8-12-2020 1:00 PM

Examining the Correlates of Adolescent Food and Nutrition Knowledge in London, Ontario

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Epidemiology and Biostatistics

ABSTRACT

Food literacy is a set of skills and knowledge that are integral to diet. It is common among teenagers to not have basic food literacy skills needed to consume a healthy diet. This exploratory study examined: (1) the current state of food and nutrition knowledge among adolescents in grades 9-12 in the London-Middlesex region of Ontario; and (2) predictors of food knowledge among adolescents. Data for this study were drawn from baseline youth and parent survey data collected for the SmartAPPetite project, a smartphone application-based intervention study which aims to improve food and nutrition knowledge and dietary habits of adolescents. Statistical analysis of the survey data indicates that higher household education and higher median neighbourhood family income, the use of mobile health applications, liking to cook, as well as confidence in reading and understanding food labels were all consistently associated with increased food and nutrition knowledge. Results of this thesis may help guide policymakers, researchers, and public health professionals in developing appropriate food and nutrition programs and curriculums to combat the decline in food literacy skills.

KEYWORDS: adolescent health, food knowledge, nutrition knowledge, food literacy, SmartAPPetite, mobile health applications

SUMMARY FOR LAY AUDIENCE

Diet quality tends to decrease in adolescence and remains suboptimal into adulthood. This is concerning because one's diet early in life sets the foundation for their eating habits for the rest of their life. Poor eating habits, as well as diminished nutrition knowledge and food preparation skills are associated with an increase in nutrition-related non-communicable diseases. One factor that may influence dietary behaviour is a concept called food literacy. Food literacy can be described a set of skills that help individuals plan and prepare nutritious, tasty, and affordable meals with confidence. Food literacy involves having food and nutrition knowledge to understand where one's food comes from, what is in it, as well as how the nutrients within food affects one's health. It is increasingly important to understand what contributes to food and nutrition knowledge among adolescents because adolescents today may lack the basic understanding and skills necessary to develop health food habits. This thesis utilized baseline data from SmartAPPetite, a five-year long population intervention, to examine food and nutrition knowledge among adolescents from the London-Middlesex area, and the individual, behavioural, and socio-economic factors related to food and nutrition knowledge. The results of this thesis found that knowledge scores were quite low, with an average total knowledge score of 54.6%, and average sub-scores of 59.8% for food knowledge and 52.2% for nutrition knowledge. These low knowledge scores are in line with previous research. An adolescent's age, ethnicity, mental health, as well as using a mobile health application, liking to cook, and confidence in reading and understanding food labels were all significantly correlated with food and nutrition knowledge across the models. Likewise, higher median neighbourhood family income and household education were consistently correlated with greater food and nutrition knowledge among adolescents. This thesis fills a gap in the Canadian literature as it has allowed for a better understanding of the food and nutrition knowledge among adolescents. Findings from this thesis may help guide policymakers, researchers, and public health professionals in developing appropriate food and nutrition programs and curriculums to combat the decline in food literacy skills.

ACKNOWLEDGMENTS

First, to the schools and students that participated in the SmartAPPetite study, and to the many volunteers, work study students, and fellow graduate students that dedicated many hours to data collection. Thank you to Moe, Andrew, Kate, Kristen and Drew for your commitment to this project. The time you have invested in this project is so greatly appreciated by graduate students whose thesis quite literally could not be possible without you!

To Dr. Jamie Seabrook, thank you for being my supervisor for four years and two masters. You saw my potential when I was just a fourth-year undergraduate student. I am so grateful for your encouragement and support throughout this journey. It has been incredible to learn from someone as humble but brilliant as yourself. You have played a significant role in shaping the researcher that I am growing into and will become!

To Dr. Jason Gilliland, thank you for accepting me as a graduate student in your lab, the Human Environments Analysis Laboratory (HEAL). It has been a privilege to learn under the acclaimed researcher that you are. I have learned so much during my time at HEAL and have been fortunate to expand my understanding of health geography. I have built lifelong friendships that I would not have formed without joining the HEAL family. Thank you for this experience!

To Dr. Saverio Stranges, thank you for being a part of my supervisory committee, and for their support, direction and feedback. It has been a privilege to be mentored by the leader and expert that you are within your field.

To Dr. Andrew Clark, thank you for your unwavering support, encouragement and belief in my ability! Thank you for challenging me to learn on my own, but for always being available to explain concepts and statistical processes to me again and again, until I understood! I will forever be grateful for your limitless kindness, patience and mentorship throughout this challenging journey!

To my family and friends, thank you for being such cheerleaders throughout the past eight years of my university education. For my best friends in other provinces, thank you for always being on the other side of texts or phone calls! To my dear friends locally, thank you for the 100s of kilometers ran, and for filling my home with dinner and brunch memories. The regular check-ins and Sunday phone dates helped guide me through some of my best and worst moments!

To my Grandma, thank you for being such a trailblazing female. Your role as a director in public health while raising a big family was nothing short of inspirational and has always motivated me to pursue education and a career in public health. Thank you for being a role model in my life!

To my amazing parents, thank you for your unwavering support in my life. Thank you for always being my anchor through all of my pursuits and endeavors. Your unconditional love and support have taught me so much and have carried me through many trials and triumphs. I love you guys so much. To my Mom, for spending endless hours talking with me on the phone daily throughout all these years, for all the care packages throughout the years to lift my spirits, and for Facetiming me into family events to always feel included. To my Dad, for always taking the time whenever I needed you, whether it was to proofread my work, or to listen to me when I needed to talk through things or make tough decisions. I think you reviewed my thesis a dozen times!

To my best friend and husband Brad, we've been through so much already in life together. I am so grateful to have you by my side and for your unconditional support! Thank you for being so excited and supportive when I decided to pursue more schooling and for uprooting your career so that we could move back to London as a family. Thank you for being my logic and strength during many sleep deprived and emotional moments during this challenging process, and the past 7 years of school that we've experienced together. Thank you for always being a compassionate and patient soul, I could not have done this without you! Love you always.

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CHAPTER 1: INTRODUCTION

1.1. Research Context: Food Literacy Among Adolescents

1.1.1. Food Habits in Adolescence

Adolescence, defined by the ages of 10 to 19 years, is a period during the life cycle where nutritional needs are high, as teenagers have entered a time of rapid growth and development (Croll et al., 2001; Vaitkeviciute et al., 2015). As well, teenagers have growing autonomy and independent decision-making ability (Croll et al., 2001; Vaitkeviciute et al., 2015). One way they can express their autonomy is through their food choices and dietary intake (Vaitkeviciute et al., 2015). Research suggests that diet quality tends to decrease in adolescence and remain suboptimal into adulthood (Lipsky et al., 2017), as teenagers' dietary patterns are characterized by skipping meals, frequent snacking, and high intakes of fast food (Vaitkeviciute et al., 2015; Colatruglio & Slater 2016). This is concerning because one's diet in childhood and adolescence sets the foundation for their eating habits for the rest of their life (Mikkilä et al., 2005; Taylor et al., 2005; Brooks & Begley, 2014; Cruz et al., 2018). As such, the establishment of these habits during adolescence can put one at risk for obesity and related chronic diseases in adulthood (Croll et al., 2001; Brooks & Begley, 2014; Vaitkeviciute et al., 2015). Yet, teenagers often lack a sense of urgency for taking care of their health, as they struggle to conceptualize how their decisions in the short-term affect their future and long-term health (Neumark-Sztainer et al., 1999; Bryan et al., 2019). Therefore, focus is being placed on a better understanding of what influences dietary behaviours during adolescence (Vaitkeviciute et al., 2015; Ronto et al., 2016a).

1.1.2. Factors Affecting Dietary Behaviours in Adolescence

Food choices and eating behaviours are influenced by a host of inter-related factors at the individual, interpersonal, community and policy level (Chenhall, 2010). For example, the social environment of teenagers can strongly influence their food choices and eating behaviours (Story et al., 2008; Salvy, 2012). Peers, family, and friends all influence the eating behaviours of teenagers through role modeling, social support, or social norms (Story et al., 2008; Salvy, 2012). The built environment, such as settings in and around the school or home, the supermarket and even sport centers can all impact the food choices of teenagers (Story et al.,

2008; Larson et al., 2006; He et al., 2012a; He et al., 2012b; Sadler et al., 2016). Individual-level characteristics that affect food choices include psychological influences such as motivation and self-efficacy (Raine, 2005; Story et al., 2008), as well as food preferences and perceptions (Raine, 2005; Hardcastle & Blake, 2016) and food literacy (Raine, 2005).

1.1.2.1. Food Literacy in Adolescence

One factor in particular that may influence dietary behaviour is a concept called food literacy (Vidgen & Gallegos, 2011; Vaitkeviciute et al., 2015). Food literacy can be defined as: "A set of skills and attributes that help people sustain the daily preparation of healthy, tasty, affordable meals for themselves and their families. Food literacy builds resilience, because it includes food skills (techniques, knowledge and planning ability), the confidence to improvise and problem-solve, and the ability to access and share information. Food literacy is made possible through external support with healthy food access and living conditions, broad learning opportunities, and positive socio-cultural environments" (Desjardins et al., 2013). Food literacy also encompasses food and nutrition knowledge which enables an individual to make informed food decisions by understanding where food comes from, the nutrients within food, and how it can affect one's health (Vidgen & Gallegos, 2014; Vaitkeviciute et al., 2015; Thomas et al., 2019).

Food literacy significantly influences diet and is therefore an integral factor for improving dietary outcomes (Vidgen & Gallegos, 2011; Vaitkeviciute et al., 2015). However, though developing food literacy during adolescence has the potential to empower this population to achieve better physical, social, and emotional health (Brooks & Begley, 2014), it is common among teenagers to not have the basic food and nutrition knowledge or skills needed to consume a healthy diet (Pendergast & Dewhurst, 2012; Vidgen & Gallegos, 2014; Wickham & Carbone, 2018; Seabrook et al., 2019). Many factors are associated with the observed decline in food literacy skills among adolescents today (Brooks & Begley, 2014). Two of the main reasons for this lack of food literacy can be attributed to a decline in cooking within the home and the loss of a home economics curriculum in school (Chenhall, 2010; Kimura, 2011; Ronto et al., 2016a; Colatruglio & Slater, 2016). It has even been identified by young adults that this lack of nutrition education at home and school were the biggest barriers to developing food literacy and applying it to eating healthy upon living independently for the first time (Colatruglio & Slater, 2016).

People are not preparing meals at home as often (Brooks & Begley, 2014). This change in food preparation, and subsequent cooking skills and food choices, may be the result of a shift in family priorities and values, as well as social roles and norms (Chenhall, 2010). Women have entered the workforce and are now balancing the demands of being a primary gatekeeper for their family's health and food needs, while also holding jobs outside of the home (Slater et al., 2012; Slater, 2013; Flagg et al., 2014). This results in time scarcity and a decrease in family meals (Slater et al., 2012; Slater, 2013; Neumark-Sztainer et al., 2013; Walton et al., 2016). Consequently, many current generation adolescents are not learning skills to prepare meals "from scratch" and may not even find food literacy skills as relevant to their life anymore (Brooks & Begley, 2014; Colatruglio & Slater, 2016). If children are neither acquiring food and nutrition knowledge nor practicing food literacy skills at home, it is important that they have the opportunity to develop these skills somewhere else. Therefore, it has been suggested that a mandatory food curriculum be introduced back into the school setting to combat this decline in food literacy and improve diet-related health outcomes (Lichtenstein & Ludwig, 2010; Kimura, 2011; Pendergast & Dewhurst, 2012).

Policymakers and healthcare professionals believe that the lack of food and nutrition education may be a significant contributor to diet-related health outcomes such as increased blood pressure, blood sugar, obesity, and cardiovascular disease (Kimura, 2011). As such, home economics would be an investment into children's health and future (Pendergast & Dewhurst, 2012). When it was first introduced into the school curriculum during the industrial revolution, home economics was supposed to help those with unhealthy diets and poor living conditions (Pendergast & Dewhurst, 2012). Today it seems as though home economics education is often disrespected and seen as inferior to the more traditional academic subjects such as math or science. This may be because food education has often been viewed as a private and domestic subject that is associated with stereotyped gender roles, belonging to women rather than the public sphere of men (Pendergast & Dewhurst, 2012). However, a home economics curriculum which focuses on food literacy could be an effective platform to practice basic meal planning, budgeting, and meal preparation in addition to exploring the complex relationship between political, economic, social, and environmental components that affect food issues (Pendergast & Dewhurst, 2012). Within home economics, children would be able to develop confidence and self-efficacy when learning how to prepare and cook healthy food for themselves (Pendergast &

Dewhurst, 2012; Desjardins et al., 2013; Krause et al., 2018). These transferable skills developed in home economics class will stay with children as they grow into autonomous teenagers, and eventually independent adults **(**Lichtenstein & Ludwig, 2010).

The lack of food literacy has been further exacerbated by our current food system that provides a readily available supply of processed and convenience foods (Slater, 2013; Colatruglio & Slater, 2016; Poelman et al., 2018). This processed food is becoming progressively more convenient, accessible and affordable (Colatruglio & Slater, 2016). People desire food products that are either easy to prepare or that come ready to eat (Colatruglio & Slater, 2016). This growing acceptance for and normalization of processed and fast food (Chenhall, 2010; Brooks & Begley, 2014) has begun to dramatically affect our food environment by favoring unhealthy food choices and makes choosing healthy foods more difficult (Poelman et al., 2018). The general population are becoming de-skilled at planning and preparing meals for themselves and their family because the readily available processed foods are eliminating the need for food planning and cooking within the home (Colatruglio & Slater, 2016; Pendergast & Dewhurst, 2012; Slater, 2013; Brooks & Begley, 2014; Wickham & Carbone, 2018). As a result, we are seeing a trend towards suboptimal diets that are higher in sugar, salt, saturated and trans-fat, and lower in fruits and vegetables, whole grains, nuts, pulses, and seafood (Hyseni et al., 2017). For example, less than half of Canadians aged 12 years and older eat the recommended daily servings of fruit and vegetables (Statistics Canada, 2014), with the Public Health Agency of Canada (2013) reporting that 3 in 5 people aged 12 and older are not getting the recommended daily servings of fruit and vegetables. One Canadian study found that only 1 in 10 Canadian youth, in grades 6-12, were meeting Canada's Food Guide recommendations for fruit and vegetable intake (Minaker & Hammond, 2016). A recent study utilized Canadian Community Health Survey data to assess the economic burden of inadequate intake of vegetables and fruit (Ekwaru et al., 2017). It was found that insufficient consumption of fruits and vegetables is not only resulting in chronic diseases but also contributing to an economic burden of 3.3 billion dollars per year from direct and indirect healthcare costs (Ekwaru et al., 2017). This is concerning because research suggests that chronic diseases, and their corresponding risk factors, are increasing among children (Panagiotopoulos et al., 2018; Lipsky et al., 2017; Brady, 2017).

1.1.2.2. Challenges to Defining and Measuring Food Literacy

There is no one standard or accepted definition for food literacy, most likely because this is a relatively new concept (Cullen et al., 2015; Truman et al., 2017; Azevedo Perry et al., 2017). Additionally, within food literacy research, there is a diverse range of definitions, characteristics, frameworks, and attributes that are considered under this umbrella term (Kolasa et al., 2001; Conference Board of Canada, 2013; Vidgen & Gallegos, 2014; Velardo, 2015; Azevedo Perry et al., 2017; Krause et al., 2018; Thomas et al., 2019). Thus, it is difficult to compare and generalize findings across food literacy research (Azevedo Perry et al., 2017). In fact, since there is not a standardized assessment tool to measure this multi-dimensional construct (Azevedo Perry et al., 2017; Thomas et al., 2019), researchers and policymakers can neither accurately nor reliably design, measure or evaluate food literacy programming (Azevedo Perry et al., 2017). Among the review papers targeting food literacy among teenagers (Brooks & Begley, 2013; Vaitkeviciute et al., 2015; Wickham & Carbone, 2018; Bailey et al., 2019), only two Canadian studies were identified (Thomas & Irwin, 2011; Slater, 2013). However, the objectives of these two studies do not come close to measuring the robustness of food literacy. Thomas et al's (2011) objective was to provide an overview for the implementation of their 18-month cooking intervention for at-risk youth while Slater et al (2013) studied enrollment trends for home economics food and nutrition classes. A consistent theme throughout all the review papers (Brooks & Begley, 2013; Vaitkeviciute et al., 2015; Wickham & Carbone, 2018; Bailey et al., 2019) was the call for more primary research measuring food literacy among the teenage population.

1.2. Thesis Rationale

The purpose of this thesis is to collect primary data on, and gain a better understanding of, food and nutrition knowledge among adolescents in the London-Middlesex region of Ontario as there is little research to date on this population and within the concept of food literacy. If we can better understand how food and nutrition knowledge influence food choices and food intake, then we can design more effective strategies and interventions that focus on promoting healthy food behaviours among adolescents. The complexity and nuances of conceptualizing food literacy make it difficult to develop one standardized measurement tool. Therefore, the measurement tool utilized in this study does not have the capacity to directly measure food literacy as a construct. However, it will be able to capture food and nutrition knowledge, which

has been shown in other research to influence food behaviours among adolescents which will be a strength in our study.

1.3. Study Objectives and Hypothesis

With limited Canadian research on food literacy among adolescents, this thesis contributes new information as it explores the current state of food and nutrition knowledge among teenagers in London, Ontario. Using data collected by the Human Environments Analysis Laboratory (HEAL), as part of the SmartAPPetite intervention, the objectives of this study are (1) to determine the current state of food and nutrition knowledge among adolescents, grades 9-12 in the London-Middlesex region of Ontario, and (2) to examine correlates of food and nutrition knowledge among this target population.

Food and nutrition knowledge are defined using a previously validated knowledge questionnaire (Anderson et al., 2002; Vereecken et al., 2004). The content domains of our measurement tool include recommendations from Dietitians, including food groups and respective nutrients, applying label reading by selecting the best food choices, and identifying the connection between diet and diseases. Correlates of food and nutrition knowledge were defined by various self-reported food habits, family mealtime patterns and self-efficacy in the kitchen, as well as demographic data such as age, gender, household income, and parental education. As previous literature suggests that food literacy is on the decline among adolescents, it was predicted that adolescents would score low on our food and nutrition knowledge assessment tool. It is hoped that this research will help guide the development of food literacy material as part of the interventions such as the SmartAPPetite smart-phone intervention to improve food literacy among adolescents in addition to guiding future food literacy program and curriculum planning.

1.4. The Theoretical Frameworks

1.4.1. Social Cognitive Theory

One health behaviour theory that is widely applied in health promotion, and particularly in interventions to promote healthy eating in youth, is Social Cognitive Theory (Nutbeam et al., 2014; Lubans, 2012; Fitzgerald et al., 2013). This theory is a helpful framework to adopt when trying to better understand the multiple influences that affect dietary knowledge, skill and behaviours of adolescents (Story et al., 2002; Lubans et al., 2012; Hall et al., 2015). Social

cognitive theory recognizes that learning is a dynamic process that occurs through interactions between an individual and their behaviours as well as their environment (Nutbeam et al., 2014). This complex interaction is referred to as reciprocal determinism, which describes the dynamic interaction between these three factors (Nutbeam et al., 2014). If we can understand how an individual, their environment and their behaviour influence one another, health promotion interventions would be able to better modify social norms (Nutbeam et al., 2014). This theory is further defined by a range of personal cognitive factors, three of which are of particular importance (Nutbeam et al., 2014). The first cognition is the ability to learn. This is acquired by observational learning and receiving rewards for different behaviours. Observing role models, the influence of peers, as well as social norms all influence behaviour. For example, observing and participating in meal preparation can increase food and nutrition knowledge as well as food skills among adolescents (Chenhall, 2010; Seabrook et al. 2019). The second cognition of importance is the ability to understand expectations; anticipating and placing value on certain outcomes based on different behaviours (Nutbeam et al., 2014). It is important from a health promotion lens to understand the underlying beliefs and motivations that drive behaviour patterns in individuals in order to modify behaviours. For example, food literacy interventions focused on improving the diets of adolescents must focus on short-term and tangible outcomes rather than long-term consequences of their behaviour. This is because teenagers struggle to conceptualize threats posed to their health long-term and do not see an urgency to change their behaviour (Neumark-Sztainer et al., 1999; Nutbeam et al. 2014; Bryan et al., 2019). The last cognition, which has been argued to be the most important capacity for behaviour change, is called self-efficacy. This term was developed by Alberta Bandura in 1997 and is defined as one's belief in their own ability to successfully perform a behaviour (Nutbeam et al., 2014). The development of self-efficacy enables an individual to perceive fewer barriers and greater benefits to adopting more healthful habits (Lubans et al., 2012). Self-efficacy is a contextual concept as it is both behaviour and situation specific. Bandura argued that behaviour change occurs through knowledge acquisition, which is developed through observational learning in addition to participatory learning (Nutbeam et al., 2014). Participatory learning occurs when an individual practices and repeats a given behaviour (Nutbeam et al., 2014), such as cooking in the kitchen to prepare a meal from scratch. Additionally, dietary self-efficacy focuses on building self-

confidence in an individual so that they can make healthy food choices despite possible barriers (Lubans et al., 2012; Muturi et al., 2016).

1.4.2. Social Ecological Theory

The social cognitive theory of behaviour change is complemented by the Social Ecological Theory. This model also acknowledges reciprocal determinism, which recognizes that human behaviour affects and gets affected by dynamic interactions between four broad levels of influence (Story et al., 2002; Chenhall, 2010; Townsend & Foster, 2013). Individual, social environmental, physical environment as well as macrosystem-level influences all affect knowledge acquisition and health behaviours such as food and nutrition knowledge, dietary choices, dietary patterns and food intake (Chenhall, 2010; Graham et al., 2013; Caperon, 2019). Examples of individual or intrapersonal level factors that impact eating behaviour include biological variables like sex and hunger, while psychosocial variables include one's attitudes, beliefs, food and nutrition knowledge and self-efficacy (Story et al., 2002; Chenhall, 2010; Graham et al., 2013; Herforth & Ahmed, 2015). Additionally, one's behavioural patterns such as mealtime routines, weight-control strategies, and perceived barriers to healthy eating like time or cost, all impact eating behaviour (Story et al., 2002; Chenhall, 2010; Graham et al., 2013). Individuals are also influenced by factors at the social environmental, or interpersonal, level (Story et al., 2002). At this level, eating behaviours are influenced by family, peers or colleagues, and social networks through role-modeling, perceived social norms or support, as well as reinforcement (Story et al., 2002; Fitzgerald et al., 2013; Partida et al., 2018). Furthermore, individuals interact with factors within various physical environmental settings, also known as the community level (Story et al., 2002). Schools and workplaces, fast-food outlets, restaurants, and convenience stores, and even vending machines are all examples of food environments at the community level that impact food choices and quality (Story et al., 2002). These diverse sectors of influence at the community level have a large impact on the availability and accessibility of food (Story et al., 2002). He et al (2012a) concluded that there was a significant relationship between school and home neighbourhoods where there was a high density of fast food outlets, and increased purchasing of fast food by teenagers. The last level of influence is the macrosystem, or societal level (Story et al., 2002). Here, factors that affect food behaviours play a more indirect but significant role on eating behaviours. These factors include policies and laws that control and support food-related issues, food production and distribution, food product

advertising and media, as well as social and cultural food norms (Story et al., 2002). It is with these theoretical frameworks, the social cognitive theory and the social ecological model, that we can begin to understand the complexities that determine food and nutrition knowledge and behaviours.

1.5. Organization of the Thesis

This thesis was written in a monograph format. *Chapter 2* provides a detailed background on the concept of food literacy, before introducing and discussing one of the sub-domains of food literacy, which is food and nutrition knowledge. This review also discusses the importance of developing food and nutrition knowledge throughout adolescence, and their role on diet and health. *Chapter 3* describes the methodology for this thesis, including the SmartAPPetite study, outcome measures and the data analysis for my thesis. Chapter 4 presents and summarizes the study findings, particularly the food and nutrition knowledge scores among high school students and predictors of their food and nutrition knowledge. Lastly, *Chapter 5* consists of the discussion, strengths and limitations of this study, suggestions for future research, and closing remarks.

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CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Adolescence is a stage in the life cycle marked by rapid growth and development (Croll et al., 2001; Vaitkeviciute et al., 2015). During this stage, nutrition is important for healthy growth (Croll et al., 2001; Ball et al., 2009; Vaitkeviciute et al., 2015). Paralleling the rapid growth during adolescence is their growing autonomy in decision-making ability (Croll et al., 2001; Vaitkeviciute et al., 2015). One way for teenagers to express their autonomy is through their food choices and dietary intake (Vaitkeviciute et al., 2015). In turn, this freedom to make food decisions may lead to diets that do not meet nutrition guidelines (Vaitkeviciute et al., 2015; Colatruglio & Slater, 2016). For example, it is common for adolescents to skip meals, snack frequently, and to consume large amounts of processed and fast-foods (Vaitkeviciute et al., 2015; Colatruglio & Slater, 2016), with the majority of their meals occurring outside of the home (Cruz et al., 2018). Additionally, while the prevalence of breakfast consumption and the intake of fruits and vegetables decreases, the daily prevalence of soft drinks increases among teenagers (Cruz et al., 2018). This is concerning because the dietary behaviours established during childhood and adolescence serves as the foundation for eating habits for the rest of their lives (Taylor et al., 2005; Lake et al., 2009; Brooks & Begley, 2014). For example, unhealthy dietary behaviours established in adolescence can put one at risk later in life for chronic diseases such as obesity (Croll et al., 2001; Brooks & Begley, 2014; Vaitkeviciute et al., 2015). Furthermore, diminished nutrition knowledge and food preparation skills, as well as poor food choices and eating patterns, have been associated with an increase in nutrition-related non-communicable diseases (NCDs) (Pendergast & Dewhurst, 2012; Vidgen & Gallegos, 2014; Thomas et al., 2019). Therefore, it is critical to understand the factors influencing dietary behaviours among adolescents before one can effectively design nutrition interventions to improve their diet (Vaitkeviciute et al., 2015; Ronto et al., 2016a).

The determining factors underlying dietary behaviours in adolescence is multifaceted. Two theories that will help guide this literature review are Social Cognitive Theory and the Ecological model (Story et al., 2002). These theories may provide insight into how the various levels of influence interact to determine the dietary behaviours of adolescents. This chapter reviews factors that affect dietary behaviours among adolescents. Specifically, this chapter will

focus on the concepts of food literacy and food and nutrition knowledge which are promising approaches to support healthy dietary behaviour in this population (Ronto et al., 2016a).

2.1.1. The Evolving Food System and its Impact on Diet Quality and Disease

It is very important for individuals to learn how to function within our contemporary food system in order to optimally choose and consume foods that will contribute to good health (Vidgen & Gallegos, 2014). Currently though, the diet quality and health of Canadians is being negatively influenced by the food environment as it has evolved to favour unhealthy food choices (Poelman et al., 2018). The ever-growing prevalence of fast-food outlets and large-scale food retail stores (Azevedo Perry et al., 2017), as well as processed and convenience foods (Slater, 2013; Colatruglio & Slater, 2016; Poelman et al., 2018), have made high-calorie and nutrient-poor foods and beverages more readily available and affordable (Azevedo Perry et al., 2017). Paralleling these changes to our food environment is a growing acceptance and normalization for these unhealthy food options, possibly because people want food products that require little to no preparation (Chenhall, 2010; Brooks & Begley, 2016; Colatruglio & Slater, 2016). Consequently, these readily available processed foods are eliminating the need for people to understand how to plan and prepare food for themselves (Colatruglio & Slater, 2016; Pendergast & Dewhurst, 2012; Slater, 2013; Brooks & Begley, 2014; Wickham & Carbone, 2018). Due to this shift in food preparation and planning, food literacy may be lacking among many people in society. Food literacy is defined as "*a collection of inter-related knowledge, skills, and behaviours required to plan, manage, select, prepare, and eat food to meet needs and determine intake*" (Vidgen & Gallegos, 2014). However, because of the current trends in our food system, consumers are failing to comprehend the various stages along the food supply chain that allows for food to go from "farm to fork" (Cullen et al., 2015). From how crops are grown and harvested, to the way animals are being raised and butchered, not to forget the transportation, distribution, and promotion of food, people are not able to make the best decisions for their health (Pendergast & Dewhurst, 2012). Without the knowledge and skills needed to obtain, understand, and apply basic food and nutrition information to make healthy food choices, diets are suffering and inadequately reflecting food and nutrition recommendations for optimal health (Azevedo Perry et al., 2017). In fact, Moubarac et al. found that Canadians are consuming about 50% of their energy from ultra-processed food (Moubarac, 2017). Therefore, it has been suggested that developing food literacy skills, such as food and nutrition knowledge, may better

equip individuals to attain healthier dietary outcomes (Conference Board of Canada, 2013; Thomas et al., 2019) and reduce the risk of diet-related non-communicable diseases, like obesity (Croll et al., 2001; Brooks & Begley, 2014; Vaitkeviciute et al., 2015).

2.1.2. Diet and Disease

In 2016, 44% of Canadians over twenty years old lived with 1 of the 10 most common chronic conditions, also known as NCDs (Public Health Agency of Canada, 2019). The ten main NCDs affecting Canadians include: hypertension, osteoarthritis, mood and anxiety disorders, osteoporosis, diabetes, asthma, chronic obstructive pulmonary disease, ischemic heart disease, cancer, and dementia (Public Health Agency of Canada, 2019). Modifiable risk factors contributing to these NCDs include: raised blood pressure, high cholesterol, elevated blood sugar, tobacco use, alcohol consumption, sedentary lifestyle and sub-optimal nutrition (Ekwaru et al., 2017; World Health Organization, n.d.). Poor diet is now the largest contributor to NCDs globally, larger than physical inactivity, tobacco and alcohol use combined (Hyseni et al., 2017). An international systematic analysis concluded that diets high in sodium, but low in whole grains, fruits and vegetables, nuts and seeds, and omega-3 fatty acids are the leading dietary risk factors for death (Afshin et al., 2019).

Concerningly, NCDs and corresponding risk factors are increasing among children (Panagiotopoulos et al., 2018; Lipsky et al., 2017; Brady, 2017), possibly due to increased obesity rates, decreased physical activity, sedentary behaviours, increased screen time, poor sleep quality and quantity, a rise in sugar-sweetened beverage consumption and unhealthy diets (Tremblay et al., 2016; Panagiotopoulos et al., 2018). Within the past two decades, type 2 diabetes in children has increased in frequency globally (Panagiotopoulos et al., 2018) and we are also seeing more children with increased blood pressure (Brady, 2017). Children with obesity tend to have poorer health, and are at greater risk for developing NCDs such as cardiovascular diseases, hypertension, type 2 diabetes, dyslipidemia, fatty liver disease, as well as orthopaedic problems, low self-esteem, depression, and social stigmatization (Kelishadi & Azizi-Soleiman, 2014; Vaitkeviciute et al., 2015; Public Health Agency of Canada 2017; Brady, 2017). In 2017, the Public Health Agency of Canada reported that 30% of children, ages 5-17, were overweight or obese (Public Health Agency of Canada, 2017). Adolescence may be a key period in the development and continuation of obesity into adulthood as well as related co-morbidities (Alberga et al., 2012; Vaitkeviciute et al., 2015). While the complexity behind what causes

obesity is beyond the scope of this paper, from a nutrition lens, unhealthy dietary behaviours established during adolescence can put one at risk for chronic diseases like obesity (Croll et al., 2001; Brooks & Begley, 2014; Vaitkeviciute et al., 2015). This is concerning because, as previously stated, adolescence is a critical period in the lifecycle where the eating habits developed can set the foundation for eating habits for the rest of their life (Taylor et al., 2005; Brooks & Begley, 2014). Therefore, one way to combat this increase in NCDs is by helping adolescents develop the necessary food literacy tools to interact with our complex, dynamic, and evolving food system and achieve healthier dietary outcomes (Pendergast & Dewhurst, 2012; Conference Board of Canada, 2013; Thomas et al., 2019).

2.1.3. Food Literacy

The concept of "food literacy" has emerged in recent years (Kolasa et al., 2001) with its definition derived from Nutbeam's concept of health literacy (Nutbeam, 2000; Nutbeam 2008). Health literacy involves having the skills and knowledge to make healthy choices to optimize one's health (Nutbeam, 2000) and to better control one's health within the context of interpersonal, intrapersonal, and environmental determinants (Nutbeam, 2008). Adapting this definition of health literacy to fit the scope of food and nutrition, Kolasa (2001) described one of the earliest definitions of food literacy as, "*the capacity of an individual to obtain, interpret and understand basic food and nutrition information and services as well as the competence to use that information and services in ways that are health enhancing.*" Kolasa's definition highlights that food literacy goes beyond food and nutrition knowledge and involves the application of this knowledge as food skills and behaviours. A food literate individual has the competency to obtain, process, and understand basic food and nutrition information while also having the ability to apply this information to make healthy food choices, which then in turn affects their health (Krause et al., 2018). Food literacy helps build resilience in individuals (Desjardins et al., 2013; Azevedo Perry et al., 2017) because they learn how to interact with the food system and navigate how to maintain healthy eating within everyday practicalities (Vidgen & Gallegos, 2014). It allows teenagers to develop confidence in the kitchen as they practice a diverse set of food skills and strengthen their self-efficacy in improvising and problem-solving when preparing meals with existing resources (Thomas & Irwin, 2011; Desjardins et al., 2013).

Many researchers have expanded upon the original definition of food literacy (Azevedo Perry et al., 2017; Vidgen & Gallegos, 2014; Cullen et al., 2015; Truman et al., 2017). For

example, Truman et al (2017) conducted an extensive scoping review to analyze the current uses of the term "food literacy." They discovered that of the 67 studies included in their analysis, there were 38 novel definitions of the term. Food literacy definitions have been diversely organized into various domains and attributes to highlight the complex set of skills, knowledge, and behaviours necessary to make healthy food choices and meet nutrition recommendations (Vidgen & Gallegos, 2014; Truman et al., 2017; Krause et al., 2018; Thomas et al., 2019). Some definitions are also incorporating an ecological approach, acknowledging the complex interconnection between an individual's skills and behaviours while existing within their cultural, environmental and social contexts (Cullen et al., 2015; Truman et al., 2017; Thomas et al., 2019).

The expansiveness of this term has led to considerable variation among the definitions and differences in how food literacy has been applied in study settings. Hence, a critical limitation in the food literacy literature is the lack of a standardized definition and measurement tool for measuring this robust construct (Cullen et al., 2015; Azevedo Perry et al., 2017; Thomas et al., 2019). Without a standardized measurement tool for capturing the full construct of food literacy, researchers are left to focus on specific components of food literacy in their study design and interventions. Examples of these food literacy studies in adolescents include research pertaining to cooking skills (Beets et al., 2007; Thomas & Irwin, 2011; Brooks & Begley, 2014 ; Seabrook et al., 2019), self-efficacy for healthier eating (Long & Stevens, 2004; Thompson et al., 2009), label reading (Hawthorne et al., 2006; Santaló et al., 2019), gardening programs to improve dietary behaviour (Lautenschlager & Smith, 2007; Beckman & Smith, 2008), and food and nutrition knowledge (O'Neil & Nicklas, 2002; Struempler & Cobrin, 2002; Banos et al., 2013; Santaló et al., 2019). When reviewing the types of food literacy programming which are being offered in Ontario, Nutrition Connections serves as a good resource. Nutrition Connections, which was formerly called the Nutrition Resource Centre (NRC), conducted a thorough review of food literacy programs in Ontario that, as of April 2019, were being provided to their communities (Nutrition Connections, 2019). These programs are offered by public health units, community health centres, family health teams, community-based and not-for-profit organizations in Ontario. The researchers found that there was a wide range of programs being offered, covering different components of food literacy, varying in goals and objectives, and

targeting diverse groups. For the purpose of this literature review, only programs that specifically targeted adolescents are documented and discussed below.

To begin, Nutrition Connections assessed programs offered at the public health level across Ontario (Nutrition Connections, 2019). They found that Kingston Frontenac Lennox and Addington Public Health maintain a resource called Healthy Eating Curriculums. They offer these models to teachers on an "as requested" basis. All modules are designed around the Ontario Health and Physical Education Curriculum and are uniquely designed for the grade 1 curriculum up to the grade 12 curriculum. Registered Dietitians and Nurses within this public health organization also run a weekly program for 4 weeks within secondary schools for youth called Under Cookstruction. Their program aims to empower teenagers to build confidence in their food preparation skills, while simultaneously improving their food skills. By doing so, they want to increase food security among youth. A pilot project was being trialed during 2019 by Registered Dietitians in Hastings Prince Edward Public Health. Their initiative, Let's Cook! Cooking with Teens, builds food literacy in teenagers by focusing on topics that will improve teenagers' food and nutrition knowledge, food skills and self-efficacy, and confidence. This program targets youth aged 13-17 years and is a 6-week program (Nutrition Connections, 2019).

Nutrition Connections also analyzed community-based organization programs and reported that Ontario 4-H programs provided opportunities to learn and develop practical cooking skills (Nutrition Connections, 2019). As part of 4-H, kids and youth ages 9-18 years meet twice a month for 8 months out of the year. Another program, Field to Table Schools, is provided by FoodShare Toronto and is offered to students, educators, and parents. Their focus is helping children and youth to be empowered by acquiring food literacy knowledge and life skills. To accomplish this, their programming focuses on plants and gardening, cooking and tasting, soil and compost, as well as food justice and security. FoodShare Toronto also provides a program over March break and the summer called School Grown. It has the goal of empowering youth and high school students through hands-on experience of growing their own food. Another food literacy program in Ontario is Growing Communities. This program has been designed by Growing Chefs! Ontario and aims to increase the food literacy of children, youth, parents and adults. Programs provided to students are often 3 hours in length (Nutrition Connections, 2019).

This provincial review highlights the diverse array of programs being offered in communities across Ontario with the goal of teaching food literacy skills. However, it is

important to recognize that no one program has comprehensively educated or measured components of this robust construct. The authors emphasize that further food literacy programming is of critical importance to improve the eating behaviours, health and wellbeing of children and families. They suggest that this goal is achievable through "collaboration, robust measurement tools, funding, and advocacy" (Nutrition Connections, 2019). In fact, one specific team of Canadian healthcare professionals and researchers are working on developing a robust measurement tool through collaboration and advocacy. This extensive study has been ongoing in Ontario by the Food Literacy and Food Skills Locally Driven Collaborative Projects (LDCP) working group. They are developing a comprehensive and standardized food literacy definition and measurement tool.

The LDCP program is an Ontario Public Health funded initiative that brings health units from across the province together (Public Health Ontario [PHO], 2019). The goal of these projects is to conduct and evaluate applied research studies that focus on shared public health interests (PHO, 2019). The interdisciplinary teams consist of public health staff, research consultants, librarians, academic partners and stakeholders (PHO, 2019; Ontario Dietitians in Public Health, n.d.). Since 2011, the Food Literacy and Food Skills LDCP research interests have focused on food literacy topics in teenagers 16 to 19 years old and in pregnant women aged 16 to 25 years (Desjardins et al., 2013). In 2011, the first research project was underway and focused on consulting with their target population to explore the meaning of food skills and to develop a working definition. Barriers and facilitators to developing and practicing food skills were also identified (Desjardins et al., 2013). Results from this study informed program development and policy in order to improve healthy food preparation in these at-risk populations (Desjardins et al., 2013). Through the rich data collected, they were able to broaden the development of their food skills definition, expand their work, and generate a definition and conceptual model for food literacy. Their food literacy definition is one of the most thorough and comprehensive to date: *"a set of skills and attributes that help people sustain the daily preparation of healthy, tasty, affordable meals for themselves and their families. Food literacy builds resilience, because it includes food skills (techniques, knowledge and planning ability), the confidence to improvise and problem-solve, and the ability to access and share information. Food literacy is made possible through external support with healthy food access and living*

conditions, broad learning opportunities, and positive socio-cultural environments" (Desjardin, 2013, pg. 82).

Most recently, the Food Literacy LDCP built off their original research from 2013 to further develop consensus on the previous fifteen attributes and five domains of food literacy (Thomas et al., 2019). This was completed by utilizing the Delphi method to evaluate the attributes for their importance and relevance, and to fit the attributes into appropriate domains (Thomas et al., 2019). A framework was developed to summarize food literacy using eleven interconnected attributes that fit within five main domains and acknowledge that food literacy is influenced by all levels within the Social Ecological Model (Thomas et al., 2019). It was concluded that the five domains of food literacy, with corresponding attributes in brackets, are: Food and Nutrition Knowledge (food knowledge, nutrition knowledge, food language and nutrition language), Food Skills (food skills), Self-Efficacy and Confidence (nutrition literacy, food and nutrition self-efficacy, cooking self-efficacy, and food attitude), Ecologic Factors (food systems and social determinants of health), and Food Decisions (dietary behaviour). These domains and attributes are interconnected and must exist together for an individual to ultimately be food literate. For example, an individual may have food and nutrition knowledge and skills but lack the self-efficacy and confidence to apply them. A comprehensive approach would need to be adapted, acknowledging the various levels of influences and social determinants of health, to impact food literacy and dietary behaviour. This framework can help guide future food literacy research and measurement as there is a need for coherent and consistent terminology in this area of research (Thomas et al., 2019).

The team is now in the process of developing a food literacy measurement tool (Desjardin et al., 2013; Azevedo Perry et al., 2017; Thomas et al., 2019). This tool is still being developed and evaluated by the LDCP team and a research team from the University of Toronto (Ontario Dietitians in Public Health, n.d.). Once complete, this tool will be of utmost importance for advancing food literacy research as it will allow for a common terminology of food literacy to be used among research groups, improve the consistency in food literacy programming, and facilitate global knowledge translation (Desjardins et al., 2013; Azevedo Perry et al., 2017; Thomas et al., 2019). Therefore, based on this overview of food literacy, it is apparent that this construct is complex, and requires this robust and validated measurement tool to adequately measure food literacy. At this time, because we do not have this tool in the literature, and similar

to other cited studies that focus on specific domains of food literacy, this thesis will specifically focus on the domain of food and nutrition knowledge outlined by the Food Literacy LDCP (Thomas et al., 2019).

2.2. Food & Nutrition Knowledge

2.2.1. What is Food & Nutrition Knowledge

Defined by the Food Literacy LDCP, the Food and Nutrition Knowledge domain of food literacy involves acquiring food and nutrition facts and information through food and nutrition experiences and education (Thomas et al., 2019). This domain consists of the following three food literacy attributes: food knowledge, nutrition knowledge, food language and nutrition language (Thomas et al., 2019). Having food knowledge can be defined as understanding where one's food comes from and what is in it. For example, this may include understanding that store-bought cookies, cakes and pastries are high in trans-fat or that canned soup is often high in salt. It could also be represented by one's ability to read a label and identify the sources of sugar in the ingredients list of a product. Food knowledge also includes having the ability to make informed choices (Thomas et al., 2019). This may be reflected in an individual's ability to understand that grilled chicken is a healthier option than fried or crispy chicken because of how its prepared. The second attribute within Food and Nutrition Knowledge is nutrition knowledge, which involves understanding nutrients within foods and how they can affect one's health. An example of this attribute would be understanding that oats and bananas are sources of fibre and that a diet low in fibre may lead to constipation. Similarly, it would be knowing that white bread has a high Glycemic Index (GI) and that eating this food item would result in a greater rise in blood sugar than would something with a lower GI. The third attribute within Food and Nutrition Knowledge is food and nutrition language, which would be reflected in a person's understanding of common food and nutrition words that are used to describe characteristics of food or food preparation. Food is often described by the nutrients in it such as a product claim that states that the food item is "high in fibre" or "low in sugar." Another example of understanding food and nutrition language would be knowing that "folding" means to gently combine ingredients together rather than beating or stirring.

2.2.2. Why is Food & Nutrition Knowledge Important

Vaitkeviciute et al (2014) conducted a systematic review studying the relationship between food literacy and dietary behaviours of adolescents. It was found that adolescents with healthier dietary patterns were those who had greater food knowledge and prepared food more frequently, possibly because food knowledge helps guide an individual to make informed decisions about their diet and food intake. Food knowledge is important to acquire and strengthen because it enables one to understand differences in food quality of food items and to recognize differences in foods that make them healthy or unhealthy (Vidgen & Gallegos, 2014; Vaitkeviciute et al., 2015). It has been suggested that a lack of food and nutrition knowledge is associated with poorer diet quality and increased consumption of unhealthy foods, thus putting one at risk for developing overweight and obesity (Lichtenstein & Ludwig, 2010). In fact, a cross-sectional study examining determinants of food intake among adolescents found that adolescents with higher food knowledge reported spending less time each day performing sedentary activities and reported consuming fewer than two snacks throughout the day (Grosso et al., 2012).

Much of the literature reviewed emphasizes the importance of baseline food and nutrition knowledge to then navigate the complex food system from purchasing healthy food options to preparing healthy meals, and what is in our food to how nutrients affect the body (Thonney & Bisogni, 2006; Thomas & Irwin, 2011; Pendergast & Dewhurst, 2012; Sustain Ontario & Ontario Edible Education Network, 2014; Vidgen & Gallegos, 2014; Azevedo Perry et al., 2017). With fewer families preparing meals at home, adolescents are having fewer opportunities to learn and apply food and nutrition knowledge (Brooks & Begley, 2014). Consequently, it has been suggested that adolescents may not even find developing food literacy skills relevant to their life anymore (Brooks & Begley, 2014). For example, although adolescents recognize that cooking skills are important to acquire for when they live independently (Colatruglio et al., 2016), Ronto et al (2016a) discovered that at their current stage of life (age 12-17), adolescents do not rate cooking skills as important. However, research suggests that children and adolescents who cook frequently consume higher quantities of fruits and vegetables (Burrows et al., 2015; Utter et al., 2016; Seabrook et al., 2019), have a preference for healthier food choices (Hersch et al., 2014), consume food prepared away from home less often (Contento et al., 2010; Robson et al., 2016), and consume less sweetened beverages and less packaged and processed food (Contento et al.,

2010). Ronto et al (2016a) discovered that adolescents rank food knowledge as more important than cooking skills because they perceive that food knowledge impacts their dietary behaviours and food choices more (Ronto et al., 2016a). Researchers argue that efforts to apply food and nutrition knowledge to healthy food practices in adolescents may be undermined by a lack of food skills (Worsley 2015; Ronto et al., 2016a), which highlights the intertwined nature of the food literacy domains. Often, programs that focus on cooking skills in children and teenagers also target food and nutrition knowledge as part of the interventions (Brown & Herman, 2005; Condrasky et al., 2010; Concannon et al., 2011; Thomas & Irwin, 2011). Many of these interventions are based on social cognitive theory or an ecological perspective as a theoretical framework to help guide their program, recognizing that there are many levels of influence (intrapersonal, interpersonal, community and macrosystem) that affect dietary behaviours and food choices in adolescents.

2.2.3. Levels of Influence that Affect the Development of Food & Nutrition Knowledge in Adolescents

Sahingoz et al. (2011) argue that an individual's nutrition knowledge directly affects their food choices. However, it is important to note that food and nutrition is one of many categories within food literacy and though one may have knowledge of nutrition and food, other complex factors also affect their nutritional choices. Other researchers recognize that food knowledge may not be sufficient to change an individual's food behaviours (Worsley, 2002; Mirmiran et al., 2007), as there is complex interplay between barriers and facilitators, all of which affect how food and nutrition knowledge gets integrated into healthy food behaviours. The next section of this review will discuss various levels of influence that may affect the food and nutrition knowledge and dietary behaviours of adolescents.

2.2.3.1. The Home Environment and Family Mealtime

Family health behaviours have a strong influence on the health behaviours of their children (Hardcastle & Blake, 2016). Likewise, parental attitudes and behaviours also affect their child's health behaviours (Hardcastle & Blake, 2016), which is important because teenagers report that attitudes and perspectives play powerful roles in both their involvement with cooking and their food intake (Ronto et al., 2016a). Specifically, having a positive attitude towards cooking and healthy eating will result in healthier dietary behaviours, while a negative attitude

will result in unhealthy food behaviours (Ronto et al., 2016a). However, we are seeing a shift in society today where families are not cooking as frequently at home and are buying more food prepared outside of the home (Chenhall, 2010; Brooks & Begley, 2014). This shift has been referred to as the "nutrition transition" (Colatruglio & Slater, 2016) and has been enabled by a shift in family priorities and values, as well as social roles and norms (Chenhall, 2010). There is a perceived scarcity of time among families today as it is more common for both parents to be working outside of the home, leaving fewer opportunities to practice and learn cooking skills, and prepare meals at home as a family (Chenhall, 2010; Slater et al., 2012; Slater, 2013; Flagg et al., 2014; Colatruglio & Slater, 2016).

When examining the relationship between maternal food knowledge and children's diet quality, Campbell et al (2013) found that maternal food knowledge was significantly associated with the availability of fruits and vegetables within the home and was inversely associated with salty snacks and soft drinks. Single-parent families can also influence food skill acquisition in adolescents (Brooks & Begley, 2013) as single-parent households may experience lower incomes, higher stress, and time constraints that affect the time spent in caregiving roles (Reicks et al., 2015; Seabrook & Avison, 2015). In addition to reporting that family meals were a challenge due to lack of time, Berge et al's (2013) also found that single mothers identified cost and a lack of cooking skills as barriers. Therefore, there may be less opportunities to learn and develop cooking skills, as well as decreased exposure to food preparation, within the home kitchen of single-parent households.

The practice of having meals together as a family is dwindling due to this nutrition transition (Colatruglio & Slater, 2016). This is concerning because adolescents report that family mealtime enables them to consume healthier foods (Ronto, 2009a). In a 5-year longitudinal study examining the relationship between family meals and diet quality among middle-school and high-school students, Neumark-Sztainer et al. (2010) found that frequency of family meals was positively associated with improved dietary intake. On the contrary, a cross-sectional study found these results were reversed when the television was on during family mealtime as adolescents consumed fewer vegetables, calcium-rich food, and grains, while having higher intakes of soft drinks (Feldman et al., 2007). A Canadian cross-sectional study, examining adolescent eating behaviours, found that 76% of adolescents in grades 9-12 reported eating in front of the television at least once during the week (Lillico et al., 2014). It has been suggested

that family mealtime is important because it plays a role in the development of eating behaviours for children and adolescents (Neumark-Sztainer et al., 2003). Fieldhouse (2016) suggests that the family meal provides opportunities for parents to model healthy eating behaviours, build a balanced meal, teach about appetite and satiety, and to expose children to a variety of different food choices and tastes, all of which contribute to the development of food and nutrition knowledge and ultimately food literacy.

It was identified by young adults that before living on their own, a barrier to acquiring and using food literacy skills, was a lack of opportunities within the home environment to learn about food from their parents (Colatruglio & Slater, 2016). Ronto et al (2016a) found that adolescents reported that they did not perceive that they had many food-related domestic responsibilities at home and identified these tasks as the budgeting and purchasing of food, as well as food preparation. Teenagers believed that they were not allowed to be involved because their parents were under time-constraints and did not want the mess from their children (Ronto et al., 2016a; Lavelle et al., 2019). However, research shows that by involving adolescents in the meal preparation process, they will experience increased self-efficacy to prepare food more frequently on their own, and will acquire improved skills and techniques for preparing this food (Larson et al., 2006; Chenhall, 2010; Thomas & Irwin, 2011; Santarossa et al., 2015; Vaitkeviciute et al., 2015; Quelly, 2019).

2.2.3.2. Self-efficacy

Self-efficacy is defined as the belief in one's ability to perform a particular behaviour in a specific situation. Self-efficacy is developed through learning, gaining knowledge and understanding, as well as developing skills (Muturi et al., 2016). It has been suggested that self-efficacy is a critical piece in behaviour change and thus is an important factor to consider in disease prevention programs. Self-efficacy builds confidence in one's self to engage in health promotion behaviours, such as increasing one's intake of fruits and vegetables while reducing intake of processed foods. Bandura's social cognitive theory of behaviour change suggests that the regulation of human behaviour, motivation, and well-being are regulated by the interactions between self-efficacy, knowledge of health risks and goals, expectations of outcomes, as well as perceived barriers and facilitators (Bandura, 2004). In a study investigating how Social Cognitive Theory can explain the dietary behaviours of female adolescents from low-income communities, Lubans et al (2012) found that intentions alone were not enough to predict healthy food

behaviours when they adjusted their models for self-efficacy. The researchers explain that although female adolescents may have strong intentions to practice healthy food behaviours, they also require strong dietary self-efficacy for intentions to translate into healthy behaviour (Lubans et al., 2012). In Muturi et al's (2016) cross-sectional study, examining factors associated with self-efficacy for food choices and healthy eating among teenagers, positive attitudes towards overall health and perceived control over one's health predicted higher efficacy for healthy eating and for making healthy food choices. Furthermore, food availability within the home and school predicted self-efficacy for healthy eating because when there were healthy food options within these environments, adolescents were more likely to have the confidence to make healthier food decisions (Muturi et al., 2016). When adolescents do not receive opportunities within the home to observe, practice and learn food literacy skills, they may lack self-efficacy and perceive that their food preparation and cooking skills are inadequate to create healthy food behaviours (Ronto, 2009a; Chenhall, 2010). In contrast, when involved with the household food preparation, adolescents experience positive psychosocial outcomes such as self-confidence (Larson et al., 2006; Desjardins et al., 2013; Quelly, 2019). In Fitzgerald et al.'s (2013) cross-sectional study that examined the relationship between dietary patterns among adolescents and their level of self-efficacy, students with higher levels of self-efficacy for healthy eating consumed healthier foods, such as higher intakes of fruits and vegetables, brown bread and low-energy drinks, than those who had lower self-efficacy. The authors also found that students with lower self-efficacy for healthy eating experienced greater peer support for unhealthy eating; these adolescents had a diet characterized by unhealthy food, such as high intakes of snacks, sweets, desserts, and biscuits (Fitzgerald et al., 2013).

2.2.3.3. Food Insecurity and Socioeconomic Status

Sociodemographic factors, such as education, income, ethnicity and gender are intrapersonal variables that also influence the food people consume (Mancino & Newman, 2007; Desjardins et al., 2013). The price of food is a key factor in what foods are purchased among families living in poverty (Beheshti et al., 2016). Lower quality foods tend to be of lower cost (Darmon & Drewnowski, 2015), and thus are more affordable to those of lower socioeconomic status (SES) (Darmon & Drewnowski, 2015; Wolfson et al., 2019). Being food insecure, defined as the inadequate or insecure access to food because of financial constraints, affects the choices of food people consume (Desjardins et al., 2013; Tarasuk et al., 2014). Household food

insecurity may leave individuals without the ability to access or consume safe, secure, nutritious, and adequate foods to meet their dietary needs and preferences (Health Canada, 2004). Approximately 1 in 8 Canadians are affected by household food insecurity (Tarasuk et al., 2014). Household food insecurity is associated with increased risk of chronic diseases as well as poor physical, mental, and social health (Tarasuk et al., 2016). A food insecure household would most likely plan and manage their diet differently than their counterparts that are more economically secure (Colatruglio & Slater, 2016; Krause et al., 2018) because of limited resources that requires them to be thrifty and frugal (Dachner et al., 2010; Desjardins et al., 2013).

Research suggests that adolescents from lower SES experience poorer access to fruits and vegetables at home (Neumark-Sztainer et al., 2003; MacFarlane et al., 2007), while experiencing greater home availability of unhealthy foods when compared to adolescents from higher SES (MacFarlane et al., 2007). In a cross-sectional study examining determinants of snack and soft drink consumption, Wouters et al (2010) concluded that food habits tended to be poorer among youth of lower SES. Ball et al (2009) compared adolescents of high and low SES and concluded that adolescents of lower SES consumed fruit less frequently while consuming processed and fast foods more regularly. They also compared adolescents based on maternal education and found that adolescents whose mothers had low education experienced lower levels of self-efficacy for increasing their fruit intake and reducing their junk food, lower perceived importance for healthy eating, less support from their family for healthy eating and greater home availability of unhealthy food compared to healthy foods (Ball et al., 2009). In a cross-sectional study examining socioeconomic differences in dietary habits of adolescents ages 13-14, Skardal et al (2014) found that adolescents from lower SES homes reported higher intake of sugar-sweetened beverages and fast food, with a lower consumption of fish and vegetables than those from higher SES. These observations, that suggest adolescents from lower SES families tend to have poorer dietary habits, may be explained by factors such as parental food knowledge, education and home food availability (Vriendt et al., 2009; Campbell et al., 2013; Masuku and Lan, 2014; Skardal et al., 2014). Skardal et al (2014) found that there were significant differences in parental food knowledge between SES, such that parents that had both higher income and education had significantly greater knowledge of food and nutrition guidelines. Similar results were found in other studies (Vriendt et al., 2009; Masuku and Lan, 2014; Hakli et al, 2016).

2.2.3.4. The Influence of Food Marketing and Food Industry

It is important to acknowledge the impact that the community level has on influencing food choices. For example, when an individual is at a grocery store, making food choices are largely influenced by the food environment (Herforth & Ahmed, 2015) and food marketing (Government of Canada, 2019).

The food environment can be defined by the availability, affordability, convenience, and desirability of foods (Herforth & Ahmed, 2015). Most simply, food availability refers to food that is available for one to eat. When looking for food at the grocery store, food availability is also related to prices. The price of food directly relates to if that food item is affordable for an individual. A systematic review and meta-analysis found that the cost of healthy food was on average $1.50/day, or $10.50/week, more money than less healthy food (Rao et al., 2013). An economic analysis shows that healthier foods cost more money, making them less accessible for those of lower SES (Drewnowski & Darmon, 2005). Drewnowski and Darmon (2005) found that there was an inverse relationship between energy density and energy cost; that is, low cost, high energy foods such as processed foods high in sugar and fat, are the lowest-cost options to consumers. The third factor that affects food choice is convenience (Herforth & Ahmed, 2015). Cost of goods can extend beyond the financial cost of purchasing foods and include time (Committee on Examination of the Adequacy of Food Resources and SNAP Allotments, 2013). These constraining factors include the time it takes for food preparation, consumption, and clean up, which are also barriers to healthy eating (Committee on Examination of the Adequacy of Food Resources and SNAP Allotments, 2013). Lastly, desirability plays a key role in food choices as internal factors such as taste, as well as external factors such as food habits, norms, and food knowledge, also contribute to the decision-making around food (Herforth & Ahmed, 2015).

Food marketing can make it difficult for people to make healthy food choices as it promotes the selection of unhealthy food products through persuasive marketing strategies such as where products get placed in the store, as well as through promoting and discounting these kinds of foods (Government of Canada, 2019; Kent et al., 2019). Food marketing today is taking on newer forms, such as sponsored posts on social media that advertise food products to consumers (Government of Canada, 2019). Teenagers are effectively being targeted by the food industry (Truman & Elliot, 2019) as high school students spend the majority of their own money

on high-energy but low-nutrient foods and drinks (Story & French, 2004; Institute of Medicine, 2006; Harris et al., 2009;). The powerful marketing messages appeal to teenagers as they are a vulnerable population due to their unique developmental stage, peer influence, as well as having high levels of exposure to these advertisements (Truman & Elliot, 2019). These messages are predominantly advertising unhealthy food (Velazquez et al., 2015; Kent et al., 2019; Truman & Elliot, 2019). For example, one Canadian study found that 98% of recreational sport settings expose children and youth to food advertisements for energy dense, low nutrient products (Prowse et al., 2018). Two other Canadian studies assessed the prevalence of food marketing in schools and found that there was a strong presence of food and beverage messaging in most of the participating elementary and secondary schools (Velazquez et al., 2015; Kent et al., 2019). Velazquez et al (2015) found that the presence of promotional materials and messaging for unhealthy foods and beverages were more prevalent in secondary schools. Food and beverage marketing that targets children and teenagers have increased in parallel with the rise in childhood obesity (Kent et al., 2019).

2.2.3.5. The Built Environment

The built environment plays a role in access to food (Larsen & Gilliland, 2008; Wolfson et al., 2019). When examining the built environment around high schools, Sadler et al (2016) found that adolescents purchased more unhealthy food, such as items bought from fast food outlets, convenience stores, pizza places and ice cream shops when they were exposed to these junk food outlets more often. These findings are in line with other research that found that the density of fast food outlets affects the purchasing of fast food by adolescents (He et al., 2012a). Furthermore, adolescents living within one kilometer of convenience stores experienced poorer diet quality than adolescents living further than one kilometer from these stores (He et al., 2012b). Similarly, He et al (2012b) observed a similar relationship with schools that were within one kilometer of convenience stores and poorer diet quality among students. This is concerning because Hardcastle et al (2016) reported that young people prefer unhealthy food (e.g., fast food) as they perceive this food to be tastier and more appealing. However, a diet high in processed foods can lead to the development of NCDs (Hyseni et al., 2017). Townsend et al. (2013) found that interpersonal factors, such as students' social environments, were associated with the food choices that adolescents made during the school day compared to intrapersonal factors. Organizational factors such as school rules and policies, and if they are controlling for the access

to unhealthy foods within the school, were associated with whether students consumed unhealthy food or not while at school (Townsend & Foster, 2013). Grimm et al. (2004) observed a positive association between soft drink availability from school vending machines and soft drink consumption among students (ages 8-13).

2.2.3.6. Gender

Research suggests that male and female adolescents rank differently on food literacy assessment tools. It has been suggested that female adolescents score higher on food and nutrition assessment tools because female adolescents care more about food, nutrition and health (Mirmiran et al., 2007), have stronger concerns about their physical appearance than males (Mirmiran et al., 2007; Naeeni et al., 2014), are more selective with their food choices (Pirouznia, 2001; Naeeni et al., 2014), appear to be more interested in the general topic of food and nutrition (Ronto et al, 2016b), and are more confident interpreting nutrition facts tables (Conference Board of Canada, 2013). All these factors may increase female adolescents' ability to make informed and healthful food choices.

For example, Ronto et al. (2016a) found that female teenagers rated the importance of understanding portion sizes when consuming unhealthy foods significantly higher than males did. Likewise, females also reported the importance of understanding how to select and prepare food in accordance with health guidelines for healthy eating higher than males (Ronto et al., 2016a). In one study assessing nutrition and food safety knowledge among adolescents, females had significantly higher scores for nutrition knowledge as well as food safety and hygiene practices than males (Turconi et al., 2008). A study examining nutritional knowledge of European adolescents found that females had higher scores on their food knowledge assessment tool than males (Sichert-Hellert et al., 2011). Similarly, Naeeni et al. (2014) observed higher scores for female adolescents on their assessment tool measuring healthy eating knowledge compared to males. Larson et al. (2006) concluded that more than 33% of females reported that they helped with preparing dinner three or more times a week compared to 25% of males. Likewise, food preparation was associated with increased fruit and vegetable consumption among females and increased vegetable consumption among males, with a decrease in soda consumption in females and fried foods among males (Larson et al., 2006).

2.3. Conclusion

Adolescence is a critical time during the life cycle where dietary behaviours are formed and serve as the foundation for dietary habits long-term (Taylor et al., 2005; Lake et al., 2009; Brooks & Begley, 2014). It is common for teenagers to have sub-optimal dietary habits as evidenced by higher intakes of processed and fast-foods, reduced fruit and vegetable intake, higher intakes of soft drinks, as well as meal skipping and frequent snacking (Vaitkeviciute et al., 2015; Colatruglio & Slater, 2016). One area of research that holds promise for improving adolescents' dietary behaviours and quality is food literacy, as developing food literacy skills will help teenagers make healthy food choices for their health (Vidgen & Gallegos, 2014). However, food literacy is a complex concept and is defined by many domains which makes it difficult to design adolescent food literacy programming that effectively incorporates all components of this construct. One of the five domains of food literacy is food and nutrition knowledge. Food and nutrition knowledge are about the acquisition of food and nutrition facts and information through food and nutrition experiences and education (Thomas et al., 2019). This thesis examines food and nutrition knowledge with the goal of better understanding what the current state of food and nutrition knowledge is among adolescents in and around London, Ontario. This research will help guide future food and nutrition interventions within this population.

2.4. References

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CHAPTER 3: METHODS

3.1. Study Design

The data used in this thesis were collected by the Human Environments Analysis Laboratory (HEAL) at the University of Western Ontario as part of a 5-year population health intervention called SmartAPPetite. SmartAPPetite is a smart-phone application designed to provide adolescents with evidence-based nutrition information in the form of action-oriented short messages, lifestyle tips, and recipes. One key factor that makes this application unique is that all messages and content are edited and approved by Registered Dietitians. The main goals of SmartAPPetite are to help teens learn more about healthy food options, how to purchase healthy foods, and to ultimately "nudge" teens towards having healthier diets.

The SmartAPPetite intervention targets students in grades 9-12 (ages 13-19). The current study is focused on teens in and around London, Ontario. This age group is of interest because it is during adolescence when individuals begin exercising independence when making decisions about the foods they consume and purchase (Vaitkeviciute et al., 2015). Dietary habits developed during adolescence set the foundation for food behaviours for the rest of their lives (Brooks & Begley, 2014, Cruz et al., 2018). Thus, adolescence is a critical time to intervene and teach teens about food and nutrition and the importance of developing healthy food behaviours.

The SmartAPPetite intervention is a longitudinal study where each participant is surveyed three times over nine months: Baseline (pre-intervention), follow-up (10 weeks after the start of the intervention), and long-term follow-up (3 months after the intervention concludes). The study protocol was approved by the University of Western Ontario's Non-Medical Research Ethics Board (NMREB #107034) and from the Research and Assessment Office of the London District Catholic School Board. Ethics approval, copies of Letters of Assent and Letters of Information are in Appendix A, Appendix B, and Appendix C respectively.

The data used in this thesis is from the baseline survey conducted during the first three years (2016-2020) of this longitudinal study.

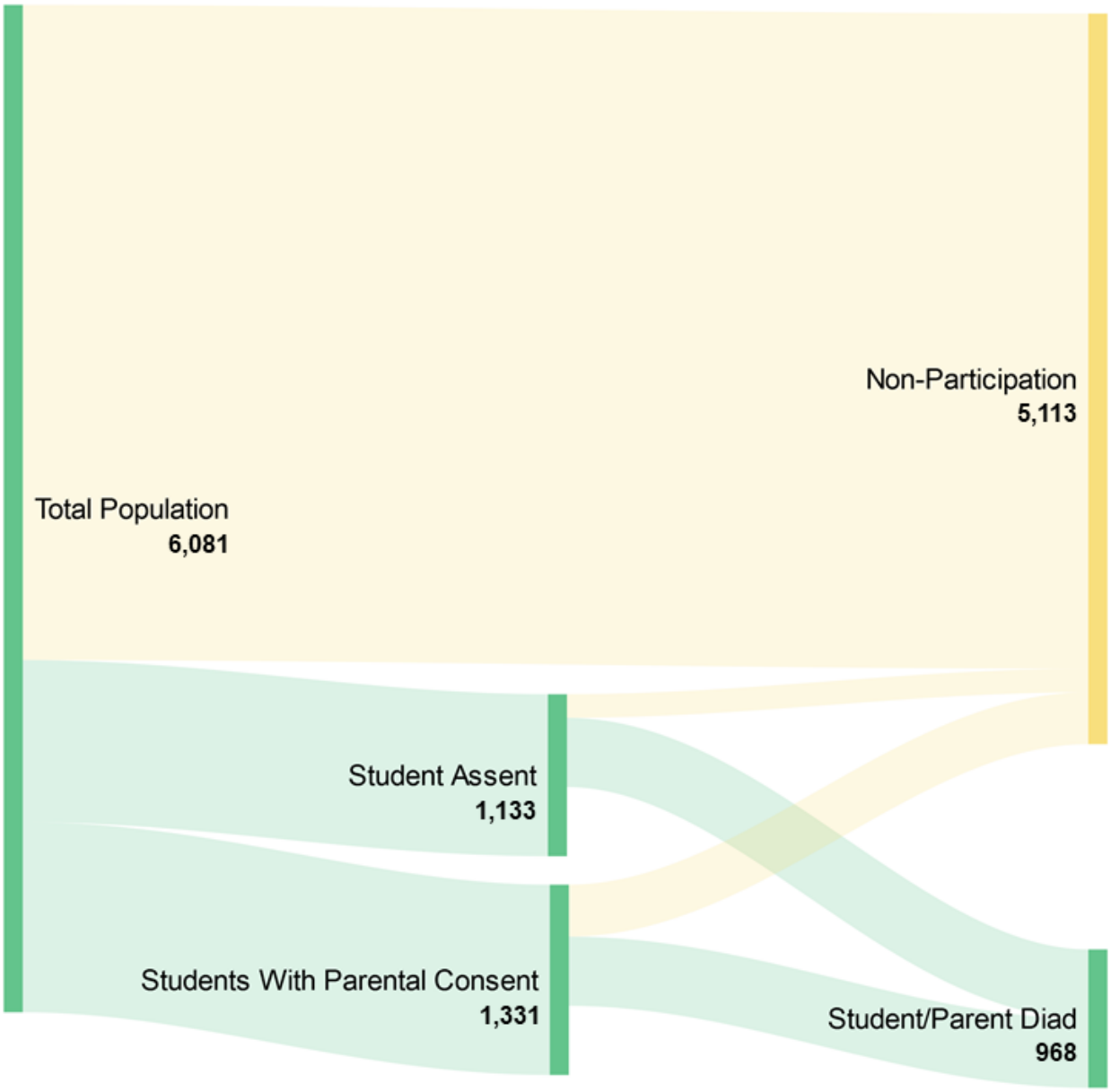
3.2. Data Collection

3.2.1 Recruitment

The recruitment of participants in the SmartAPPetite project was initiated upon contacting principals at eight selected schools, through an introductory email that provided them with information about the project, letters of information, and invitation to participate. Two of the high schools involved in this first phase of SmartAPPetite were rural schools, five high schools were suburban, and one school was urban. The food environments around these schools varied as there was less exposure to food outlets in the rural community than within the suburban and urban areas. Once school principals gave their permission for their schools to participate in the study, SmartAPPetite researchers conducted classroom presentations to recruit student participants from a total population of 6,081 across the eight schools. Letters of information were sent home with students for their parents or guardians. Parents/Guardians of students under the age of 18 years were then asked to provide parental consent (n=1,331). Parents were also asked to complete an optional online survey (n=1,205). If a student was 18 years of age or older, they could provide their own consent following the guidelines of the Ontario Education Act. Contact information of the research team was provided to parents to allow them the opportunity to ask questions about the study. Students with parental consent met with researchers and were asked to provide their own assent to participate in the study (n=1,133). Refer to Figure 1 for a visual depiction of how the final sample size of 968 participants was derived.

Once students were recruited, the research teams from the HEAL conducted data collection at local high schools by being on site at each school during survey days to distribute the survey codes, as both the survey and diet recall are hosted on online platforms (i.e., Qualtrics & ASA-24). The research teams organized groups of students to complete their individual surveys in locations within the schools that had Wi-Fi connections and enough space for students to work through the survey alone. All participants received an instructions sheet that outlined their unique user ID to access the survey and dietary recall, as well as detailed steps for how to sign onto Qualtrics and ASA-24. Research team members were also available to answer any questions that students may have had and troubleshoot any software or technology issues.

Figure 1: Final sample size flowchart



3.2.2 Surveys

This study will be using data from two baseline surveys: Parent Survey & Youth Survey. Copies of the surveys can be found in Appendix D. The Parent Survey consisted of 29 questions regarding food purchasing behaviours, family meal habits, and individual and family level characteristics. The parent survey was the main source for socioeconomic status (SES) data used in this study, such as family structure, educational attainment, and postal codes which were used to generate neighborhood level income data.

The youth survey included 55-items (88 questions) and consisted of 4 sections: general information; general eating habits; nutrition questions; and knowledge questions (including food knowledge and nutrition knowledge). The general information section asked about individual and household characteristics (e.g., gender, age, ethnicity, food allergies). Next, students were asked about their general eating habits which included questions about fruit and vegetable intake. The nutrition section asked food behaviour questions which included questions about how often they purchased foods from various food establishments (e.g., restaurants, coffee shops, grocery stores). This section also asked questions that measured youth attitudes towards cooking and label reading. The last section of the youth survey, which includes the knowledge questions, is the main focus of this thesis. The knowledge section measures food knowledge, as well as nutrition knowledge. The knowledge survey was adapted from previously used surveys (Anderson et al., 2002; Vereecken et al., 2004; Klieman et al., 2016) and consists of 22-items (50 questions) in the format of multiple-choice questions.

3.3 Measures

3.3.1 Dependent Variables

There are three dependent variables that will be used for this study: Total Knowledge Score, Food Knowledge Score, and Nutrition Knowledge Score. Total Knowledge Score is the percentage of the 50 knowledge questions (see **Table 3.1** for a list of the questions) that each student answered correctly. Answers were considered incorrect if they specified 'I do not know' or if the answer was left blank. Only participants who answered 50% or more, or at least 25 questions, were considered a complete response. All other students were removed from analysis.

Guided by the research conducted by the Food Literacy and Food Skills Locally Driven Collaborative Project (LDCP) working group (Desjardins, 2014; Azevedo Perry, 2017; Thomas, 2019), the 50 knowledge questions were categorized into two groups: food knowledge or nutrition knowledge. The Food Literacy and Food Skills LDCP working group defines food and nutrition knowledge as follows: ***Food knowledge*** is understanding where one's food comes from and what is in it, in addition to having the ability to make informed choices (Thomas et al., 2019). ***Nutrition knowledge*** is understanding nutrients within foods and how they can affect one's health (Thomas et al., 2019).

Two Registered Dietitians independently assessed and categorized each knowledge question based on the above criteria to establish which type of knowledge the question was measuring. Any discrepancies between categorization were discussed until an agreement was reached. The results of the coding are illustrated in **Table 3.1**.

Table 3.1 Knowledge Survey Questions Coded as Food or Nutrition Knowledge

Food Knowledge Questions
Do you think these foods and drinks are typically high or low in added sugar?
Do you think these foods are typically high or low in salt?
Which of these foods has the most trans-fat?
Compared to minimally processed foods, processed foods are:
If a person wanted to buy a yogurt at the supermarket, which would have the least sugar/sweetener?
Looking at product 1, what are the sources of sugar in the ingredient list?
If the % Daily Value for sodium was greater than 15%, it is considered "high in" sodium:
"Light" foods (or diet foods) are always good options because they are low in calories.
Nutrition Knowledge Questions
How many servings of fruit and vegetables per day do experts advise teens to eat as a minimum?
Do health experts recommend that people should be eating more, the same amount, or less of the following items?
How many times per week do experts recommend that people eat fish (e.g. salmon, tuna, tilapia)?
How many times per week do experts recommend that people eat breakfast?
Do you think these foods are typically high or low in fibre?
Do you think these foods are a good source of protein?
The amount of calcium in a glass of whole milk compared to a glass of skimmed milk is:
Which would be the healthiest and most balanced sandwich lunch?
Which would be the healthiest burger choice when eating at a restaurant:
Looking at products 1 and 2, which one has the most calories (kcal) per biscuit:
Which of these diseases is related to a low intake of fibre?
Which of these diseases is related to how much sugar people eat?
Which of these diseases is related to how much salt (or sodium) people eat?
Which one of these foods is classified as having a high Glycemic Index?
To maintain a healthy weight people should cut fat out completely.

The Food Knowledge Score consists of the percentage of correct answers out of the 16 items included in the sub-score, meaning that at least 8 items had to have been answered to be included in the analysis. The Nutrition Knowledge Score consists of the percentage of correct answers from the remaining 34 items classified included in this sub-score, requiring at least 17 items to have been answered to be included in the analysis. The knowledge scores were assessed for internal consistency using Cronbach's Alpha (Cohen, 2013). The results found an alpha of 0.65 for food knowledge and an alpha of 0.75 for nutrition knowledge. These alpha values indicate that the internal consistency for food knowledge and nutrition knowledge, respectively, are moderate and strong (Cohen, 2013).

3.3.2 Independent Variables

The independent variables analyzed in this thesis are outlined in **Table 3.2**, including the level of measurement for each variable, the data source for the variables (youth or parent survey), as well as how some variables were derived using data from the SmartAPPetite survey.

Table 3.2 Definition of Independent Variables

Variable Name	Data Type	Data Source	Measurement
Visible Minority	Binary	Youth survey & parent survey	***Visible Minority (1)***: South Asian, East Asian, Middle Eastern, Latin American, Indigenous, Black, & Other. ***Caucasian (0)***: White / Caucasian
Male	Binary	Youth survey	***Male (1); Female (0).*** Students self-reported their gender. Four students identified as non-binary were considered missing.
Age	Continuous	Youth survey	***Age in years***
Allergy or Health Condition	Binary	Youth survey	***Yes (1); No (0).*** Derived from 2 binary questions: (1) Do you have health conditions that affect your eating patterns? (2) Do you have food allergies and/or intolerances that affect your eating patterns?
Use Food, Nutrition, Health Apps	Binary	Youth survey	***Yes (1); No (0).*** Measured with the question: Do you use any food, nutrition, or health apps on your smartphone or tablet?
Eating with Family	Continuous	Youth survey	***Number of nights per week.*** Measured with the question: During a typical week, how many evenings do you eat dinner with your family?
Prepare Dinner	Continuous	Youth survey	***Number of nights per week.*** Measured with the question: During a typical week, how many evenings do you prepare or help prepare dinner??
Median Neighbourhood Family Income	Continuous	Parent survey	***$10,000 Canadian dollars.*** Median family income for the dissemination area (DA) of the primary home postal code. DAs are frequently used as proxies for neighbourhoods (Healy & Gilliland, 2012).
Lone Parent Household	Binary	Parent survey	***Yes (1); No (0)***
Maximum Education	Categorical	Parent survey	***Post-Secondary Education (0):*** Trade or other non-university certificate or diploma, University certificate or diploma below bachelor's level, and bachelor's degree. ***High School Diploma or Less (1):*** Less than high school diploma or equivalent & high school diploma or equivalency ***Post-Graduate Education (2):*** University certificate, diploma, or degree above the bachelor's level. Derived from the maximum education level of all parents/guardians who lives in the primary household.
Good Self-Reported Mental Health	Binary	Youth survey	***Good Mental Health (1):*** Good, Very Good, & Excellent ***Poor Mental Health (0):*** Poor & Fair Measured with a 5-pt Likert scale question: In general, how do you rate your own mental health?
Food Label Confidence	Binary	Youth survey	***Agree (1):*** Agree & Strongly Agree ***Disagree (0):*** Neutral, Disagree, & Strongly Disagree Measured with a 5-pt Likert scale question: I have no problem reading and understanding food labels
Prepare meals	Binary	Youth survey	***Agree (1):*** Agree & Strongly Agree ***Disagree (0):*** Neutral, Disagree & Strongly Disagree Measured with a 5-pt Likert scale question: Cooking or preparing meals helps me eat more healthy
Enjoy Cooking	Binary	Youth survey	***Agree (1):*** Agree & Strongly Agree ***Disagree (0):*** Neutral, Disagree & Strongly Disagree Measured with a 5-pt Likert scale question: I like to cook

3.4. Statistical Analysis

To be included in the analysis for this thesis, students must have answered at least 26 of the 50 knowledge questions and a survey must have been completed by their parent/guardian. This resulted in a final sample of 968 students.

3.4.1 Preliminary Analysis

Data cleaning and analysis were performed using IBM SPSS, version 26 (IBM Corp, Armonk, NY). Means and standard deviations were used to describe normally distributed continuous data, while medians and interquartile ranges were used to describe skewed continuous variables. Histograms were reviewed for continuous variables to assess data distributions and identify skewed data. Percentages were calculated for categorical variables. The independent samples t-test was used to compare mean differences in continuous outcome variables (food knowledge, nutrition knowledge, and total knowledge scores) between two groups. The one-way analysis of variance (ANOVA) compared mean differences in knowledge scores between three or more independent groups. Tukey's HSD post hoc test was used to determine which specific groups were significantly different from one another. Pearson correlation coefficients determined the direction and strength of the relationships between knowledge scores and normally distributed continuous variables, whereas Spearman's rank correlation coefficient assessed the correlation between skewed continuous and/or ordinal variables. Correlation coefficients were interpreted as follows: ≥0.75 very good to excellent; 0.50-0.75 moderate to good; 0.25-0.49 fair; and ≤0.25 little to no correlation (Colton, 1974).

3.4.2 Missing Data

Missing data was a result of non-response to questions either in the parent or youth survey. Wherever possible, data were filled in using other information provided from the survey. For example, youth ethnicity was asked in both the youth and parent survey. Youth-reported ethnicity was used first, but where missing (4 cases), parent-reported youth ethnicity was used. Age and grade were asked in the youth survey. Where age was not provided (11 cases), the average age within the grade of that student was used.

There were five main variables (lone parent, maximum education, times per week dinner was eaten as a family, and times per week student prepared or helped to prepare dinner) that could not be filled in with alternative data. Little's Missing Completely at Random (MCAR)

analysis was used to test the hypothesis that the missing data in these variables were missing at complete random (IBM, n.d.). Results of Little's MCAR revealed that each of the five variables were MCAR (IBM, n.d.). Therefore, it was appropriate to utilize multiple imputation, and more specifically fully conditional specification, to fill in the missing data for these variables (IBM, n.d.). There were 763 participants with complete data, and 205 participants had at least one independent variable that had to be imputed. A total of 1.8% of data was imputed using multiple imputation.

It has been suggested that when imputing data, the number of imputed datasets should equal the percent of missing data (White et al, 2011). Therefore, following these guidelines, 21 datasets were imputed as this reflected the total percent of missing data. All variables that were included in the final analyses were included when conducting the imputation model. There were no additional, auxiliary variables that were further added to the model.

3.4.3 Multiple Linear Regression Analyses

Multiple linear regression models were used to address the primary objective, which was to understand correlates of food and nutrition knowledge among adolescents. Three models were assessed, one with food knowledge as the outcome, nutrition knowledge as the outcome in the second model, and total knowledge score for the third model. Individual factors (i.e., age, gender, ethnicity, food allergies or health condition that affects food intake, mental health, attitudes towards cooking, and confidence in label reading), sociodemographic factors (i.e., income, maximum household education, and lone-parent household), and dietary behaviour (i.e., use of a food and nutrition application, frequency of helping to prepare dinner, and frequency of eating dinner as a family) were included in each model. Collinearity diagnostics were determined through the tolerance statistic and variance inflation factor (VIF), which showed that collinearity was not a problem between covariates (Tabachnick & Fidell, 2001). All multiple linear regression models were computed both as a complete case analysis (i.e., with listwise deletion applied to the data), and separately using imputed data for missing cases. Only results from the imputed data models are described in the results. All bivariate associations between independent and dependent variables with a p-value <0.10 were retained in the regression models, but key variables identified in the literature were also carried into the models. These key variables included gender, single-parent households, and family mealtime behaviours.

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CHAPTER 4: RESULTS

4.1. Characteristics of the Sample

4.1.1. Individual Characteristics

The characteristics of the sample are illustrated in **Table 4.1**. The average age of youth respondents was 15.5 years old (Standard Deviation [*SD*] = 1.2). Most youth respondents were female (62.1%), Caucasian (61.9%), lived in two-parent households (78.7%), and had a parent or guardian with a post-secondary education defined as a post-secondary degree, diploma, or certificate (62.6%). The median neighborhood family income (2016) measured at the Census Dissemination Area level was $93,677 (*SD* = 2,755) in Canadian Dollars.

Additionally, 30% of students reported using a food, nutrition or health application, while 20.2% of students reported having an allergy or health condition that affected their food intake. When asked to rate their mental health on Likert scales, 78.4% of students reported that their mental health was good, very good, or excellent.

4.1.2. Food Behaviours and Attitudes

Students self-reported preparing or helping to prepare dinner on average 2.8 (*SD* = 2.0) evenings per week. Also, students reported that their family ate dinner together a median of 5.0 (*IQR* = 4.0) evenings per week. Students were asked three questions that measured attitudes towards food and nutrition. When asked to rank their agreement with the statement “I like to cook”, 64.5% of students reported that they either agreed or strongly agreed. When asked to rate the statement “Cooking or preparing meals helps me eat more healthy,” 67.0% of students reported that they either agreed or strongly agreed. Lastly, 76.2% of students either agreed or strongly agreed with the following statement “I have no problem reading and understanding food labels.”

4.1.3. Knowledge Scores

The first objective of this analysis was to determine the current state of food and nutrition knowledge among adolescents in London, Ontario. The average total score on the food and nutrition survey was 54.6% (*SD* = 14.0). This score can be further broken down into the two sub-scores. The average score for the food knowledge section was 59.8% (*SD* = 18.0), while the average score for nutrition knowledge was 52.2% (*SD* = 14.0).

Table 4.1 Baseline Characteristics

Characteristics	Total Sample (Complete Sample)
Sample Size, N	968
Knowledge Scores %, *mean (SD)*	
Food knowledge score	59.8 (18.0)
Nutrition knowledge score	52.2 (14.0)
Total knowledge score	54.6 (14.0)
Individual Characteristics	
Visible minority, n (%)	369 (38.1)
Male n *(%)*	362 (37.9)
Missing cases	12 (1.2)
Age in years, mean (SD)	15.5 (1.2)
Good self-reported mental health, n (%)	758 (78.4)
Socio-Demographic Characteristics	
Lone parent household, n (%)	206 (21.3)
Missing cases	19 (2.0)
Maximum education, n (%)	
High school diploma or less	117 (12.1)
Post-secondary degree, diploma, certificate	606 (62.6)
Post graduate degree education	177 (18.3)
Missing cases	68 (7.0)
Median neighbourhood family income, mean (SD)	9.37[1] (0.28)
Food Behaviours and Attitudes	
# of times / week student helps prepare dinner, mean (SD)	2.8 (2.0)
Missing cases, n (%)	54 (6.6)
# of times / week family eats dinner together, median (IQR)	5.0 (4.0)
Missing cases, n (%)	34 (3.5)
Use food, nutrition, or health apps, n (%)	290 (30.0)
Allergy or health condition affecting food intake, n (%)	196 (20.2)
Missing Cases	54 (6.6)
Confidence in reading & understanding food labels, n (%)	738 (76.2)
Cooking helps me to be healthy, n (%)	649 (67.0)
I like to cook, n (%)	625 (64.5)

[1]Median neighbourhood family income is presented in Canadian dollars and by tens of thousands of dollars

4.2. Bivariate Statistical Analysis

Bivariate relationships were assessed between dependent and independent variables using complete cases (n = 763). Independent samples t-tests results are reported in Table 4.2. Visible minority students scored significantly lower on food, nutrition and total knowledge scores than Caucasian students ($p < 0.01$). Females scored significantly higher on nutrition knowledge than males ($p = 0.04$). Students with poor mental health scored significantly higher on food knowledge ($p = 0.01$), nutrition knowledge ($p = 0.01$), and total knowledge ($p < 0.01$) scores. Adolescents from single-parent households scored significantly lower on nutrition knowledge ($p = 0.01$) and total knowledge ($p = 0.03$) compared to students from two parent households. Those who used a food, nutrition, or health app scored significantly higher on all scores compared to students who did not use apps ($p < 0.01$). Students with allergies or health conditions affecting food intake scored significantly higher on total knowledge score ($p = 0.04$). High levels of confidence in reading and understanding food labels resulted in significantly higher food, nutrition, and total knowledge scores ($p < 0.01$). Similarly, students that reported that cooking and preparing meals helped them to eat healthier scored significantly higher on all three scores ($p < 0.01$). Students who reported that they liked to cook scored significantly higher on food ($p = 0.01$), nutrition ($p < 0.01$), and total ($p < 0.01$) knowledge scores.

Table 4.3 reflects Pearson's correlation coefficients for normally distributed continuous variables and Spearman's rank correlation coefficients for variables with a non-parametric distribution. Food ($p = 0.02$), nutrition ($p < 0.01$), and total ($p < 0.01$) knowledge scores were weakly correlated with an increase in student age. Likewise, food, nutrition, and total knowledge scores were weakly correlated with an increase in median neighbourhood family income ($p < 0.01$). There were strong correlations between food ($p = 0.01$), nutrition ($p < 0.01$), and total ($p = 0.01$) knowledge scores and the number of evenings per week families ate dinner together.

A one-way analysis of variance (ANOVA) was used to compare knowledge score between parental education levels. Post-hoc results are presented in Table 4.4. Adolescents whose parents had a post-graduate education scored significantly higher on food ($p = 0.03$), nutrition ($p < 0.01$), and total ($p < 0.01$) knowledge scores than students whose parents had a high school diploma or less, and scored significantly higher on nutrition knowledge ($p = 0.03$) than students whose parents had a post-secondary degree, diploma, or certificate. Students whose parents had a post-secondary degree, diploma, or certificate scored significantly higher on

nutrition (p <0.01) and total (p = 0.01) knowledge scores than students whose parents had a high school diploma or less.

Table 4.2 Independent Samples t-Test for Complete Cases: Comparing Mean Knowledge Scores Between Binary Variables

Variables	Food Knowledge				Nutrition Knowledge				Total Knowledge Score			
	N	Mean	SD	p	n	Mean	SD	p	n	Mean	SD	p
Ethnicity												
White	599	62.2	17.2	< 0.01	599	53.8	14.0	< 0.01	599	56.5	13.8	< 0.01
Visible minority	369	55.9	18.6		369	49.6	13.6		369	51.6	14.0	
Gender												
Female	594	60.2	17.3	0.56	594	53.0	13.7	0.04	594	55.3	13.5	0.10
Male	362	59.4	19.0		362	51.1	14.3		362	53.8	14.7	
Mental health												
Poor	210	63.0	15.8	0.01	210	54.7	12.9	0.01	210	57.4	12.5	< 0.01
Good	758	58.9	18.5		758	51.5	14.2		758	53.9	14.4	
Lone parent household												
1 Parent/Guardian	206	58.7	17.4	0.35	206	49.9	14.4	0.01	206	52.7	14.1	0.03
2 Parents/Guardians	743	60.0	18.2		743	52.9	13.8		743	55.2	14.0	
Use food, nutrition, or health app												
Yes	290	63.8	17.8	< 0.01	290	55.0	13.7	< 0.01	290	57.8	14.0	< 0.01
No	678	58.1	17.8		678	51.0	14.1		678	53.3	13.9	
Allergy or health condition affecting food intake												
Yes	196	62.1	17.3	0.05	196	54.1	13.8	0.05	196	56.7	13.7	0.04
No	718	59.4	17.8		718	52.0	13.7		718	54.3	13.9	
Confidence in reading & understanding food labels												
Agree	738	61.6	17.4	< 0.01	738	53.7	13.8	< 0.01	738	56.3	13.7	< 0.01
Disagree	230	53.8	18.6		230	47.4	13.5		230	49.4	13.8	
Cooking & preparing meals helps me eat healthier												
Agree	649	61.3	17.4	< 0.01	649	53.2	13.8	< 0.01	649	55.8	13.7	< 0.01
Disagree	319	56.7	18.8		319	50.2	14.2		319	52.3	14.4	
I like to Cook												
Agree	625	60.9	17.7	0.01	625	53.3	13.7	< 0.01	625	55.7	13.8	< 0.01
Disagree	343	57.8	18.4		343	50.3	14.2		343	52.7	14.4	

Table 4.3 Pearson's Correlation Coefficients Between Continuous Variables and Knowledge Scores

Variables	Food Knowledge Score	Nutrition Knowledge Score	Total Knowledge Score
Age (in years)			
N	968	968	968
Pearson Correlation	0.07	0.10	0.10
P	0.02	< 0.01	< 0.01
Median neighbourhood family income			
N	968	968	968
Pearson Correlation	0.15	0.17	0.18
P	< 0.01	< 0.01	< 0.01
# of times / week student helps prepare dinner			
N	914	914	914
Pearson Correlation	-0.06	-0.05	-0.06
P	0.08	0.12	0.08
# of times / week family eats dinner together			
N	934	934	934
Spearman's Rho	0.73	0.91	0.82
P	0.01	< 0.01	0.01

Table 4.4 One-Way ANOVA Post Hoc Test: Mean Differences in Knowledge Scores Between Maximum Household Educations

Post Hoc Comparison Variables		Food Knowledge Score		Nutrition Knowledge Score		Total Knowledge Score	
		Mean Difference	***p***	***Mean Difference***	***p***	***Mean Difference***	***p***
High school diploma or less	Post-secondary	-3.24	0.16	-4.84	< 0.01	-4.33	< 0.01
	Post-graduate education	-5.43	0.03	-7.78	< 0.01	-7.03	< 0.01
Post-secondary degree, diploma, or certificate	High school diploma	3.24	0.16	4.84	< 0.01	4.33	0.01
	Post-graduate education	-2.19	0.31	-2.93	0.03	-2.7	0.05
Post-graduate education	High school diploma	5.43	0.03	7.78	< 0.01	7.03	< 0.01
	Post-secondary	2.19	0.31	2.93	0.03	2.7	0.05

4.3. Multiple Linear Regression Models

The second objective of this analysis was to examine correlates of food and nutrition knowledge among our sample, which was examined using a multiple linear regression model to evaluate factors related to food knowledge score (**Table 4.6**), nutrition knowledge score (**Table 4.7**), and total nutrition score (**Table 4.8**). Each table outlines the regression results from the complete case analysis (models 1a, 2a, & 3a) as well as the multiple-imputation-based analysis (models 1b, 2b, & 3b). The R-values produced in the regression models using imputed data are stronger in **Table 4.5**, while the significance, magnitude and direction of each predictor variable and outcome measure do not change substantially between the two analyses. Therefore, the interpretations presented in the following sub-sections reflect the imputed results.

Table 4.5 Linear Regression R-values and Sample Sizes for Complete Case & Imputed Data Analysis

	R-value		Sample Size	
	Complete Case	**Imputed Data**	**Complete Case**	**Imputed Data**
Food Knowledge	0.326	0.357	763	968
Nutrition Knowledge	0.370	0.386	763	968
Total Knowledge	0.381	0.403	763	968

4.3.1. Food Knowledge Score

The results of the food knowledge multiple regression models are presented in Table 4.6. Students who identified as visible minority scored 5.13% (95% CI -7.45, -2.82, $p < 0.01$) lower on the food knowledge sub-section of the survey than students who identified as Caucasian. Every year increase in a student's age resulted in a 1.15% (95% CI 0.24, 2.05, $p = 0.01$) increase on the food knowledge sub-section of the survey. Students who reported good mental health scored 4.35% (95% CI -7.08, -1.61, $p < 0.01$) lower than those who reported poor mental health. For every $10, 000 increment increase in median neighborhood family income, students scored 0.59% (95% CI 0.17, 1.01, $p = 0.01$) higher on food knowledge. For every one evening increase in preparing or helping to prepare dinner, students scored 0.97% (95% CI -1.59, -0.36, $p < 0.01$) lower on the food knowledge component of the survey. Those who reported using a food, nutrition, or health app scored 4.32% (95% CI 1.90, 6.74, $p < 0.01$) higher than students who reported not using these types of apps. Higher levels of self-reported confidence in reading and understanding food labels was associated with a 7.63% (95% CI 5.08, 10.18, $p < 0.01$) increase

in food knowledge. Similarly, students who reported that cooking and preparing meals helped them to eat healthier scored 3.07% (95% CI 0.66, 5.48, $p = 0.01$) higher than their counterparts.

Table 4.6 Multiple Linear Regression for Food Knowledge Score

	Model 1a: Complete Case					Model 1b: Imputed Data				
	B	**SE**	**p**	**CIs (.95)**		**B**	**SE**	**p**	**CIs (.95)**	
(Constant)	34.65	9.58	< **0.01**	15.84	53.46	23.93	8.83	**0.01**	6.62	41.23
Individual Characteristics										
Visible minority	-5.53	1.29	< **0.01**	-8.05	-3.00	-5.13	1.18	< **0.01**	-7.45	-2.82
Male	0.56	1.26	0.66	-1.92	3.04	0.03	1.17	0.98	-2.27	2.32
Age (in years)	0.94	0.51	**0.06**	-0.06	1.93	1.15	0.46	**0.01**	0.24	2.05
Good self-reported mental health	-4.38	1.53	< **0.01**	-7.39	-1.37	-4.35	1.40	< **0.01**	-7.08	-1.61
Socio-Demographic Characteristics										
Lone parent household	-0.41	1.50	0.78	-3.35	2.53	-0.18	1.40	0.90	-2.93	2.56
Median neighbourhood family income ($10,000 CAD)	0.3	0.24	0.34	-0.24	0.69	0.59	0.21	**0.01**	0.17	1.01
Maximum education (ref: post secondary education)										
High school or less	-2.03	1.89	0.28	-5.75	1.68	-1.18	1.72	0.49	-4.55	2.20
Post-graduate education	3.00	1.51	**0.05**	0.04	5.96	2.13	1.46	0.14	-0.72	4.99
Food Behaviours and Attitudes										
# of times / week student helps prepare dinner	-0.85	0.33	**0.01**	-1.49	-0.21	-0.97	0.31	< **0.01**	-1.59	-0.36
# of times / week family eats dinner together	0.17	0.31	0.58	-0.43	0.77	0.35	0.28	0.21	-0.20	0.90
Use food, nutrition, health apps	3.34	1.31	**0.01**	0.76	5.92	4.32	1.23	< **0.01**	1.90	6.74
Allergy / health condition affecting food intake	2.02	1.47	0.17	-0.87	4.92	1.28	1.47	0.38	-1.59	4.16
Confidence in reading & understanding food labels	5.75	1.44	< **0.01**	2.94	8.57	7.63	1.30	< **0.01**	5.08	10.18
Cooking & preparing meals helps me eat healthier	2.95	1.34	**0.03**	0.31	5.59	3.07	1.23	**0.01**	0.66	5.48
I like to cook	2.24	1.32	0.09	-0.35	4.84	1.83	1.21	0.13	-0.54	4.21

Table 4.7 Multiple Linear Regression for Nutrition Knowledge Score

	Model 2a: Complete Case					Model 2b: Imputed Data				
	B	**SE**	**p**	**CIs (.95)**		**B**	**SE**	**p**	**CIs (.95)**	
(Constant)	27.71	7.37	< **0.01**	13.25	42.18	17.83	6.77	**0.01**	4.56	31.11
Individual Characteristics										
Visible minority	-3.86	0.99	< **0.01**	-5.80	-1.91	-3.13	0.90	< **0.01**	-4.91	-1.36
Male	-1.66	0.97	0.09	-3.56	0.25	-1.32	0.90	0.14	-3.08	0.44
Age (in years)	1.06	0.39	**0.01**	0.30	1.82	1.28	0.36	< **0.01**	0.59	1.98
Good self-reported mental health	-3.48	1.18	< **0.01**	-5.79	-1.17	-3.18	1.07	< **0.01**	-5.28	-1.08
Socio-Demographic Characteristics										
Lone parent household	-1.94	1.15	0.09	-4.20	0.32	-1.91	1.06	0.07	-4.00	0.17
Median neighbourhood family income ($10,000 CAD)	0.38	0.18	**0.04**	0.03	0.73	0.52	0.16	**<0.01**	0.20	0.84
Education level (ref: post secondary education)										
High school or less	-3.59	1.46	**0.01**	-6.44	-0.73	-3.13	1.32	**0.02**	-5.71	-0.54
Post-graduate education	3.21	1.16	**0.01**	0.93	5.48	2.72	1.12	**0.02**	0.53	4.91
Food Behaviours and Attitudes										
# of times / week student helps prepare dinner	-0.65	0.25	**0.01**	-1.1	-0.16	-0.74	0.24	**<0.01**	-1.21	-0.27
# of times / week family eats dinner together	0.12	0.24	0.62	-0.35	0.58	0.20	0.22	0.35	-0.22	0.62
Use food, nutrition, health apps	1.62	1.01	0.11	-0.37	3.60	2.55	0.95	**0.01**	0.69	4.40
Allergy / health condition affecting food intake	1.18	1.13	0.30	-1.04	3.40	0.99	1.11	0.38	-1.20	3.17
Confidence in reading & understanding food labels	5.14	1.10	< **0.01**	2.97	7.30	6.36	1.00	< **0.01**	4.41	8.32
Cooking & preparing meals helps me eat healthier	1.11	1.03	0.29	-0.92	3.13	1.69	0.94	0.07	-0.16	3.54
I like to cook	1.96	1.02	**0.05**	-0.04	3.95	2.07	0.93	**0.03**	0.25	3.89

Table 4.8 Multiple Linear Regression for Total Knowledge Score

	Model 3a: Complete Case					Model 3b: Imputed Data				
	B	**SE**	**p**	**CIs (.95)**		**B**	**SE**	**p**	**CIs (.95)**	
(Constant)	29.93	7.31	< **0.01**	15.59	44.28	19.78	6.75	< **0.01**	6.55	33.01
Individual Characteristics										
Visible minority	-4.39	0.98	< **0.01**	-6.32	-2.46	-3.77	0.90	< **0.01**	-5.54	-2.01
Male	-0.95	0.96	0.33	-2.84	0.95	-0.89	0.90	0.32	-2.64	0.87
Age (in years)	1.02	0.39	**0.01**	0.26	1.77	1.24	0.35	< **0.01**	0.55	1.93
Good self-reported mental health	-3.77	1.16	< **0.01**	-6.06	-1.48	-3.55	1.07	< **0.01**	-5.65	-1.46
Socio-Demographic Characteristics										
Lone parent household	-1.45	1.14	0.21	-3.69	0.79	-1.36	1.06	0.20	-3.44	0.72
Median neighbourhood family income ($10,000 CAD)	0.33	0.18	0.07	-0.02	0.68	0.54	0.16	< **0.01**	0.22	0.86
Education level (ref: post secondary education)										
High school or less	-3.09	1.44	**0.03**	-5.92	-0.26	-2.50	1.32	0.06	-5.08	0.08
Post-graduate education	3.14	1.15	< **0.01**	0.88	5.40	2.53	1.11	**0.02**	0.35	4.71
Food Behaviours and Attitudes										
# of times / week student helps prepare dinner	-0.72	0.25	< **0.01**	-1.20	-0.23	-0.82	0.24	< **0.01**	-1.28	-0.35
# of times / week family eats dinner together	0.13	0.23	0.57	-0.33	0.59	0.25	0.22	0.25	-0.17	0.67
Use food, nutrition, health apps	2.17	1.00	**0.03**	0.20	4.14	3.11	0.94	< **0.01**	1.27	4.96
Allergy / health condition affecting food intake	1.45	1.12	0.120	-0.76	3.66	1.08	1.12	0.34	-1.12	3.28
Confidence in reading & understanding food labels	5.33	1.10	< **0.01**	3.18	7.48	6.77	0.10	< **0.01**	4.82	8.72
Cooking & preparing meals helps me eat healthier	1.70	1.03	0.10	-0.32	3.71	2.13	0.94	**0.02**	0.29	3.97
I like to cook	2.05	1.01	**0.04**	0.07	4.03	2.00	0.93	**0.03**	0.18	3.81

4.3.2. Nutrition Knowledge Score

The results of the nutrition knowledge regression models are presented in **Table 4.7**. Students who identified as visible minority scored 3.13% (95% CI -4.91, -1.36, $p < 0.01$) lower on the nutrition knowledge sub-section of the survey than students who identified as Caucasian. Every year increase in a student's age resulted in a 1.28% (95% CI 0.59, 1.98, $p < 0.01$) increase on the nutrition knowledge sub-section of the survey. Students who reported good mental health scored 3.18% (95% CI -5.28, -1.08, $p < 0.01$) lower on nutrition knowledge than those who reported poor mental health. For every $10, 000 increment increase in median neighborhood family income, students scored 0.52% (95% CI 0.20, 0.84, $p < 0.01$) higher on nutrition knowledge. Adolescents whose parents had a post graduate education scored 2.72% (95% CI 0.53, 4.91, $p = 0.02$) higher on nutrition knowledge than students whose parents had a post-secondary degree, diploma, or certificate, while students whose parents had a high school diploma or less scored 3.13% (95% CI -5.71, -0.54, $p = 0.02$) lower on the nutrition knowledge sub-section compared to students whose parents had either a post-secondary degree, diploma or certificate**.** Similar to food knowledge, for every one evening increase in preparing or helping to prepare dinner, students scored 0.74% (95% CI -1.21, -0.27, $p < 0.01$) lower on the nutrition knowledge component of the survey. Those who reported using a food, nutrition, or health app scored 2.55% (95% CI 0.69, 4.40, p = 0.01) higher than students who reported not using these types of apps. Higher levels of self-reported confidence in reading and understanding food labels was correlated with a 6.36% (95% CI 4.41, 8.32, $p < 0.01$) increase in nutrition knowledge. Students who reported that they liked to cook scored 2.07% (95% CI 0.25, 3.89, $p = 0.03$) higher on nutrition knowledge.

4.3.3. Total Knowledge Score

The results of the total knowledge regression models are presented in **Table 4.8.** Total knowledge score was a composite score consisting of the combined sub-scores, food knowledge and nutrition knowledge. Students who identified as visible minority scored 3.77% (95% CI -5.54, -2.01, $p < 0.01$) lower on the food and nutrition knowledge survey than students who identified as Caucasian. Every one year increase in a student's age resulted in a 1.24% (95% CI 0.55, 1.93, $p < 0.01$) increase in food and nutrition knowledge. Students who reported good mental health scored 3.55% (95% CI -5.65, -1.46, $p < 0.01$) lower in food and nutrition

knowledge than those who reported poor mental health. For every $10, 000 increment increase in median neighborhood family income, students scored 0.54% (95% CI 0.22, 0.86, $p < 0.01$) higher on food and nutrition knowledge. Adolescents whose parents had a post graduate education scored 2.53% (95% CI 0.35, 4.71, $p = 0.02$) higher on the food and nutrition knowledge survey than students whose parents had a post-secondary degree, diploma, or certificate. For every one evening increase in preparing or helping to prepare dinner, students scored 0.82% (95% CI -1.28, -0.35, $p < 0.01$) lower on the food and nutrition knowledge survey. Those who reported using a food, nutrition, or health app scored 3.11% (95% CI 1.27, 4.96, $p < 0.01$) higher than students who reported not using these types of apps. Higher levels of self-reported confidence in reading and understanding food labels was correlated with a 6.77% (95% CI 4.82, 8.72, $p < 0.01$) increase in food and nutrition knowledge. Students who reported that they liked to cook scored 2.0% (95% CI 0.18, 3.81, $p = 0.03$) higher on the food and nutrition knowledge survey.

4.4. References

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CHAPTER 5: DISCUSSION

Limited research has been published on food literacy among Canadian adolescents. This thesis utilized baseline data from the SmartAPPetite project to examine food and nutrition knowledge among adolescents from the London-Middlesex area, and the individual, behavioural, and socio-economic factors related to food and nutrition knowledge. Food literacy skills are important for adolescents to develop as these skills will help them interact with our complex and evolving food system, achieve healthier dietary outcomes (Pendergast & Dewhurst, 2012; Conference Board of Canada, 2013; Thomas et al., 2019), and help reduce the risk of developing diet-related non-communicable diseases over the life course (Croll et al., 2001; Brooks & Begley, 2014; Vaitkeviciute et al., 2015).

The first objective of this thesis was to better understand current food and nutrition knowledge of teens in our study area. The results found that knowledge scores were, on average, relatively low, with an average total knowledge score of 54.6%, and average sub-scores of 59.8% for food knowledge and 52.2% for nutrition knowledge. It is possible that higher scores were achieved for food knowledge because this type of knowledge involves understanding where one's food comes from and what is in it, such as understanding that canned soup is high in salt. Having nutrition knowledge takes food knowledge a step further and involves being able to make the connection and understand that a diet high in salt may lead to increased blood pressure. Therefore, nutrition knowledge involves a deeper understanding of how the nutrients within foods can affect one's health. These low knowledge scores are in line with previous research and are a public health concern as they suggest that adolescents may not have the necessary food and nutrition knowledge to have a healthy diet (Pendergast & Dewhurst, 2012; Vidgen & Gallegos, 2014; Vaitkeviciute et al., 2015; Colatruglio & Slater, 2016; Wickham & Carbone, 2018; Seabrook et al., 2019; Thomas et al., 2019).

The second objective of this thesis was to investigate correlates of food and nutrition knowledge among the target population. In line with the social ecological theory of behaviour change, the findings of this thesis show that there are factors at the individual, behavioural, and socio-economic levels that influence both food and nutrition knowledge. At the individual level, an adolescent's age, ethnicity, and mental health were all significantly correlated with food and nutrition knowledge across the models. The behavioural factors that were positively correlated

with food and nutrition knowledge were the use of a health application, liking to cook, and confidence in reading and understanding food labels. At the socio-economic level, higher family income and household education was consistently correlated with greater food and nutrition knowledge.

This thesis was also grounded in the social cognitive theory as this theory recognizes that learning is a dynamic process that occurs through interactions between an individual and their behaviours and environment (Nutbeam et al., 2014). Food behaviours, such as confidence in cooking, are developed through dynamic interactions between behaviour and environment. However, there is a societal shift among families where it is becoming common to buy prepared foods outside of the home environment instead of preparing meals at home (Chenhall, 2010; Brooks & Begley, 2014). As a result, adolescents are not understanding the importance of developing food literacy skills (Brooks & Begley, 2014; Colatruglio & Slater, 2016). This is problematic as developing these skills is important during adolescence because of the critical role that diet plays in mitigating diet-related diseases (Lichtenstein & Ludwig, 2010; Kimura, 2011; Pendergast & Dewhurst, 2012). In one Canadian study, young adults reported that their biggest barriers to developing food literacy skills as adolescents were a lack of nutrition education at school and home (Colatruglio & Slater, 2016). If adolescents are not learning food literacy skills within the home, they need to be given the opportunity in a different environment to develop these skills. The remainder of this chapter will focus on discussing key findings of this thesis in the broader context of existing literature. Recommendations will be made on how policy and community interventions can be enhanced to support adolescents in developing food literacy skills.

5.1. Individual & Family Level Factors

Sex was not significant in the regression models for food, nutrition, or total knowledge scores. These findings contrast with what has been found in the food literacy literature (Pirouznia, 2001; Larson, 2006; Mirmiran et al., 2007; Naeeni et al., 2014; Ronto et al, 2016b). For example, one European study found that female adolescents (ages 12.5-17.5 years) scored significantly higher on food knowledge than males (Sichert-Hellert et al., 2011). Likewise, Naeeni et al. (2014) reported that female students (10-18 years) scored higher on nutritional knowledge and had a heightened awareness for healthy eating than males. An Italian study examining eating habits and food behaviours among adolescents, as well as nutritional and food safety knowledge, concluded that females had significantly higher nutrition knowledge and food safety and hygiene practices

than males (Turconi et al., 2008). One cross-sectional Canadian study looking at self-reported eating habits, meal preparation patterns, and cooking skills among Canadians concluded that females were more proficient in their cooking skills than males (Slater & Mudryj, 2016). It is unclear as to why there is not a difference in the food and nutrition knowledge among this study's population of Canadian adolescents. It could be that Canadian youth have different socially-constructed gender roles around food and nutrition. However, future research is needed to better understand the role gender plays in food and nutrition knowledge.

Ethnicity was significant in all three regression models when measuring food and nutrition knowledge. Adolescents of visible minority scored lower on food, nutrition, and total knowledge scores than their Caucasian counterparts. Ethnicity as a correlate of food literacy has been inconsistently reported in the literature. For example, in Riediger et al.'s (2007) cross-sectional study examining fruit and vegetable intake patterns among adolescents, there was not a significant difference in intake among adolescents from different ethnic groups. Similarly, another cross-sectional Canadian study (Ree et al., 2008) concluded that food choices were independent of an individual's ethnicity (Caucasian/visible minority). In contrast, Bhawra et al. (2017) found that the ethnicity of young Canadians (ages 16-30 years) was a significant predictor for the support of food policies and regulations, such as nutrition symbols and warnings on food products, food taxations and subsidies, food marketing bans, and maximum salt limits. For example, Caucasian and Aboriginal study participants were less likely to support nutrition symbols and warnings compared to those of mixed ethnicity (Bhawra et al., 2017). Caucasian participants were more supportive of marketing bans, Chinese participants were less supportive of taxation and subsidies, and Aboriginal participants were less supportive of a maximum limit on salt in packaged foods (Bhawra et al., 2017). While inconsistencies among these study findings exist, it is important to acknowledge that these studies examine ethnicity differently, measure different components of food literacy and utilize different measurement tools. For example, this thesis is the first study to measure food and nutrition knowledge using the formal definition from the Locally Driven Collaborative Projects Food Literacy (LDCP) working group. Unfortunately, research does not identify reasons for the role of ethnicity in food literacy. It could be that visible minority students are more likely to be recent immigrants to Canada and therefore less familiar with Canadian foods, thus scoring lower on regionally specific food and nutrition knowledge questions. The survey used in this thesis asked questions based on regionally specific food items and thus minority groups

may have performed differently if there had been knowledge questions capturing familiar foods to their culture. Future research needs to focus on examining these differences in food and nutrition knowledge scores to better understand why visible minority teens have significantly less knowledge than their Caucasian counterparts.

Though counter-intuitive, students who reported good mental health had significantly lower knowledge scores across all three regression models. Guided by clinical experience, individuals experiencing eating disorders have a heightened interest in and awareness of food and nutrition. Therefore, one possible explanation for these findings is that students that are suffering from disordered eating and eating disorders may have reported poor mental health on the youth survey and have an increased understanding of food and nutrition. However, further research is needed to better understand this relationship.

It was observed that youth with higher median neighbourhood family income scored higher on the food and nutrition knowledge survey. Factors such as parental food knowledge, education, and home food availability (Vrieddt et al., 2009; Campbell et al., 2013; Masuku and Lan, 2014; Skardal et al., 2014) may explain why adolescents from lower income families have lower food and nutrition knowledge. For example, Skardal et al (2014) found that there were significant differences in parental food knowledge between levels of socioeconomic status (SES), such that parents who had both higher income and education had significantly greater knowledge of food and nutrition guidelines. Similar results were found in other studies (Vrieddt et al., 2009; Masuku and Lan, 2014; Hakli et al, 2016). One example, at the community level, for how lower income families are being reached is through The Child and Youth Network's Ending Poverty Group in London, Ontario. This organization is working to improve the food literacy of low-income families through a program called Food Families (Food Families, n.d.). Food Families aims to equip families with the knowledge, skills, and confidence to develop food literacy to apply these skills to their everyday life. In addition, this organization helps families develop financial literacy, teaching them how to purchase and prepare healthy food on a budget (Food Families, n.d.). These programs are offered around London in various neighbourhoods to also bring communities together (Kovacs Group, 2015). In 2015, Food Families was evaluated for its effectiveness in bringing community programs to neighbourhoods to improve the food literacy of families (Kovacs Group Inc, 2015). Key findings of this report showed that families gained the knowledge and skill to purchase affordable and healthy food, while preparing balanced meals with confidence (Kovacs

Group Inc, 2015). Community-based programs, like Food Families, have the potential to help increase food literacy among low income families.

5.2. Behavioural Level Correlates

This thesis found that adolescents who reported confidence in reading and understanding food labels, liking to cook, as well as having an understanding that cooking meals can lead to eating healthier had significantly higher total food and nutrition knowledge. One possible mechanism to explain these findings is through the capacity of self-efficacy. According to social cognitive theory, one of the most important cognitions for behaviour change is self-efficacy (Nutbeam et al., 2014). Self-efficacy was defined by Albert Bandura as one's belief in their own ability to successfully perform a behaviour (Nutbeam et al., 2014). Behaviour change occurs by learning and acquiring knowledge through observational learning and participatory learning (Nutbeam et al., 2014). Participatory learning occurs when an individual practices and repeats a given behaviour (Nutbeam et al., 2014), such as by cooking a meal or reading and interpreting food labels, which were variables measured in this thesis.

Dietary self-efficacy is also a term coined in the literature, which focuses on building self-confidence to make healthy food choices despite possible barriers (Lubans et al., 2012; Muturi et al., 2016). For example, adolescents may develop dietary self-efficacy by learning how to read and interpret food labels. Likewise, when adolescents are involved in food preparation, they develop increased dietary self-efficacy and food literacy skills (Larson et al., 2006; Chenhall, 2010; Thomas & Irwin, 2011; Santarossa et al., 2015; Vaitkeviciute et al., 2015; Quelly, 2019). It has been found that students with higher levels of dietary self-efficacy consume healthier foods, such as higher intakes of fruits and vegetables, brown bread and low-energy drinks, than those with lower self-efficacy (Fitzgerald et al, 2013). Therefore, creative and research-driven food literacy programs, like SmartAPPetite, will help youth develop and practice dietary self-efficacy as they learn and understand the context of their food choices, practice health-promoting dietary behaviours, and increase their food literacy.

This thesis found that students who prepared or helped to prepare dinner scored lower on knowledge scores across all three regression models. This study was unable to capture if the students were preparing meals from scratch or warming up pre-prepared and packaged foods. It is documented in the literature that there is a perceived scarcity of time among families today and as a result there is fewer opportunities to practice and learn cooking skills, and prepare meals at

home as a family (Chenhall, 2010; Slater et al., 2012; Slater, 2013; Flagg et al., 2014; Colatruglio & Slater, 2016). Therefore, the study findings may be a result of students not preparing meals from scratch and rather warming up frozen meals for dinner. This would not result in participatory learning nor the development of food and nutrition knowledge. Further research is needed to better understand the relationship found.

The current study found that adolescents who used food, nutrition, and health applications scored higher on food, nutrition, and total knowledge than students who did not use these applications. It is possible that students who utilize mobile health applications may already have a higher level of food and nutrition knowledge and that is why they enjoy using these mobile applications. Future research, using longitudinal study designs, should investigate the directionality of the relationship between engaging with a mobile health application and increased food and nutrition knowledge. It is not possible to confirm or reject this relationship with the available data in this cross-sectional study.

Given the ubiquity of smartphones and the relatively low cost of implementation compared to other approaches (Boschen & Casey, 2008; Ly et al., 2012), nutrition interventions using a mobile application is a promising approach to teach youth about food and nutrition. Research suggests that mobile health applications can have a positive effect on the health of adolescents. For example, Dute et al. (2016) examined mobile apps that promote nutrition, physical activity, and prevention of overweight in adolescents and concluded that mobile health interventions may be an effective tool for promoting healthy lifestyles. Similarly, Fedele et al. (2017) conducted a meta-analysis examining if the use of mobile health interventions can improve health outcomes, such as a change in blood sugar or dietary intake, in youth and found that mobile interventions resulted in a small but significant positive effect on these health outcomes. However, research is needed to better understand the effectiveness of nutrition applications as a strategy for improving food behaviour and food literacy in adolescents because many health applications focus on weight loss and food intake tracking (Coughlin et al., 2015; DiFilippo et al., 2015; Paramastri, 2020), rather than food literacy. In fact, one systematic review concluded that there is a need for future research to better understand the influence that technology-driven interventions can have on changing food intake among youth (Wickham & Carbone, 2018). Wickham and Carbone (2018) also recommended that adolescent-specific food literacy measures be developed to evaluate changes more accurately in food and nutrition knowledge, skills, and intake of adolescents.

The SmartAPPetite study is a smart-phone application intervention designed to provide adolescents with evidence-based and action-oriented nutrition information. SmartAPPetite research will be able to measure the effectiveness of using a mobile nutrition application to improve food and nutrition knowledge and dietary intake. Findings from this thesis will help guide the SmartAPPetite dietitians when developing message content for the writing process. For example, messages can focus on label reading and how to interpret and understand what every component on the label means, as well as message content that explains the health benefits of cooking at home and from scratch. Messaging can be written to empower youth and build their confidence cooking and preparing their own meals. This is important, as findings from this thesis show that teenagers who have higher food and nutrition knowledge report that they enjoy cooking, know how to read and understand food labels, and understand that cooking and preparing one's own meals can help them eat in a healthier way. In line with Wickham and Carbone's (2018) recommendation, it is important to better understand how the SmartAPPetite application can encourage students to engage with the application and provide enriching content that is meaningful to adolescents.

5.3. Bring Back Home Economics

Consistently throughout the literature, researchers suggest that a decline in preparing meals at home with family, and the absence of home economics and nutrition education in school curriculums are two of the main contributors to the observed lack of food skills and knowledge among adolescents (Chenhall, 2010; Kimura, 2011; Ronto et al., 2016a; Colatruglio & Slater, 2016). Consequently, it is believed that this decline in food literacy skills may play a role in diet-related health outcomes such as obesity, high blood pressure, and elevated blood sugar (Kimura et al., 2011). Researchers suggest that a mandatory food and nutrition curriculum should be implemented to provide equal opportunity for adolescents to learn and develop food literacy skills (Lichtenstein & Ludwig, 2010; Kimura, 2011; Pendergast & Dewhurst, 2012; Slater & Mudryj, 2016). Taking a systems approach, implementing school curriculum is an investment into the health and future of youth (Pendergast & Dewhurst, 2012) and may have the largest impact on the adolescent population.

Results from this thesis may also support the belief that students are not learning about food and nutrition knowledge as a population-group within the school setting. Findings from this study showed that food and nutrition knowledge only increased by 1% for every one-year increase

in an adolescent's age. Though these results were statistically significant, it can be argued that these results are not a meaningful difference in nutritional terms. This observation may be because as a population group, Ontario students do not have a mandatory course dedicated to food and nutrition throughout primary school. It is noteworthy that students take a mandatory health and physical education curriculum from kindergarten to grade 8 (Ontario Ministry of Education, 2019). However, after grade 8, students are only required to take one credit of health and physical education (Ontario Ministry of Education, 2020). Grade 9 Healthy Active Living Education (HALE) is the most commonly taken course to satisfy the mandatory credit (Ontario Ministry of Education, 2019). The health component of this specific Grade 9 HALE course is divided into four main topic areas, only one of which is healthy eating. These findings may help bring awareness to the need for a mandatory food and nutrition course, which would empower adolescents and provide them with the opportunity to develop self-efficacy when learning and practicing food literacy skills (Pendergast & Dewhurst, 2012; Desjardins et al., 2013; Krause et al., 2018).

5.4. Study Strengths & Limitations

To our knowledge, this study provides the first empirical evidence for the current state of food and nutrition knowledge among a Canadian adolescent population. Findings from this thesis have the potential to help guide policymakers and public health professionals in program planning and curriculum development to improve the food literacy of adolescents. The large sample size was also a strength as it enabled the analysis to adequately detect correlates of food and nutrition knowledge. Likewise, the youth survey was designed to measure a diverse array of content, making it possible to control for many different variables in the models.

This study was cross-sectional in nature. Thus, study findings must be interpreted as correlations, as it is not possible to determine causality with cross-sectional data. The extent to which our results are generalizable to London-Middlesex schools is also unknown, as a random sample was not obtained. Nonetheless, a large sample size was achieved, and this initial sample of youth does provide important insight into the current state of food and nutrition knowledge among a diverse group of adolescents. It is important to acknowledge that students self-select to enroll and participate in the SmartAPPetite intervention study, raising possible concern over self-selection bias.

Lastly, when the SmartAPPetite measurement tools were developed, food literacy was still a relatively new concept, with no conceptual model, nor were there standardized and validated

food literacy surveys or measurement tools for this Canadian adolescent population. Therefore, the youth survey was adapted from previously used measurement tools. During the writing of this thesis, the LDCP Food Literacy working group published extensive research on food literacy. To ensure that this thesis applied the latest evidence from the LDCP, an evidence-based approach was taken by two registered dietitians to categorize each question of the SmartAPPetite assessment tool according to the LDCP's food and nutrition knowledge definitions. Cronbach's Alpha was tested for both sub-scores (food knowledge and nutrition knowledge) and the alpha values were acceptable.

5.5. Future Direction

The findings of this thesis will be integrated into the larger SmartAPPetite study and will inform future planning of similar interventions to improve the food literacy of adolescents. Researchers have encouraged policymakers to implement mandatory food and nutrition curriculum in the school setting as a population-level intervention to combat the decline in food literacy and improve diet-related health outcomes (Lichtenstein & Ludwig, 2010; Kimura, 2011; Pendergast & Dewhurst, 2012). More research is needed to better understand food literacy as a whole construct to develop appropriate curriculum for adolescents. Findings may also help guide future research towards optimal methods for delivering food literacy interventions to effectively educate teenagers and provide them with the skills to navigate the food system. From a population lens, future research can study how to best develop community programs that will target adolescents most at risk for low food literacy.

The call for a validated food literacy measurement tool has been consistently stated in the literature (Brooks & Begley, 2013; Vaitkeviciute et al., 2015; Azevedo Perry et al., 2017; Wickham & Carbone, 2018; Bailey et al., 2019; Thomas et al., 2019), as current studies measure different components of food literacy (Thomas & Irwin, 2011; Brooks & Begley, 2013; Slater, 2013; Vaitkeviciute et al., 2015; Wickham & Carbone, 2018; Bailey et al., 2019). A validated food literacy assessment tool is critical to advance this field of study, as it would ensure the accuracy in measuring the concept of food literacy across the board. Once a validated food literacy tool is published and available, it will ensure that food literacy research going forward is accurate and standardized in measuring this concept, allowing for research to be comparable.

5.6. Conclusion

The purpose of this thesis was to determine food and nutrition knowledge among adolescents in the London-Middlesex region of Ontario, Canada. The average knowledge scores for both food and nutrition were relatively low (58.8% and 52.6% respectively). These low knowledge scores are in line with previous research. This is a concern because they suggest that adolescents may not have the necessary food literacy skills, such as food and nutrition knowledge, to maintain a healthy diet.

The second goal of this thesis was to determine correlates of food and nutrition knowledge. It is increasingly important to understand what contributes to food and nutrition knowledge among adolescents because it is common for teenagers to have sub-optimal dietary habits and diet quality. Developing food and nutrition knowledge and practicing food literacy skills will better equip adolescents to make healthy food choices. The correlates of food and nutrition knowledge that were consistently significant across the models included: age, ethnicity, mental health, the use of mobile health applications, liking to cook, as well as confidence in reading and understanding food labels. As well, higher household education and family income were correlates found to be consistently associated with food and nutrition knowledge.

This thesis fills a gap in the Canadian literature as it has allowed for a better understanding of the food and nutrition knowledge among adolescents. Findings from this thesis will help guide SmartAPPetite researchers in enhancing message content and future planning of the mobile application. Results may also help guide policymakers, researchers, and public health professionals in developing appropriate food and nutrition programs and curriculums to combat the decline in food literacy skills.

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Wickham, C. A., & Carbone, E. T. (2018). What's technology cooking up? A systematic review of the use of technology in adolescent food literacy programs. *Appetite*, *125*, 333-344. https://doi.org/10.1016/j.appet.2018.02.001

APPENDIX A: SmartAPPetite Adolescent Study The Western University Non-Medical Ethics Board Approval

Western Research

Date: 14 December 2017

To: Dr. Jason Gilliland

Project ID: 107034

Study Title: SmartAPPetite Adolescent Study

Application Type: NMREB Amendment Form

Review Type: Delegated

Full Board Reporting Date: January 12, 2018

Date Approval Issued: 14/Dec/2017

REB Approval Expiry Date: 28/Sep/2018

Dear Dr. Jason Gilliland,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
SmartAPPetite_Assent_Control_2017-11-22_Clean	Written Consent/Assent	22/Nov/2017	R2
SmartAPPetite_Assent_Intervent_2017-11-22_Clean	Written Consent/Assent	22/Nov/2017	
SmartAPPetite_LOIConsent_Control_2017-11-22_Clean	Written Consent/Assent	22/Nov/2017	
SmartAPPetite_LOIConsent_Intervent_2017-11-22_Clean	Written Consent/Assent	22/Nov/2017	
SmartAPPetite_ParentSurvey_FINAL_2017-10-22	Paper Survey	22/Oct/2017	Parent - NEW
SmartAPPetite_Protocol-UWO_R2_2017-11-22_Clean	Protocol	22/Nov/2017	R2
SmartAPPetite_YouthSurvey_FINAL_2017-10-22	Online Survey	22/Oct/2017	YOUTH - New

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kelly Patterson, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

APPENDIX B: SmartAPPetite Letter of Assent for Adolescents in the Control Group and Intervention Group

Research Project: SmartAPPetite Youth Study
Letter of Assent

Principal Investigator: Dr. Jason Gilliland, PhD Department of Geography, University of Western Ontario

To whom it may concern,

Have you ever wanted to learn more about how to choose healthy foods, prepare healthy meals, or buy healthy options at restaurants?
Our research team based at Western University is working with high school students like you to promote healthy living and healthy eating. We invite you to participate in a message-based nutrition intervention called SmartAPPetite. SmartAPPetite aims to provide users with teen-specific knowledge on healthy living and healthy eating. This study will take place in your high school this year, where your school will participate in the study without using the app to provide a baseline understanding of student knowledge about nutrition. We will offer the app to you after the third survey.

What are we going to study?
The purpose of this study is to evaluate our message-based intervention, SmartAPPetite, to improve healthy food access, food knowledge, and dietary behaviours of high school students.

What would you have to do?
Complete the Youth Survey. You will be asked to complete a 40-minute online survey 3-times: one now, one in 8- to 10-weeks, and one in 6-months. Part 1 asks about you, your food knowledge, eating habits, and food purchasing behaviours. Part 2 is a 24-hour recall diary, for which you will be led through a guided online survey to help remember the type and amount of food you ate the previous day.

Upon completion, you will receive a $10 gift card for completing the first survey, and $15 gift cards for completing each of the second and third surveys.

Participation in this study will also give you a chance to win a MacBook Air, which we will be giving away in a grand prize draw to one student from each school. You will earn up to 7 entries into the draw by registering for the study and completing each survey. Students who withdraw from the study will not lose any earned entries.

Do you have to participate?
No - you only have to participate if you would like to. You are also allowed to stop at any time or refuse to answer any questions. We will never share your information with anyone else, not even your parents. You are allowed to see your information at any time. The researchers from Western University will be happy to answer any questions or concerns you have.

Research Project: SmartAPPetite Youth Study
Assent Form

I have had all of my questions answered and agree to participate in this study.

Print Name: _____ _____
First name Last name

Student's Email Address: _____

Today's Date: _____

Research Project: SmartAPPetite Youth Study
Letter of Assent

Principal Investigator: Dr. Jason Gilliland, PhD Department of Geography, University of Western Ontario

To whom it may concern,

Have you ever wanted to learn more about how to choose healthy foods, prepare healthy meals, or buy healthy options at restaurants? Our research team based at Western University is working with high school students like you to promote healthy living and healthy eating. We invite you participate in a message-based nutrition intervention called SmartAPPetite. SmartAPPetite aims to provide users with teen-specific knowledge on healthy living and healthy eating. This study will take place in your high school this year.

What are we going to study?
The purpose of this study is to evaluate our message-based intervention, SmartAPPetite, to improve healthy food access, food knowledge, and dietary behaviours of high school students.

What would you have to do?
Complete the Youth Survey. You will be asked to complete a 40-minute online survey 3-times: one now, one in 8- to 10-weeks, and one in 6-months. Part 1 asks about you, your food knowledge, eating habits, and food purchasing behaviours. Part 2 is a 24-hour recall diary, for which you will be led through a guided online survey to help remember the type and amount of food you ate the previous day.

Upon completion, you will receive a $10 gift card for completing the first survey, and $15 gift cards for completing each of the second and third surveys.

Participation in this study will also give you a chance to win a MacBook Air, which we will be giving away in a grand prize draw to one student from each school. You will earn up to 7 entries into the draw by registering for the study and completing each survey. You can also earn an additional entry each time you open AND rate a message in the app (limit one entry per message). Students who withdraw from the study will not lose any earned entries.

Receive SmartAPPetite Intervention for 10 Weeks.

a. ***If you have a smartphone or tablet device (with data or WiFi connectivity)***, you will be asked to download the free SmartAPPetite app and sign up for an account with your email address. You will receive up to 3 healthy eating and healthy lifestyle messages per day for 10 weeks. Each message will include a tip about healthy eating and healthy lifestyle for teens, and often a recipe related to the tip, and a list of local, healthy food vendors based on their geographic location. The app also provides GPS-enabled messaging to inform the user if they are close to any local vendors of healthy food.
b. ***If you do not have a smartphone or tablet device*** you will have the option of receiving a daily message through email for 10 weeks. These messages will include tips about healthy eating and healthy lifestyle about teens, related recipes, and local vendors of healthy food items close to their school.

Focus Group. Upon completion of the study, you may be asked to take part in a focus group to provide feedback about SmartAPPetite and discuss suggestions for improvement. All focus groups will be audiorecorded to ensure we catch the whole conversation. If you do not want to be audio recorded then do not participate in the focus group portion of the study. Please be advised that although the researchers will take every precaution to maintain confidentiality of the data, the nature of focus groups prevents the researchers from guaranteeing confidentiality. The researchers will remind participants to respect the privacy of your fellow participants and not repeat what is said in the focus group to others. If the results are published, your name will not be used.

Do you have to participate?

No - you only have to participate if you would like to. You are also allowed to stop at any time or refuse to answer any questions. We will never share your information with anyone else, not even your parents. You are allowed to see your information at any time. The researchers from Western University will be happy to answer any questions or concerns you have.

Research Project: SmartAPPetite Youth Study
Assent Form

I have had all of my questions answered and agree to participate in this study.

Print Name: _____ _____
First name Last name

Date: _____

Student's Email Address: _____

Student's Age: _____

Please indicate which way you would like to participate in the SmartAPPetite project:

- ☐ Through a smartphone or tablet
- ☐ By email

Focus Groups:

- ☐ Please check the box if you would like to participate in the focus groups at the end of the study

APPENDIX C: SmartAPPetite Letter of Information for Parental Consent for Adolescents in the Control Group and Intervention Group

Research Project: SmartAPPetite Youth Study
Letter of Information

Principal Investigator: Dr. Jason Gilliland, PhD Department of Geography, University of Western Ontario

Dear Parent/Guardian,

Dr. Jason Gilliland and his research team from Western University invite your high school-aged child to participate in a study using a nutrition and healthy living smartphone app (e.g., android, iOS, email) called SmartAPPetite. SmartAPPetite provides users with scientifically valid information on how to eat healthy, and healthy living in general. This app has been created to help address the increase in diet related chronic disease, such as diabetes, cardiovascular disease, cancer, obesity, dental disease, and osteoporosis. This study will involve high school-aged youth from schools across Southwestern Ontario between 2018 and 2021.

Purpose of this Study. The purpose of this study is to evaluate the effectiveness of a message-based nutritional intervention program called SmartAPPetite, which aims to improve healthy food access, food literacy, and dietary behaviours in an adolescent population. Your child's school has been selected to participate in the study without using the app to provide a baseline understanding of student knowledge about nutrition. We will offer the app to all students in the school after the third survey. Any high school-aged adolescents who can speak and read English (and their parents) are welcome to take part in our research. The purpose of this letter is to provide you with the information required for you to make an informed decision regarding your child's participation in our research.

Do we have to participate in this study? Your participation in this study is completely voluntary. You and your child do not have to participate. You can each refuse to answer any survey questions, and can choose to leave the study at any time. If you or your child decides to leave the study at any time (even AFTER the study has been completed) please contact the project team at _____, any data collected from you or your child will be immediately destroyed and excluded from the analysis.

What will happen in this study?

If **you** agree to participate, you will be asked to:

Complete the Parent Survey. This short 10-minute survey will ask questions about your family's meal and shopping behaviours, as well as other information about your family socio-economic status. The Parent Survey is completely voluntary - your child can still join the study themselves if you decide not to fill out the Parent Survey; however, as the survey gives us critical information from the point of view of parents, we would really appreciate your participation.

If **your child** agrees to participate, they will be asked to:

Complete the Youth Survey. Your child will be asked to complete a 40-minute online survey 3-times: one now, one in 8- to 10-weeks, and one in 6-months. Part 1 asks your child about themselves, their food knowledge, their eating habits, and food purchasing behaviours. Part

2 is a 24-hour recall diary, for which your child will be led through a guided online survey to help them remember the type and amount of food they ate the previous day.

Compensation

If you participate in the parent survey, you will receive a $10 gift card. Upon participation in the youth surveys, your child will receive gift cards as follows: $10 for first survey, $15 for second and third survey (total of $40 in gift cards).

Participation in this study will also give your child a chance to win a MacBook Air, which we will be giving away in a grand prize draw to one students from each school. Students will earn up to 7 entries into the draw by registering for the study and completing each survey. Students who withdraw from the study will not lose any earned entries.

What are the benefits and risks if my child participates?

By participating in this research, students and parents will help us evaluate the effectiveness of the SmartAPPetite project. By better understanding the impact of the app has on teen food habits, purchasing, and knowledge, we can use the app as a population intervention for teens.

There is little risk to your child if he/she participates in this study, but there is a slight chance that you or your child may be uncomfortable sharing details of your family, such as economic status or eating patterns. We are also asking for your email address and postal code. Geographic locational information, such as postal code, helps us establish the geographical impact of food choices and accessibility to food vendors and retailers.

We are minimizing the risks you may feel as follows:

- All information collected in this study is kept strictly confidential.
- You or your child will not be personally identified or identifiable by name in any of the documents related to the study, except for the consent form. This will be accomplished by assigning a unique identification code.
- Materials and data files will ONLY be viewed by members of the research team and will be stored in a locked filing cabinet until transferred onto a password protected computer in a secure facility at the University of Western Ontario.

Representatives of The University of Western Ontario's Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research. Data will be kept until the conclusion of data analysis and publications from this study are completed. The results of this study will only be presented for groups so that participants will never be individually identifiable. While we do our best to protect your information there is no guarantee that we will be able to do so. If data is collected during the project which may be required to report by law, we have a duty to report. You do not waive any legal rights by signing this consent form.

Who do I contact if I have any other questions?

If you have any further questions about the project we encourage you to please contact a research team member listed below.

If you have any further questions regarding your child's rights as a study participant, please contact the Office of Human Research Ethics at _____ or at: _____. You may also make general inquiries about this research by e-mailing _____.

Download this letter for your own records at the following link: INSERT LINK

Research Project: SmartAPPetite Youth Study
Consent Form

Completion of the following consent form indicates that you have read the ***Letter of Information***, your agreement to allow your child to participate in this study, and have had all questions answered to your satisfaction.

By providing the following information, I agree for my child to participate in this study.

Student's Name: _____

Student's School: _____

Student's 2nd Period Teacher: _____

Parent's Name: _____

Do you agree to participate in the brief 10-minute parent survey, for which you will receive a $10 gift card for Amazon as a thank you for participating?

☐ Yes ☐ No

IF YES → The survey will ask the following question before auto directing the parent to the parent survey on a new Qualtrics survey.

If you would like to receive a $10 Gift Card from Amazon as a thank you for participating in the survey, please provide your email address and we will email it to you within 4 weeks. Your email address will not be used for any other purpose then stated above.

_____

Enter your email address

_____

Verify your email address

IF NO → The consent form will be submitted to allow their child to participate in the study.

Research Project: SmartAPPetite Adolescent Study
Letter of Information

Principal Investigator: Dr. Jason Gilliland, PhD Department of Geography, University of Western Ontario

Dear Parent/Guardian,

Dr. Jason Gilliland and his research team from Western University invite your high school-aged child to participate in a nutrition and healthy living smartphone app (e.g., android, iOS, email) called SmartAPPetite. SmartAPPetite provides users with scientifically valid information on how to eat healthy, and healthy living in general. This app has been created to help address the increase in diet related chronic disease, such as obesity, diabetes, cardiovascular disease, cancer, dental disease, and osteoporosis. This study will involve high school-aged youth from schools across Southwestern Ontario between 2018 and 2021.

Purpose of this Study. The purpose of this study is to evaluate the effectiveness of a message-based nutritional intervention program called SmartAPPetite, which aims to improve healthy food access, food literacy, and dietary behaviours in an adolescent population. Any high school-aged adolescents who can speak and read English (and their parents) are welcome to take part in our research. The purpose of this letter is to provide you with the information required for you to make an informed decision regarding your child's participation in our research.

Do we have to participate in this study? Your participation in this study is completely voluntary. You and your child do not have to participate. You can each refuse to answer any survey questions, and can choose to leave the study at any time. If you or your child decides to leave the study at any time (even AFTER the study has been completed) please contact the project team at _____, and any data collected from you or your child will be immediately destroyed and excluded from the analysis.

What will happen in this study?

If **you** agree to participate, you will be asked to:

Complete the Parent Survey. This short 10-minute survey will ask questions about your family's meal and shopping behaviours, as well as other information about your family socio-economic status. The Parent Survey is completely voluntary - your child can still join the study themselves if you decide not to fill out the Parent Survey; however, as the survey gives us critical information from the point of view of parents, we would really appreciate your participation.

If **your child** agrees to participate, they will be asked to:

Complete the Youth Survey. Your child will be asked to complete a 40-minute online survey 3-times: one now, one in 8- to 10-weeks, and one in 6-months. Part 1 asks your child about themselves, their food knowledge, their eating habits, and food purchasing behaviours. Part 2 is a 24-hour recall diary, for which your child will be led through a guided online survey to help them remember the type and amount of food they ate the previous day.

Receive SmartAPPetite Intervention for 10 Weeks.

If your child has a smartphone or tablet device (with data or WiFi connectivity), they will be asked to download the free SmartAPPetite app and sign up for an account with their email address. They will receive up to 3 healthy eating and/or healthy lifestyle messages per day for 10 weeks. Each message will include a tip about healthy eating and healthy lifestyle for teens, and often a recipe related to the tip, and a list of local, healthy food vendors based on their geographic location. The app also provides GPS-enabled messaging to inform the user if they are close to any local vendors of healthy food. To participate in this study, your child's email address must be provided to our team so that we can create a SmartAPPetite app account for your child.

If my child does not have an smartphone or tablet device, they will have the option of receiving a daily message through email for 10 weeks. These messages will include tips about healthy eating and/or healthy lifestyle for teens, related recipes, and local vendors of healthy food items close to their school. To participate in this study, your child's email address much be provided to our team so that we can send them email-based SmartAPPetite messages.

Focus Group. Upon completion of the study, your child may be asked to take part in a focus group to provide feedback about SmartAPPetite and discuss suggestions for improvement. All focus groups will be audio-recorded to ensure we catch the whole conversation. If you do not want your child to be audio-recorded, they may not participate in the focus group portion of the study. Please be advised that although the researchers will take every precaution to maintain confidentiality of the data, the nature of focus groups prevents the researchers from guaranteeing confidentiality. The researchers will remind participants to respect the privacy of your fellow participants and not repeat what is said in the focus group to others. If the results are published, direct quotes may be used, but your child's name will not be used.

Compensation

If you participate in the parent survey, you will receive a $10 gift card. Upon participation in the youth surveys, you will receive gift cards as follows: $10 for first survey, $15 for second and third survey (total of $40 in gift cards).

Participation in this study will also give your child a chance to win a MacBook Air, which we will be giving away in a grand prize draw to one student from each school. Students will earn up to 7 entries into the draw by registering for the study and completing each survey. Students will also earn an additional entry each time they open AND rate a message in the app (limit one entry per message). Students who withdraw from the study will not lose any earned entries.

What are the benefits and risks if my child participates?

By participating in this research, students and parents will help us evaluate the effectiveness of the SmartAPPetite project. By better understanding the impact of the app has on teen food habits, purchasing, and knowledge, we can use the app as a population intervention for teens. Potential anticipated benefits to the participants include: increased awareness of the health benefits of healthy and local foods; increased food literacy and knowledge of how to incorporate healthy, local, and seasonal foods into their household menus; increased fruit and vegetable consumption; healthier diets and better overall health.

There is little risk to your child if he/she participates in this study, but there is a slight chance that you or your child may be uncomfortable sharing details of your family, such as economic status, eating patterns. We are also asking for your email address, postal code, and the app is GPS-enabled. Geographic locational information, such as postal code, helps us establish the geographical impact of food choices and accessibility to food vendors and retailers. However, any locational information collected is strictly confidential and approved research team members will only be able to access the information after the completion of the study. Participants also have the option to turn-off GPS location services within the application at any time.

We are minimizing the risks you may feel as follows:

- All information collected in this study is kept strictly confidential.
- You or your child will not be personally identified or identifiable by name in any of the documents related to the study, except for the consent form. This will be accomplished by assigning a unique identification code.
- Materials and data files will ONLY be viewed by members of the research team and will be stored in a locked filing cabinet until transferred onto a password protected computer in a secure facility at the University of Western Ontario.

Representatives of The University of Western Ontario's Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research. Data will be kept until the conclusion of data analysis and publications from this study are completed. The results of this study will only be presented for groups so that children will never be individually identifiable. While we do our best to protect your information there is no guarantee that we will be able to do so. If data is collected during the project which may be required to report by law, we have a duty to report. You do not waive any legal rights by signing this consent form.

Who do I contact if I have any other questions?

If you have any further questions about the project we encourage you to please contact a research team member listed below.

If you have any further questions regarding your child's rights as a study participant, please contact the Office of Human Research Ethics at _____ or at: _____. You may also make general inquiries about this research by e-mailing _____.

Download this letter for your own records at the following link: INSERT LINK

Research Project: SmartAPPetite Adolescent Study
Consent Form

Completion of the following consent form indicates that you have read the ***Letter of Information***, your agreement to allow your child to participate in this study, and have had all questions answered to your satisfaction.

1. Study Participation:

Would you like your child to participate in this study?

☐ Yes ☐ No

2. Group Discussion:

Would you like your child to participate in the audio-recorded group discussion, where anonymous direct quotes from the group discussions may be used by the research team in publications?

☐ Yes ☐ No

By providing the following information, I agree for my child to participate in this study.

Student's Name: _____

Student's School: _____

Student's 2nd Period Teacher: _____

Parent's Name: _____

Do you agree to participate in the brief 10-minute parent survey, for which you will receive a $10 gift card for Amazon as a thank you for participating?

☐ Yes ☐ No

IF YES → The survey will ask the following question before auto directing the parent to the parent survey on a new Qualtrics survey.

If you would like to receive a $10 Gift Card from Amazon as a thank you for participating in the survey, please provide your email address and we will email it to you within 4 weeks. Your email address will not be used for any other purpose then stated above.

_____

Enter your email address

_____

Verify your email address

IF NO → The consent form will be submitted to allow their child to participate in the study.

APPENDIX D: SmartAPPetite Parent Survey and Student Survey

RESEARCHER NOTE NOT INCLUDED ON THE SURVEY: THIS SURVEY WILL BE CONVERTED TO QUALTRICS ONLINE SOFTWARE TO ALLOW THE PARENTS TO COMPLETE THE SURVEYS ONLINE.

Parent Survey

We need your help to make *SmartAPPetite for Youth a success*. Your honest answers to the following questions are very important. This should only take 5-10 minutes to complete. If you have more than one child bringing home a survey - we would appreciate you filling out a survey for each child since some answers will be specific to each child. You are not obligated to fill out any questions for which you are not comfortable answering; in this case, please leave blank.

Family Meal & Food Purchasing Behaviours

In a typical week, how many days per week does your family eat dinner together?

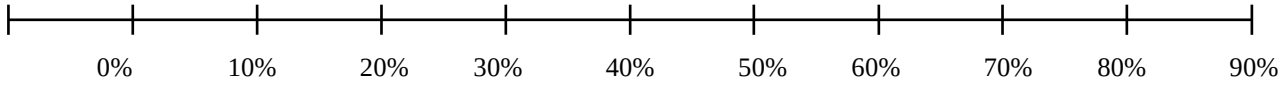
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7

In a typical week, how many days per week does your family have the TV on during meal time?

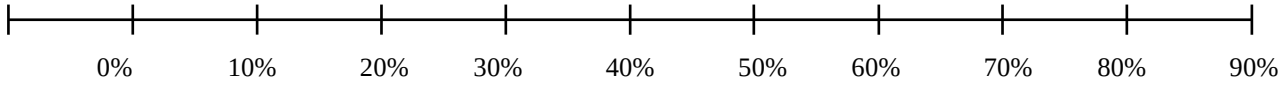
O 0 O 1 O 2 O 3 O 4 O 5 O 6 O 7

For the following statements, place an 'X' along the line at the percentage (%) that best describes your actions when you go grocery shopping?

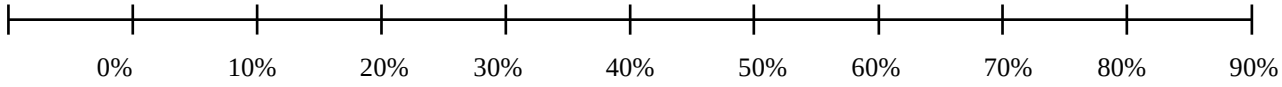
When I buy food, I plan ahead by making a list.



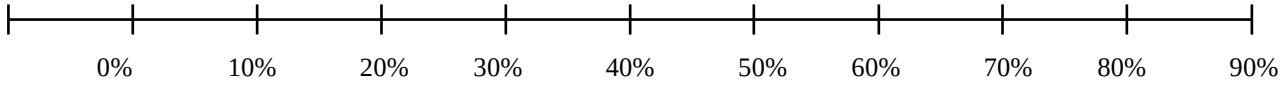
Before I go grocery shopping, I look at the flyers to plan my shopping list.



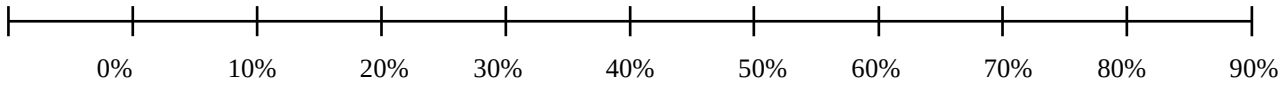
I have a budget when I go grocery shopping and I stick to it.



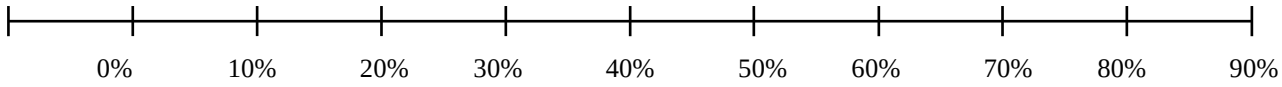
When I go grocery shopping, I only go down the aisles that have the specific items I need.



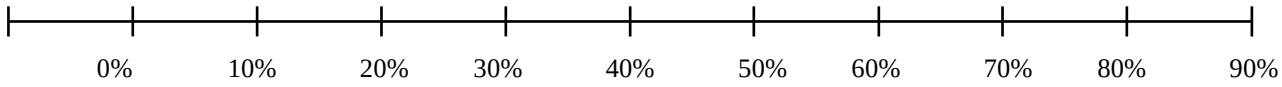
When I am grocery shopping, I spend time comparing different brands of the same food to make sure I am getting the healthiest option.



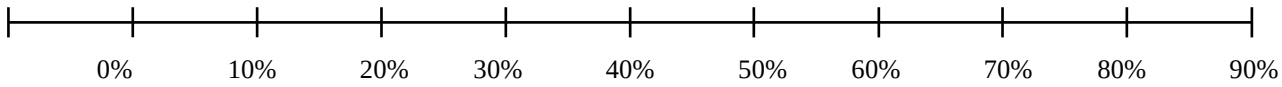
My child goes grocery shopping with me.



My child asks me to buy food that I didn't plan to buy.

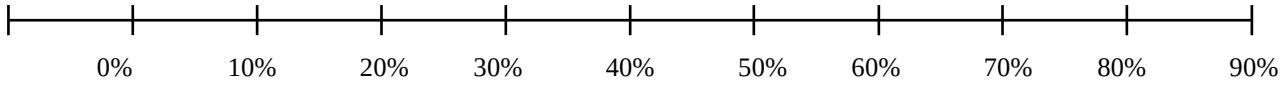


I buy food that I don't plan to buy, because my child asks me to.

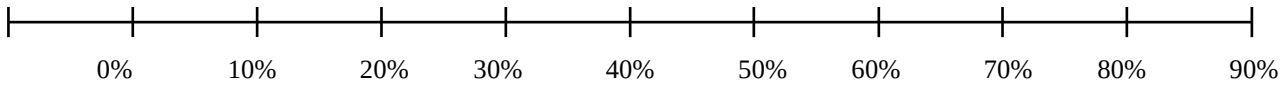


For the following statements, place an 'X' along the line at the percentage (%) that best describes how often you have the following <u>rules for your child</u>?

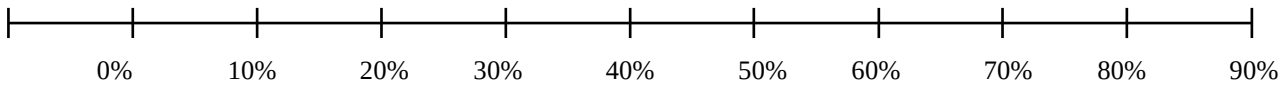
Meals are only eaten while the TV is off



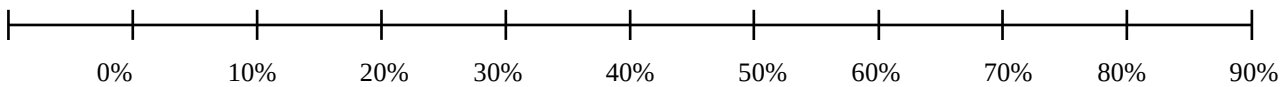
Electronics (e.g., phones, iPods, handheld, gaming devices) are forbidden during meal time



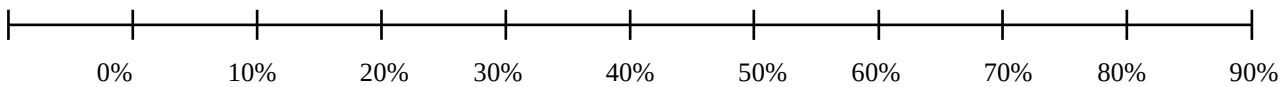
Not allowed to eat fast food



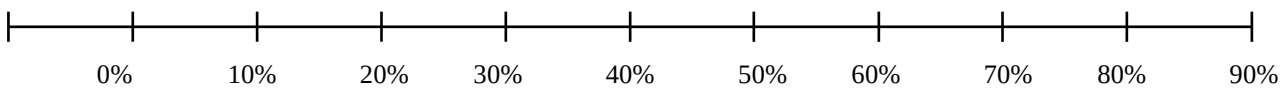
Dinner is eaten with the family



Can have dessert only after the main course is eaten



Only fruit for dessert



General Household Information

My **<u>child</u>**:

- O Lives in one home
- O Splits their time equally between 2 homes
- O Lives in one home but regularly visits/lives in a second home

- O Has another living arrangement: _____

How would you describe your **child's** ethnic background (choose all that apply)?

- O White / Caucasian
- O South Asian (e.g. East Indian, Pakistani, Sri Lankan)
- O East Asian (e.g., Chinese, Japanese, Korean)
- O Middle Eastern (e.g., Egyptian, Iranian, Lebanese)
- O Latin American (e.g., Mexican, Columbian, Peruvian)
- O Indigenous (i.e., First Nations, Métis, or Inuit)
- O Black (e.g., African, Caribbean)
- O Other (Please Specify): _____

Answer these questions for you.

What is **your** relationship to the child taking part in the study?

O Parent O Guardian O Other _____

What is **your** gender?

O Male O Female O I identify as _____

What is the highest certificate, diploma, or degree that **you** have completed?

- O Less than high school diploma or equivalent
- O High school diploma or equivalency
- O Trade or other non-university certificate or diploma
- O University certificate or diploma below the bachelor's level
- O Bachelor's degree (e.g., BA, BSc)
- O University certificate, diploma or degree above the bachelor's level
- O Don't know

Which of the following best describes **your** current work status?

- O Paid work full-time
- O Paid work part-time
- O Seasonal Work
- O Self-Employed
- O Volunteer Work
- O At home with children
- O Retired
- O Unemployed
- O Student
- O Other _____
- O I prefer not to answer

Does your child have a **second** parent/guardian in **your** household?

O Yes O No (If no, please go to Question 28)

If your child has a **second** parent/guardian who lives in **your** household, please answer these questions on their behalf.

What is **their** relationship to the child taking part in the study?

- O Parent
- O Guardian
- O Other _____

What is **their** gender?

- O Male
- O Female
- O They identify as _____

What is **their** highest certificate, diploma, or degree completed?

- O Less than high school diploma or equivalent
- O High school diploma or equivalency
- O Trade or other non-university certificate or diploma
- O University certificate or diploma below the bachelor's level
- O Bachelor's degree (e.g., BA, BSc)
- O University certificate, diploma or degree above the bachelor's level
- O Don't know

Which of the following best describes **their** current work status?

- O Paid work full-time
- O Paid work part-time
- O Seasonal Work
- O Self-Employed
- O Volunteer Work
- O At home with children
- O Retired
- O Unemployed
- O Student
- O Other _____
- O I prefer not to answer

Answer these questions for your household.

Please indicate the total income from all sources that you and other members of your household received in the last year (Jan-Dec) before taxes. The total income from all sources was:

- O Less than $20,000
- O $20,000 - $29,999
- O $30,000 - $39,999
- O $40,000 - $49,999
- O $50,000 - $59,999
- O $60,000 - $69,999
- O $70,000 - $79,999
- O $80,000 - $89,999
- O $90,000 - $99,999
- O $100,000 - $109,999
- O $110,000 - $119,999
- O $120,000 - $129,999
- O $130,000 - $139,999
- O $140,000 - $149,999
- O $150,000 or more
- O I don't know
- O I prefer not to answer

What is the postal code of your home: ___ ___ ___ - ___ ___ ___

You are finished!

Thank you for completing the survey.

SmartAPPetite Study: Youth Survey

We need your help to better understand what aspects of nutrition are of interest to teens like you. Your honest answers to the items in this survey are very important to us. This will not take long to complete. Remember….

- We want to know what you think
- There are no right or wrong answers
- Everything you tell us will be kept strictly confidential
- Try to answer all the questions

RESEARCHER NOTE NOT INCLUDED ON THE SURVEY: THIS SURVEY WILL BE CONVERTED TO QUALTRICS ONLINE SOFTWARE TO ALLOW THE STUDENTS TO COMPLETE THE SURVEYS ONLINE.

A. General Information

1. I am a

   o Male o Female o I identify as (*please specify)* _____

2. What is your current age?

   o 13 o 14 o 15 o 16 o 17 o 18 o 19

3. What grade are you currently in?

   o 9 o 10 o 11 o 12 o 13

4. How many people live (including yourself) in your main home? _____

5. Postal code at your main home: __ __ __ __ __ __ (e.g. N6A 5K6)

6. What is your ethnicity? (Please select all that apply)

   o White/Caucasian
   o South Asian (e.g., East Indian, Pakistani, Sri Lankan)
   o East Asian (e.g., Chinese, Japanese, Korean)
   o Middle Eastern (e.g., Egyptian, Iranian, Lebanese)
   o Latin American (e.g., Mexican, Columbian, Peruvian)
   o Indigenous (i.e., First Nations, Métis, or Inuit)
   o Black (e.g., African, Caribbean)
   o Other (Please Specify): _____

7. Do you own a smartphone?

   o Yes, with a data plan o Yes, without a data plan o No

8. Do you own a tablet or iPod?

   o Yes, with a data plan o Yes, without a data plan o No

9. Do you have access to WiFi at home?

o Yes o No

10. Do you use any food, nutrition, or health apps on your smartphone or tablet?

o Yes o No

11. Do you use any wearable fitness devices (e.g., fitbit, Garmin)?

o Yes o No

12. In general, how do you rate your own physical health?

o Excellent o Very Good o Good o Fair o Poor

13. In general, how do you rate your own mental health?

o Excellent o Very Good o Good o Fair o Poor

14. Physical activity is an activity that increase your heart rate and makes you get out of breath some of the time. Add up all the time you spend in physical activity each day. Some examples of physical activity are running, brisk walking, rollerblading, biking, dancing, skateboarding, swimming, soccer, basketball.

Over the past 7 days, how many days were you physically active for a total of at least 60 minutes per day?
o 0 o 1 o 2 o 3 o 4 o 5 o 6 o 7

15. Do you have any health conditions that affect your eating patterns (select all that apply)?

- o I do not have a health condition that affects my eating patterns.
- o Food allergies
- o Celiac
- o Crohn's / Colitis
- o Type-1 diabetes
- o Type-2 diabetes
- o Other (Please specify) _____
- o Other (*Please specify*) _____

16. Based on my allergies or intolerances of certain foods, I cannot eat the following (select all that apply):
    - O I do not have any allergies or intolerances to food
    - O Eggs
    - O Gluten / Wheat
    - O Milk / Lactose
    - O Peanuts
    - O Sesame
    - O Other (Please specify) _____
    - O Other (*Please specify*) _____

17. I eat the following way (Select all that apply):
    - O Gluten-free
    - O Lactose-free
    - O Kosher
    - O Halal
    - O Vegetarian
    - O Vegan
    - O Other (Please specify) _____
    - O Other (Please specify) _____
    - O None of the above

B. General Eating Habits

1. In a typical day, about how many servings of fruit do you eat? Examples – 1 serving is equal to a piece of fresh fruit (like an apple), 1/2 cup of fruit

   _____ servings

2. In a typical day, about how many servings of vegetables do you eat? Example – 1 serving is equal to a small bowl of fresh or cooked vegetables, or 1 cup of green salad. Do not count French fries or potato chips.

   _____ servings

C. Nutrition Questions

1. During a typical day, how many meals do you eat? _____
2. During a typical day, how many snacks do you eat? _____

3. During a typical week, how many times do you go food shopping alone? _____
4. During a typical week, how many times do you go food shopping with a parent? _____
5. During a typical week, how often do you purchase food from the following types of locations?
   a. Supermarket or grocery store

      Times per Month: _____ OR Times per Week: _____

   b. Convenience store, corner store, gas station, or pharmacy

      Times per Month: _____ OR Times per Week: _____

   c. Fast food restaurant or coffee shop

      Times per Month: _____ OR Times per Week: _____

   d. Full-service/sit-down restaurant

      Times per Month: _____ OR Times per Week: _____

6. Please rate your level of agreement with the following statements.

		Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a	Eating healthy food is important to me	O	O	O	O	O
b	I like to cook	O	O	O	O	O
c	Cooking or preparing meals helps me eat more healthy	O	O	O	O	O
d	Cooking or preparing lunch at home helps me save money	O	O	O	O	O
e	Cooking or preparing lunch to take to school takes too much time	O	O	O	O	O
f	I have no problem reading and understanding food labels	O	O	O	O	O

Breakfast

7. During the last week, on which days did you eat BREAKFAST and where?

a. Monday:

o I did not eat breakfast

o Ate at home

o Ate at a free breakfast program at school

o I bought breakfast at school

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

b. Tuesday:

o I did not eat breakfast

o Ate at home

o Ate at a free breakfast program at school

o I bought breakfast at school

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

c. Wednesday:

o I did not eat breakfast

o Ate at home

o Ate at a free breakfast program at school

o I bought breakfast at school

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

d. Thursday:

o I did not eat breakfast

o Ate at home

o Ate at a free breakfast program at school

o I bought breakfast at school

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

e. Friday:

o I did not eat breakfast

o Ate at home

o Ate at a free breakfast program at school

o I bought breakfast at school

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

f. Saturday:

o I did not eat breakfast

o Ate at home

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

g. Sunday:

o I did not eat breakfast

o Ate at home

o I bought a breakfast from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

Lunch During the School Week (Monday - Friday)

8. During the last week, on which days did you eat LUNCH and where?

a. Monday:

o I did not eat lunch

O I ate at home

O Ate a lunch I brought from home

O Ate at a free lunch program at school

O I bought lunch at school

O I bought a lunch from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

b. Tuesday:
O I did not eat lunch

O I ate at home

O Ate a lunch I brought from home

O Ate at a free lunch program at school

O I bought lunch at school

O I bought a lunch from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

c. Wednesday:
O I did not eat lunch

O I ate at home

O Ate a lunch I brought from home

O Ate at a free lunch program at school

O I bought lunch at school

O I bought a lunch from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

d. Thursday:
O I did not eat lunch

O I ate at home

O Ate a lunch I brought from home

O Ate at a free lunch program at school

O I bought lunch at school

O I bought a lunch from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

e. Friday:
O I did not eat lunch

O I ate at home

O Ate a lunch I brought from home

O Ate at a free lunch program at school

O I bought lunch at school

O I bought a lunch from another place (Please specify place)

Place Name: _____ Closest Intersection: _____

9. During a typical week, how often do you leave school to buy lunch (e.g., from a fast food restaurant, convenience store, grocery store)?

   Times per Month: _____ OR Times per Week: _____

10. During a typical week, how often do you leave school to buy snacks (e.g., from coffee shop, convenience store, grocery store)?

    Times per Month: _____ OR Times per Week: _____

    Dinner/Supper

11. During a typical week, how many evenings do you eat dinner? _____

12. During a typical week, how many evenings do you eat dinner with your family? _____

13. During a typical week, how many evenings do you prepare or help prepare dinner? _____

14. During a typical week, how many evenings do you eat food from restaurants (takeout or eat in) or pre-made dinners from stores (e.g., microwave dinners, canned chili or pasta)? _____

D. General Nutrition Knowledge Questions

This is a survey, not a test. Your answers will help identify which dietary advice people find confusing. It is important that you complete it by yourself. Your answers will remain anonymous. If you don't know the answer, mark "not sure" rather than guess.
Thank you for your time.

The first few items are about what advice you think experts are giving us.

1. How many servings of fruit and vegetables per day do experts advise teens to eat as a minimum? (select one)
   O 2 O 3 O 4 O 5 or more O Not Sure

2. Do health experts recommend that people should be eating more, the same amount, or less of the following items? (select one box per food)

	More	Same	Less	Not Sure
a. Fruit	O	O	O	O
b. Food and drinks with added sugar	O	O	O	O
c. Vegetables	O	O	O	O
d. Fatty foods	O	O	O	O
e. Processed red meat	O	O	O	O
f. Wholegrains	O	O	O	O

g. Salty foods	O	O	O	O
h. Water	O	O	O	O
i. Unsaturated fats	O	O	O	O
j. Trans fats	O	O	O	O
k. Saturated fats	O	O	O	O

3. How many times per week do experts recommend that people eat fish (e.g. salmon, tuna, tilapia)? (select one)

O 1-2 times per week O 3-4 times per week O Every day O Not sure

4. How many times per week do experts recommend that people eat breakfast? (select one)

O 3 times per week O 4 times per week O Every day O Not sure

Experts classify foods into groups. We are interested to see whether people are aware of food groups and the nutrients they contain.

5. Do you think these foods and drinks are typically high or low in added sugar? (select one per food)

	High in added sugar	Low in added sugar	Not sure
a. Diet cola drinks	O	O	O
b. Plain yogurt	O	O	O
c. Ice cream	O	O	O
d. Ketchup	O	O	O
e. Melon	O	O	O

6. Do you think these foods are typically high or low in salt? (select one per food)

	High in salt	Low in salt	Not sure
a. Frozen vegetables	O	O	O
b. Bread	O	O	O
c. Baked beans	O	O	O
d. Red meat	O	O	O
e. Canned soup	O	O	O

7. Do you think these foods are typically high or low in fibre? (select one per food)

	High in fibre	Low in fibre	Not sure
a. Oats	O	O	O
b. Bananas	O	O	O
c. White Rice	O	O	O
d. Eggs	O	O	O
e. Potatoes with skin	O	O	O
f. White pasta	O	O	O

8. Do you think these foods are a good source of protein? (select one per food)

	Good source	Not a good source	Not sure
a. Chicken	O	O	O
b. Cheese	O	O	O
c. Fruit	O	O	O
d. Baked beans	O	O	O
e. Butter	O	O	O
f. Nuts	O	O	O

9. Which of these foods has the most trans-fat? (select one)

O Fish O Canola Oil

O Store bought cookies, cakes and pastries O Eggs

O Not Sure

10. The amount of calcium in a glass of whole milk compared to a glass of skimmed milk is: (select one)

O About the same O Much higher O Much lower O Not sure

11. Which one of the following items has the most calories per cup? (select one)

O Sugar O Protein O Fibre O Fat O Not Sure

12. Compared to minimally processed foods, processed foods are: (select one)

O Higher in calories O Higher in fibre O Lower in Salt O Not Sure

The next few items are about choosing foods

13. If a person wanted to buy a yogurt at the supermarket, which would have the least sugar/sweetener? (select one)

O 0% fat cherry yogurt O Natural plain yogurt O Creamy fruit yogurt O Not sure

14. Which would be the healthiest and most balanced sandwich lunch? (select one)

O Ham sandwich + fruit + blueberry muffin + fruit juice

O Tuna salad sandwich + fruit + low fat yogurt + water

O Egg salad sandwich + chips + low fat yogurt + water

O Not sure

15. Which would be the healthiest burger choice when eating at a restaurant: (select one)

O Crispy chicken burger O Hormone-free burger O Grilled chicken burger

O Fried fish burger O Not sure

The following questions are related to food labels:

PRODUCT 1

Nutrition Facts **Valeur nutritive** Per 1 biscuit (8g) / pour 1 biscuit (8g)	
Amount **Teneur**	**% Daily Value** **% valeur quotidienne**
Calories / Calories 50	
Fat / Lipides 1g	**2%**
Saturated / Saturés 1g + Trans / trans 0g	**3%**
Cholesterol / Cholestérol 0mg	
Sodium / Sodium 100mg	**4%**
Potassium / Potassium 105mg	**3%**
Carbohydrates / Glucides 10g	**3%**
Fibre / Fibres 3g	**12%**
Sugar / Sucres 5g	
Protein / Protéines 2g	
Vitamin A / Vitamine A	0%
Vitamin C / Vitamine C	0%
Calcium / Calcium	2%
Iron / Fer	5%

INGREDIENTS: OAT FLAKES, SUGAR, PALM OIL, FORTIFIED WHEAT FLOUR, WHOLE WHEAT FLOUR, FRUCTOSE, MALT SYRUP, SALT, RAISING AGENTS (SODIUM HYDROGEN CARBONATE, AMMONIUM, HYDROGEN CARBONATE), FLAVOURING.

PRODUCT 2

Nutrition Facts **Valeur nutritive** Per 2 biscuits (16g) / pour 2 biscuits (16g)	
Amount **Teneur**	**% Daily Value** **% valeur quotidienne**
Calories / Calories 60	
Fat / Lipides 3g	**4%**
Saturated / Saturés 1g + Trans / trans 0g	**3%**
Cholesterol / Cholestérol 0mg	
Sodium / Sodium 150mg	**6%**
Potassium / Potassium 200mg	**6%**
Carbohydrates / Glucides 15g	**5%**
Fibre / Fibres 1g	**4%**
Sugar / Sucres 5g	
Protein / Protéines 4g	
Vitamin A / Vitamine A	0%
Vitamin C / Vitamine C	0%
Calcium / Calcium	3%
Iron / Fer	5%

INGREDIENTS (PRODUCT 2): WHEAT FLOUR, PALM OIL, CORN SYRUP, MALT, SALT, YEAST, LEAVENING AGENTS (SODIUM BICARBONATE, AMMONIUM BICARBONATE, SODIUM PYROPHOSPHATE), CORN STARCH, SOY LECITHIN, SODIUM METABISULPHITE.

16. Looking at products 1 and 2, which one has the most calories (kcal) per biscuit (select one)

O Product 1 O Product 2 O both have the same quantity O Not sure

17. Looking at product 1, what are the sources of sugar in the ingredient list? (select one)

O Sugar and malt syrup O Sugar, fructose and lecithin

O Sugar, fructose and malt syrup O Not sure

18. If the % Daily Value for sodium was greater than 15%, it is considered "high in" sodium: (select one)

O Agree O Disagree O Not Sure

19. "Light" foods (or diet foods) are always good options because they are low in calories. (select one)

O Agree O Disagree O Not Sure

This section is about health problems or diseases related to diet

20. Which of these diseases is related to a low intake of fibre? (select one)

O Constipation O Anaemia O Tooth decay O Not sure

21. Which of these diseases is related to how much sugar people eat? (select one)

O High blood pressure O Tooth decay O Anaemia O Not sure

22. Which of these diseases is related to how much salt (or sodium) people eat? (select one)

O Hypothyroidism O Diabetes O High blood pressure O Not sure

23. Which one of these foods is classified as having a high Glycaemic Index (Glycaemic Index is a measure of how a food affects blood sugar levels, thus a high Glycaemic Index means a greater rise in blood sugar after eating)? (select one)

O Wholegrain cereals O White bread O Fruit and vegetables O Not sure

24. To maintain a healthy weight people should cut fat out completely. (select one)

O Agree O Disagree O Not Sure

You are finished!
Thank you for completing the survey.

APPENDIX E: Curriculum Vitae

RACHEL A. BROWN
Curriculum Vitae

EDUCATION

Registered Dietitian May 2018 – Present
College of Dietitians of Ontario

MSc – Masters of Science in Epidemiology and Biostatistics
Schulich School of Medicine and Dentistry, Western University, London, ON Sept. 2018 – Aug. 2020

MScFN – Masters of Science in Foods and Nutrition
Brescia University College at Western University, London, ON Sept. 2016 – Apr. 2018

BScFN – Honors Specialization in Nutrition and Dietetics
Brescia University College at Western University, London, ON Sept. 2012 – Apr. 2016

PUBLICATIONS

Brown, R. A., Dakkak, H., Gilliland, J., & Seabrook, J. A. (2019). Predictors of drug use during pregnancy: The relative effects of socioeconomic, demographic, and mental health risk factors. *Journal of Neonatal-Perinatal Medicine*, *12*(2), 179-187.

Brown, R. A., Dakkak, H., & Seabrook, J. A. (2018). Is breast best? Examining the effects of alcohol and cannabis use during lactation. *Journal of Neonatal-Perinatal Medicine*, *11*(4), 345-356.

Dakkak, H., **Brown, R**., Twynstra, J., Charbonneau, K., & Seabrook, J. A. (2018). The perception of pre-and post-natal marijuana exposure on health outcomes: a content analysis of Twitter messages. *Journal of Neonatal-Perinatal Medicine*, *11*(4), 409-415.

Basiuk, M., **Brown, R. A**., Cartwright, D., Davison, R., & Wallis, P. M. (2017). Trace organic compounds in rivers, streams, and wastewater in southeastern Alberta, Canada. *Inland Waters*, *7*(3), 283-296.

COURSE ASSISTANTSHIP

Course Assistant Oct. 2016 – Apr. 2017
Brescia University College at Western University, London, ON
Research Methodology (4411) and Statistics for Sociology (2205)

RESEARCH EXPERIENCE

Master's Thesis in Epidemiology and Biostatistics Sept. 2018 – Present
Western University, London, ON

- Examined baseline food and nutrition knowledge among high school students in London, Ontario using SmartAPPetite data, and studied predictors of food and nutrition knowledge
- Completed data collection at local high schools and facilitated focus groups

Master of Science in Foods and Nutrition Research Projects Sept. 2016 – Apr. 2018
Brescia University College at Western University, London, ON

- Original research: *Predictors of drug use during pregnancy: the relative effects of socioeconomic, demographic, and mental health risk factors*
- Review paper: *Is Breast Best? Examining the Effects of Alcohol and Cannabis Use during Lactation*

Student Researcher and Lab Technician Sept. 2009 – Aug. 2015
Hyperion Research Ltd., Medicine Hat, AB

- Lead student researcher on three-year long study researching the health of South Saskatchewan River's watershed to provide a framework for local policy on wastewater treatment and pharmaceutical monitoring
- Led team focused on developing a standard operating procedure for the genotyping of *Giardia* through polymerase chain reaction (PCR) method.

SPEAKING ENGAGEMENTS

Presenter, The Canadian Sociological Association Annual Conference June 2017
Ryerson University, Toronto, ON

- Oral presentation on my primary Masters research topic *Predictors of drug use during pregnancy: the relative effects of socioeconomic, demographic, and mental health risk factors*

Student Presenter, Talks on Fridays Student Development and Recognition Program Apr. 2017
Lawson Health Research Institute, London, ON

Guest Lecturer, Research Ready Seminar Series Feb. 2107
Brescia University College at Western University, London, ON

AWARDS AND HONOURS

Canadian Institutes of Health Research Canada Graduate Scholarship- M Sept. 2019 – Aug. 2020

Children's Health Research Institute Graduate Research Fellowship Sept. 2018 – Apr. 2019

NSERC Undergraduate Student Research Awards May 2014 & May 2015