The impacts of food insecurity on academic performance: How are schools mitigating this concern?

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Dedication

I would like to dedicate this work to my family. To my mother and father who have been by my side every step of the way and who have always empowered me to pursue my dreams and raised me to be who I am today. To my younger siblings, Karim and Arij, for their love, support and motivation throughout my academic career. Finally, to my fiancé Mohamed for always believing in me and enabling me to be the best version of myself. Thank you.

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Abstract

Food insecurity is characterized by the consumption of low quantity or quality foods, worrying about food supply and/or acquiring foods through socially unacceptable means (Alaimo et al., 2001). Food insecurity is associated with poor physical and mental health putting food insecure students at an increased risk of low performance on standardized assessments (Howard, 2011). This mixed methods study aimed at establishing the relationship between food insecurity and EQAO examination performance in Ottawa, and describes the strategies used to mitigate the effects of food insecurity in schools. The results unveiled that while schools use community-based interventions and provide healthful eating education to parents, food insecurity remains associated to lower test scores on the EQAO grade 3 and grade 6 standardized examinations. As such, current interventions being used within schools in Ottawa are not adequately meeting the needs of food insecure students.

Chapter 1: Introduction

Typically, clean eating refers to a diet consisting of healthful foods such as minimally processed, natural, and fresh items including fruits and vegetables (Ambwani et al., 2019) combined with low consumption of sugar-sweetened beverages and fast foods (Fryar et al., 2018). In the past decade, the notions of clean and healthy eating have become a central concept in our society's nutritional discourse (Ambwani et al., 2019; Landry et al., 2019). This is exemplified by the increasing popularity of fitness inspiration and clean eating trends across various social media outlets (Tiggermann & Zaccardo, 2015; Raggat et al., 2018). One of the factors which influence the dietary quality of individuals is their general nutrition knowledge and the availability of health promotion initiatives within their social environments (Sobal et al., 2014). However, while healthy nutritional education is important, it is necessary to understand that an individual's diet is also dependent on their ability to apply their nutrition knowledge through their daily food choices (Mete et al., 2018). For instance, one should opt for low sodium popcorn rather than packaged regular chips as a snack. Furthermore, a challenge that individuals may face to healthful eating is the experience of food insecurity. Food insecurity is defined as a lack of access to either informational or financial resources resulting in the consumption of low quality and/or quantity foods, acquiring foods in social unacceptable means such as begging or scavenging and/or worrying about food supply (Alaimo et al., 2001). As such, creating a healthy food environment requires a combined effort in which healthful nutrition education and accessibility to healthful food items are prioritized. Furthermore, interventions favouring healthful eating should be provided in schools since healthy eating interventions are most effective with youth as they are the largest consumers of unhealthy food items and typically consume a diet low in fruits and vegetables (Fryar et al., 2018).

The impacts of unhealthful food environments are significant, especially for individuals living in low socioeconomic neighborhoods as individuals living in poor food environments are 25 to 46% less likely to have healthful diets and are thus more likely to experience food insecurity (Lamichhane, et al, 2012). For example, Melchior et al. (2012) report that food insecurity predicts a two-fold increase in the likelihood of persistent childhood hyperactivity and inattention, depression and anxiety even after accounting for family socio-economic circumstances and parental mental health. Food environments are defined by the availability, affordability, and quality of food, as well as the geographical access to food (Health Canada, 2013). More specifically, food availability refers to the actual food items available in a given food environment such as supermarkets. Food affordability is defined as the non-sale cost of food items within a food environment. For instance, if a food item was part of a 50% off promotion, then affordability of the item would be determined at the pre-sale price rather than the 50% off promotional price. Food quality on the other hand refers to the state of food items in a given food environment, for instance if available food items are rotting then the food quality is poor. Finally, geographic food access is defined by the availability of food environments (e.g. supermarkets) within a one-kilometer walking radius within a neighbourhood. In Canada, low socioeconomic status neighborhoods tend to have poorer food environments (Health Canada, 2013) which puts its population at a 25 to 46% increased risk of developing metabolic diseases (Lamichane et al., 2012). In fact, food insecurity has consistently been found to be associated with poor food environments and the development of coronary heart disease, diabetes, and hypertension due to higher intake of fat, sodium, carbohydrates, red and processed meats, as well as sugar (Redmond et al., 2016; Kimani-Murage et al., 2011; Dubowitz, et al., 2012). In addition to these conditions, food insecurity also has an impact on mental health. As reported by Poole-Di

Salvo (2016), food insecurity acts as a metabolic stressor which leads to increased mental health concerns such as hyperactivity and inattention, depression, and anxiety. Combined, these findings indicate that the healthful quality of foods contribute to individual's wellbeing through their continued overall health.

Developing my passion for healthful eating

Throughout my time at the University of Ottawa, I completed two undergraduate degrees; a Bachelor of Science in Biomedical Sciences and a Bachelor of Science in Psychology. In my biomedical degree, I was introduced to the concept of social determinants of health which included the impact that socioeconomic status, education, and neighborhood environments could have on the health (in)equity of individuals (Government of Canada, 2020). For instance, when considering food security status, if an individual lives in a neighborhood with low availability of healthful foods and lacks the financial resources to obtain healthful food items then the individual's social determinants of health are considered to be contributing to their health inequity.

During my psychology degree, I was fortunate to work with Dr. Elizabeth Kristjansson on my undergraduate thesis which explored the relationship between the nutritional quality of food environments in Ottawa and the health outcomes within those neighborhoods. Through this thesis, I gained a deeper understanding of social determinants of health. My results indicated that poor neighborhood food environments were associated to significantly higher indices of adverse health outcomes. More precisely, the study revealed that food environment quality was negatively correlated to diabetes ($p < 0.01$), chronic obstructive pulmonary disease ($p < 0.01$), and even mental health visits ($p < 0.05$). In addition, my thesis demonstrated that the lowest socioeconomic status neighborhoods in Ottawa had significantly worse quality ($p < 0.01$) and

availability ($p < 0.05$) of healthful food items than high socioeconomic status neighborhoods. In this way, it becomes apparent that individuals living in low socioeconomic neighborhoods are more likely to be surrounded by a poor food environment quality and are at an increased risk of experiencing food insecurity and its associated adverse health outcomes.

Beyond my studies, I also have personal experience on how healthful eating and access to nutritional resources can impact one's wellbeing. In 2012, I was diagnosed with celiac disease after experiencing severe fatigue, weight loss and nausea for several months. I was fortunate to have access to a dietitian through my medical insurance and worked closely with her on changing my diet by following a gluten-free nutritional plan which slowly re-established my micronutrient levels and increased my energy levels allowing me to take up my daily activities. The impacts of a healthful gluten-free diet have also been shown to significantly improve the quality of life and health of many other individuals living with celiac disease (Mustalahti et al., 2002), reiterating the vital role that access to nutritional education and healthful foods can play on individual's physical and psychological health.

In 2018, I had my second experience which stressed the importance of nutrition in supporting overall well-being. In September of that year, I was diagnosed with Chiari Malformation, a brain malformation which causes severe headaches, dizziness, and muscle weakness among other symptoms. This condition decreased my quality of life as I endured multiple consecutive weeks with severe headaches and other associated symptoms which made it very difficult for me to be actively engaged in my professional and academic life. Upon talking to my dietitian, I was informed that she had read a study (Liu et al., 2017) where neurologic conditions and the associated pain could be managed through a healthful and balanced ketogenic diet as this dietary plan reduced inflammation in the brain. I was again fortunate to have access

to a medical insurance policy which covered dietitian services and ever since I have been following my dietitian's customized gluten-free ketogenic meal plans which has allowed me to carry out my regular activities without many exceptions. I am cognizant that my socioeconomic status and educational path have allowed me not only to access healthful food items in the grocery store and to make educated nutritional choices, but it has also allowed me to receive in-depth nutritional education aimed at alleviating my specific symptoms and increasing my quality of life. This is evidently not the case for a proportion of the Canadian population as recent surveys show that 1 in every 8 households, or 4.4 million Canadians, are food insecure (Tarasuk & Mitchell, 2020). Nonetheless, these experiences provided me with personal insights on the impacts of healthful nutrition which have only furthered my passion on studying equitable access to healthful foods and nutritional education in Canada.

Developing my interest in standardized testing

During my psychology undergraduate degree, I was introduced to the field of psychometrics by Dr. Chris Beauchamp, vice-president of psychometrics at a private firm in Ottawa. In his course, Dr. Beauchamp outlined how psychometric principles could be used to build standardized assessments for licensing and credentialling purposes. Following the end of the course, I was offered a student summer position as an Exam Development Specialist at his psychometric firm which eventually turned into a permanent part time position with the company. In this capacity, I gained hands-on experience on how standardized assessments were constructed starting from the blueprinting process, the item writing groups, and ending in the exam and key validation meetings. My primary role consisted in facilitating these meetings with professors from various universities across Canada as to develop certification exams in the healthcare sector. During these meetings, I heard many anecdotal accounts of professors'

experiences working with students from disadvantaged socioeconomic backgrounds. The professors were of the opinion that these students experienced additional roadblocks compared to more advantaged students since they had to work more hours outside school, provide for family members, among other duties. Upon reflecting on these anecdotes, it became clear to me that standardized testing could play a role in furthering achievement gaps between groups of opposing socioeconomic backgrounds, an association which has been demonstrated in the literature (White et al., 2016). In this way, I began to realize that standardized assessment methods may be an inequitable form of performance evaluation which could have lasting negative impacts on the professional and academic futures of low socioeconomic status students.

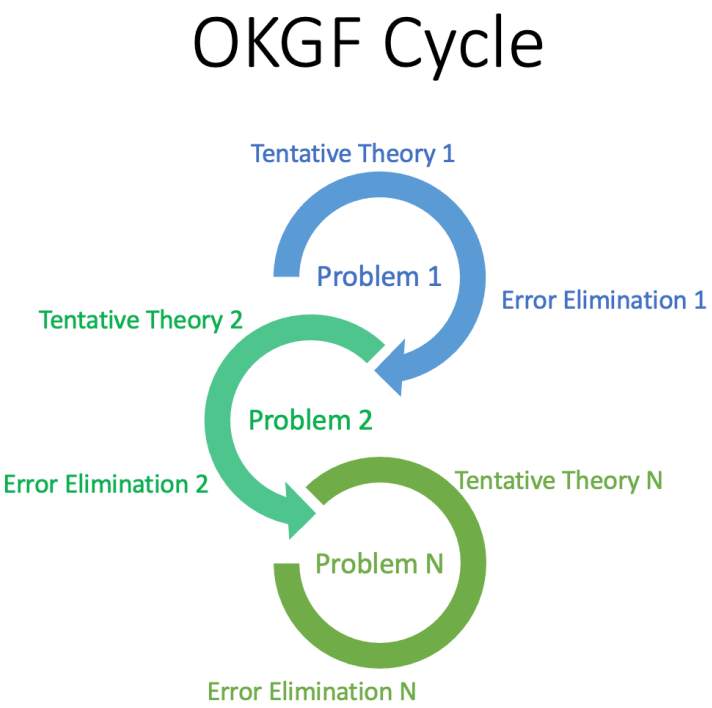
Another factor that become evident in my role as an Exam Development Specialist was that asking subject matter experts, most often professors, to write examination questions with a minimally competent candidate in mind could automatically create bias against disadvantaged and marginalized student populations, ultimately impeding their success. In the context of exam development, a minimally competent candidate refers to an exam taker who possesses the minimum knowledge to perform a given profession's duties adequately as determined by subject matter experts. In one of the item writing sessions I facilitated, I recall one professor stating that a student with a history of clinical anxiety and panic attacks should not be allowed to apply for accommodation for an MRI technician standardized licensing examination due to the nature of the job. In this professor's opinion, a minimally competent MRI technician should not let their anxiety permeate onto their performance on the standardized licensing examination, an assessment which would determine whether or not that student could gain employment after graduation. The granting of testing accommodation, for the professor, was evidence enough that the student was unfit for the clinical setting and thus did not meet the requirements of a

minimally competent candidate. Having analyzed the results of my undergraduate psychology thesis and experienced the benefits of healthful eating myself, I was struck by the notion that individuals living with food insecurity are not only typically of lower socioeconomic status which already places an economic barrier to academic success but are also at an additional risk for the development of adverse mental and physical health outcomes as a result of food insecurity, one of which is anxiety and depression (Melchior et al., 2012). Upon researching on the psychological impacts of test taking, I found a study describing the relationship of testing anxiety and examination performance. According to Cassady and Johnson (2002), test taking in itself elicits varying amounts of physiological arousal (anxiety) in individuals. Moderate physiological arousal is correlated to higher performance on standardized examination while high physiological arousal is found to have a stable negative impact on performance (Cassady & Johnson, 2002). Reflecting on these findings, I began contemplating whether food insecure students, already experiencing higher baseline anxiety levels (Maynard et al., 2019), and who experience the same moderate testing anxiety as their food secure counterparts, may display a higher overall physiological arousal resulting in decreased performance on standardized assessment methods. Through these personal and professional experiences, I became increasingly interested in studying the impacts of food insecurity on standardized testing through a social justice lens which emphasizes equal access to resource and the promotion of wellness amongst disadvantaged groups (Torres-Harding et al., 2012). More specifically, I wanted, and still aspire, to delve into the impacts of food insecurity status on standardized examination performance. For this reason, I decided to apply for a master's in education focused on assessment methods.

Developing my research proposal

After being accepted into the master's in education program at the University of Ottawa, I proceeded to familiarize myself with Professor Chitpin's work on decision-making of educational leaders where I came across the conceptual framework entitled the Objective Knowledge Growth Framework (OKGF) (Chitpin, 2015). The OKGF as proposed by Chitpin (2015) offers a problem-solving framework in which a given situation is first problematized as problem one or P1. Then, a first tentative theory, or TT1, is proposed to resolve the problematic of P1. As no theory fully resolves all aspect of a problem, TT1 is put through error elimination, or EE1. Through this error elimination, the areas of the problem which are not adequately addressed by the solution or which were not identified and covered by the first problem are highlighted. Following error elimination, the new areas of the issue can then be integrated in the formulation of a second problem, or P2. The cycle then repeats itself until the most adapted solution to the problem at any given time within its given context is found (see Figure 1). To provide a concrete example, one could apply the framework to address food insecurity. For instance, a decision-maker could establish their P1 as "How to address food insecurity in the school?". The decision-maker then establishes their first tentative solution, or TT1, such as "Offer subsidized food programs for students at lunchtime". The tentative solution or theory is then put into practice and the decision-maker is invited to look for downfalls in their solution through error elimination. For instance, it could be the case that due to social perception and fears of being stigmatized, food insecure children are not opting for subsidized meals during lunch. Following, the initial P1 needs to be revised to address the error in the first iteration of the OKGF. For example, the revised problem P2 could be "How to ensure that food insecure students are taking part in the subsidized food programs?".

Figure 1. The objective knowledge growth framework (OKGF) steps for decision-making.



Reading the various applications of the OKGF in Dr. Chitpin's body of work (Chitpin & Chitpin, 2017; Chitpin, 2015, Chitpin, 2008) I came to the realisation that the framework could be used to problematize the influence of food insecurity on academic performance on standardized assessment methods, effectively combining my passion for social justice and equity through improvement of food environments and my interest in psychometrics through academic assessments. To do so, I decided to focus my attention on the Educational Quality Accountability Office (EQAO) standardized examinations for Ontarian students in grades 3, 6 and 9 as I intended to study the association of food insecurity on academic performance in Ottawa which has, to date, not been done. Furthermore, in Canada there are no federal nutrition policies nor feeding programs to mitigate the effects of food insecurity within schools. Rather, each province is responsible for the development of policies and programs to manage school foods. In Ontario,

multiple ministries are responsible for school food programs. For example, the Ontario Ministry of Education released the Program Memorandum No. 150 back in 2010 which outlined the nutritional standards which must be followed for any food sold during school hours (Ontario Ministry of Education, 2010). However, the policy does not apply to foods offered to students at no cost. As such, evaluating the impact of food insecurity on academic performance and identifying strategies used to mitigate the effect of food insecurity in schools is of vital importance in order to determine gaps in Ontario's education system which may be leading to inequity of opportunities for food insecure students.

To do so while applying the OKGF, the first problem (P1) is whether food insecurity is being mitigated within Ottawa's schools. The first tentative theory (TT1) is the current food supplementation and nutritional education programs in Ottawa's schools. The theory is then put through error elimination by investigating whether a relationship still persists between food insecurity rates and EQAO standardized test scores. As this relationship has yet to be established in the literature, it is unclear whether this relationship is significant. However, if a relationship persists, then it is an indicator that the current strategies used by Ottawa's schools are not adequately addressing the needs of their food insecure students indicating the need to develop a new problematization of food insecurity in schools in order to devise a better adapted solution to addressing food insecurity within Ottawa's schools.

As such, the following chapter, written to meet the requirements of my master's thesis, employs the OKGF as its theoretical framework in order to investigate the impact of food insecurity and academic performance in Ottawa. More specifically, the aim of the study is to establish the relationship between food insecurity and academic performance and describe current school-based interventions in order to highlight the importance of new and continued

efforts to mitigate food insecurity within our schools. The article follows *Emerald Publishing* editorial guidelines and is thus approximately 6,000- 7,000 words, double-spaced, written in Times New Roman size 12 font, follows APA 6th edition guidelines and is superseded by a 150-word abstract.

Chapter 2: The Book Chapter

The impacts of food insecurity on academic performance: Are schools addressing this concern?

Abstract

Food insecurity is characterized by the consumption of low quantity or quality foods, worrying about food supply and/or acquiring foods through socially unacceptable means (Alaimo et al., 2001). Food insecurity is associated with poor physical and mental health putting food insecure students at an increased risk of low performance on standardized assessments (Howard, 2011). This mixed methods study aimed at establishing the relationship between food insecurity and EQAO examination performance in Ottawa, and describes the strategies used to mitigate the effects of food insecurity in schools. The results unveiled that while schools use community-based interventions and provide healthful eating education to parents, food insecurity remains associated to lower test scores on the EQAO grade 3 and grade 6 standardized examinations. As such, current interventions being used within schools in Ottawa are not adequately meeting the needs of food insecure students.

Introduction

In our current educational environment, individuals and institutions are evaluated and ranked based on their academic outcomes. For instance, in the United States, the *Every Student Succeeds Act* is still reliant on test scores to determine the ranking of schools (Glazerman et al., 2018). In Ontario, Canada, the Education Quality and Accountability Office (EQAO) creates and administers large scale standardized assessments to grades 3, 6, and 9 students. These scores are then used to determine whether a student is meeting the prescribed curriculum and each individual school's results are published on the EQAO website to ensure accountability of

Ontario's education system (Education Quality and Accountability Office, 2018). However, as reported by Swann (2000), school principals face challenges regarding the increased emphasis on student achievement as measured by standardized examinations as this approach has resulted in a narrowed definition of student achievement which cannot be applied to all students. In other words, when considering individual student needs, it becomes apparent that the provincial curriculum does not provide equal learning opportunities to all students (Swann, 2000). More specifically, the EQAO scores indicate that the constructivist approach to teaching employed by Ontarian schools and based on the idea of active social interactions in the classroom is only meeting the needs of a subset of students within the population (Chitpin, 2016). Furthermore, these inequitable educational opportunities negatively impact disadvantaged children's future earning potential and their ability to be economically self-sufficient in the long term (Hernandez, 1994; Levy & Murnane, 1992).

Among those whose needs may not be addressed by the current Ontario curriculum, students living with food insecurity are at a notable disadvantage. Food insecurity is characterized by the consumption of low quantity or low-quality foods, worrying about food supply and/or acquiring foods in socially unacceptable ways such as begging or scavenging (Alaimo et al., 2001). As of 2012, approximately 15.2% of Ontarian children are living in food insecure households, a prevalence which has remained more or less steady since 2005 (Tarasuk et al., 2016). This is particularly concerning since school aged children are a population whose growth and development is sensitive to nutritional stress and the experience of childhood food insecurity is highly associated with the development of adverse physical, mental health and learning outcomes (Howard, 2011; Alaimo, et al., 2001; Stormer & Harrison, 2003; Fletcher & Frisvold, 2017).

As frequently reported, food insecurity in school aged children is associated with an increase in aggressive behaviors, anxiety and hyperactivity (Howard, 2011; Kleinman et al., 1998). Furthermore, food insecure children exhibit lower self-control, low attentiveness and low task persistence, as well as disruptive classroom behaviour which hinders the effectiveness of classroom-based learning (Lu et al., 2019; Alexander et al., 1993). These effects are also shown to persist throughout the individual's lifespan and negatively impact student academic performance. In fact, Jyoti et al. (2005) report that children who enter kindergarten experiencing food insecurity have smaller increases in mathematics and reading proficiency exams in third grade. On the other end of the spectrum, food security is often associated with increased learning capacities and better overall health. In fact, healthy diets in childhood are reported as a significant contributor to enhanced learning (Florence et al., 2008). Moreover, students who consume a nutritious oatmeal breakfast perform better on cognitive tests than those who consume ready to eat cereals of the same caloric value (Mahoney et al., 2005). Thus, a child's diet quality has an impact on their overall academic performance.

There is a lack of research in Ontario related to both the impact of food insecurity on EQAO scores and its impact on school leaders' decision making. In fact, many studies investigating the relationship between food insecurity and academic performance is conducted in the United States and those conducted in Canada are primarily done in Nova Scotia (Faught et al., 2017). To date, no studies investigating the relationship between food insecurity and academic performance have been done in Ottawa, Canada. Thus, this chapter will seek to add to the Ontarian perspective by first investigating the relationship between food environment quality and academic performance on the EQAO standardized exams in Ottawa, Canada's schools and

will then seek to understand the ways in which schools are working towards mitigating food insecurity. More specifically, this chapter aims at answering the following two questions:

1) In what ways are schools working towards mitigating the issue of student food insecurity?
2) What is the relationship between Ottawa neighborhood food environment quality and academic performance on the EQAO standardized examinations?

The chapter then concludes by discussing the findings in regard to its implications for the association between food insecurity and academic performance in Ottawa, Canada.

Literature Review

According to Maslow's hierarchy of needs (Maslow, 1943), an individual must satisfy multiple needs before attaining self-actualization. The first step consists of meeting one's physiological needs which are the biological requirements for human survival such as adequate food intake. The second step necessitates attainment of one's safety needs which are characterized by stability and health (Maslow, 1943). However, the literature highlights that food insecure children are not meeting their basic physiological needs. In fact, children and adolescents living with food insecurity are often experiencing reduced healthful food availability which has a negative impact on their mental health and leads to the development of metabolic diseases (Jones, 2017; Redmond et al., 2015) ultimately impacting their chances of academic success.

Diet quality's influence on academic success

According to Florence et al. (2008), diet quality is a more significant contributor to academic performance than socioeconomic factors. In fact, the authors demonstrate that food adequacy and variety, as well as meeting the recommended servings of each food group, are

particularly important for academic performance (Florence et al., 2008). Canadian studies also reveal a negative association between food insecurity and achievement on standardized examinations (Faught et al., 2017; Roustit, et al., 2010). However, food insecure children, by definition, are often consuming suboptimal diets. A study conducted in Quebec, Canada revealed that food insecure families typically consume low nutritional and high energetic items such as white bread, potatoes, frozen foods, foods with a high sugar content and soft drinks (Hamelin et al., 2002). Furthermore, Canadian household food insecurity is associated with lower consumption of milk products, fruits, vegetables, and meats (Kirkpatrick & Tarasuk, 2008; Kirk et al., 2015). In regard to macronutrients, it is shown that low socioeconomic families living with food insecurity tend to consume less vitamin A, vitamin C, thiamin, fiber, calcium, protein, magnesium and iron (Ricciuto & Tarasuk, 2007; Kirkpatrick et al., 2008; Fung et al., 2013). The effects of such diets are detrimental to the overall health and academic performance of children. In fact, iron deficiency in children is associated with lower scores on cognitive tests and standardized examinations (Pollitt et al., 1989; Aligne & Auinger, 2001; Hlatswayo et al., 2016). It is also reported that iron improved cognitive ability in the long term while consuming “empty calories”, energetically dense but low in nutritional value, had only a short-term effect (Figlio & Winicki, 2005). Moreover, the consumption of fewer fruits and vegetables, combined with a high caloric intake from fats, increases the likelihood of failing a test (Gunter & Daly, 2013). Finally, low socioeconomic students living with food insecurity are more likely to have a high intake of sugar, soft drinks and fried foods which are all correlated to poor academic performance on standardized examinations (Fu et al., 2007; Park et al., 2012; Edwards et al., 2011; Ickovics et al. 2014).

The influence of weight status on academic success

When assessing the impact of this dietary pattern on Canadian adults and adolescents, Kirkpatrick et al. (2008) reports a positive relationship between household food insecurity and the consumption of energetically dense foods which ultimately impacts weight status over time. In fact, unhealthy diets characterized by inadequate intake of fruits, vegetables and whole grains and an increased intake of sugar and fat is identified as a fundamental factor leading to obesity and being overweight (Ebbeling et al., 2002; Nicklas & Johnson, 2004; Wu et al., 2018). In addition, Kirk et al. (2015) reveal that students living in moderately and severely food insecure households have a poorer diet quality and higher body mass index (BMI) compared to their food secure classmates. More specifically, children and adolescents living with food insecurity are more likely to develop central adiposity (Dubowitz et al. 2012). This outcome is of particular importance since being overweight or experiencing obesity is correlated with poorer school performance while food security, healthy weight and eating at fast-food restaurants one time or less a week are the strongest predictors of academic achievement (Ickovics et al., 2014). Furthermore, a Canadian study which assessed grade five students reveals that diet quality and body weight are strongly associated with quality of life (Wu et al., 2018). The impact of food insecurity on children and adolescents is not exclusive to physical health. In fact, food insecurity is consistently associated with poor overall well-being and psychological health.

The influence of food insecurity's psychological outcomes on academic success

It has long been demonstrated that metabolic stress in which the body initiates a catabolic response due to external stressors is associated with food insecurity in school-aged children, leading to impaired attention and memory processes (Pollitt et al., 1998; Melchior et al., 2012; Althoff et al., 2017). It is also believed that food insecurity generates uncertainty over the ability

to maintain an adequate food supply which provokes a stress response that could be a contributor to the development of anxiety and depression through feelings of powerlessness, alienation, shame, and guilt (Bernal et al., 2016). In fact, a study conducted in Quebec, Canada reveals that food insecure individuals reported a strong sense of social alienation due to experiencing a lack of food access in an industrialized country where 7 out of 8 households are food secure (Hamelin et al, 2002; Tarasuk & Mitchell, 2020). Moreover, children living with food insecurity exhibit increased difficulties getting along with peers, depressive disorders, suicidal ideation, fatigue and irritability when compared to food secure children (Alaimo et al., 2002; Brown & Pollitt, 1996; Shankar et al., 2017). The development of such psychological conditions is also correlated with lower scores on standardized achievement tests (Lalongo et al., 2001; Zychinski & Polo, 2012). In addition, food insecure children are more likely to have seen a psychologist and are also more likely to repeat a grade, have lower arithmetic scores and have been suspended from school (Alaimo, et al., 2001).

It is widely accepted that test-taking elicits varying amounts of anxiety. Moderate physiological arousal due to anxiety is correlated to higher examination performance. However, high physiological arousal has a stable negative impact on examination performance (Cassady & Johnson, 2002). Thus, as food insecure children experience increased daily anxiety due to worries concerning food (Maynard et al., 2019), they may also experience further physiological arousal due to moderate testing anxiety. This would lead to a higher overall physiological arousal which may cause a deterioration of their mental condition leading to decreased examination performance (Heissel et al., 2017). The association between food insecurity and anxiety is also supported by Howard (2010) who reports that childhood food insecurity is concurrent with unhealthy changes in dietary intake and psychological stress. Furthermore, worrying about food,

acquiring food in socially unacceptable ways such as begging or scavenging, disruptions of meal patterns and frequent alterations in food quality and quantity, when compounded with pre-existing anxiety due to mild food insecurity, yield an even poorer mental health condition. Thus, food insecurity seems to have an important influence on an individual's overall well-being and mental health (Jones, 2017). Additionally, Ashiabi (2005) reports that children experiencing high levels of emotional distress due to food insecurity exhibit attention difficulties and a lack of motivation which decreases the likelihood of being engaged in school.

Food insecurity's influence on school engagement

As food insecurity impacts children's overall well-being, it also negatively impacts children's school engagement (Ashiabi, 2005; Ashiabi, 2007). School engagement is defined as regular participation in classroom/school activities and is demonstrated through a student's feelings of belongingness to the school's settings and values (Goodenow & Grady, 1993, Fredricks et al., 2004; Wang, 2013). There are many proposed mechanisms by which food insecurity lowers school engagement. According to Reid (2000), food insecurity may affect a child's energy levels, impact the child's psychological well-being and/or result in hunger. These findings are further supported by more recent studies which found that food insecurity negatively impacts children's school engagement through its impact on emotional well-being (Ashiabi, 2005). In addition, there is empirical evidence which demonstrates that children living with food insecurity are apathetic, withdrawn, unresponsive to their environments, passive and have decreased motivation (Walker et al., 2007; Grandtham-McGregor 1995; Brown et al., 1996). Moreover, Howard (2011) reports that food insecurity impairs children's development of interpersonal relations, self-control and approaches to learning. In fact, the author found that food insecure children are one-half of a standard deviation lower than food secure children on

those measures (Howard, 2011). These findings are also supported by Alaimo et al. (2001) who reports that food insecurity is associated with lower math scores, increased interpersonal conflicts and increased frequency of illness. It is also hypothesized that the negative impact of food insecurity on physical and psychological health contributes to the increase of school absenteeism and to the decrease of children's motivational capacities for learning (Roustit et al., 2010). This association is further supported by studies conducted in Canada, the United States, Ethiopia and Venezuela that show a strong negative impact of food insecurity on school activity, academic performance and absenteeism (Tamiru et al., 2016; Roustit et al., 2010; Jyoti et al., 2005). Thus, food insecurity can lead to unhealthy eating behaviours in students that negatively impact their psychological and physical health, as well as their academic successes.

As reported by Chitpin (2016), the primary role of school principals is to ensure that students are actively engaged in their learning process. In fact, the author argues that principals should encourage teachers to empower students to question, discover and discuss new knowledge generated through student activity (Chitpin, 2016). However, given the increased incidence of absenteeism, academic disengagement and lower overall well-being in children living with food insecurity, the implementation of these strategies may become quite difficult. One strategy that is commonly used by school leaders to alleviate the effects of food insecurity in schools is the usage of subsidized school food supplementation programs.

Impact of school food supplementation programs

Access to a subsidized school food supplementation program is often comparable to an increase in a household's income (Bhattacharya et al., 2006). In fact, a household with two children participating in the school breakfast program for five days a week saves, on average, $92.50 CAD per month or $1,110 CAD a year (Fletcher et al., 2017). Moreover, it is believed

that participation in school breakfast programs increases a child's consumption in the morning hours, reduces the percentage of calories from fat, reduces micronutrients deficiencies, and increases fiber intake (Fletcher et al., 2017). Combined, these outcomes are thought to improve diets and thus reduce food insecurity within the household. In addition, students who consume breakfast generally outperform their counterparts in regard to visual search, sustained attention, and memory tests (Cooper et al., 2011). However, there is mixed empirical evidence on the impact of school food supplementation programs on the long-term diet quality of food insecure children.

Positive Outcomes

Multiple studies demonstrate a positive impact of subsidized food programs on food insecurity. In fact, in Wisconsin, participation in the school breakfast program is associated with increased test scores and a decrease in school tardiness and absenteeism (Bartfeld et al., 2019). In addition, participation in school breakfast programs delivered in the classroom is associated with an increased serum level of vitamin C, vitamin E and folate (Corcoran et al., 2016). Furthermore, in a study conducted in Greece, the researchers reported that student groups receiving educational intervention in addition to receiving a daily healthy meal show a significant decrease in their measure of household food insecurity when compared to a group of students solely receiving educational interventions (Dalma et al., 2019). Further research conducted in Quebec, reveals that school food assistance helps adolescents succeed during secondary school and may be a successful poverty reduction strategy (Roustit et al., 2010). Finally, a study conducted at a Vermont Middle School reveals that participation in the school's breakfast program significantly lowers the difference between food insecure and food secure individuals in terms of consuming breakfast (Khan et al., 2011). Although these studies demonstrate some benefits of school food

supplementation programs, there are also studies that indicate the need to improve school-based interventions, especially in regard to the nutritional values of the subsidized meals.

Negative Outcomes

In fact, research shows that, although national lunch school programs in the United States do improve diet quality, third and fifth graders living with food insecurity still have relatively poor diet quality (Landry et al., 2019). In addition, the food provided in national school lunch programs may not be of adequate nutritional value to negate the long-term effects of food insecurity (Dunifon & Kowaleski-Jones, 2003). It is also reported that participation in national school lunch programs does not significantly change children's vitamin and mineral intake which results in a lack of improvement of the overall nutritional intake of food insecure children (Dunifon et al., 2003). These findings are also supported by Marmot (2005) who reports that food insecurity is still strongly correlated to low healthy food consumption, regardless of receiving food aid. Furthermore, without adequate food nutrition education, participation in food aid programs results in unhealthy dietary choices (Alaimo et al., 2001). In addition, a study investigating the effects of school accountability on school nutrition reveals that educational leaders faced with the threat of sanctions due to low test scores chose to alter the nutritional content of school meals on test days by providing students with an increase of simple carbohydrates (empty calories) in an attempt to temporarily improve cognitive performance. The authors also found no evidence that those school lunches were nutritious (Figlio et al., 2005). Finally, participation in a school breakfast program is not found to significantly impact reading and math test scores (Corcoran et al., 2016).

Impact of community-based interventions

Another strategy used to curb food insecurity are charitable food banks offered by the community. In March of 2018, around 1,096,935 Canadians visited a food bank of which 35% were children (Food Banks Canada, 2018). However, research conducted in Quebec indicates that fruits and vegetables were difficult to access on a regular basis and, if available, were often almost rotten (Hamelin et al., 2002). Furthermore, due to concerns regarding social image, parents preferred providing their children with packaged items such as pizza pockets or pop tarts rather than a healthier and more sustainable option such as pea soup (Hamelin et al., 2002). In Ontario, research demonstrates that food hampers given out to families do not provide adequate macro- nor micro-nutrients, food group servings, or caloric energy per person (Irwin et al., 2007). In addition, nutrient-dense foods remain much more expensive than energy-dense foods (Nackers & Appelhans, 2013). Finally, research shows a negative impact on test scores when low socioeconomic status families experience long intervals between reception of provincial financial aid and school examination dates (Cotti et al., 2018). Thus, although school and community-based programs may contribute to the promotion of healthy eating, the current strategies used to aid in the alleviation of childhood food insecurity may not be sufficiently meeting the needs of food insecure households.

Theoretical Framework

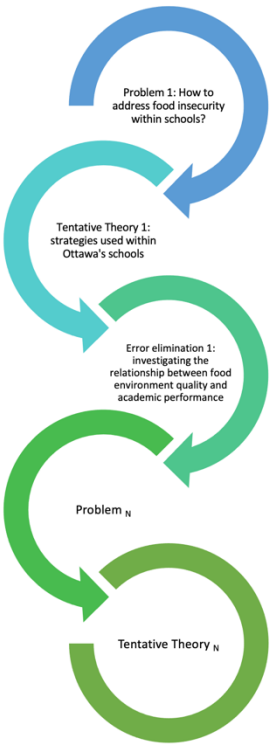
This study aims at establishing the relationship between food environment quality and EQAO test scores and to explore the current school food supplementation programs used in Ottawa. To do so, The Objective Knowledge Growth Framework (OKGF) based on Karl Popper's critical rationalism was adopted (Chitpin, 2015).

According to Popper (1963), the methodology that is best suited for scientific inquiry is one that combines both empiricism and rationality as it approaches an issue objectively with no pre-conceived idea or biases regarding the findings or solutions. This methodology aims at making conjectures and then trying to falsify them. To achieve this goal, Popper theorizes that a researcher should first begin their project with a problem which arises against a set of assumptions, techniques and/or procedures. These assumptions are then used to guide the scientific inquiry (Popper, 1963; Popper, 1972). In this study, the problem emerged against the societal and political assumptions that the current school food programs and funding are meeting the needs of food insecure children and that the use of standardized examinations in Ontario are an equitable measure of academic achievement as demonstrated by the policies and regulations put forth by the government of Ontario. The second step of the scientific inquiry involves the deduction of conjectures which will then be tested objectively with a critical attitude (Popper, 1963; Popper, 1972). Whether the conjecture is refuted or corroborated, it will still allow for the transformation of background knowledge and will bring our collective knowledge closer to the truth.

Many theorists such as Weber (1969) have heavily criticized Popper's claim that the methods used in the natural sciences are comparable to those used in social sciences due to the inherent imprecise and unquantifiable nature of these methods (Liberson, 1982). However, Popper responds by emphasizing that conjectures and refutations are suitable to all sciences and further defines the aim of social sciences as the practice of tracing the unintended social repercussions of intentional human actions (Popper, 1963). Thus, according to Popper, researchers must understand the participant's situation in order to obtain a tentative explanation or prediction of the situation.

The OKGF (Chitpin, 2015) is a cyclical problem-solving framework which incorporates Popper's empiricism and rationalism (see figure 1). To do so, the OKGF starts by positing an initial problem, or P1. Within the context of the present study, the initial problem is how to mitigate the effects of food insecurity within Ottawa's schools. The framework then invites the problem-solver to put forth a tentative theory, or TT1, which is an initial solution to P1. In this study, the tentative theories are the strategies used within Ottawa's schools to alleviate student food insecurity. Following, the OKGF cycles invites the problem-solver to apply the tentative theory and put it through an error elimination phase, or EE1. During this phase, the tentative theory is tested in an effort to refute it. If the tentative theory is shown to contain errors, then a new problem, P2, or a new theory, TT2, is elaborated until the most adapted solution for a given problem at a given time is found. In the present study, the error elimination will be done by investigating whether a relationship between food environment quality and EQAO examination performance persists within Ottawa's schools. If so, then the tentative theory is empirically refuted and a second, more adapted tentative theory, or TT2, to the problem of student food insecurity in Ottawa should be adopted.

Figure 1. The Objective Knowledge Growth Framework



By adopting the OKGF for this study, an objective and critical lens will be employed when analyzing the quantitative and qualitative data. The resulting findings will either refute or corroborate the conjecture that current strategies used to mitigate the effects of food insecurity in Ontario schools are successful.

The end goal of the OKGF is then to determine the effectiveness of the solutions which are currently in place within schools by objectively examining the outcome of those tentative solutions in such a way that avoids confirmation biases. In the current study, if a relationship between food environment scores and EQAO performance persist, then it may be an indication that current strategies aimed at mitigating food insecurity within Ottawa's schools are not widespread or impactful enough to cover all aspects of the issue at hand.

Methodology

This study employed a mixed method, sequential, exploratory research design (Johnson & Christensen, 2020). As such, the study was conducted in two phases.

Phase One

The first step in the OKGF cycle after identification of the problem, is the elaboration and implementation of a tentative solution. Within this study, the tentative solution is the current food related strategies employed within Ottawa's schools. In this way, the first phase of the study is qualitative in nature and aims at identifying the strategies used by Ottawa's schools to mitigate the impacts of student food insecurity. To do so, a content analysis was carried out on Ottawa's school websites located within the school districts of each grocery store. A total of 113 schools are included in the analysis of which 24 are located in quintile 1 neighborhoods, 23 are located in quintile 2 neighborhoods, 18 are located in quintile 4 neighborhoods, and 48 are located in quintile 5 neighborhoods. All 113 websites were visited within a two-week period. While

reviewing the content of each websites, seven key terms were used for the search including (1) food; (2) healthy; (3) eating; (5) bank; (6) nutrition; and (7) breakfast. All resources, classes, and activities relating to healthy eating and/or food supplementation were collected and categorized depending on the quintile in which the school is located as well as the intervention type used.

Phase Two

The second phase of the study was quantitative in nature and aims at establishing the correlational relationship between neighborhood food environment scores and the neighborhood's results on the EQAO standardized examinations. The sample consisted of 45 supermarkets located in Ottawa. Of those 45 supermarkets, 20 were located in the highest socioeconomic status neighborhoods of Ottawa and 25 were located in the lowest socioeconomic status neighborhoods of Ottawa. Socioeconomic status of each neighborhoods is derived from the Ottawa Neighbourhood Study (2015) team and is determined through five variables: percent of residents aged 24 to 65 with no high school degree or diploma, percent of residents living in low income as defined by the Ontario government, unemployment rate, percent of families who are lone-parent, and average household income. The data was then normally distributed and divided into quintiles. This research project aims at studying the food environments of socioeconomic status quintiles 1 and 2 for the highest socioeconomic status neighborhoods, as well as quintiles 4 and 5 for the lowest socioeconomic status neighborhoods.

As per the OKGF cycles, the identification and implementation of the tentative solution is followed by an error elimination phase in which downfalls or shortcomings of the implemented solution are identified in an attempt to refute the solution and avoid confirmation bias. If no errors are identified and the solution cannot be refuted, then the solutions used in phase one would be shown to be appropriate for the given time and context of the study. However, if a

relationship is shown to persist between food environment quality and EQAO examination results then the solutions may not be adequately addressing food insecurity within Ottawa's schools.

For the purpose of this study, a supermarket is defined as an establishment which offers a general line of foods, such as canned, dry and frozen foods, fresh fruits and vegetables, fresh and prepared meats, dairy products, baked products and snack foods. The establishments also carry non-food household products such as non-prescription drugs (Statistics Canada, 2017) and are free of any membership requirements.

Nutritional Environment Measures Survey of Stores (NEMS-S)

The NEMS-S (University of Pennsylvania, 2010) is a validated tool with a high degree of inter-rater reliability kappas which ranges from 0.84 to 1.00 and has a high test-retest reliability which ranges from 0.73 to 1.00 (Glanz et al., 2007). This survey was used to assess the availability, quality, and pricing of healthful food items as compared to their unhealthful food counterparts within a given supermarket. The specific food categories assessed were milk, fresh fruits and vegetables, ground beef, hot dogs, frozen dinners, baked goods, beverages, bread, chips, and cereals

In order to reflect the most recent research in regard to the nutritional value of certain food items, some categories of the survey were modified. Firstly, in the carbonated beverages section, Diet Coke © was replaced by carbonated water. This decision was made as a recent study revealed that artificial sweeteners found in diet beverages led to an increase in waist circumference and BMI overtime (Fowler et al., 2015). Secondly, the fruit juice category was removed due to higher than recommended values of sugar per serving within both the fruit juice and the 100% juice products. Furthermore, since all serving units and brands are American on

the published survey, they were replaced with their Canadian equivalents. For instance, units of pint, quart, half gallon and gallon were replaced by cup, half-liter, liter and four liters respectively. The NEMS-S data of all 45 grocery stores was collected in the Fall of 2018 and the studied EQAO results were taken from the 2018-2019 academic year.

Data collection procedure

All 45 grocery stores were visited within a six-week period to ensure that the variance of availability, quality, and pricing was not due to seasonal changes in food selection. Each visit lasted an average of 25 minutes and followed the same procedure to ensure consistency (see Appendix A). Firstly, milk was assessed by recording the availability and pricing for a cup, half liter, liter and four liters of skim, 1% fat, and whole milk. Then, the availability, pricing and quality of fresh bananas, apples, oranges, grapes, cantaloupe, peaches, strawberries, honeydew melon, watermelon and pears were recorded. The same was done for fresh carrots, tomatoes, sweet peppers, broccoli, lettuce, corn, celery, cucumbers, cabbage and cauliflower. The quality of these items was rated as acceptable if at least 50% of the available stock was fresh with no signs of rotting or withering. Following, the availability and pricing of lean ground beef or turkey, standard ground beef, and hot dogs was assessed. Then, the pricing and availability of reduced-fat and regular frozen dinners, whole-wheat bagels, regular muffins, carbonated water, Coke © as well as, low-sodium and regular chips was recorded. Finally, the availability and pricing of whole wheat and regular white bread as well as Cheerios © and Honey Nut Cheerios © was recorded.

Data Scoring

The same scoring sheet was used to assess each supermarket (see Appendix B). Fruits and vegetables were scored in terms of availability and quality. A maximum of 3 points were

granted for availability where 3 points were allocated if all 10 varieties were available, 2 points were allocation if 9 out of 10 varieties were available, 1 point was allocated if 8 out of 10 varieties were available, and no points were given if 7 or less varieties were available. For quality, a maximum of 3 points were granted where 3 points were allocated if 100% of the overall available produce were judged acceptable, 2 points were allocated if 90% were acceptable, 1 point was allocated if 80% were acceptable, and no points were granted if 70% or less were acceptable. The remaining categories of the NEMS-S were assessed with regards to availability and pricing.

With regards to availability, a maximum of three points were allocated for milk products where two points were allocated if skim milk was available, and an additional point was given if over 50% of the stock was skim or 1% fat products. For ground beef, a maximum of 4 points were granted where 2 points were given if lean meat (under 10% fat) was available and an additional point was given if 2 to 3 varieties of lean meat were available or an additional two points were given if over 3 varieties were available. Hot dogs, baked goods, chips and cereal were also scored for availability where two points were granted if healthy options were available. With regards to the availability of frozen dinners, 3 points were granted if 3 healthy varieties (containing less than 9 grams of fat per serving) were available, 2 points were granted if 1 or 2 varieties were available and no points were allocated if no healthy alternatives were present. As for beverages, if a healthy alternative such as carbonated water was available, a point was allocated. Finally, in the bread category, two points were allocated if whole wheat or whole grain bread was available, and an additional point was allocated if the store carried more than five varieties.

When assessing pricing for all items excluding fresh produce, two points were allocated for a given food category if pricing was lowest for healthy alternatives, one point was allocated if the pricing was identical for healthy and full-fat options, and one point was removed if pricing was lowest for the full-fat alternative.

In summary, the overall NEMS-S scores range from -9 to 52 points with availability scores ranging from 0 to 28, pricing scores ranging from -9 to 18, and quality score ranging from 0 to 6.

Statistical Analysis

For the purpose of this study, the independent variable was food environment scores as assessed by the NEMS-S survey and the dependent variable was the schools' EQAO scores. All statistical analysis were run using IBM's SPSS © software (IBM Corporation, 2020). Firstly, two sets of analysis of variances (ANOVAs) were conducted. The first determined whether there is a significant difference between neighborhood's NEMS-S scores and the second determined whether neighborhood EQAO scores significantly differ. Following, a series of post-hoc Tukey's test with an alpha of 0.05 were run to pinpoint which neighborhood quintiles differ from each other.

Finally, a Pearson correlation with a Bonferroni adjustment was run to determine the relationship between NEMS-S scores and grades 3,6, and 9 EQAO examination results. To do so, the NEMS-S scores of grocery stores within the same district of a given school as determined by the City of Ottawa's GeoMap were averaged for every school. This was done to determine the overall food environment quality in which the school is located. The EQAO results of 113 schools were collected from the EQAO's website. However, due to the privacy policies of the

EQAO which hides the results of schools who had a small cohort of students take the test, a total of 34 schools were not included in this portion of study.

Results

Phase 1: Qualitative Analysis

Table 1 presents a summary of the frequency of strategies used by schools located within SES quintiles 1,2,4, and 5 in Ottawa. A total of 113 school websites were analyzed of which 24 were located in quintile 1, 23 were located in quintile 2, 18 were located in quintile 4, and 48 were located in quintile 5. The common strategies used by all studied schools are subsidized food programs (e.g. snack and breakfast programs), healthy eating activities (e.g. vegetable eating contests), healthy eating resources for parents (e.g. healthy cooking recipes and lunch packing guides), partnerships with public health organizations, school-based activities promoting healthy lifestyles (e.g. Healthy Schools Initiative), staff resources for students (e.g. case-coordinators or school nurses), partnerships with community food centres (e.g. local grocery stores or farms), links to community resources, advertisement of local food banks, and use of local emergency food cupboards.

As shows in Table 1, a total of 33 schools did not advertise any food related strategies on their website. Quintile 1's most used strategy is providing healthful eating resources for parents such as heart healthy recipes and advice on packing healthy lunches which was reported by 7 schools. The schools within quintile 1 also reported using school-based programs such as clubs or afterschool activities which promote health eating (5 schools), links to community resources such as the Ottawa Heart's Institute's guide for healthy living (6 schools), displayed partnerships with community food centres (3 schools) as well as advertisement of food banks (3 schools). The remainder of the interventions were minimally used (2 schools or less).

Quintile 2's most used strategies are the advertisement of local food banks and partnerships with community food centres such as grocery stores to increase the availability of healthful foods for their students. Each of these strategies were used within 8 schools or 35% of the studied sample. Schools within quintile 2 also made use of healthy eating education for students (3 schools) and healthy eating activities such as vegetable eating competitions (3 schools). The remainder of the strategies were minimally used within the studied sample (2 schools or less).

The most frequently used strategy in Quintile 4 is the implementation of subsidized food programs such as free or reduced priced snacks, breakfasts, and lunches for students. This strategy was reported by 8 schools or 44% of the studied sample. Schools in quintile 4 also frequently made us of health eating resources for parents (4 schools) and links to community resources (6 schools). The remainder of the strategies were minimally used within the studied sample (2 schools or less).

Finally, quintile 5's most used strategy is partnerships with community food centres such as charitable foundations in order to provide free meals to their student's in-need. This strategy was adopted by 14 schools or 29% of the studied sample. The next most used strategies within quintile 5 were subsidized food programs (13 schools), healthy eating resources for parents (12 schools), advertisement of food banks (12 schools), links to community resources (5 schools) and partnerships with public health organizations (3 schools). The remainder of the strategies were minimally used by schools located within quintile 5 neighborhoods (2 schools or less).

Table 1. Frequency of schools using a given strategy within each SES quintile.

	Quintile 1	Quintile 2	Quintile 4	Quintile 5
Subsidized food programs	4	2	8	13
Healthy eating activities	2	3	2	1
Healthy eating resources for parents	7	2	4	12
Partnerships with Public Health organizations	2	0	1	3
School-based programs to support healthy eating and physical activity	5	0	1	1
Staff resources for students	1	0	1	0
Partnerships with community food centres	3	8	1	14
Links to community resources	6	2	6	5
Advertisement of Food Banks	3	8	1	12
Emergency Food Cupboard	1	1	1	1
Healthy eating education for students	2	3	2	2
No strategy	7	8	4	14

Phase 2: Quantitative Analysis

The results of the one-way ANOVA comparing food environments indicated that a significant difference between quintiles 1,2,4, and 5 NEMS-S score persisted in Ottawa F (3,40) = 9.790, $p < 0.01$. Follow-up Tukey's post-hoc tests revealed that food environment scores significantly differed between quintiles 1 and 4 ($p = 0.028$), quintiles 1 and 5 ($p < 0.01$), quintiles 2 and 4 ($p = 0.038$), and quintiles 2 and 5 ($p < 0.01$).

With respect to the EQAO grade 3 results, the ANOVA revealed a significant difference in the achievement results of the studied neighborhoods for the writing F (3,40) = 9.736, $p <$

0.01, reading F (3,40) = 10.435, $p < 0.01$, and maths sections F (3,40) = 11.150, $p < 0.01$. Follow-up Tukey's post hoc analysis revealed that EQAO grade 3 writing results significantly differed between quintiles 1 and 5 ($p = 0.005$), quintiles 2 and 4 ($p = 0.012$), and quintiles 2 and 5 ($p < 0.01$). EQAO grade 3 reading performance significantly differed between quintiles 1 and 5 ($p < 0.01$) and quintiles 2 and 5 ($p < 0.01$). EQAO grade 3 maths results differed significantly between quintiles 1 and 5 ($p < 0.01$) and quintiles 2 and 5 ($p < 0.01$). These results indicate that the performance on the EQAO results for grades 3 differ significantly between schools located within neighborhoods of high and low socioeconomic status.

When looking at the EQAO grade 6 examination performances, the ANOVA indicates significant differences in achievement levels between the neighborhood quintiles for the writing F (3,39) = 7.323, $p < 0.01$, reading F (3,39) = 12.186, $p < 0.01$, and math sections F (3,39) = 4.040, $p = 0.014$. Post-hoc Tukey's follow-up tests reveal that the EQAO grade 6 writing performance differed significantly between quintiles 1 and 5 ($p < 0.01$) and quintiles 2 and 5 ($p < 0.01$). EQAO grade 6 reading performance differed significantly between quintiles 1 and 5 ($p < 0.01$), quintiles 2 and 4 ($p < 0.01$), and quintiles 2 and 5 ($p < 0.01$). Finally, EQAO grade 6 math results differed significantly between quintiles 2 and 5 ($p = 0.017$). These results indicate that the performance on the EQAO results for grade 6 differ significantly between schools located within neighborhoods of high and low socioeconomic status.

Correlational Analysis

Following the ANOVA analyses, Pearson correlations were run with a Bonferroni adjustment in order to establish the relationship between food environment scores as determined by the NEMS-S and the performance on grade 3 and 6 EQAO examinations (see Appendix C). The results of this correlational analysis reveal that food environment scores are positively

correlated to the EQAO grade 3 writing results r (43) = 0.398, p = 0.007, reading results r (43) = 0.421, p = 0.004, and maths results r (43) = 0.545, $p < 0.01$. Food environments scores are also positively correlated to the EQAO grade 6 writing performance r (42) = 0.511, $p < 0.01$, reading performance r (42) = 0.543, $p < 0.01$, and maths performance r (42) = 0.448, p = 0.002. Due to small sample sizes, the grade 9 results could not be analyzed. The results indicate that a relationship persists between EQAO scores and food environment quality within Ottawa's schools.

Discussion

As of 2018, 11% of Ottawa's population or approximately 109,500 individuals are living with marginal to severe food insecurity (Tarasuk & Mitchell, 2020). Individuals living with food insecurity tend to consume sub-optimal diets high in ultra-processed foods and low in fresh foods (De Araujo et al., 2018) which is contradictory to current dietary recommendations (Health Canada, 2019). This dietary style puts school aged children at an increased risk of developing overall health concerns such as diabetes and depression (Bernal et al., 2016; Wu et al., 2018) which ultimately impacts their level of engagement in school (Ashiabi, 2005) and their performance on standardized assessment methods. While government funded social assistance programs are available in Canada, the welfare benefits received are often insufficient to overcome food insecurity (Dietitians of Canada, 2012). In fact, Canadian families receiving social assistance represent over 50% of food insecure households and are 13 times more likely to indicate the presence of child food insecurity (McIntyre et al., 2000; Office of Nutrition Policy and Promotion, 2010; Tarasuk et al., 2014). Thus, school retain some responsibility in addressing the concern of food insecurity within their student body.

This study aimed to apply the OKGF (Chitpin, 2015) in order to ascertain whether current strategies used to mitigate the effects of food insecurity in Ottawa's schools are meeting the needs of food insecure students. The first phase of the study aimed at identifying the current tentative theories employed by Ottawa's schools to address the concern of student food insecurity. The content analysis of 113 school websites revealed that eleven common strategies were used by Ottawa's schools. Of those strategies, the most common interventions were the use of subsidized food programs, partnerships with community food centres, and advertisement of local food banks. The emphasis put on these strategies is not surprising as food banks and other charitable food organizations such as subsidized food programs remain the only publicly available interventions for food insecurity in Canada over the past 30 years (Tarasuk et al., 2014). Thus, the strategies used in Ottawa's schools which aim at providing guidance on how to access food banks and incorporating charitable food services within the school may seem to be one of the most suitable strategies to mitigate student food insecurity. However, the effectiveness of charitable food supplementation programs in mitigating food insecurity remains unclear. In fact, it has been consistently reported that the quantities and nutritional quality of food items offered through these programs were poor (Bocskei & Ostry, 2010; Willows & Au, 2006) and did not alleviate food insecurity even amongst severely food insecure families (Loopstra & Tarasuk, 2012). Within the context of education, this may imply that the consequences of food insecurity on academic performance may not be sufficiently mitigated despite the implementation of charitable/subsidized food programs within schools.

The second phase of this study was used to determine whether the current strategies used in Ottawa's schools are mitigating student food insecurity. In accordance with the OKGF, the identified tentative solutions identified in phase one of the study were put through error

elimination. As demonstrated in the results, it is indeed shown that food insecurity is correlated to academic performance as measured by standardized assessments within Ottawa's schools. In fact, this study reveals that food environment quality is positively correlated to the results of the EQAO grade 3 and 6 reading, writing and maths examinations. This relationship indicates that students living in lower quality food environments and most likely to experience food insecurity are underperforming on the EQAO standardized assessment methods as compared to their peers living in higher quality food environments. Furthermore, the study highlights that lower SES neighborhoods have a significantly lower food environment quality than higher SES neighborhoods in Ottawa. In this way, the OKGF demonstrates that in attempting to mitigate the influences of food insecurity on academic performance in Ottawa's schools as measured by the EQAO examinations, the current strategies centred on the use of charitable food organizations are prone to error as they do not alleviate student food insecurity as indicated by the continued relationship between food environment and EQAO scores. As such, different and more holistic solutions should be put in place if standardized testing will continue to take place within Ottawa's schools in order to assess a student's academic performance and the accountability of schools with the assumption that such testing is an equitable and fair form of assessment. For instance, previous studies have found success in establishing intergenerational strategies aimed at alleviating food insecurity by involving students, parents, and seniors and providing a combination of nutritional education, on-site provisions of healthful foods, and opportunities to collaborate with community stakeholders such as non-profit organizations in order to actively connect individuals with local and healthful food resources (Dalma et al., 2019; Jarrott et al., 2019). However, it is important to note that programs such as these require continuous support from governmental funding agencies.

Although food insecurity is most certainly not the only factor impacting on academic performance, the findings of this study are consistent with the current literature documenting food insecurity. According to Nackers & Appelhans (2013), lower quality food environments are associated with higher indices of food insecure household as they have greater accessibility and availability of unhealthful obesity-promoting food items. In addition, multiple Ontarian studies have revealed that living in a low-quality food environment increases the likelihood of adolescents purchasing unhealthful fast-food items (He et al., 2012) while living in higher quality food environment decreases the likelihood of childhood obesity (Larsen et al., 2014). Furthermore, according to Wu et al. (2018), childhood obesity is related to poor academic performance, an association which can be partially explained through deficits in working memory resulting from the low nutritional value of food insecure dietary styles.

Beyond these associations, food insecurity status has itself been proven to be a predictor of poor academic performance from kindergarteners (Jyoti et al., 2005), school-aged children (Esfandiari et al., 2017) all the way to university students (Davidson & Morrell, 2020). There are multiple factors through which food insecurity impacts students' performance on standardized assessment methods. According to Slopen et al. (2010), food insecurity, even when controlling for poverty, is a strong predictor for externalized and internalized behavioural issues in children. These behaviours are considered important risk factors which can deteriorate childhood well-being and increase the likelihood of developing psychopathologies (Slopen et al., 2010). These behavioural concerns are theorized to arise due to the nutritional inadequacies of food insecure diets which can impact the neurodevelopment of children leading to irregularities in executive functioning and self-regulation (Jackson & Vaughn, 2016; Vaughn et al., 2016). As a result, food insecure children are at an increased risk of developing psychopathologies such as ADHD,

depression, or low social well-being (Jyoti et al., 2005) and are thus more likely to perform poorly on academic assessments (Sijtsema et al., 2014). In this way, the observed association between food environment quality and performance on the EQAO exams in this study provides additional credence that food insecurity status is still impacting the overall health and wellbeing of students in Ottawa and impacting their academic performance.

Evidently, these physiological and psychological outcomes of food insecurity also impact the degree of academic engagement of these students. School engagement is associated to decreased drop-out rates and problematic behaviors, as well as increased academic success (Ashiabi, 2005; Furrer & Skinner, 2003). However, food insecurity has been shown to decrease school engagement (Ashiabi, 2005) through decreased energy levels, increased absenteeism and a higher risk for psychosocial and neurocognitive concerns. Thus, food insecure children are more likely to be disengaged at school resulting in lower academic performance on standardized examinations, an association which is reflected by this study.

Given that the results of this study reveal that current attempts to curb the impacts food insecurity on academic performance are not completely mitigating that relationship, one may conjecture that the reliance on the EQAO examinations to assess academic success is further reinforcing achievement gaps between food insecure and food secure students. That is the assumption that food strategies within schools are meeting the needs of food insecure students and that students are being provided equitable opportunities to perform optimally on standardized assessment may not be correct. In this way, the reliance that the Ministry of Education of Ontario places on EQAO results to ensure the accountability of schools and the success of students may indeed be inequitable. More specifically, the EQAO examination results may be impacted by the extraneous factors of school engagement, weight status,

psychopathologies and deficiencies in neurocognitive development all resulting from food insecurity status and poor food environments.

Conclusion

This study reveals that the food environment quality of high SES neighborhoods is higher than the environment of lower SES neighborhoods in Ottawa. In addition, the study highlights that food environment quality scores as measured by the NEMS-S tool are positively correlated to the EQAO examinations results for grades 3 and 6 reading, writing and maths subsections. Following the OKGF cycles, this study uses this relationship to demonstrate that the current strategies adopted by Ottawa's schools to mitigate the impacts of food insecurity are insufficiently meeting the needs of food insecure students. Thus, schools should re-problematize the issue of food insecurity within their schools. In addition, the Ministry of Education of Ontario has cause to reconsider its usage of the EQAO results in determining accountability of schools serving a high proportion of food insecure students. In fact, this study has shown that food insecurity is still correlated to decreased performance on standardized testing, an association which is not taken into consideration within current accountability policies in Ontario. Finally, this study stresses the need for improved intervention strategies and governmental support in order to decrease food insecurity within our schools.

Limitations

This study presents three primary limitations. Firstly, based on the nature of correlational studies, a causal link between food insecurity and academic performance cannot be established. As can be deduced, there are a variety of extraneous factors that could influence the relationship between neighborhood food environment quality and the neighborhood's overall EQAO scores such as decreased parental aspirations. However, food insecure individuals are typically at an

increased risk for unhealthy eating habits due to the greater availability and accessibility of unhealthful foods within their home and community environments (Nackers et al., 2013). Thus, evaluating the relationship between neighborhood food environment quality and academic performance still has merit. Secondly, strategies listed on school websites may not be an exhaustive list of interventions used by school principals to mitigate the impacts of food insecurity within their schools. It is therefore possible that principals are using additional methods to address food insecurity. Nonetheless, globally the strategies being used, no matter the nature, are still not disrupting the relationship between food environment quality and academic performance on the EQAO examinations. Finally, due to the sampling method used for this study, the sample was not big enough to determine a correlation between food environment quality and performance on grades 9 and 10 standardized tests. As such, future studies should work to include additional schools within their sample to establish that relationship.

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Chapter 3: Final Thoughts

My study, conducted in partial fulfillment of the requirements for a Master of Arts in Education program, investigated the relationship between food environment quality and the overall performance of various socioeconomic status (SES) neighborhoods on the EQAO standardized examinations in Ottawa. More specifically, the findings of my study demonstrate that the quality of neighborhood food environments in Ottawa is positively correlated to the neighborhood's average performance on the EQAO exams. This then implies that the healthier a child's diet is (e.g., increased intake of fresh produce and less consumption of processed food items), the less psychosocial and health barriers are experienced by the student leading to a higher performance on standardized assessments in Ottawa. My study's findings can be extrapolated to underline three main critiques of the Ontario Ministry of Education's and Ottawa schools' practices in regard to testing and mitigating food insecurity. Firstly, the findings contribute to a growing body of evidence (Florence et al., 2008; Faught et al., 2017) demonstrating that the EQAO examinations may not be an equitable method of assessment, as a student's food insecurity status can become a hinderance to their academic performance and success. In this way, the Ministry of Education's reliance on standardized examination scores to maintain the accountability of schools may be erroneous. More specifically, my study demonstrates that the use of EQAO standardized assessments creates an inequitable educational environment for food insecure students which has the potential of negatively impacting their future earning potential and enforcing an inter-generational transmission of social inequalities (Roustit et al., 2010). Secondly, my findings may also be used to stress the importance of implementing provincial policies which would regulate the nutritional value of free or subsidized meals given to students in schools as currently no such policies exist (Ontario Ministry of

Education, 2010). As discussed in Chapter 1 of my thesis, dietary quality is influence by both healthful food availability and the accessibility of nutritional education and/or health promoting initiatives within an individual's social environment (Sobal et al., 2014). Moreover, a student's school constitutes a major player in their social environment (Boocock, 1973; Lopez et al., 2021). Thus, implementing policies which aim at increasing the presence of healthful meals, whether sold or distributed for free, should be put in place to aid in mitigating food insecurity within our schools. In the case where healthful foods are not made available through subsidized meals, then holistic initiatives such as the Health-Promoting School in which health education is supported by the social environment and ethos of a school may increase the health of students through healthful eating education and physical activity (Lee, 2012). As demonstrated in my study, the percentage of schools adopting such an approach in Ottawa is minimal as compared to other strategies such as community food banks. In this way, a tentative solution which could be tested by more schools in Ottawa could be the implementation of health and nutrition education for students and parents. By doing so, schools could encourage students to make healthier meal choices thereby increasing their likelihood of academic success as measured by standardized tests. While the findings have important implications in regard to standardized testing and healthful eating, the study did present some limitations in its sample size, qualitative data collection methodology, as well as some anomalies in the findings.

As mentioned in the article presented in chapter 2, the study lacked sufficient data to evaluate the relationship between food environment quality and the average performance on the EQAO grade 9 and grade 10 OSSLT examinations within the studied neighborhoods. For the purposes of this study, only the neighborhoods located within SES quintiles 1,2,4, and 5 were considered. This decision was made as the study aimed to investigate the differences between the

highest and lowest SES neighborhoods of Ottawa. Thus, studying quintile 3 neighborhoods, presenting a middle or average SES, was out of scope for this study. However, it is possible that including SES quintile 3 neighborhoods in future studies could provide more data in regard to grade 9 and 10 performances on the EQAO examinations, allowing for a correlation to be established. A second limitation in the data collected for this study stemmed from the EQAO's privacy policies which hid all EQAO results from schools who had a small cohort of students taking their standardized assessments, representing a loss of 34 data points. As a result, these schools could not be included in the study, potentially impacting the strength of the relationship between food insecurity and EQAO performance found in this study. Indeed, using Cochran's formula with a known population size of 242 elementary schools (Conseil des Écoles Publiques de l'Est de l'Ontario, 2021; Écoles Catholique du Centre-Est, 2021; Ottawa-Carleton District School Board, 2021; Ottawa Catholic School Board, 2021), the ideal sample size with a confidence level of 95% is 149 schools. Given that a total of 113 schools were included in the study's sample, and considering the loss of data points, the accuracy of the results is weakened. Future studies investigating the impact of food insecurity in schools should aim to include an additional 36 schools to the sample by studying Quintile 3 neighborhoods.

The study's qualitative data collection strategy could also present a weakness for the study. Due to the time and scope constraints of the MA in Education program, a content analysis of all 113 school websites was favoured over face-to-face interviews with principals. By doing so, the qualitative data may not represent an exhaustive account of the strategies used in schools to mitigate the impacts of food insecurity. Furthermore, schools who failed to report an intervention strategy were disproportionately part of the Ottawa Catholic School Board. It is possible that these schools are not in the habit of posting their interventions and programs online,

favouring to communicate these to parents and students directly. In addition, this method of qualitative data collection did not allow for follow-up on the effectiveness or frequency of the strategies used within each school. Thus, conducting face-to-face interviews could have unveiled additional strategies or impacted the frequencies reported in the study. However, as indicated in Chapter 2, the main strategies used to mitigate food insecurity in Canada is the use of food subsidized programs (Tarasuk et al., 2014), a tendency which was reflected in the findings of the present study. Nonetheless, future studies investigating strategies used in schools to mitigate food insecurity should incorporate semi-structured interviews with educational staff and students to uncover whether addition strategies are being used in Ottawa and to determine their perceived effectiveness.

When considering the quantitative results of my study, the post-hoc tests revealed trends which could be incorporated in future research. Firstly, the post-hoc Tukey's tests showed that no significant differences were identified between Quintile 4 and Quintile 5 neighborhoods across most EQAO grade levels and test sub-sections, as well as in food environment scores as measure by the NEMS survey. Statistically speaking, this indicates that the test could not reject the null hypothesis H_0 which posits that quintile 4 and quintile 5 belong to the same population (i.e., low socioeconomic neighborhoods of Ottawa). In this way, it could be advantageous to treat quintile 4 and quintile 5 as the same low SES group as there are no significant differences between them. The same case can be made for quintile 1 and quintile 2 that would then be combined to form the high SES group. The second anomaly which arose from the quantitative data analysis was in regard to the EQAO grade 6 math results. The Tukey's post-hoc test indicated that the only observed significant difference was between Quintile 2 and Quintile 4 ($p < 0.05$). This finding was not anticipated as it would have been expected that quintile 1 and

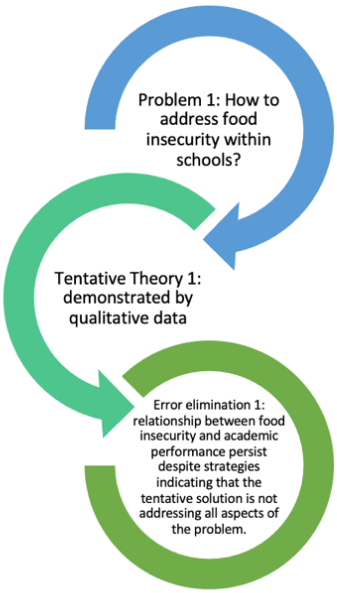
quintile 4 would also be significant given that quintile 2 and quintile 4 were significant as seen in the EQAO grade 3 maths post-hoc analysis. This finding may be due to the fact that the samples sizes were unequal in the studied groups. When using Tukey post-hoc tests with such samples, the method becomes conservative and potentially less powerful. In fact, according to Rusticus and Lovato (2019), for positively paired samples where variance increases with sample size, Tukey post hoc tests tend to lose a portion of their statistical power. In this way, my study may have been susceptible to Type II errors where significant differences were missed due to the conservative nature of the post-hoc tests chosen.

Finally, my study did not directly assess school's food insecurity rates. Rather, food environment scores were used to establish the correlation between food insecurity and standardized testing performance. The extrapolation of poor food environment to estimate food insecurity is supported by the literature. In fact, according to Pérez et al. (2017), local food environments in Montreal are associated with the severity of household food insecurity. Additionally, it was found that reduced access to healthful foods as a result of poor food environments is associated to food insecurity prevalence (Hossfeld & Mendez, 2018). Thus, the use of food environment quality to assess the impact of food insecurity on standardized test performance remains valid. However, food environments are not only characterized by grocery stores. Rather, neighborhood food environments are also influence by restaurants (Saelens et al., 2007) and corner stores (Cavanaugh et al., 2013). As such, future research should look to incorporate these food sources in order to provide a more complete depiction of Ottawa's neighborhood food environment quality.

Although my study contained limitations, it still presented an example of how the Objective Knowledge Growth Framework (OKGF) could be used as a theoretical framework for

mixed methods studies. As demonstrated in Chapter 2, the OKGF was used to put the identified food insecurity interventions in Ottawa through error elimination using the relationship between food insecurity and EQAO test scores in order to identify whether inequitable conditions still persisted for food insecure students in Ottawa. In this way, the OKGF enabled triangulation in the methodology through the use of both quantitative and qualitative data, ultimately increasing the validity of the results of this study. As shown in figure 2, the initial problem was how to address food insecurity within school. To uncover the current strategies, or tentative theories, used within Ottawa's schools, a qualitative analysis was conducted which revealed that schools make use of food banks, resources to parents, partnerships with community centres, etc… Following these findings, the quantitative phase of the study put these theories through error elimination. Through this phase, it was determined that food insecurity is still correlated to academic performance in Ottawa, indicating that the solutions put in place in schools are not addressing all facets of the issue at hand. This then, invites one to re-consider the issue of food insecurity and academic performance to either implement a better, more adapted solution or rethink the reliance on standardized testing to assess student success and school accountability.

Figure 2. Visualization of the OKGF cycles



To conclude, the study's methodology and results have provided a deeper understanding on the factors which can increase the disparities between advantaged and disadvantaged students, ultimately creating inequitable learning environments within our education system in Ottawa. Although I understand that certain forms of standardized data usage are required to ensure the general safety of the public such as in medical field, the process of conducting and completing my research has pushed me to consider the adverse impacts of standardized testing misuse in assessing students' academic performance and school accountability. Ultimately, this thesis has only furthered my dedication to the field of education and has invigorated my interest in nutrition and health education.

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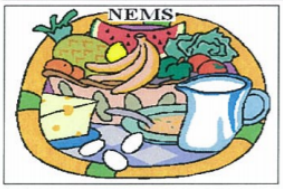
Appendices

Appendix A: Nutritional Environment Measures of Stores Survey (NEMS-S)

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page



Rater ID: ☐☐

O Grocery Store
O Convenience Store
O Other_____

Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐
Month Day Year

Start Time: ☐☐:☐☐ O AM O PM

End Time: ☐☐:☐☐ O AM O PM

Number of cash registers: ☐☐

O SD O FC O FF O Specialty O Other

Restaurant ID: ☐☐-☐-☐☐-☐☐☐

Site Visit Date: ☐☐/☐☐/☐☐
Month Day Year

Start Time: ☐☐:☐☐ O AM O PM
End Time: ☐☐:☐☐ O AM O PM

Menu/Internet Review Date: ☐☐/☐☐/☐☐
Month Day Year

Start Time: ☐☐:☐☐ O AM O PM
End Time: ☐☐:☐☐ O AM O PM

Other Visit/Interview Date: ☐☐/☐☐/☐☐
Month Day Year

Start Time: ☐☐:☐☐ O AM O PM
End Time: ☐☐:☐☐ O AM O PM

Comments: _____

Nutrition Environment Measures Survey (NEMS)
Cover Page

8250013302

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #1: MILK

Rater ID: ☐☐ Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐ (Month Day Year)

○ Grocery Store ○ Convenience Store ○ Other

Marking Instructions

Please use a pencil or blue or black ink. Correct ● Incorrect ✓ ⊗ ◒ ◉

A. Reference Brand

1. Store brand (preferred) ○ Yes ○ No

2. Alternate Brand Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Comments: _____

B. Availability

Comments:

1. a. Is low-fat (skim or 1%) available? ○ Yes ○ No _____

b. If not, is 2% available? ○ Yes ○ No ○ NA _____

2. **Shelf space:** (measure only if low fat milk is available)

Type	Pint	Quart	Half gallon	Gallon
a. Skim	☐☐	☐☐	☐☐	☐☐
b. 1%	☐☐	☐☐	☐☐	☐☐
c. Whole	☐☐	☐☐	☐☐	☐☐

C. Pricing All items should be same brand

Comments:

1. Whole milk, quart $☐.☐☐ _____

2. Whole milk, half-gallon $☐.☐☐ _____

3. Skim or 1% milk, quart $☐.☐☐ _____
(Lowest-fat milk available)

4. Skim or 1% milk, half-gallon $☐.☐☐ _____
(Lowest-fat milk available)

Alternate Items:

5. 2%, quart $☐.☐☐ ○ N/A _____

6. 2%, half-gallon $☐.☐☐ ○ N/A _____

8898156331

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #2: FRUIT

Rater ID: ☐☐

Date: ☐☐/☐☐/☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Bananas**		O	O	$☐.☐☐	☐	O	O	O	O	
2. **Apples**	O Red delicious O_____	O	O	$☐.☐☐	☐	O	O	O	O	
3. **Oranges**	O Navel O_____	O	O	$☐.☐☐	☐	O	O	O	O	
4. **Grapes**	O Red seedless O_____	O	O	$☐.☐☐	☐	O	O	O	O	
5. **Cantaloupe**		O	O	$☐.☐☐	☐	O	O	O	O	
6. **Peaches**		O	O	$☐.☐☐	☐	O	O	O	O	
7. **Strawberries**		O	O	$☐.☐☐	☐	O	O	O	O	
8. **Honeydew Melon**		O	O	$☐.☐☐	☐	O	O	O	O	
9. **Watermelon**	O Seedless O_____	O	O	$☐.☐☐	☐	O	O	O	O	
10. **Pears**	O Anjou O_____	O	O	$☐.☐☐	☐	O	O	O	O	

11. **Total Types:** (Count # of yes responses) ☐☐

0450176946

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #3: VEGETABLES

Rater ID: ☐☐

Date: ☐☐/☐☐/☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Carrots**	O 1 lb bag O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
2. **Tomatoes**	O Loose O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
3. **Sweet Peppers**	O Green bell peppers O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
4. **Broccoli** With Stem	O Bunch O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
5. **Lettuce**	O Green leaf O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
6. **Corn**		O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
7. **Celery**		O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
8. **Cucumbers**	O Regular O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
9. **Cabbage**	O Head O_____	O	O	$☐.☐☐	☐	O	O	O	O	_____ _____
10. **Cauliflower**		O	O	$☐.☐☐	☐	O	O	O	O	_____ _____

11. **Total Types:** (Count # of yes responses) ☐☐

6577396766

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #4: GROUND BEEF

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability and Price

Item	Available Yes	No	N/A	Price/lb.	Comments
Healthier option:					
1. Lean ground beef, **90% lean, 10% fat** (Ground Sirloin)	O	O		$☐.☐☐	
Alternate Items:					
2. Lean ground beef, (<10% fat) ☐☐ **% fat**	O	O	O	$☐.☐☐	
3. Ground Turkey, (≤10% fat) ☐☐ **% fat**	O	O	O	$☐.☐☐	

4. # of varieties of lean ground beef (≤10% fat) O 0 O 1 O 2 O 3 O 4 O 5 O 6+

Regular option:					
5. Standard ground beef, **80% lean, 20% fat**	O	O		$☐.☐☐	
Alternate Item:					**Comments**
6. Standard alternate ground beef, if above is not available ☐☐ **% fat**	O	O	O	$☐.☐☐	

4349643520

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #5: HOT DOG

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability and Price

Item	Available Yes	No	N/A	Price/pkg.	Comments
Healthier option:					
1. (ti Maple Lodge Chicken Wieners	O	O		$☐.☐☐	
Alternate Items: (≤ 9g fat)					
2. Fat-free other brand 0g fat ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ (Brand name) ☐☐☐ (Kcal/svg)	O	O	O	$☐.☐☐	
3. Light Wieners (turkey/pork)	O	O	O	$☐.☐☐	
4. Light beef Franks (usually 1/3 less calories, 50% less fat)	O	O	O	$☐.☐☐	
5. Turkey Wieners (1/3 less fat)	O	O	O	$☐.☐☐	
6. Other ☐☐☐☐☐☐☐☐☐☐☐☐	O	O	O	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg
Regular option:					
7. (t Schneiders All Pork original recipe	O	O		$☐.☐☐	
Alternate Items: (≥10g fat)					
8. Beef Franks (regular)	O	O	O	$☐.☐☐	
9. Other ☐☐☐☐☐☐☐☐☐☐☐☐	O	O	O	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg

5986187936

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #6: FROZEN DINNERS

Rater ID: ☐☐ Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐ (Month Day Year)

O Grocery Store O Convenience Store O Other

A. Reference Brand

1. Stouffer's brand (preferred) O Yes O No

2. Alternate brand (with reduced-fat dinners available) Brand Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Comments: _____

B. Availability

Smart Ones can be used as an alternative to Lean Cuisine

1. Are reduced-fat frozen dinners available? (≤9g fat/8-11 oz.) O Yes O No _____

Shelf space:(measure only if reduced-fat frozen dinners are available)

2. Reduced-fat dinners/regular dinners: Proportion O < = 10% O 11-33% O 34-50% O 51%+

C. Pricing (All items must be same brand)

Reduced-Fat Dinner	Price/ Pkg	Regular Dinner	Price/ Pkg	Comments
1. Lean Cuisine **Lasagna** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Stouffer's **Lasagna** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
2. Lean Cuisine **Roasted Turkey Breast** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Stouffer's **Roasted Turkey Breast** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
3. Lean Cuisine **Meatloaf** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Stouffer's **Meatloaf** ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	

Reduced-Fat Alternate (≤ 9g fat)	Price/ Pkg	Regular Alternate (≥ 10g fat)	Price/ Pkg	Comments
4. Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
5. Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	
6. Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	Other _____ ☐☐ oz. ☐☐☐ Kcal. ☐☐ g fat	$☐☐.☐☐	

7422087785

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #7: BAKED GOODS

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability & Price

Low-fat baked goods ≤3g fat/serving

Item	Available Yes	Available No	Amt. per package	g fat/ per item	kcal/ per item	Price	Comments
Healthier option:							
1. Dempsters Whole Wheat Bagels Single	O	O		☐☐	☐☐☐	$☐.☐☐	
	Yes	**No**	**N/A**				
Package	O	O	O	☐☐	☐☐	☐☐☐	$☐.☐☐	
Alternate Items:	**Yes**	**No**	**N/A**				
2. English muffin	O	O	O	☐☐	☐☐	☐☐☐	$☐.☐☐	
3 a. Low-fat muffin ☐☐☐☐☐☐☐☐☐	O	O	O	☐☐	☐☐	☐☐☐	$☐.☐☐	
b. # varieties of low fat muffins	O 0	O 1	O 2	O 3+			
Regular option (≥ 4g fat/serving or 400 Kcal/serving):							
4. Regular muffin	O	O		☐☐	☐☐	☐☐☐	$☐.☐☐	
Alternate Items:	**Yes**	**No**	**N/A**				
5. Regular Danish	O	O	O	☐☐	☐☐	☐☐☐	$☐.☐☐	
6. Other	O	O	O	☐☐	☐☐	☐☐☐	$☐.☐☐	

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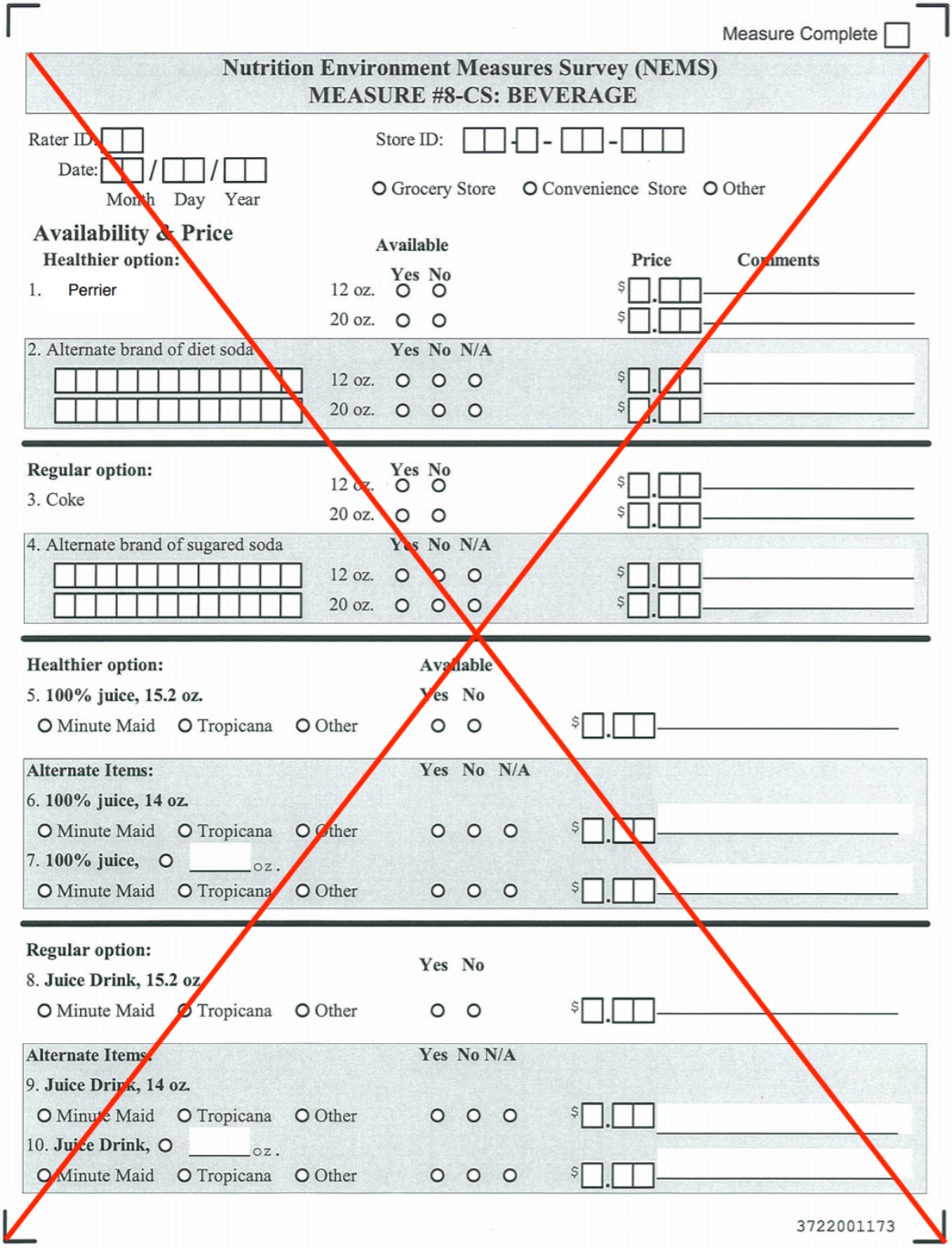

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #8-CS: BEVERAGE

Rater ID: ☐☐ Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐ (Month Day Year)

○ Grocery Store ○ Convenience Store ○ Other

Availability & Price

		Available			Price	Comments
Healthier option:		Yes	No			
1. Perrier	12 oz.	○	○		$☐.☐☐	
	20 oz.	○	○		$☐.☐☐	
2. Alternate brand of diet soda ☐☐☐☐☐☐☐☐☐☐☐☐		Yes	No	N/A		
	12 oz.	○	○	○	$☐.☐☐	
	20 oz.	○	○	○	$☐.☐☐	
Regular option:		Yes	No			
3. Coke	12 oz.	○	○		$☐.☐☐	
	20 oz.	○	○		$☐.☐☐	
4. Alternate brand of sugared soda ☐☐☐☐☐☐☐☐☐☐☐☐		Yes	No	N/A		
	12 oz.	○	○	○	$☐.☐☐	
	20 oz.	○	○	○	$☐.☐☐	

	Available			
Healthier option:	Yes	No		
5. **100% juice, 15.2 oz.** ○ Minute Maid ○ Tropicana ○ Other	○	○		$☐.☐☐
Alternate Items:	Yes	No	N/A	
6. **100% juice, 14 oz.** ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐
7. **100% juice,** ○ _____ oz. ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐
Regular option:	Yes	No		
8. **Juice Drink, 15.2 oz.** ○ Minute Maid ○ Tropicana ○ Other	○	○		$☐.☐☐
Alternate Items:	Yes	No	N/A	
9. **Juice Drink, 14 oz.** ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐
10. **Juice Drink,** ○ _____ oz. ○ Minute Maid ○ Tropicana ○ Other	○	○	○	$☐.☐☐

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Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #8-GS: BEVERAGE

Rater ID: ☐☐ Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐ (Month Day Year)

○ Grocery Store ○ Convenience Store ○ Other

Availability & Price

Healthier option:	Available size	Available Yes	No	Price	Comments
1. Perrier	12 pack 12 oz.	○	○	$☐.☐☐	
		Yes	No N/A		
	6 pack 12 oz.	○	○ ○	$☐.☐☐	
2. Alternate brand of diet soda		Yes	No N/A		
☐☐☐☐☐☐☐☐☐☐☐☐	12 pack 12 oz.	○	○ ○	$☐.☐☐	
☐☐☐☐☐☐☐☐☐☐☐☐	6 pack 12 oz	○	○ ○	$☐.☐☐	
Regular option:		Yes	No		
3. Coke	12 pack 12 oz.	○	○	$☐.☐☐	
		Yes	No N/A		
	6 pack 12 oz.	○	○ ○	$☐.☐☐	
4. Alternate brand of sugared soda		Yes	No N/A		
☐☐☐☐☐☐☐☐☐☐☐☐	12 pack 12 oz.	○	○ ○	$☐.☐☐	
☐☐☐☐☐☐☐☐☐☐☐☐	6 pack 12 oz	○	○ ○	$☐.☐☐	

Healthier option:	Yes	No		
5. Minute Maid 100% juice, (64 oz., half gallon)	○	○	$☐.☐☐	
Alternate Items:	Yes	No N/A		
6. Tropicana 100% juice, (64 oz., half gallon)	○	○ ○	$☐.☐☐	
7. Other: ☐☐☐☐☐☐☐☐☐☐☐☐	○	○ ○	$☐.☐☐	
Regular option:	Yes	No		
8. Minute Maid juice drink, (64 oz., half gallon)	○	○	$☐.☐☐	
Alternate Items:	Yes	No N/A		
9. Tropicana juice drink, (64 oz., half gallon)	○	○ ○	$☐.☐☐	
10. Other: ☐☐☐☐☐☐☐☐☐☐☐☐	○	○ ○	$☐.☐☐	

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Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #9: BREAD

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability & Price

Item	Available Yes	No	N/A	Loaf size (ounces)	Price/loaf	Comments
Healthier Option: Whole grain bread (100% whole wheat bread and whole grain bread)						
1. Dempsters 100% Whole Wheat Bread	O	O		☐☐	$☐.☐☐	
Alternate Items:						
2. Sara Lee Classic 100% Whole Wheat Bread	O	O	O	☐☐	$☐.☐☐	
3. Other: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	O	O	O	☐☐	$☐.☐☐	
4. # of varieties of 100% whole wheat bread and whole grain (all brands)	O 0	O 1	O 2	O 3	O 4	O 5 O 6+
Regular Option: White bread (Bread made with refined flour)						
5. Dempster's White Bread	O	O		☐☐	$☐.☐☐	
Alternate Items:						
6. Sara Lee Classic White Bread	O	O	O	☐☐	$☐.☐☐	
7. Other: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	O	O	O	☐☐	$☐.☐☐	

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Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #10: BAKED CHIPS

Rater ID: ☐☐ Store ID: ☐☐-☐-☐☐-☐☐☐

Date: ☐☐/☐☐/☐☐ (Month Day Year)

○ Grocery Store ○ Convenience Store ○ Other

Availability & Price

Low-fat chips ≤3g fat/1 oz. serving

Item	Size (oz.)	Available	Price	Comments
Healthier Option :		**Yes No**		
1. PopCorners	☐☐ oz.	○ ○	$☐.☐☐	
Alternate Item:		**Yes No N/A**		
2. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	○ ○ ○	$☐.☐☐	
3. # of varieties of popcorn chips ny brand)	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+			
Regular Option (select most comparable size to healthier option available):		**Yes No**		
4. Lays Potato Chips Classic	☐☐ oz.	○ ○	$☐.☐☐	
Alternate Item:		**Yes No N/A**		
5. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	○ ○ ○	$☐.☐☐	

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Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #11: CEREAL

Rater ID: ☐☐

Date: ☐☐/☐☐/☐☐
Month Day Year

Store ID: ☐☐-☐-☐☐-☐☐☐

O Grocery Store O Convenience Store O Other

Availability & Price

Healthier cereals < 7 g sugar per serving

Item	Available Yes	No	N/A	Size (ounces)	Price	Comments
Healthier Option :						
1. Cheerios (Plain)	O	O		☐☐	$☐.☐☐	
Alternate Item:	**Yes**	**No**	**N/A**			
2. Other _____	O	O	O	☐☐	$☐.☐☐	
3. # of varieties of healthier cereals	O 0	O 1	O 2	O 3+		
Regular Option (≥7g of sugar per serving):						
4. Cheerios (Flavored) _____	O	O		☐☐	$☐.☐☐	
Alternate Item:	**Yes**	**No**	**N/A**			
5. Other _____	O	O	O	☐☐	$☐.☐☐	

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Appendix B: NEMS-S Scoring Sheet.

	Availability	Pricing	Quality
Milk	Yes low-fat = 2 Proportion > 50 = 1	Lower for lowest fat = 2 Same for both = 1 Higher for low fat = -1	
Fruits	< 8 varieties = 0 8 varieties = 1 9 varieties = 2 10 varieties = 3		80% = 1 90% = 2 100% = 3
Vegetables	< 8 varieties = 0 8 varieties = 1 9 varieties = 2 10 varieties = 3		80% = 1 90% = 2 100% = 3
Ground Beef	Yes, lean meat = 2 2-3 varieties = 1 Over 3 = 2	Lower for lean = 2 Same = 1 Higher for lean = -1	
Hot dogs	Yes = 2	Lower for light = 2 Higher for light = -1	
Frozen Dinners	Yes, all 3 = 3 Yes 1 or 2 = 2 None = 0	Lower for reduced fat = 2 Same = 1 Higher for reduced fat = -1	
Baked Goods	Yes = 2	Lower for low-fat = 2 Same = 1 Higher for low fat = -1	
Beverages	Yes = 1	Lower for Perrier = 2 Same = 1 Higher for Perrier = -1	
Bread	Yes = 2 >2 varieties = 1	Lower for whole wheat 2 Same = 1 Higher for whole wheat = -1	
Baked Chips	Yes = 2	Lower for baked = 2 Same = 1 Higher for baked = -1	
Cereal	Yes, healthy cereal = 2	Lower for healthy = 2 Same = 1 Higher for healthy = -1	

Appendix C: Tables of Quantitative Results

Table 2. Results of the Pearson Correlations.

Relationship with the neighborhood NEMS-S scores	Results
Grade 3 writing	r (43) = 0.398, p = 0.007
Grade 3 reading	r (43) = 0.421, p = 0.004
Grade 3 maths	r (43) = 0.545, p < 0.001
Grade 6 writing	r (42) = 0.511, p < 0.001
Grade 6 reading	r (42) = 0.543, p < 0.001
Grade 6 maths	r (42) = 0.448, p = 0.002