception-May 2006	Cochrane review	RCT NRCT CBA ITS	18/18	**School feeding programs and academics or cognitive performance** *(18 studies; 9 in developing countries; 9 in developed countries).Of these, 3 studies in developed countries around milk program only.*	**Learning** *Psychosocial outcomes; School attendance Short and long-term cognition; Behaviour*	Strong

Table B. Review Studies: School Meal and Snack Programs and the Impact on Fruit and Vegetable Intake

Author	Included studies (years) & study design	Total studies/articles *(n1/n2)*	Intervention categories (author terminology)	Total number articles/ category	Total number studies with school FV snack program (free or subsidized)/ intervention category	Comments	Health evidence rating
Delgado-Noguera et al, 2011	1966-Oct. 2009 SR & MA RCT/NRCT	19/19 4 of the 19 studies included a school FV snack component. All studies conducted in a high income country.	Board games or computer-based interventions	3	0	None	Strong
			Multicomponent interventions	11	1	Included study had free or subsidized FV snack, curriculum and family component.[58] Remainder (10 studies) had no FV snack.	
			Free or subsidized program	3	2	One study had free FV snack only;[52] one had free FV snack and education component.[60]	
			Other comparisons	2	1	One study had free FV snack and education and family components.[61]	
de Sa & Lock, 2008	Not specified-search conducted August 2007 DR RCT/NRCT	30/34 5 of the 30 studies included a school FV snack component. All studies conducted in a high income country.	*Note: multiple classifications/study intervention type (Total number of studies by intervention exceeds 30)*			Two studies were free FV snack single component interventions only;[52,64] one study was a free FV snack only intervention follow-up.[55] Two studies had free FV provision plus education components.[60,63] 5 studies did not provide FV provision but were classified as FV provision by review author; (rational provided: accessibility was increased through the intervention).	Strong
			FV provision (free or subsidized)	10	**5**		
			Classroom based	24	0		
			School wide	18	0		
			Teacher involvement	10	0		
			Peer leader involvement	3	0		
			School food service	12	0		
			Parent involvement	14	0		
			School nutrition policy	5	0		
			Community Involvement	5	0		
			Other	1	0		

Author	Included studies (years) & study design	Total studies/articles *(n1/n2)*	Intervention categories (author terminology)	Total number articles/ category	Total number studies with school FV snack program (free or subsidized)/ intervention category	Comments	Health evidence rating
Evans et al, 2012	1985-2009 SR & MA RCT NRCT	27 in SR 21 in MA	Multicomponent programs that motivate and engage children and families to change their eating behaviours	#s not identified	#s not identified	8 studies in the Evans, 2012 data extraction table were identified as having a free or paid (subsidized) school FV snack. Of the 8 studies, 2 were single component school FV snacks;[53,64] one was a free versus paid subsidized FV snack;[54] four studies had either free FV snacks plus education components[60,63] or free FV snacks plus education and family components.[52,62]	Strong
			Single-component programs that provide and distribute free or subsidized FV.	#s not identified	Numbers not identified		
Van Cauwenberghe, 2010	2007 DR No restrictions on study design. Distinction made between stronger and weaker study designs.	42/53	Educational interventions	20	0		Strong
			Environmental interventions	8	5	Two studies had free FV snack only;[64,65] one study was a subsidized FV snack;[59] one study explored a free versus paid, subsidized, FV snack;[54] and one study was a follow-up to a free FV snack intervention.[55]	
			Multicomponent interventions	14	6	One study had a free FV snack only;[52] 3 studies were free FV snack and education components;[60,63] or Free FV snack with education and family components;[61] one study had free *or* subsidized FV snack, curriculum and family component.[58] A final study was a paid, subsidized FV snack with a classroom and family component.[53]	