The Association Between Nutrition and Academic Achievement Among Children and Youth

Policy Brief

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Policy Bench

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Table of Contents

Executive Summary

Issue: What is the impact of the school environment - particularly school-based food programs or other nutrition-related initiatives on students' academic performance? In addition, what are the implications of the association between nutrition and academic achievement for policies to improve child nutrition — especially in the context of the COVID-19 pandemic and its impact on child health, eating habits, and other outcomes?

Background: Malnutrition has different forms, including undernutrition, inadequate vitamins or minerals, and overweight or obesity. Poverty and food insecurity are important causes of malnutrition. In Canada, 1 in 5 children under 18 years of age live in households affected by some level of food insecurity, with an increasing trend in the last decade, and about 30% of children aged 5-17 are considered to be overweight or have obesity. There is a clear link between health and education, including healthy eating. Evidence suggests that better nutrition contributes to healthy growth and development in children, as well as improved academic performance. Therefore, school-based nutrition or healthy eating programs may have a positive impact on student learning, academic achievement, and learning trajectories.

Findings: A review of the available evidence from Canada and other countries showed that household food insecurity is associated with lower academic performance. Studies have shown not only that healthy eating is positively associated with academic achievement among children, but also that unhealthy diets such as consumption of sugar-sweetened beverages and nutrient-poor food (i.e. junk food, fast food) can adversely affect academic performance. Evidence also suggests a negative association between student obesity and academic performance. In Canada, school food programs are limited, and program components and participation rates vary widely. However, evidence from other countries has shown the potential health and economic benefits of school food programs, especially for socio-economically disadvantaged students. Evidence on the impact of school food programs on academic achievement outcomes remains mixed, and may depend on the age and socio-economic status of the students as well as program-related factors (i.e., frequency, nutritional quality, and whether breakfast, snacks, or lunch are offered). While more research is needed to determine which students may benefit the most from school food programs and which components are most successful, researchers have suggested that healthy school food programs are still a cost-effective approach to increase students' test scores compared to other interventions. Early evidence suggests that the COVID-19 pandemic has affected food security disproportionately among households with children and marginalized children. Significant changes in children's lifestyles and routines due to school closures during the pandemic have resulted in alterations to their diet and eating environment, with some studies finding an increase in unhealthy foods, weight gain, and obesity. However, more research is needed to determine the effects of these pandemic-related changes in child health and nutrition on educational outcomes.

Executive Summary

Policy Recommendations: The COVID-19 pandemic provides an opportunity to re-think current child nutrition programs and policies to improve child health and development, and ultimately their educational outcomes. Based on the reviewed evidence, this brief presents recommendations in three areas. First, there is a need for stronger national and subnational policies to eliminate food insecurity among children. Second, the expansion of funded school-based food programs to improve food security and healthy eating behaviours among students should be a priority. Third, more research will help improve our understanding of the association between nutrition and academic achievement. Appropriate monitoring and evaluation systems should also be developed to measure the long-term effects of school food programs on children's nutrition, well-being, learning, and other outcomes.

The Association Between Nutrition and Academic Achievement Among Children and Youth

1.0 Introduction

The importance of healthy nutrition and its impact on children's development and academic achievement are common interests of many health and educational agencies, schools, parents, and communities. Even in high-income countries such as Canada, there remain significant inequalities in access to nutritionally adequate foods which are essential for children's optimal health, development, and learning (UNICEF Canada, 2020). In 2020, Canada ranked 30th among 38 wealthy countries in the overall state of child well-being according to the UNICEF Report Card 16, demonstrating the need for more equitable policies and programs to improve outcomes for Canadian children and youth (UNICEF Canada, 2020). The school environment is an ideal setting to provide better nutrition and promote healthy eating habits among children and youth, especially since they spend up to half of their waking hours in school and consume up to half of their daily food intake (one-third on average) while at school (Alberta Health Services, n.d.; Tugault-Lafleur et al., 2017).

This report reviews evidence from Canada and other high-income countries on the association between nutritional factors and academic performance among primary and secondary school students. Given the potential importance of school food programs or other school-based nutrition initiatives for promoting both student health and academic achievement, any available evidence on the benefits, challenges, and impact of school food programs is reviewed. Finally, evidence on the ways that the COVID-19 pandemic has affected children's access to healthy foods and the implications of the pandemic for children's health and education moving forward is discussed.

2.0 Overview of Methods

A scan of the literature was conducted to determine the breadth of information available and to identify, collect, and synthesize information relevant to the research question. Various search engines, research portals, and institution-specific websites were utilized for the identification and collection of relevant data. Sources were included in the literature scan if they were found to contain variables of interest and keywords relevant to the research objective (e.g., nutrition, food, healthy eating, children, academic achievement, education, school, school food programs, Canada). In addition, search strategies were developed and refined as results were reviewed.

A wealth of studies were found on the association between healthy eating and academic achievement among students. These studies have investigated a wide range of nutrition-related programs and conditions such as dietary behaviors, school meal programs, and malnutrition in all its forms including undernutrition, inadequate vitamins or minerals, overweight and obesity. In order to narrow the scope of this review and gather the most relevant and current information, the literature search largely focused on evidence from systematic reviews and meta-analyses, as well as other studies published within the last ten years, or no earlier than the year 2000. Findings were also primarily limited to those

relevant to younger children (i.e., primary school aged) rather than post-secondary students. Finally, as one of the aims of this review was to focus on Canadian school nutritional programs, any available evidence from Canada was prioritized; however, information from other countries was also included where relevant.

3.0 Food Insecurity

3.1 Overview of food insecurity in Canada

Food insecurity is defined as having inadequate or insecure household access to food due to financial constraints and is one mechanism for the adverse effects of low socioeconomic status on health (Public Health Agency of Canada, 2018; Marmot, 2005). In Canada, household food insecurity is measured with the Household Food Security Survey Module (HFSSM) on the Canadian Community Health Survey (CCHS), which consists of 18 questions about experiences of food insecurity. Using this measure, a household's food insecurity can be categorized into three levels[1] (PROOF, 2021a; Tarasuk et al., 2022):

1) **Marginal** – some indication of worry about running out of food and/or limited food selection due to a lack of money for food
2) **Moderate** – compromise in quality and/or quantity of food due to a lack of money for food
3) **Severe** – disrupted eating patterns – i.e., missed meals, reduced food intake, and at the most extreme, going day(s) without food

Household food insecurity is considered one of the structural drivers of health inequities (Public Health Agency of Canada, 2018) and is consistently associated with poor physical and mental health outcomes, including higher risk of diabetes and cardiovascular disease, infections and hospitalization, depression and anxiety (Polsky & Gilmour, 2020; Starr et al., 2019). There is also a graded relationship with those living in severely food insecure households most likely to experience adverse health outcomes (Jessiman-Perreault & McIntyre, 2017).

While food insecurity affects both adults and children, data suggests that households with children are at greater risk of food insecurity and its associated outcomes compared to households without children (Tarasuk et al., 2022). Among children, evidence from the US has shown that food insecurity at the household level negatively affects children's health

[1] In contrast, if no items on the scale are affirmed, the household is categorized as "food secure" – i.e., there is no indication of income-related food access problems.

and developmental outcomes, and that the risk of adverse outcomes is even greater among young children with identifiable child food insecurity (Wight et al., 2014; Cook et al., 2006). On the other hand, research also indicates that parents often attempt to protect their children from the impacts of food insecurity by sacrificing their own nutritional needs (i.e. by consuming smaller portions themselves) in order to allocate more resources and food to their children (Lane et al., 2019).

Factors affecting food security are diverse and interrelated. Population growth, urbanization, climate change, changes in diets, and supply chain issues are among the factors contributing to greater uncertainty about future food security. The socioeconomic dimensions of household food security encompass four groups of measures: food availability (e.g. food production, food producer prices), food access (e.g. household income, consumer food prices, government transfers, remittances, household tax incidence), food utilization (e.g. household food basket), and vulnerability and resilience measures (e.g. household savings, and official development assistance aid payments) (Achterbosch et al., 2014).

Poverty is a primary driver of food insecurity – in general, as household income decreases, the risk of food insecurity increases (PROOF, 2021a). In Canada, 1 in 5 (21%) children live in conditions of poverty[2] – a higher than average rate compared to 46 rich countries in the world (UNICEF, 2020). Poverty rates are even higher among Indigenous children – a direct result of colonialism, racism, residential school experiences and other discriminatory policies and practices. A report from 2019 found that almost half (47%) of all First Nations children in Canada live in poverty, with First Nations children living on reserves facing the highest rate of child poverty in the country (53%) (APTN National News, 2019). In Toronto, 1 in 4 children live in poverty, and about 40% of all children go to school hungry (Toronto Foundation for Student Success, n.d.). Poverty is not just a cause of food insecurity, but it can also be a consequence – as poverty and malnutrition are interconnected through a cyclical relationship. This means that poverty creates unfavorable conditions that contribute to or reinforce malnutrition; yet at the same time, malnutrition can produce conditions of poverty by reducing the economic potential of individuals and of populations as a whole (Siddiqui et al., 2020).

Food insecurity is a key social determinant of health yet there is a lack of effective policy responses to this problem (Men & Tarasuk, 2021). Although all federal, provincial, and territorial governments have committed to poverty reduction strategies, only some have identified specific, measurable targets or commitments to eliminate poverty (PROOF, 2021b). Prince Edward Island (PEI) was the first province to declare explicit targets for reducing food insecurity with a commitment to eliminate food insecurity among children by 2030 (PROOF, 2021b).

[2] Relative child poverty is defined as children who live in households which, taking account of household size and composition, fall below 60% of the national median per capita income (UNICEF, 2020).

Recent data on food insecurity in Canada:

Food insecurity is a serious and growing problem in Canada. According to recent data from Statistics Canada, the number of people living in food-insecure households has increased in the last decade, with 15.9% of households in 2021 (representing 5.8 million people) experiencing some level of food insecurity in the past 12 months (Tarasuk et al., 2022). The current prevalence of household food insecurity is higher than estimates from previous years (i.e. 12.7% of households in 2017-18; 12.5% in 2013), although direct comparisons over time cannot be made due to differences in sampling methods (Tarasuk & Mitchel, 2020; Tarasuk et al., 2015). In terms of severity, a substantial proportion of households with food insecurity experienced more extreme deprivation (7.4% of households were moderately insecure, and 4.2% were severely insecure). Other findings on Canadian households that are more vulnerable to food insecurity include:

- Households with children and marginalized groups are disproportionately affected - almost 1 in 5 children under 18 years of age in Canada (19.6%, over 1.4 million children) live in food insecure households (Tarasuk et al., 2022).
- Black and Indigenous households have the highest rates of food insecurity: almost one third (30.7%) of off-reserve Indigenous peoples across the provinces and almost one quarter of Black individuals (22.4%) lived in food insecure households in 2021, compared to 13.2% of people identifying as White/not a visible minority (Tarasuk et al., 2022).
- Households with recent immigrants also appear to be more vulnerable – data from 2017-18 showed that households with a recent immigrant (less than 5 years in the country) had a higher prevalence of food insecurity (17.1%) compared to those with a newcomer who has been in Canada longer (13.8%), and Canadian-born respondents (12.2%) (Tarasuk & Mitchell, 2020).
- Across age groups, children and young adults (aged 6-17 years) have the highest prevalence of household food insecurity – more than triple the prevalence found among older adults (aged 75+) (Tarasuk et al., 2022).
- The prevalence of food insecurity also differs across provinces and territories, with Quebec having the lowest prevalence among both adults and children; and Nunavut having the highest prevalence[3] (Tarasuk et al., 2022).

3.2 Food insecurity and academic achievement

The effects of food insecurity for children include not only negative impacts on their health, development, and well-being, but also their academic success. An analysis of data from a Canadian study (the Children's Lifestyle and School performance Study (CLASS)) conducted among grade 5 students in Nova Scotia in 2011 (Faught et al., 2017a) found a strong negative association between food insecurity and academic achievement, as measured by performance on standardized tests. Even after adjusting for socioeconomic status, diet, weight status, sex, physical activity, screen time, and region of residence, children living in

[3] The most recent data for the territories was collected in 2020 and does not include levels of 'marginal' food insecurity (Tarasuk et al., 2022)

very low food secure households had lower odds of meeting expectations in reading (OR=0.65; 95% CI [0.44, 0.96] and mathematics (OR=0·62, 95% CI [0·45, 0·86]).

A similar association between food security and educational outcomes has been found among secondary school students. Using an intersectional approach, Robson et al. (2021) examined the relationship between food insecurity and academic achievement (measured by high school grades and post-secondary confirmation[4]) among a sample of 7,208 secondary school students[5] in Toronto, Ontario, and how this relationship differs by race. Data sources for the analyses included the 2011 Toronto District School Board Grade 7 to 12 Student Census (which included questions about eating habits), administrative records, and college and university application information. Findings showed a positive association between food security and grade 11 and 12 average grades and post-secondary confirmation, after controlling for other determinants of educational outcomes (i.e., students' sex, parental education, special education needs and immigration status). However, results varied by race (self-identified ethno-racial group), suggesting that the academic benefits of food security are not experienced by all racial groups in the same way. For example, among White students, the association between increased food security and greater academic achievement was the strongest; however, this relationship was weaker for other racial groups. East Asian students, even when food insecure, achieved higher marks and had higher rates of being accepted to university; and among Black students in grades 11 and 12, there was only a small difference in average grades (63% vs. 68%) between those at the lowest and highest ends of the food security index. These findings suggest that achievement variations by racial group are likely not limited to only food security issues and may relate to other social and cultural factors that were not captured in this study (Robson et al., 2021).

One systematic review (Shankar et al., 2017) analyzed 23 peer-reviewed articles (11 cross-sectional and 12 longitudinal studies) across Western industrialized countries, including the US, Canada, UK, and Australia, to examine the association between food insecurity and childhood developmental, behavioural, and academic outcomes across different age groups (infants, preschoolers, school-aged children, and adolescents). The results indicated that household food insecurity, even at marginal levels, was associated with children's behavioural, academic, and emotional problems from infancy to adolescence, although the correlates of food insecurity differed by developmental stage. In school-aged children, studies have shown an association between food insecurity and less optimal behavioral and academic outcomes; while the major correlates among adolescents were psychosocial (e.g.,

[4] "Confirmed acceptance" as an outcome variable refers to the condition where a student applied to a college or university, the application was accepted, and the student accepted an offer of admission.
[5] Data for the study were from students who were aged 17 years of age and enrolled in a Toronto district school during fall 2011.

mental health symptoms and diagnoses). The review also revealed a dose-response relationship between length of time or level of food insecurity and developmental-behavioural domains, including academic performance, grade repetition, and use of special education services. However, multivariate analysis showed that the relationship between food insecurity and negative developmental and behavioral outcomes was attenuated after controlling for background characteristics, such as parental distress.

Summary: *In Canada, 1 in 5 children under 18 years of age (over 1.4 million children) live in households affected by some level of food insecurity. Research shows that household food insecurity is associated with poorer health, well-being and academic outcomes among children and youth, demonstrating the need for more attention and action to address students' nutritional needs.*

4.0 Healthy Dietary Intake

It is well-known that a healthy diet is beneficial for children's overall health and development, yet rates of overweight and obesity among children are rising globally (GBD 2015 Obesity Collaborators, 2017). The increased availability and accessibility of fast foods, which are often high in unhealthy fats, calorie-dense and nutrient-poor, may have an adverse impact on children's health and other outcomes, such as cognitive performance and academic achievement.

Evidence from Canada:

The relationship between healthy dietary intake and academic achievement among children has been supported by several studies from Canada, described below. Overall, these studies show that healthier eating habits, such as consumption of recommended amounts of nutritious foods and regularly consuming breakfast, are associated with more positive academic outcomes, most commonly measured by grades.

- An analysis of self-reported data on health behaviours and academic achievement from a nationally representative sample of Canadian early adolescents[6] (n = 28,608, ages 11–15) found that healthy eating behaviours, including frequent consumption of vegetables and fruits and regularly having breakfast and dinner with family, were positively associated with higher levels of academic achievement. In contrast, increased consumption of junk foods and sugar sweetened beverages (i.e., sweets, soft drinks and energy drinks, fast food, chips), as well as overweight and obesity were negatively associated with academic achievement (Faught et al., 2017b).
- Faught et al. (2019) examined the relationship between diet and academic performance among a sample of 11,016 adolescents from the COMPASS study in Alberta and Ontario.[7] Data were from grade 9, 10 and 11 students in Year 4 (Y4:

[6] The study involved secondary data analysis of data from the Canadian version (Cycle 7) of the 2014 Health Behaviour in School-aged Children (HBSC) study.
[7] The COMPASS Study is a prospective cohort study aims to collect longitudinal data from a sample of student in grades 9–12 (ages 13–18 years) and their schools in the provinces of Alberta and Ontario in Canada.

2015/16) of the study who also provided follow-up data in Year 5 (Y5: 2016/17), when they were in grades 10, 11 or 12. Students self-reported their adherence to Eating Well with Canada's Food Guide, 2011 and their academic achievement in Math and English.[8] Results indicated that adherence to recommendations for certain food groups (e.g. protein-rich foods in the Meat and Alternatives group, and Vegetables and Fruit) showed promise as behavioural targets for higher academic achievement among youth. For example, if students met recommendations for the Meat and Alternatives group at either or both time points, they had 1.11–1.28 increased odds of achieving a higher level in math compared to students who did not meet the recommendation at either time point.

- Similar findings were reported in a study of adolescents' food intake (n=325) from four junior high schools in Prince Edward Island, which found that students with higher academic performance (average grades above 90%) were more likely to consume milk, vegetables, and fruit daily than those who reported lower grades (MacLellan et al., 2008).
- In Nova Scotia, McIsaac et al. (2015) used data from a population-based survey of students in grades 4–6 (about 9–12 years old) and their parents across 18 schools in a rural school board in 2013-14 to examine the relationship between health behaviours (including both healthy eating and physical activity) and academic performance in Mathematics and English Language Arts (ELA). After adjusting for gender, household education and income, results showed a positive association between unhealthy behaviours and poor academic performance. Specifically, students with lower diet quality[9] and those who consumed at least one sugar-sweetened beverage per day had lower ELA grades, while students who skipped breakfast had lower Mathematics grades.
- Recent data from Ontario shows the importance of nutrition in early childhood for parent-reported school concerns and school readiness – a multidimensional construct that includes cognitive, behavioral, and emotional aspects of a child's development and is an important predictor of children's future success in school and other domains (Omand et al., 2021a; Omand et al., 2021b). Using data from a prospective cohort study,[10] researchers examined the association between a parent-completed measure[11] of nutritional risk in early childhood (aged 18 months to 5 years) with a teacher-completed measure of school readiness (the Early

Students were recruited within participating COMPASS schools using active-information passive-consent parental permission protocols (Fought et al., 2019).

[8] Students were asked: "In your current or most recent Math course, what is your approximate overall mark?" The same question was asked for English marks. Possible response selections were: 90%–100%, 80–89%, 70–79%, 60–69%, < 60%. Follow-up academic achievement was treated as the outcome variable and analyses were adjusted for academic achievement reported at baseline.

[9] As measured by both the Diet Quality Index (DQI) scores and the Youth Healthy Eating Index (YHEI).

[10] The Applied Research Group for Kids (TARGet Kids!, the largest primary care research network in Canada based in Toronto, Ontario. Data were collected between 2015-2020 for study A, and between 2011-2018 for study B.

[11] The Nutrition Screening for Toddlers and Preschoolers (NutriSTEP) – validated questionnaires for assessing nutritional risk in children aged 18 months to 5 years.

Developmental Instrument, EDI[12]). Results showed that high nutritional risk (including subscores on eating behaviors and dietary intake) was associated with 4.28 times greater odds of being vulnerable on the EDI in year two of kindergarten and lower scores on each of the EDI domains (Omand et al., 2021a). The strongest association was found between nutritional risk and scores on the domains of language and cognitive development, and communication skills and general knowledge. In another analysis of data from the same cohort study, higher nutritional risk among children was also found to be associated with 1.18 times increased odds of school concerns[13] at ages 4-10 years (Omand et al., 2021b). Together, these findings highlight the importance of establishing healthy eating behaviors through nutritional interventions in early childhood in order to optimize children's developmental and educational outcomes.

Evidence from other countries:

Similar findings have also been reported among older adolescents in the U.S. For example, results from the 2019 US National Youth Risk Behavior Survey (YRBS) showed a significant association between academic grades and dietary behaviours (Centers for Disease Control and Prevention, 2020a). High school students with higher academic grades were more likely to have healthy dietary behaviours, including eating breakfast on all seven days before the survey (42% of students with mostly A's ate breakfast compared to 20% with mostly D/F's); eating fruit or drinking 100% fruit juice one or more times per day (62% of students with mostly A's ate fruit or drank fruit juices compared to only 54% of students with D/F's); eating vegetables one or more times per day (66% of students with mostly A's ate vegetables compared to only 52% of students with mostly D/F's); and **not** drinking a soda or pop (41% of students with mostly A's compared to 21% of students with mostly D/F's). However, the researchers noted that these associations do not prove causation, and more research is required to determine the nature of the relationship between healthy eating and grades.

These findings from individual studies are also consistent with results of systematic reviews on the association between dietary intake and academic achievement. For example:

- Burrows et al. (2017) reviewed 40 studies (including 32 cross-sectional studies) from 18 countries to evaluate the literature on associations between dietary intake and behaviours and academic achievement among school-aged children. Overall, the review found moderate associates between several aspects of dietary intake and achievement. For example, diet quality/meal patterns (7 studies) had positive associations with academic achievement, whereas consumption of energy-dense, nutrient-poor junk/fast food (9 studies) had a negative association with

[12] The EDI measures five developmental domains in kindergarten (physical health and well-being, social competence, emotional maturity, language and cognitive development, and communication skills and general knowledge). Vulnerability indicates scores lower than a population-based cutoff at the 10th percentile on at least one domain.

[13] School concerns were measured using a parent-completed question of whether the school has expressed any concern about their child in a number of areas (e.g. speech and language, learning, attention, behaviors, independence). Responses were dichotomized as yes (any concern) or no concerns.

achievement. A total of six studies reported significant associations between academic achievement and consumption of adequate amounts of fruit and vegetables. However, the authors noted that most studies assessed only a single aspect of diet rather than the broader, more complex concept of dietary intake.

- Cohen et al. (2016) conducted a systematic review of 21 studies[14] to evaluate whether healthier dietary consumption impacts executive functioning among children and adolescents. Executive functioning (EF) [15] – defined as neurocognitive processes involved in goal-directed behaviour – is known to be associated with academic performance, among other health and social outcomes. Most school-based nutrition studies (including 7 studies focused on eating breakfast) among children or adolescents aged 6–18 years examined food quality and macronutrients. The results showed a consistent and positive long-term effect of a healthier diet[16] on EF, while consuming less-healthy snack foods (i.e., sugar-sweetened beverages and red/processed meats) was associated with poorer EF. The studies that examined the acute association between healthier foods with lower Glycemic Index (GI)[17] and Glycemic Load (GL)[18] with EF showed mixed results, although the majority suggested improved EF with lower GI/GL foods. Given the association between healthier diets and improvements in EF, the authors suggest that policies to improve school food environments may have important implications for children's academic performance.

Summary: *Several cross-sectional studies have shown a positive association between healthy dietary intake and academic achievement and adverse effects of junk foods. There is limited evidence from scientifically rigorous studies to support a causal relationship, except for executive functioning, which is an important skill that contributes to academic achievement among children and adolescents.*

[14] Studies varied in design, including four randomized studies, five cross-over designs, one cross-over randomized design, ten cross-sectional and one longitudinal study.

[15] Executive functioning (EF) is a particularly important domain within cognitive processing and consists of the mental capacity to make goal-directed behaviours, including inhibitory control, working memory, attention and planning. EF skills develop throughout childhood and adolescence and parallel the developmental changes that occur in the brain throughout this period. Cognitive functioning plays an important role in both academic achievement and health-related decision making among children and adolescents.

[16] In this study healthier foods were defined based on the recommendations from the Dietary Guidelines for Americans and Harvard's Healthy Eating Plate, which advise diets high in whole grains, fruits and vegetables, as well as lean proteins or proteins high in unsaturated fats (e.g. fish), and low in red/processed meats, SFA, trans fats and sugar. Diets having a low glycaemic index or glycaemic load and that were consistent with these healthier guidelines were also considered healthy.

[17] GI glycemic index (GI) compares the potential of foods containing the same amount of carbohydrate to raise blood glucose. Examples for low GI: green vegetables, most fruits, raw carrots, kidney beans, chickpeas, lentils, and bran breakfast cereals; examples for high GI: white rice, white bread and potatoes

[18] The GL is calculated by multiplying the GI by the amount of carbohydrate in grams (g) provided by a food serving and then dividing the total by 100.

5.0 Micronutrients

Good nutrition, including adequate intake of micronutrients, is essential for brain function and cognitive performance. Research has shown that deficiencies of micronutrients such as vitamin A, vitamin B_{12}, iron, zinc, and folate among children can affect their cognitive development and functioning, leading to outcomes such as lower Intelligence Quotient (IQ) scores, poor memory, impaired verbal and non-verbal learning, attention deficit, and delayed processing speed (Annan et al., 2019; Lam & Lawlis, 2017). Micronutrient deficiencies can also have significant consequences for children's physical health and growth, including a weakened immune system, which can lead to missed time in the classroom, increased risk of diseases and child mortality (Annan et al., 2019). Therefore, the direct effects of micronutrients on cognitive development as well as indirect effects through mental and physical development can have important implications for children's academic performance.

Food fortification is one public health strategy to reduce micronutrient deficiencies in children; however, the effects of fortified food on academic performance remains unclear (Wang et al., 2017; Lam & Lawlis, 2017). Reasons for the inconsistent findings in review studies such as those described below may be related to the role of other individual-level or socioecological factors that can influence the effects of fortified food on academic outcomes, (Wang et al., 2017). Differences have also been noted according to children's baseline levels of micronutrients, with some evidence suggesting that micronutrient interventions are more effective for children who are deficient before the intervention compared to healthy children (Lam & Lawlis, 2017).

- Al Khalifah et al. (2020) reported the results of a meta-analysis of 20 randomized clinical trials (RCTs) assessing the effects of fortification of milk, cereal, juice, bread, yogurt, and cheese with vitamin D among healthy children aged 1–18 years old, compared with no fortification. The findings showed that although cognitive function improved by a mean difference of 1.22 IQ points (95% CI 0.65, 1.79) for children who received fortified foods, there was no consistent evidence for an effect on academic achievement.
- An earlier systematic review of RCTs published up to 2008 suggested a small positive effect of multiple micronutrient supplementation on cognitive performance among schoolchildren (up to 16 years old) (Eilander et al., 2010). Results showed a small but nonsignificant effect of interventions on fluid intelligence[19] and a significant positive effect on academic performance, but no significant effects were found for other cognitive domains (i.e., short-term memory, processing speed, sustained attention) or for crystallized intelligence. While these findings suggest that micronutrient interventions might be beneficial, the authors concluded that the evidence was not robust enough to recommend micronutrient supplementation for

[19] Fluid intelligence comprises comprehension, problem solving and reasoning abilities and is typically measured through tasks such as analogies and series completions. Crystallized intelligence describes a set of acquired skills and knowledge over time (i.e. verbal comprehension, vocabulary) and is therefore seen as more dependent on experience and education compared to fluid intelligence (Eilander et al., 2010).

improving cognitive or academic performance due to the limited number of trials and variance across interventions.

- A more recent systematic review of 19 RCTs published after the year 2000 evaluated the effect of micronutrient interventions on cognitive or academic performance among children aged 4-18 (Lam & Lawlis, 2017). The results showed a significant improvement in the fluid intelligence domain among micronutrient-deficient children following micronutrient interventions, especially for iron-deficient or iodine-deficient children at baseline. However, findings were inconsistent for healthy subjects and for outcomes in other cognitive domains such as memory, attention, and school performance.

Summary: *Evidence on the importance of micronutrients for children's cognitive and physical development is clear; however, evidence on the impact of micronutrient interventions such as food fortification on academic performance remains inconsistent.*

6.0 Eating Breakfast

Regular consumption of breakfast has many benefits for children's mental and physical health. When children start the day with a nutritious and well-balanced meal, they are essentially refueling their brains and bodies (i.e. 'breaking the fast') by taking in the nutrients and energy needed to kick start their metabolism and return blood sugar levels to normal (Canada Safety Council, 2011; Adolphus et al., 2016). However, despite these benefits, many school-aged children do not eat breakfast, with breakfast skipping more commonly observed among children of lower socioeconomic status (Lundqvist et al., 2019).

Children who regularly eat breakfast are more likely to have higher daily nutrient intake levels and a normal BMI compared to children who skip breakfast. There is also evidence

indicating that breakfast consumption has positive effects on children's behavioural and cognitive performance, including enhanced memory, concentration, and attention span (Adolphus et al., 2013). However, some researchers have noted that the effects of eating breakfast on cognitive performance may be short-term, and whether these effects translate into positive academic outcomes in the long-term is less clear and may depend on the frequency and regularity of breakfast consumption (Adolphus et al., 2013). Fewer studies have examined the effects of breakfast on learning behaviour and measurable academic outcomes such as school grades or test scores (vs. cognitive outcomes); however, results from some of these studies and reviews are described below.

- One Canadian study (Sampasa-Kanyinga & Hamilton, 2017) examined the association between breakfast consumption and academic performance[20] among middle- and high-school students using data from the 2013 cycle of the Ontario Student Drug Use and Health Survey, a province-wide repeated cross-sectional school-based survey[21] of 9912 students in grades 7-12. More than half of students in the study ate breakfast regularly (55.2%). After adjusting for age, sex, ethnicity, SES and parental education, the results showed that regular breakfast consumption was significantly associated with greater odds of higher academic performance (adj OR= 1.63, 95% CI [1.21-2.20]). An additional finding was that breakfast consumption was associated with higher levels of school connectedness[22] – an important factor for both health and learning outcomes. While students who felt connected to their school also reported higher academic performance, the association between breakfast and academic performance was independent of levels of connectedness.
- An umbrella study that summarized nine systematic review studies examined the relationship between breakfast consumption and academic performance among students in the US. The results from these review studies generally showed small, positive associations between eating breakfast and different academic outcomes, including cognitive performance and attendance, whereas skipping breakfast was associated with decreased cognitive performance among students (Michael et al., 2015).
- Lundqvist et al. (2019) reviewed 26 studies[23] from countries with advanced economies[24] that examined the long-term effects of eating breakfast in children and

[20] In this study regular breakfast consumers were those students who ate breakfast on all five days and less regular breakfast consumers were those who ate breakfast less frequently. Academic performance was treated as a binary measure indicating whether the students achieved good marks (70%-100%) vs poor marks (below 70%).
[21] The Ontario Student Drug Use and Health Survey uses a two-stage (school, class) stratified (region and school type) cluster sample design. The total sample was 10,272 students from 42 school boards, 198 schools, and 671classrooms.
[22] School connectedness refers to students' belief that teachers and other adults at school care about them and their learning.
[23] Studies were published between 2003-2017. Nineteen of the included studies were observational, including four longitudinal studies with follow-up periods ranging from 6 months to 27 years. Six studies employed controlled trials—five randomized and one non-randomized—and one study used a separate-group design.
[24] UK (7studies); the United States (3 studies); Canada, Norway, Australia, and Sweden (2 studies each); and Denmark, Germany, Italy the Netherlands (1 study each) and four multinational studies.

adolescents (aged 6 to 18) on outcomes relevant for economic evaluation (i.e., identifying the long-term costs and benefits of interventions using measures such as quality-adjusted life years). The results showed consistent positive effects of eating breakfast on cognitive performance (e.g. attention, tension and calmness, response speed; 8 studies), academic achievement (8 studies), quality of life and well-being (3 studies), and morbidity risk factors (e.g. metabolic syndrome, insulin resistance, cardiovascular risk factors and headache; 9 studies).

- Adolphus et al. (2013) considered the evidence from 36 articles examining the chronic and acute effects of habitual breakfast consumption on in-class behaviour and academic performance in children and adolescents. Findings showed a mainly positive effect of breakfast on on-task behaviour in the classroom, as well as suggestive evidence of a positive association between higher quality and frequency of habitual breakfast and school performance. However, conclusions were limited due to the influence of confounding variables (i.e., SES), the wide range of outcome measures, and differences in how breakfast consumption is operationalized across studies.
- A systematic review of 15 published studies in English and Korean (12 cross-sectional and 3 cohort studies) by Jeong (2019) examined the relationship between breakfast consumption by school-age adolescents (at home or school) and academic achievement—measured by the overall Grade Point Average (GPA), or individual subject scores. The study findings confirmed the positive association between having regular breakfast and improved academic achievement among students - the academic performance of students who had regular breakfast was more than two times higher than those who did not have breakfast.
- Finally, Babaeer and Wraith (2018) reviewed 12 studies on the association between habitual breakfast consumption and academic performance for adolescents aged 11-19. The findings showed mixed evidence as well as some methodological limitations of existing studies, which did not allow for firm conclusions about the effects of habitual breakfast on academic performance to be drawn. For example, eight studies showed a positive relationship with school grades, while four papers had non-significant results.

Summary: *Strong evidence supports the small positive association between breakfast consumption and different academic outcomes, including cognitive performance. However, there is not enough evidence to demonstrate a causal relationship between breakfast and academic achievement due to low quality study design (mostly cross-sectional studies), as well as inconsistencies in definition and measurement of breakfast consumption and reporting time for academic outcomes across studies.*

7.0 Obesity

7.1 Overview of child obesity

Paradoxically, the coexistence of obesity with undernutrition is threatening many parts of the world, and if immediate action is not taken, millions of people in the coming decades will suffer from an array of serious health problems and premature death (World Health Organization, n.d.). Worldwide, the prevalence of overweight and obesity among children rose by 47.1% between 1980 and 2013 (Ng et al., 2014). The rate of increase in childhood obesity in many countries has been higher than adult obesity (27.5% increase globally from 1980-2013) (GBD 2015 Obesity Collaborators, 2017; Ng et al., 2014).

In Canada, child and youth obesity rates have nearly tripled in the last 30 years (Government of Canada, 2019), and currently, 30% of children aged 5-17 are considered to be overweight or have obesity (Government of Canada, 2018). Addressing the factors that contribute to childhood obesity can not only help to reduce the associated long-term negative health outcomes, including hypertension, type 2 diabetes, heart disease, stroke, and certain types of cancer, but action during childhood can also help reduce the likelihood of being classified as overweight or with obesity later in life. Accordingly, the Government of Canada identifies childhood overweight and obesity as a priority for action and has outlined a number of strategies to advance the *Framework for Action to Promote Healthy Weights* at the national and subnational levels (Government of Canada, 2011).

7.2 Obesity and academic achievement

The problem of overweight and obesity also has implications for children's academic achievement. Many researchers have examined the relationship between overweight/obesity and academic performance in children and adolescents, although the exact nature and magnitude of this relationship, including the potential role of other moderating factors, is still not clear (He et al., 2019). Some of the relevant findings from Canada and review studies are summarized below:

- In the first study to use a representative sample of early adolescents in Canada, Faught et al. (2017b) conducted a secondary analysis on self-reported data from the Canadian version (Cycle 7) of the 2014 Health Behaviour in School-aged Children (HBSC) study — a nationally representative sample of 28,608 Canadian adolescents ages 11–15. After adjusting for age, sex, SES, diet and physical activity, the results

showed a negative association between overweight (adj OR = .86, 95% CI: .77-.95) and obesity[25] (adj OR =.68, 95% CI: 0.59-.79) and academic achievement.

- A meta-analysis of 60 studies (involving 164,049 participants) published up to 2017 (He et al., 2019) showed a weak negative correlation between BMI and academic achievement (r = −.111, 95% CI [−.155 to −.067], P < .01). This association was also shown to be moderated by factors such as study region and grade. For example, the relationship between BMI and achievement was stronger in American and European samples than in Asian samples, where it was close to zero—suggesting possible cultural differences in the relationship. The association between BMI and academic performance also varied by grade level—a lower pooled effect size was found in elementary school samples compared to middle school and high school, but there were no significant differences between school subjects (e.g. math, reading, science). There were also no significant sex differences overall.
- Martin et al. (2017) synthesized 31 observational prospective cohort studies (from 17 cohorts) among healthy[26] students aged 3–18 years to examine the longitudinal association between child and adolescent obesity and academic achievement. The study found an association between obesity and math achievement in adolescent girls, with significantly lower math scores at age 13-14 in girls with obesity at baseline compared to healthy-weight peers. However, there was no consistent association for other subjects, age groups, or for boys. Based on the qualitative research findings included in the study, the researchers suggested that the results for adolescent girls could be potentially mediated by psychosocial experiences such as weight-related bullying and executive cognitive functions.

Besides academic achievement, other research has focused on the relationship between obesity and executive functioning (EF). The proper functioning of EF is relevant for physical health, as well as mental health, school achievement and job success. While the link between EF and obesity has been well established in adults, there is less evidence on children and adolescents (Mamrot & Hanć, 2019).

- A systematic review aimed to address this gap by examining this association, using a variety of indicators of obesity as well as three core categories of EF (inhibitory control, working memory, and cognitive flexibility). The results from 27 papers among participants aged 3-18 years old showed that cognitive functioning is significantly related to body weight in both children and adolescents, with the strongest association found between poor inhibitory control and higher BMI and being classified as overweight or with obesity. However, the mechanism behind the association is still unclear (Mamrot & Hanć, 2019).

[25] Height and weight were self-reported by students in the survey. These values were used to calculate body mass index, which became a measure of body weight as per age- and sex-specific standards used by WHO. Children were classified as overweight if they were more than one standard deviation above the mean and with obesity if they were more than two standard deviations above the mean.
[26] The inclusion criteria for the study were students aged 3-18 years who did not have any conditions associated with overweight/obesity or impaired school performance

Finally, the link between obesity and academic performance may be influenced by stigma associated with obesity and negative perceptions from others, including educators – known as weight bias. Some review studies noticed the presence of weight bias in educational settings among educators (both in-service and pre-service), school staff and classmates and concluded that negative attitudes toward students with obesity are pervasive and could lead to differential treatment and educational disparities (Nutter et al. 2019; Puhl et al., 2009). However, further research is needed to assess the impact of weight bias on educational achievement and determine its relative contribution in relation to other possible factors (Puhl et al., 2009).

- Evidence from Canada suggests that weight bias may exist as early as kindergarten. Data from a prospective cohort study of young children in Toronto was used to examine the association between age- and sex-standardized body mass index (zBMI) in early childhood and vulnerability in school readiness (see also pg. 7 of this report). Results from a sample of 1,015 children showed no significant association between zBMI at age 4 (before the start of kindergarten) and school readiness in kindergarten[27]; however, a post hoc analysis found that children in year two of kindergarten (but not those in year one) who were classified as overweight or with obesity had twice the odds of vulnerability in school readiness compared to normal weight peers (OR=2.07), as well as lower social competence scores (Omand et al., 2022). The authors suggested that the impact of weight bias in the classroom may increase with age, which may explain the difference between children in years one and two of kindergarten.
- While most studies have focused on children and adolescents, a review by Hill et al. (2019) sought to examine the association between obesity and tertiary education outcomes among young people aged 16+. Of the 16 included studies, all six cross-sectional studies and eight out of 10 longitudinal studies reported lower educational achievement among students with obesity (BMI ≥ 30 kg/m^2). Overall, studies showed that students with obesity do less well in tertiary education than their healthy weight peers: three of four studies showed reduced enrolment; six of eight studies found that graduation was less likely, and all six studies reporting on academic performance showed lower performance in students with obesity. Five of nine studies found that obesity had a greater impact on girls' educational achievement than boys. The authors suggest that these findings support the existence of weight bias in educational achievement; however, little is known about the processes that underpin this apparent weight bias.

[27] School readiness was measured using the teacher-completed Early Development Instrument (EDI) during the second half of year 1 of kindergarten and/or year 2 of kindergarten (at ages 4-6 years). Overall vulnerability in school readiness was dichotomized as yes or no (vulnerability in at least one of the five domains).

Summary: *Evidence supports a small negative association between student obesity and academic performance, and larger pooled effect size among adolescents in middle school and high school compared to younger children. Evidence on sex differences was not consistent. The exact nature of this association, including potential mechanisms or causal pathways, remains unclear.*

8.0 School Food Programs

8.1 Overview of school food programs in developed countries

The school food environment, including school meal programs and nutrition services, can be an important source of daily nutrition for children. In addition to providing meals and snacks, schools can also promote healthy eating behaviours by providing students with opportunities to learn about nutrition and practice healthy eating through available foods, messaging, and education (Michael et al., 2015). Many countries have recognized these benefits of school-based food programs and have implemented them to ensure that all students have reliable access to nutritious food in a safe environment. However, there is wide variation in programs available globally, structures, and offerings, as described below. Appendix 1 also provides an overview of school meal programs in high-income countries as of 2020.

In addition, data from the US shows that many children do not take advantage of school meal programs – especially breakfast programs, as only half as many children participated in the National School Breakfast Program (NSBP) compared to the lunch program in 2019 (Cuadros-Meñaca et al., 2022).

In a traditional school breakfast program, children must arrive at school before classes begin to receive breakfast, which tends to result in lower participation rates. A new alternative in recent years called "breakfast after the bell" (BAB) is being implemented as one way to increase participation through different delivery models: a) prepackaged grab-and-go breakfasts that children bring to their classrooms at the beginning of the school day and b) second-chance breakfasts served mid-morning during a class break. BAB has been shown to meaningfully increase participation in school breakfast (Cuadros-Meñaca et al., 2022). Moreover, evidence suggests that BAB can be incorporated into the school day without an adverse effect on student academic achievement – which may help ease concerns from educators that the program could disrupt usual learning time (Cuadros-Meñaca et al., 2022).

McGill et al. (2020) conducted a rapid review to assess the impact of meals provided at school on various outcomes (including food security, health, education, social, and economic outcomes), particularly for socio-economically disadvantaged students. The review identified 56 articles on school meal programs[28] delivered in seven high-income countries.[29] The key findings of this review on the types and diversity of programs included:

- The programs were very diverse: They included both breakfast and lunch programs; may be offered universally or targeted at disadvantaged students or disadvantaged schools; and may be offered through full or partial government funding and/or through a combination of government and non-government funding.
- All school meal programs included a variety of foods. School breakfast programs usually consisted of cereal, milk (fresh, ultra-heat treatment (UHT) milk powder), bread or toast, spreads, yogurt, fruit (fresh, canned or dried) and juice. Lunch programs provided a variety of meat/meat alternatives, whole grains, fruits, vegetables, and low-fat dairy options. Two snack programs were also found: in Canada, the snack program included at least one serving of fruit and vegetables and milk and milk alternatives (milk, cheese, yogurt, fortified soy beverages); while the US *Fresh Fruit and Vegetable Program* offered fresh fruits and vegetables only.
- In the US, UK, and Greece only, school meal programs were based on nutritional guidelines, including specific macronutrient and micronutrient guidelines. Participation in these programs was positively associated with higher fruit and vegetable consumption and a healthier diet. However, none of the reviewed studies provided sufficient information to determine whether this approach may translate to healthier weight status.

[28] Of the included studies, 23 reviewed breakfast programs, 21 related to lunch programs and 12 included both breakfast and lunch programs.
[29] The US (n=35), the UK (n=6), Australia (n=5), Canada (n=3), Greece (n=3), Japan (n=2), France (n=1), New Zealand (n=1) and South Korea (n=1)

As described by Everitt et al. (2020), there has been a recent shift worldwide towards school food programs with a broader scope that goes beyond considerations of diet quality by integrating health and environmental safety concerns as well. This newer phase of programs aims to promote health by addressing the social and environmental determinants of health and improving food literacy among students. For example, the school curriculum may include content about food, culture, and sustainable food production while also providing nutritious and sustainable food options at school. Findings from a scoping review of evidence on school food programs with different components showed that multi-component programs that included nutrition education paired with food provision had more significant dietary improvements among students (Everitt et al., 2020).

8.2 Overview of school food programs in Canada

Canada does not currently have a national school nutrition program or guidelines for school food programs at the federal level (Godin et al., 2017). At present, Canada is the only G7 nation without a national school food program (Fawcett-Atkinson, 2020). As a result, Canada ranks poorly with respect to providing children with access to nutritious food, ranking 37th out of 41 wealthy nations on country performance to achieve Sustainable Development Goal 2: 'End hunger, achieve food security and improved nutrition' (Ruetz & McKenna, 2021; UNICEF, 2018; UNICEF, 2017).

In Canada, school food programs fall under the responsibility of the provinces and territories. Although the Federal government is responsible for providing transfer payment funding to support health and education across the provinces/territories, the scope of this funding often falls short of funding school food initiatives due to other competing priorities (Martorell, 2017). Additional funding for school nutrition programs comes from other sources, such as corporations, fundraising, and nongovernmental organizations (Godin et al., 2017).

At the provincial/territorial level, many different school food policies and guidelines have been developed and implemented over the past two decades. The aim of these policies is to improve school food environments, support healthy eating and provide recommendations or requirements for the provision or sale of food and beverages within the school (Hernandez et al., 2018). Appendix 2 provides a summary of school food programs in Canada as of 2020 and existing publications for each program.

However, a patchwork of local programs can only cover a small percentage of Canada's 5 million school-age children. For instance, available data from 2018/19 suggests that collectively, provinces and territories partially funded a minimum of 35% of schools to provide free breakfasts, snacks and/or lunches to a minimum of 21% of all students in Canada (Ruetz & McKenna, 2021). Moreover, access to school food programs across the country shows a high level of inequity, with the estimated prevalence[30] of school food

[30] Data on program reach, availability and access is difficult to collect and compare across provinces/territories as not all jurisdictions collect data at the provincial level. Therefore, only partial data was available for some provinces.

programs in 2018/19 ranging from as low as 18% of schools in Alberta and 37% in Manitoba to rates of 90-96% in Atlantic Canada and close to 100% in the territories (Ruetz & McKenna, 2021). Program participation rates also varied widely, following a similar pattern as the prevalence rates. Overall, while breakfast programs are growing across the country, program demand often exceeds supply (Godin et al., 2017; Ruetz & McKenna, 2021).

Progress Towards a National School Food Program in Canada

Recent calls by advocates and organizations for greater investment by the federal government into school-based food programs have emphasized the economic benefits of a national school food program, in addition to the potential to improve children's health, educational, and other outcomes (Food Secure Canada, 2019). In response to these calls, the federal government has taken steps towards achieving this goal, including the following:

- The 2019 Federal Budget declared the government's intent to create a national school food program, representing the first commitment towards such a program.
- The Food Policy for Canada launched in 2019 aimed to have all major national political parties provide support for a universal cost-shared national school food program.
- Bill C-201: An Act to Develop a National School Food Program for Children (also known as the *School Food Program of Children Act*), was introduced to the House of Commons in 2021 and is currently in the process towards enactment. In 2021, three mandate letters to members of the cabinet (from the Ministers of Agriculture and Agri-Food; Families, Children and Social Development; and Health) referenced school nutrition and/or healthy eating for the first time (Coalition for Health School Food, 2021).

8.3 School food programs and academic achievement

Recent research has focused on evaluating the impact of school food programs; however, fewer studies have focused quantitatively on academic achievement and other educational or cognitive outcomes, compared to health, social, and behavioral benefits (Roustit et al., 2010). According to Cohen et al. (2021), academic performance may be influenced by school meal programs both directly (as a result of improved nutrition) and indirectly (e.g., through improved attendance rates). A summary of evidence from selected Canadian studies and review studies is provided below.

Evidence from Canada:

- Muthuswamy (2012) evaluated the implementation of the Feeding our Future program in Ontario, delivered by the Toronto District School Board (TDSB) as a school-based program that offered nutritious breakfast to all students in participating middle- and secondary schools. Qualitative findings from the first year

of implementation indicated improved student behaviours and attitudes, reduced tardiness, reduced incidence of disciplinary problems, and enhanced ability to stay on task after one year of participation in the program. The second-year evaluation was based on a student survey among all students in the participating schools (n=4,050)[31], and aimed to determine the impact of the program on student health, behaviour, attendance, attention, and achievement. For achievement, information from report card data after the second year of implementation was compared with the provincial standard (Levels 3 and 4). Findings showed that a greater proportion of students in Grades 7 and 8 who ate breakfast on most days at school achieved better results on learning skills and were more likely to achieve or exceed provincial standards in Reading, Math and Science compared to those who had the morning meals only a few days a week or not at all. For instance, 61% of students who ate the morning meal on most days in a school week achieved or exceeded the provincial standard in Reading compared to half (50%) of the students who ate morning meals on only a few days or not at all. In addition, students who ate the morning meal were more likely to attend school regularly and be on track for graduation, and less likely to be suspended (Muthuswamy, 2012). However, these initial findings were based on cross-sectional analyses; further investigation using longitudinal cohort analyses to track the impact of the program on student achievement and other behaviours over time are also needed.

- One study from Quebec, Canada, used data from the 1999 Social and Health Survey of Children and Adolescents to determine the effect of school food programs on the association between household food insecurity and school difficulties. The study compared results among adolescents attending schools where a food assistance program was available to those that did not.[32] The study found that although household food insecurity was strongly associated with indicators of academic difficulty, this association disappeared for adolescents who benefited from school food assistance programs - for whom the risk of below-average grades decreased significantly. In other words, these findings suggest that school meal programs can moderate the association between household food security and academic difficulties in disadvantaged neighbourhoods, and may be part of a successful poverty reduction strategy (Roustit et al., 2010).

Evidence from the US:

- A study that examined the impact of the School Breakfast Program (SBP)[33] on student achievement in the US applied a difference-in-differences analysis to

[31] The overall response rate for the survey was 76%. The survey was voluntary and confidential but not anonymous to be matched with information collected from the TDSB's Student Information System and other datasets such as the 2008 Parent Census, the 2006 Student Census, and Safe Schools to review the program and its outcomes.

[32] At the time of the survey, the Quebec Ministry of Education, Leisure, and Sport managed a food assistance initiative through which meals (breakfast, lunch, or snacks) were distributed to students in underprivileged areas according to needs as identified by school boards.

[33] The SBP is a federal entitlement program that offers breakfast to any student who attends a school that participates in the program, with a focus on low-income students – students of low-income (from households

compare cognitive achievement among students in schools across states that mandated SBP with those in states without mandates (Frisvold, 2015). Results indicate that state mandates increase the availability of breakfast in schools, and the availability of breakfast increases achievement scores. Specifically, attending a school that offers SBP increased math achievement by 8% of a standard deviation. According to other researchers Cuadros-Meñaca et al. (2022), these findings represent some of the strongest evidence of a causal link between school breakfast programs and higher academic performance among children in lower-income schools.

- One study in the US state of Arkansas (Cuadros-Meñaca et al., 2022) analyzed the effect of different breakfast delivery methods on academic achievement by comparing academic results for third grade students from 23 schools offering "breakfast after the bell" (BAB) delivery models and 161 schools offering the regular school breakfast program (NSBP) as a synthetic control group. The results showed that overall, there was no systematic or meaningful effect of BAB delivery on student's math and English Language Arts (ELA) scores during the first year of BAB implementation. However, some small but significant positive effects on math scores were found among specific subgroups of students, including fourth-grade children classified as economically disadvantaged. The authors suggest that these findings are still important as they demonstrate that there is no adverse impact on student academic achievement by incorporating BAB into the school day. Moreover, BAB may still have a beneficial impact on students as far as it increases their participation in breakfast programs overall; however, this study was unable to identify specific students who might benefit most from this.
- Anderson et al. (2018) examined whether the quality of school meals affects student achievement in California. The study used longitudinal data from all California (CA) public schools (elementary, middle, and high schools) on school-level breakfast and lunch vendors and school-by-grade-level standardized test results over five years, (2009-2013) to compare schools that contracted with healthy food vendors to those that used standard vendors.[34] The results showed that switching to a healthy meal vendor was associated with a 0.036 standard deviation increase in test scores, relative to in-house meal preparation. There was also modest evidence of a larger effect for economically disadvantaged students, as defined by eligibility for free or reduced-price lunches. These findings suggest that nutritional quality of school meals is important for student achievement, although there was no impact on student obesity rates.

with income equal to or below 130% of the poverty guidelines) are eligible for free meals; while other students receive reduced-price meals.

[34] The nutritional quality of vendor school lunches was measured using an enhanced version of the Healthy Eating Index (HEI). The research team considered additional points for healthy options that exceeded USDA requirements (e.g., salad bars) and subtracted points for unhealthy options (e.g., fast foods, certain processed foods, and high-sugar foods. A vendor was classified as healthy if its HEI score was above the median for all vendors in the sample.

Evidence from review studies:

- Findings from a systematic review (Cohen et al., 2021) which included 47 published papers and government reports in economically developed countries (including 8 cluster RCTs and 28 quasi-experimental designs) showed some evidence of positive impacts of universal free school meals on academic performance; however, the results were mixed. Most studies examining universal free school meals that included **free lunch** found positive associations with diet quality, food security, and academic performance. However, there was mixed evidence from the studies examining only universal free **breakfast**. In addition, some studies found improved attendance in relation to universal meal programs, but other studies showed improvements only among higher-risk populations (i.e. lower income; food insecure). Overall, this review concluded that universal free school meals are associated with positive outcomes, particularly in the presence of strong nutrition guidelines and standards.
- A rapid review of evidence on impacts of school meal programs in high-income countries by McGill et al. (2020; also described in Section 7.1) included 12 studies with cluster RCTs and quasi-experimental design, 6 longitudinal studies and 19 surveys and cross-sectional studies. Findings indicated a number of positive health-related and social outcomes for school meal participants; however, the evidence on the impact of school meal programs on *educational outcomes* was mixed. For instance, there was little impact overall on school attendance across the reviewed studies; and only half of the studies found a positive association between participation in school meal programs and academic performance, although findings appeared to be more promising for adolescents.

Summary: *School food programs are limited in Canada and few studies have considered academic performance variables as quantitative outcome measures. Results of many studies from the US support the positive association between school meal programs and students' academic performance. Research also suggests that universally accessible programs help to increase participation, which may enhance the academic benefits of school food programs. Further research is needed to compare the efficacy of school lunch and breakfast programs.*

8.4 Economic benefits of school food programs

Besides the benefits of school programs for student academic achievement, health, and well-being, they may also lead to economic benefits for local communities and nations. Serving local food in school food programs (e.g., through local procurement targets) results in increased investment in the local economy and can impact regional food production, local business earnings, long-term gross domestic product, and the creation or sustainment of part-time jobs (Food Secure Canada, 2019). The preliminary results from two case studies on the economic impact of school food programs in the US strengthened the call for 'farm to

school'[35] stakeholders, with strong relationships to local producers (Christensen et al., 2017). Ruetz and Fraser (2019) found that if Canada followed the 'farm to school' approach where 30% of funds are spent on local agriculture, then a $1.6 billion investment could contribute $4.8 billion in domestic food purchases by 2029. In addition, the potential employment impact of investing in national school food program would include the stimulation of as many as 200,000 new jobs to run the program, including food service workers, dietitians, government staff and local coordinators (Ruetz & Fraser, 2019).

More importantly for public health, research shows that child nutrition behaviors developed early in life persist into adulthood (Craigie et al., 2011). Therefore, greater investment in school food programs for children and youth could help reduce preventable costs of poor diet and nutrition-related disease that may occur later in life (Ruetz & Fraser, 2019). One study found that unhealthy eating contributes to a significant economic burden in Canada, similar in magnitude to the burden of smoking and even larger than physical inactivity (Lieffers et al., 2018). The researchers estimated the economic burden of chronic diseases (e.g., type 2 diabetes, cardiovascular diseases, cancers) attributable to unhealthy eating and found that not meeting the Canadian food recommendations was responsible for CAD$13.8 billion/year (direct health care: CAD$5.1 billion, indirect: CAD$8.7 billion).

However, evidence on the specific economic costs and benefits of school meal programs is lacking. For example, the review of evidence on the impacts of school meal programs conducted by McGill et al. (2020) did not find any economic evaluations of school meal programs that targeted disadvantaged students.

Results from one study suggest that interventions to improve the nutritional quality of school meal programs can be highly cost-effective, even when the program has only a modest impact on student achievement. After cost-analysis and comparing with other interventions to improve students' test scores, the results showed that the test score gains from contracting with a healthy meal provider for school food programs, while modest in magnitude, come at very low cost compared to in-house meal preparation. Specifically, the researchers found that it would cost about $222 per year to raise a student's test score by

[35] "Farm to school – programs, policies, or interventions intended to enrich the connection communities have with fresh, healthy food and local food producers by changing food purchasing and education practices at schools and early care and education settings. Farm to school implementation differs by location, but always includes one or more of the following three core elements of farm to school: (1) Procurement: Local foods are purchased, promoted, and served in the cafeteria or as a snack or taste-test; (2) Education: Students participate in education activities related to agriculture, food, health, or nutrition; and (3) School gardens: Students engage in hands-on learning through gardening. Farm to school empowers children and their families to make informed food choices while strengthening the local economy and contributing to vibrant communities." (Christensen et al., 2017, P. 4)

0.1 standard deviations through switching from in-house meal preparation to a healthy meal provider, which is several times lower than a variety of benchmark estimates.[36]

Summary: *School food programs have economic benefits for local communities. Healthy food programs at schools can be a very cost-effective intervention to increase students' test scores compared to other interventions. School food programs that meet the Canadian food recommendations can help to prevent some of the direct and indirect costs to the government of chronic diseases in adulthood.*

8.5 Other benefits of school food programs

In addition to the potential educational and economic benefits of school food programs, there may be other health and social benefits as well:

Health benefits:

- One literature review (McGill et al., 2020) showed that participation in school meal programs that were based on nutrition guidelines was associated with a healthier diet, such as healthier eating behaviours, increased fruit and vegetable consumption, and reduced nutritional inadequacy of diets.
- Results of a review in Canada showed that school-based snack programs increased the acceptance and willingness to try new foods, vegetables, and fruits, however, it did not change home consumption.
- There is a lack of evidence on the impact of school food programs on body mass or obesity rates.

Social and behavioral benefits:

- Evidence has shown social benefits of school food programs for children, including increased socialization, social contact, friendship development and peer connectedness from eating together, learning to be responsible, working with adults, and developing a community network (Everitt et al., 2020; McGill et al., 2020).
- Other benefits associated with universal free school meals include reductions in students' behavioural incidents (e.g., fights) and suspensions (Cohen et al., 2021; Altindag et al., 2020) and a decrease in discipline infractions after implementing school breakfast programs (Cuadros-Meñaca et al., 2022).

Overall, students in schools that provide food programs and nutrition education have more opportunities to learn about and practice healthy eating through available foods and beverages. A healthy school nutrition environment that provides nutrition education and messages about food in the cafeteria and throughout the school campus can help to support health and academic success (Michael et al., 2015).

[36] In the Tennessee STAR class size reduction experiment, it cost $1368 per year to raise a student's test score by 0.1 standard deviations.

Finally, school food programs, particularly those that incorporate local foods, have the potential to improve students' food literacy and knowledge about sustainable food systems, including where food comes from, choosing local and sustainable food, minimizing food waste, and composting (Food Secure Canada, 2019). School food programs can also promote food skills as an important component of food literacy. According to Canada's Dietary Guidelines, building basic food skills, such as the ability to prepare nutritious meals and snacks, can contribute to improved food choices and eating behaviors among children and is an essential component of strategies to support life-long healthy eating habits (Health Canada, 2019).

8.6 Challenges and recommendations for school food programs in Canada

Challenges related to school food programs in Canada include challenges with evaluation of programs as well as existing barriers and limitations of the programs themselves.

A scoping review by Everitt et al. (2020) showed that overall, the breadth and depth of data on school food programs in Canada – particularly longitudinal data – is lacking, which limits the ability to determine best practices and recommendations. There is also a need for more consistent and reliable measurement tools to monitor and evaluate school food environments and programs in Canada. Given the diversity of existing programs and the complexity of school environments, there is heterogeneity in existing tools and no standardized validated method of evaluation currently exists (Everitt et al., 2020).

One barrier to school food program participation that has been identified in the literature is the potential for stigma associated with using such programs. Therefore, it is important to consider health inequities and ways of minimizing any stigmatization and social exclusion of families experiencing food insecurity through school food programs (McIsaac et al., 2018). Researchers and other stakeholders have highlighted the strengths of **universal** food programs, which ensure that food is accessible to all students regardless of their level of food security, rather than targeting specific students. For example:

- Accessibility is cited as one of the criteria for municipal funding of student nutrition programs in the city of Toronto, which states that programs must be universally accessible and non-stigmatizing to ensure that all children feel welcome (Muthuswamy, 2012).
- Universal programs also help to remove any financial barriers to participation, allowing more children to access nutritious food at school who may not have been able to pay (Muthuswamy, 2012).
- The aim of increasing program participation is supported by evidence from a systematic review of universal free school meals, in which almost all available studies (14 out of 15 studies) found a positive association between universal school meals and participation rates (Cohen et al., 2021). However, despite these potential benefits of universal, free school meal programs, they are not widely available in many countries at the global level (Cohen et al., 2021).

Other limitations of school food programs in Canada as identified in this review are centered on considerations of culture and economic sustainability (Everitt et al., 2020):

- **Culture** – while many programs have broadened to address issues such as environmental sustainability, few have focused on culture, cultural diversity and the importance of providing culturally appropriate foods in school programs. Greater consideration of the local culture and involvement of the community are important elements in building a school food program that helps to promote health equity.
- **Economic sustainability** – many programs identify financial constraints as a limitation. This includes having sufficient resources to procure food, recruit enough staff, build capacity, and monitor and evaluate the program. In addition, programs that rely on a limited number of volunteers may not be able to run as frequently as institutionalized programs.

In the Canadian context, it would be important to consider these elements not only in the development and implementation of programs, but also when designing or adapting tools to understand or evaluate their impact.

Everitt et al. (2020) developed a framework to guide schools in Canada on components that should be considered in the development of their food programs in order to maximize program benefits. The three main components identified in the framework are shown in Figure 1 below.

Figure 1: Considerations for school food programs (Everitt et al., 2020)

Consistent with the recommendations noted above, Hernandez et al. (2018) have also identified a set of key characteristics for a national school food program in Canada, based on the available national and international evidence (presented in Appendix 3). These include universality, health promotion, respect for culture and local conditions,

sustainability, and multi-component programs. These characteristics have helped to inform the current set of guiding principles for school programs endorsed by the Coalition for Healthy School Food – the largest school food network in Canada. These principles are listed in Appendix 4.

9.0 Impact of the COVID-19 Pandemic on Children's Nutrition

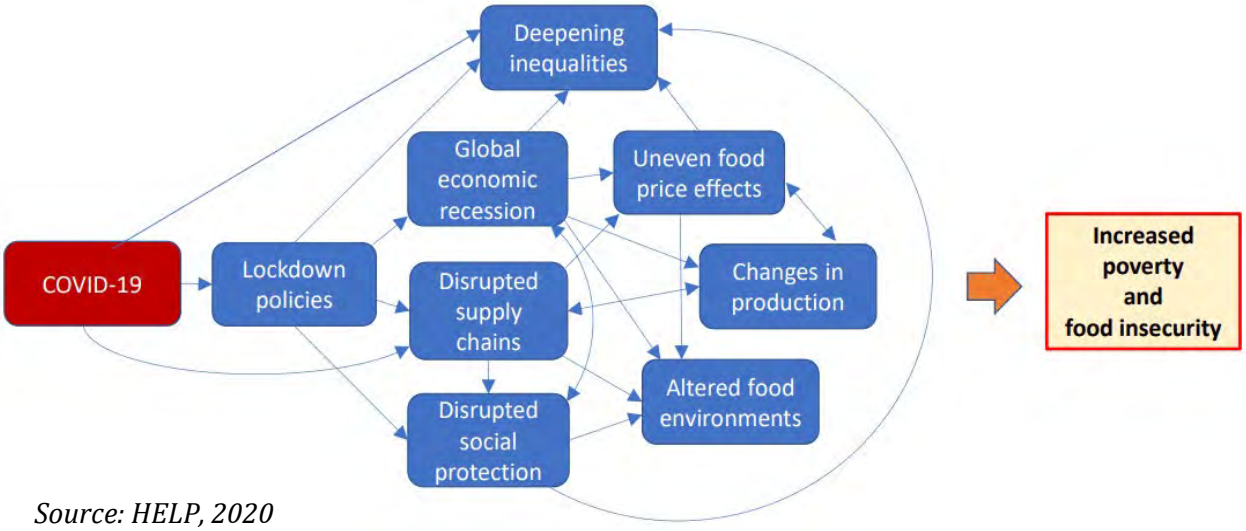
9.1 Food security during the COVID-19 pandemic

Global overview:

According to the World Bank (2022), a number of recent global factors – including supply chain disruptions and the continued economic impacts of the COVID-19 pandemic – have led to all-time record high food prices, triggering a global crisis that threatens to reverse years of development gains. Two years into the pandemic, the number of severely food-insecure people worldwide had reportedly doubled, with further increases projected by the end of 2022 (USGLC, 2022). The implementation of strict public health measures to control the spread of the virus led to a serious slowdown in economic activity with cascading effects on food systems and people's food security and nutrition (HELP, 2020). Figure 2 depicts a brief overview of these dynamics.

The COVID-19 pandemic and its associated public health measures have impacted food security and nutrition for people worldwide, but children in particular have experienced severe impacts, including increased rates of child hunger and malnutrition. For example, the World Food Program (2020) estimated that 370 million children in April 2020 (during the peak of school closures in the first wave of the pandemic) and 234 million in May 2021 lost access to school meals due to school closures in the wake of the pandemic. Estimates also suggest that COVID-19 disruptions and supply chain issues may push an additional 9.3 to 13.6 million children into acute malnutrition (USGLC, 2022).

Figure 2. The dynamics of COVID-19 that threaten food security and nutrition



Source: HELP, 2020

Evidence from Canada:

Rising food costs are also a major concern in Canada, where the price of food rose by nearly 10% from April 2021 to April 2022, according to data from the Consumer Price Index (Statistics Canada, 2022). As a result, one in five Canadians reported in 2022 that they are "somewhat" or "very" likely to obtain food or meals from community organizations in the next six months, and this percentage was much higher for households with at least one child under the age of 18 compared to households without children (13% vs. 5% reported being "very" likely to obtain food from community organizations) (Statistics Canada, 2022). These food cost increases have come during a period when many Canadians have been forced to partially or completely stop working due to the pandemic, often resulting in temporary or longer-term income reductions. Consequently, many households – especially single-income households – have less income to allocate towards food, putting them at greater risk of food insecurity and associated health problems.

In Canada, data on household food security during the pandemic is available from cross-sectional surveys:

- The Canadian Perspectives Survey Series 2 – a cross-sectional, online survey[37] of Canadians aged 15 years or older residing in the ten provinces conducted in the early months of the pandemic (between May 4 to 10, 2020) showed that only 14.6% of households reported experiencing some level of food insecurity[38] in the last 30 days (Polsky & Gilmour, 2020). The findings suggested that households with children were more likely to report food insecurity compared to households without children: only 32.5% of households that were food secure were households with children, compared to 44% of marginally insecure and 45% of moderately insecure households. Findings also showed that recent experiences of household food insecurity were associated with poorer mental health outcomes.
- Data from the population-based Canadian Community Health Survey (CCHS) – a cross-sectional survey collected among 26,831 respondents across the 10 provinces from September to December 2020 – was used to estimate levels of household food

[37] Note that this sample did not include individuals without access to Internet and some of the groups that are most vulnerable to food insecurity (i.e., the homeless population, residents of the territories and remote regions, and on-reserve First Nations people).

[38] Household food security status was assessed using the six-item Household Food Security Survey Module (HFSSM) short form – a subset of the 18-item HFSSM, which has been used to monitor food insecurity in Canada since 2005. Questions asked about the household food situation in the past 30 days.

security[39] in comparison to pre-pandemic levels (Polsky & Garriguet, 2022). Results showed that overall estimates of food insecurity were lower in the fall of 2020 (during the second wave of the pandemic) compared to 2017/18 estimates (9.6% reported some level of food insecurity in the last 12 months in 2020, vs. 12.6% in 2017/18). Based on these findings, it is unclear whether the pandemic exacerbated levels of household food insecurity during the time frame specified.

- A systematic review synthesizing evidence on the prevalence of household food insecurity in Canada during the COVID-19 pandemic reported findings from four studies that collected data between April 2020 and April 2021 (Idzerda et al., 2022). Results across studies showed the reported prevalence of household food insecurity (including marginal to severe levels) ranged from 14% to 17%. Two studies reported higher prevalence of food insecurity among households with children compared to households without children; however, these differences were not tested statistically. Overall, evidence indicated that total household food insecurity may have increased during the pandemic, especially in populations that were already vulnerable (i.e., households with children and those who are job insecure); however, the amount of evidence was limited and the authors suggested that results should be interpreted with caution due to a serious risk of bias across the studies.

Evidence from the U.S.:

- In June 2020, Patrick et al. (2020) conducted a national survey of parents with children under 18 in the US. The results showed an increase in food insecurity during the first months of the pandemic: the proportion of parents reporting any level of food insecurity increased from 32.6% in March 2020 to 36.0% in June 2020, and the proportion experiencing moderate or severe levels increased from 6% to 8%.
- Data from the 2020 Household Pulse Survey conducted among a nationally representative sample in the US (n = 20,543 households with children) were used to examine determinants of household food insecurity as well as transitions during the pandemic (Morales et al., 2021). Results revealed that the sociodemographic factors contributing to high levels of household food insecurity during the pandemic were similar to those that existed before the pandemic (i.e. low-income households; racial/ethnic minorities; households headed by women). Findings also showed that relatively disadvantaged households were more likely to transition into food insecurity during the pandemic. For example, among households with children that were previously food-secure but moved into food insecurity during the pandemic (n= 13,366), the head of the household was more likely to be a woman; Hispanic,

[39] Household food security status was assessed using the full 18-item scale of the Household Food Security Survey Module (HFSSM). Questions asked about experiences of food insecurity in the last 12 months.

younger, less healthy (based on a self-reported measure[40] of respondents' general health status), and less educated.

- A longitudinal study conducted during the early months of the pandemic used survey data from two sources[41] to examine the impact of the COVID-19 crisis on low-income Americans and racial disparities. Five repeated online surveys of the Supplemental Nutritional Assistance Program (SNAP) from April to June 2020 found that food insecurity and debt accrual grew more prevalent over this time period, and job losses compounded. The results also revealed significant racial disparities in the economic impact of the pandemic within the low-income population overall; however, there were differences across the various indicators of food insecurity. For example, data from one survey showed a higher percentage of White households reporting food insecurity in June (68%) compared to Black and Latinx households (about 60%); while another survey showed a greater increased in food insecurity among Black and Latinx households (Enriquez & Goldstein, 2020).

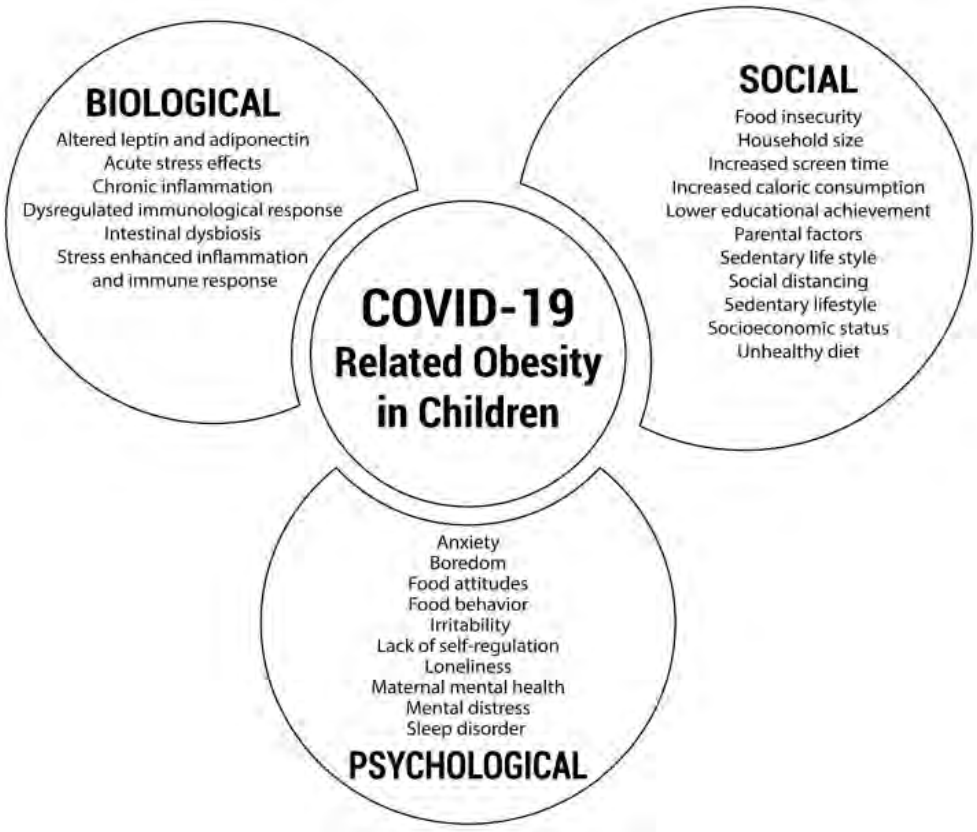
9.2 Child obesity during the COVID-19 pandemic

The rapid spread of COVID-19 led governments around the world to implement strong public health measures to reduce transmission, including lockdowns, reduced access to public services, and school closures; however, these mitigation measures have had unintended negative consequences as well, especially for children. For example, children lost access to structured school activities and school-based supports, including food programs and physical activity programs, and their regular routines and eating habits were disrupted. Given the importance of healthy nutrition and eating behaviours for child health and development as shown throughout this report, it will be imperative to monitor the impact of these COVID-related measures and disruptions on child health and nutrition outcomes to inform effective prevention and intervention strategies for post-pandemic recovery.

Tsenoli et al. (2021) applied a biopsychosocial model to understand factors that influence COVID-19 pandemic-related obesity in children, as presented in Figure 3. This study suggested that the collision of both the rising childhood obesity pandemic and the COVID-19 pandemic has magnified the risk factors for obesity, resulting in a greater risk of developing adiposity and worsening pre-existing obesity. The authors suggest that weight management among children during and after the pandemic should be a priority, and all stakeholders must critically review the biopsychosocial needs of children to reduce the negative impact of both obesity and COVID-19.

[40] Specifically, a continuous measure of general health status on a scale from 1 (poor) to 5 (excellent).
[41] Data were from the Supplemental Nutritional Assistance Program (SNAP) and U.S. Census Bureau Household Pulse Survey.

Figure 3. Biopsychosocial factors that influence COVID-19 pandemic related obesity in children (Tsenoli et al., 2021)



This 'collision' of childhood obesity and COVID-19 has been described as a '*syndemic*' (La Fauci et al., 2022). The notion of a syndemic was first introduced by Merrill Singer in the 1990s to identify adverse health events in which biological and social factors interact to enhance an individual's vulnerability and worsen health outcomes (Singer et al., 2021; La Fauci et al., 2022). Other researchers have also included rising food insecurity as part of the syndemic, such that obesity, food insecurity, and COVID-19 all occur together and increase the adverse consequences of each other, with a disproportionate impact on vulnerable populations (Pryor & Dietz, 2022). According to these authors, the interaction of these three overlapping pandemics calls for a common solution. For instance, reducing food insecurity would help decrease the prevalence of obesity, which would simultaneously decrease the frequency and severity of negative COVID-19-related outcomes.

While some reports indicate a rise in child obesity during the pandemic, evidence from large-scale studies is still limited, and data collection on the impact of the pandemic on children's eating habits in Canada – including how these changes may have affected educational outcomes – is still ongoing (e.g. CIHR, 2022). However, some of the available evidence is summarized below:

- A review of nine published papers from cohort or cross-sectional studies published up to November 2020 showed that the majority of adolescents and young adults (aged 5-25) have increased their food intake and gained weight during the pandemic. Changes in dietary behaviours, including an increased number of meals, increased food intake and unhealthy food choices, including fried foods, potatoes, meat and sugary drinks, were noted during the COVID-19 pandemic compared to the period before lockdown (Stavridou et al., 2021).
- Data from the Children's Hospital of Philadelphia Care Network was used to compare average obesity rates among patients aged 2 to 17 years from the period of June-December 2019 to June-December 2020 (Jenssen et al., 2021). Results showed that obesity prevalence increased on average, from 13.7% in 2019 to 15.4% in 2020. The increase was larger for children aged 5-9 years, those with low-income, and those who were Hispanic or Black – suggesting that pre-existing disparities in obesity may have widened during the pandemic.
- Longitudinal data on a sample of over 400,000 children aged 2 to 19 years collected by the CDC from 2018 to 2020 showed that average BMI nearly doubled during the pandemic period compared to pre-pandemic rates (Lange et al., 2021). The increase in BMI was greater among younger children (aged 6-11) and among those with overweight or obesity prior to the pandemic.

Summary: *The COVID -19 pandemic has affected food security globally. The results of surveys from the US and Canada demonstrate that food insecurity has increased among households with children during the pandemic. Weight gain and obesity among children and adolescents has also been observed in different countries, due to significant changes to children's daily routines and eating habits. However, it may be too soon to capture enough evidence on the effects of greater food insecurity and obesity during the pandemic on children's academic achievement. It will be important to identify and support those households most at risk for food insecurity and plan for effective monitoring and evaluation of the short- and long-term impacts of the pandemic on children's health and nutritional needs and behaviours.*

10.0 Limitations of the Available Evidence

There are a number of limitations in the existing literature on the association between nutrition and academic achievement which constrain our ability to understand and determine evidence-based practices and policies. Some of the gaps identified in this review include a lack of studies from Canada and a lack of longitudinal studies to examine the temporal relationship and longer-term impacts of nutrition programs or interventions. The heterogeneity across studies, including the diversity of school food environments and programs, also makes it more challenging to make comparisons and draw conclusions from the findings. Conclusions are also limited due to methodological and design issues across many studies, as most studies examined associations between nutritional variables and outcomes through surveys and cross-sectional designs, and may not have controlled for other potential confounding factors that may be linked to nutrition and school performance (i.e. stress, anxiety, depression). A higher level of evidence (i.e. from randomized controlled trials) would be needed to identify causal relationships and support efficacy of any intervention. For example, in many studies, it cannot be determined whether healthy eating habits lead to better academic performance, if academic achievement leads to healthier dietary behaviours, or if some other factor(s) influences both diet and achievement.

Differences between study methods and measurements, including measures of academic performance (i.e. self-reported vs. school board data) and the lag time (day or year) between the introduction of school food programs and effects on academic performance, are other limitations of existing studies. In addition, many of the reviewed studies assessed only a single dietary behaviour/aspect of diet, such as breakfast consumption, and did not consider the broader concept of dietary intake. There is also a lack of strong evidence comparing the impacts of different types of school food programs (i.e. breakfast vs, lunch programs) on students' academic performance.

In the recent context of the COVID-19 pandemic, more research is also needed to examine the short- and long-term effects of the pandemic on children's academic achievement through malnutrition pathways (undernutrition due to food insecurity and overweight and obesity).

11.0 Conclusion and Recommendations

Food insecurity is a serious and growing problem for children in Canada – approximately 1 in 5 children (19.6%) under 18 years of age (over 1.4 million children) currently live in households affected by some level of food insecurity, and this proportion has increased over the last decade. Food insecurity is a key driver of health inequities, with considerable negative consequences for child health, development, and well-being. In Canada, rates of food insecurity are disproportionately higher among certain populations or regions, including households with children, Black and Indigenous children, and those living in the northern territories of the country. Rising food prices and food shortages on top of the ongoing economic impacts of the COVID-19 pandemic have exacerbated disparities in food

access and security, threatening a global food crisis. There is an urgent need for effective policy responses to address food insecurity in Canada.

There is a clear link between health and education, and this includes healthy eating. As shown in this report, evidence from several studies supports the relationship between students' academic achievement and various nutritional factors, including household food security, healthy diet and avoiding junk foods, eating breakfast, and lower rates of obesity. Therefore, an increased focus on programs and policies to reduce food insecurity and improve healthy eating behaviours as well as food literacy and food skills among children and youth will not only benefit children's overall development, but may also have a positive impact on learning trajectories including educational and employment outcomes.

One potential opportunity to improve children's health, well-being, and productivity is through enriching the school food environment by enhancing nutrition education and expanding school food programs. There is substantial evidence from scientific studies that supports the efficacy of school food programs, although the effect size tends to be moderate, and there is a lack of studies that have evaluated academic achievement as an outcome measure. Evidence also supports the economic benefits of healthy school meal programs, demonstrating that programs which provide healthy food options are a cost-effective intervention for increasing academic performance, and can also improve local economies. However, despite the potential benefits of school food programs, they remain somewhat limited in Canada due to a lack of sufficient resources and the absence of a national program.

Based on the available evidence, the following policy recommendations relevant to the Canadian context have been identified. These strategies are especially important in the context of current COVID-19 pandemic response and recovery planning, given the adverse effects of the pandemic on household food insecurity and child health and nutrition.

1. There is a need for more effective policies by federal and provincial/territorial governments to reduce food insecurity and increase food access among Canadian children and families. Policies should focus on the root causes of food insecurity, such as income-based interventions to address poverty. Households at greater risk should also be identified and targeted, such as those that are women-headed, racialized, marginalized, of a lower SES, those relying on social assistance, and households with more children.

2. The expansion of school food programs as part of a multisectoral approach to improve children's nutrition and health behaviours – and consequently academic achievement – should be a national priority. Evidence suggests that universally accessible school food programs are essential for reducing stigma and boosting participation among students. Programs should also incorporate considerations of culture, the local environment, and sustainability – both environmental and economic sustainability.

3. There is a need for more research to address some of the limitations in the literature on the issue of child nutrition and academic achievement in Canada. This includes research to understand and evaluate how governmental policies and practices shape the prevalence and severity of household food insecurity, as well as the impact of such policies on outcomes relevant to child health and development. Research to evaluate the effects of policies and programs such as school food programs should also include strategies for long-term monitoring and evaluation to identify areas in need of improvement and inform future policies.

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Appendix 1: Overview of School Meal Programs in High-Income Countries

Location	Program name/ organization	Description	Population	URL
SA, Australia	School Breakfast Program School Lunch Program. Foodbank South Australia.	Breakfast foods are delivered to all registered schools in SA. Foods include cereal, long-life milk, canned fruit, Vegemite, jam, fresh fruit, and bread. Program also helps provide fruit bowls in classrooms and common areas around the school. Students who attend breakfast club can make a sandwich for lunch and also pick up fruit/muesli bars for snacks.	Disadvantaged students. The lunch program is available to all students who don't have lunch. School teachers can encourage students to go to breakfast club and make lunch.	Breakfast program: https://www.foodbank.org.au/SA/schoolbreakfast/?state=sa Lunch program: https://www.foodbank.org.au/SA/schoollunchprogram/?state=sa
NSW and ACT, Australia	School Breakfast for Health Program. Foodbank.	Available in 100 registered schools across NSW and ACT. Provide a nutritious breakfast.	Disadvantaged students.	https://www.foodbank.org.au/homepage/who-we-help/schools/?state=nsw-act
VIC, Australia	School Breakfast Club. Foodbank in partnership with the Victorian Government.	Available in 1000 Victorian Government schools. Provide nutritious breakfast to students. Lunches and take-home holiday supply packs have been added to the program.	Disadvantages students in Government schools.	https://www.foodbank.org.au/homepage/who-we- help/schools/?state=vic
QLD, Australia	School Breakfast Program. Foodbank.	Available in over 300 schools. Program supplies cereal, bread, milk, spreads and fresh fruit.	Disadvantaged students. Schools register to participate..	https://www.foodbank.org.au/homepage/who-we- help/schools/?state=qld

WA, Australia	School Breakfast Program. Foodbank.	Provides a nutritious breakfast to students.	Disadvantaged students.	
NT, Australia	School program. Foodbank.	More than a meal program as it incorporates cooking classes and can also supply personal care items. They provide fresh food and groceries for schools to provide breakfast, morning tea and lunch.	Disadvantaged students.	https://www.foodbank.org.au/homepage/who-we-help/schools/?state=nt
Australia	School Lunch Program. Eat up.	Service 250 schools around Australia. Make and deliver fresh sandwiches to registered schools.	Disadvantaged students.	https://eatup.org.au/
VIC, Australia	School Lunch Program. Carevan.	Provides local primary schools with a school lunch pack which is prepared by VCAL students.	Disadvantaged primary school students.	https://www.carevan.com.au/what-we-do/school-lunch-program/
NSW, Australia	School breakfast program. YMCA.	Provides cereal toast and fruit. Run by YMCA staff and volunteers 4 mornings per school week.	Disadvantaged students.	https://www.ymcansw.org.au/community-services/youth/breakfast-program/
SA, Australia	School Breakfast & Lunch Program. Kickstart for Kids.	Provide breakfast and lunch (sandwich) to 350 schools.	Focus on disadvantaged students.	https://kickstartforkids.com.au/breakfast/
VIC, Australia	The Tribe School Lunches Program. Salvation Army.	Provide freshly packed lunches.	Disadvantaged students.	https://www.facebook.com/salvos100thoUSndmeals/posts/the-tribe-school-lunches-program-is-a-new-initiative-run-by-the-salvos-in-ballar/1020597454790028/
Finland	Finnish School Meal System Government.	Free school meals are provided each day. Providing school meals is mandatory for municipalities. The free school lunches	All students between 6-16 years.	https://www.oph.fi/en/statistics-and-publications/publications/school-meals-all https://ec.europa.eu/jrc/sites/jrcsh/fil

		encourage students to have a balanced diet		es/jrc-school-food-policy- factsheet-finland_en.pdf
Sweden	School lunches. Government.	Free school meals are provided each day. Providing school meals is mandatory for municipalities. The free school lunches must be nutritious. Meals are hot and salad, bread, butter and milk are on the menu.	Every child between 7-16 and most students aged 16- 19 years. .	https://www.livsmedelsverket.se/en/food-habits-health-and- environment/maltider-i-vard-skola-och-omsorg/skola https://ec.europa.eu/jrc/sites/jrcsh/files/jrc-school-food-policy- factsheet-sweden_en.pdf
New Zealand	School Lunch Program. NZ Government.	A new initiative providing free and healthy school lunch daily.	Year 1-8 students in schools with high levels of disadvantage.	https://www.education.govt.nz/our-work/overall-strategies-and- policies/wellbeing-in-education/free-and-healthy-school-lunches/
New Zealand	Food for Kids KidsCan.	Food (bread, baked beans, muesli bars, yoghurt, spreads) are provided to schools weekly or fortnightly so students have access to food at school everyday.	Disadvantaged students,	https://www.kidscan.org.nz/our-work/food-for-kids
Canada	School Breakfast Program. Breakfast Club of Canada.	Provides daily nutritious breakfasts at 1887 schools across Canada.	All students in elementary and high school.	https://www.breakfastclubcanada.org/#
Canada	School Nutrition Program. Alberta Government	Students receive a daily nutritious meal.	Students at participating schools in Alberta.	https://www.alberta.ca/school-nutrition-program.aspx

Canada	Student Nutrition Program Ontario Government. Various organizations take lead in different municipalities.	Students have access to nutritious food through breakfast, lunch and snack programs. Program differs based on location because different agencies are responsible.	School-aged children and youth across Ontario.	https://www.ontario.ca/page/student-nutrition-program https://studentnutritionontario.ca/programs/
US	National School Lunch Program. United States Department of Agriculture.	Free or reduced-price lunches are available at participating schools.	All students can participate in meal program. Household income determines eligibility of child for free or reduced- price lunch.	https://www.ers.usda.gov/topics/food-nutrition-assistance/child-nutrition-programs/national-school-lunch-program/
US	The school breakfast program. United States Department of Agriculture.	Federally funded breakfast program.	Not specified.	https://www.fns.usda.gov/sbp/school-breakfast-program https://www.cdc.gov/healthyschools/npao/schoolmeals.htm
England	Free school meals. Government.	Free school lunches. Food must be nutritious.	Children whose parents receive benefits.	https://commonslibrary.parliament.uk/research-briefings/sn04195/ https://www.gov.uk/school-meals-healthy-eating-standards
Ireland	School Meals Scheme. Government	Breakfast/Snack, Lunch or Dinner may be provided. Providers apply to government for funding.	School-aged students at schools in disadvantaged areas.	https://www.gov.ie/en/service/29a3ff-school-meals-scheme/?referrer=https://www.welfare.ie/en/Pages/School-Meals-Programme.aspx

Scotland	School meals. Government.	Free nutritious lunch provided.	Every primary school student in years 1-3. Other students are eligible if they or their parents are on benefits.	https://www.mygov.scot/school-meals/
Wales	Free school meals. Government.	Free nutritious meals provided.	Disadvantaged students.	https://gov.wales/free-school-meals-coronavirus-guidance-schools
Greece	National School Lunch Program. Government	Nutritious lunch provided.	School students from eligible families.	https://www.greececsd.org/Page/525

Appendix 2: Summary of School Food Programs in Canada and Publications per Program

Province	Program name	Type	Publication date and type
British Columbia	BC Farm to School Salad Bar	Lunch salad bar	Social Research & Demonstration Corporation (2010), Grey
	New Westminster breakfast, lunch, snack programs	Breakfast, lunch & snack	Scott et al. (2017) Grey
	BC Fruit and Vegetable Snack Program	Fruit and vegetable snack	ActNow BC (2008) Grey, Context (2013) Grey, Naylor et al. (2007) Grey
Alberta	School Milk Program	Milk	1998 -peer-reviewed
	Central Alberta First Nations gardening and snack program	Gardening and snack	2015 (2 peer-reviewed), 2013 Grey
Saskatchewan	Food For Thought	Lunch & snack	2016- Grey
	Elementary School Milk program	Milk	2015 and 2016- Peer-reviewed
	School meal program samples	Breakfast, lunch, snack	2011 peer and grey
Manitoba	Manitoba Nutrition Positive	Breakfast, lunch, snack, fruit & vegetable	2011, Grey
Ontario	Child Nutrition Program	Breakfast & snack	Russell et al. (2007) Peer-reviewed
	Ontario Northern First Nations Snack Program	Snack	Skinner et al. (2012), Peer-reviewed
	Sandy Lake school-based diabetes prevention program	Lunch	Saksvig et al. (2005), Peer-reviewed
	Breakfast for Kids	Breakfast, lunch & snack	Valatis (2009), Grey
	Better Beginnings Better Futures	Breakfast, lunch, snack & garden	Edward (1998), Grey
	Feeding our Future	Breakfast	Easwaramoorthy (2012), Grey
	First Nations Fruit, Vegetable and Milk Programs	Fruit, vegetable, and milk	Gates et al. (2013) Peer-reviewed, Gates et al. (2013) Peer-reviewed, Gates (2010) Grey
	Northern Fruit and Vegetable Pilot Program	Fruit and vegetable	He et al. (2009) Peer-reviewed, He et al. (2012) Peer-reviewed, Sangster Bouck et al. (2011) Peer-reviewed, He et al. (2008) Grey
Ontario/ Alberta	COMPASS Study	Breakfast	Godin et al. (2018) Peer-reviewed, Leatherdale (2016) Peer-reviewed

Province	Program name	Type	Publication date and type
Quebec	Social and Health Survey of Children	Breakfast, lunch, and snack	Roustit et al. (2010) Peer-reviewed
New Brunswick	Healthy Minds Breakfast	Breakfast	Policy and Planning Branch (2006) Grey
Nova Scotia	Eating Well, Learning Well	Fruit & vegetable	Abrey, (2008), Grey
Newfoundland	Kids Eat Smart	Breakfast, lunch and snack	Goss Gilroy Inc. (2013) Grey
Prince Edward Island	Fruit and Vegetable Pilot Program	Fruit & vegetable snack	Taylor (2003) Grey

Source: Everitt et al. (2020)

Appendix 3: Suggested Key Characteristics for a National School Food Program for Canada

Key Characteristics	Underlying Principle
Universal	SFPs welcome all students in a school community. They are offered at no cost or subsidized cost to families and administered in a non-stigmatizing manner. In a shared cost model, payment is made in a way that ensures privacy.1Programs are promoted to ensure that all students have access to healthy food in school daily.
Health Promoting	SFPs are consistent with nutrition policies that focus on the provision of whole foods, and in particular vegetables and fruit. Nutrition policies that mandate the provision of a variety of vegetables and fruit (such as requiring lunches to include a minimum of two servings daily with variation) help to simplify the task for schools and districts. Focusing on the foods that fit within a healthy diet also provides an important modelling opportunity.
Respectful	Programs respect local conditions and needs so as to be culturally appropriate and locally adapted. Programs in diverse inner cities will look different from those in remote Northern communities, for example, and involvement by stakeholders with local experience is critical to success.
Connected	Programs are connected to local communities and work towards drawing upon local food resources where possible, supporting local producers and creating economic multipliers. Programs also engage the broader community including parents, grandparents, local businesses, and community leaders to foster sustainability.
Multi-component	Programs use an education integrated approach with curricula to incorporate food literacy (from the farm to the fork to food waste), nutrition education, and food skills. Students are involved with SFPs through hands-on food preparation, budgeting, management, and other learning to foster experiential learning (learning by doing).
Sustainable	Programs are sustainable financially and in terms of capacity-building and in response to societal changes. This means ensuring that SFP staff and volunteers receive adequate training to ensure they understand their role in teaching and role modeling for students. Funding at the local level is stable and partnerships to support the program are created. Critical to the success of SFPs is regular monitoring and evaluation, and adaptability as circumstances change. This includes ensuring financial transparency and accountability for programs at the federal and more local levels.

Source: Hernandez et al. (2018)

Appendix 4: The Coalition for Healthy School Food's Guiding Principles for School Food Programs

Principle	Description
Universal	Ensure that ALL children in a school can access the program in a non-stigmatizing manner. Over time, all children in Canada will be able to participate in a school food program.
Health Promoting	Serve tasty, nourishing and culturally appropriate whole foods, focusing on vegetables and fruits. Ensure that programs are in line with the revised **Canada's Food Guide** and that they foster a healthy food environment where students can develop a positive relationship with food.
Cost-Shared	Use federal funding to both expand on current provincial, city, parental and community funding and to initiate new programs in a cost-shared model.
Flexible and Locally Adapted	Successful school food programs reflect and respect the local context of the school and region and are connected to their local communities. Ensure that funding builds on existing programs, local knowledge, skills and relationships and that it supports different food service models, from breakfast to lunch to snacks.
Committed to Indigenous Control over Programs for Indigenous Students	Embed Indigenous Food Sovereignty in a School Food Program for Canada and negotiate funding for school food programs with Indigenous Nations and leaders.
Driver of Community Economic Development	Encourage school food programs to set local and sustainably produced food purchasing targets, which would create jobs for Canadian farmers and local food producers.
Promoting Food Literacy	Support the conditions for school food programs to be integrated into the curriculum and enable food literacy and experiential food skills education.
Supported by Guidance and Accountability Measures	Ensure that programs are guided by Canada-wide nutritional standards, conflict of interest safeguards that prevent programs from marketing unhealthy food and specific products, as well as a framework for consistent Canada-wide program evaluation

Source: The Coalition for Healthy School Food (2018). Our Guiding Principles. Retrieved from https://www.healthyschoolfood.ca/guiding-principles