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The Development and Evaluation of a Smartphone Nutrition Intervention for Adolescents

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Graduate Program in Geography
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Arts
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Abstract

A diet high in fruit and vegetables is associated with the prevention of many chronic diseases; however, only one in ten Canadian students in grades 6 to 12 consume the recommended daily intake of fruits and vegetables. Using smartphones to deliver nutrition interventions is an emerging area of research, although to-date these interventions typically limit their focus to weight loss. The overarching purpose of this research is to redevelop and evaluate an existing smartphone application for an adolescent population. This thesis used a mixed-methods approach to gain adolescent perspectives on how to redevelop the app and to evaluate its use as a nutrition intervention. Semi-structured focus groups were conducted to determine what content and functionality adolescents want in a nutrition smartphone app. A pilot intervention was conducted in a London, Ontario high school to evaluate recruitment and retention methods, performance of app features, suitability of study instruments, and overall feasibility. The pilot study provided methodological contributions and verified the feasibility of undertaking a full-scale intervention. Findings from a full-scale intervention with adolescents will determine if the app intervention is able to elicit a change in food literacy, food purchasing, and dietary behaviours.

Keywords

Smartphone, Adolescent, Food Literacy, Local Food, Nutrition, Intervention, Food Environments

Co-Authorship Statement

The following thesis included two manuscripts that will be submitted for publication in peer-reviewed journals.

Chapter 3 was written by Sarah Cappuccitti with Danielle Tobin and Jason Gilliland as co-authors. Sarah Cappuccitti created the focus group guide, conducted the focus groups, completed all data analysis, and is the primary author of the text. Cappuccitti had assistance from research associates from the Human Environments Analysis Laboratory when more than one focus group occurred at the same time. Dr. Danielle Tobin served as a second coder for analysis and Dr. Jason Gilliland is the primary investigator for the SmartAPPetite study and advised and approved all aspects of study design. Both Dr. Tobin and Dr. Gilliland provided guidance and were involved in developing the methodology and proofreading this chapter.

Chapter 3: Cappuccitti, S., Tobin, D., & Gilliland, J. Adolescent Perspectives on Nutrition Apps: Identifying Desired Content and Functionality.

Chapter 4 was written entirely by Sarah Cappuccitti with proofreading and edits from Danielle Tobin, Andrew Clark, Colleen O'Connor, Sean Doherty, Richard Sadler, Piotr Wilk, Sylvia Rinaldi, and Jason Gilliland. Cappuccitti was the principal author for this chapter and completed all data collection and data analysis. Dr. Gilliland is the primary investigator for the study and conceived the idea for the SmartAPPetite project and adolescent intervention. Each co-author is a member of the SmartAPPetite team and assisted in the development of the study design. Dr. Piotr Wilk was consulted and provided guidance for statistical analysis in this chapter. Additionally, Harrison Bannister assisted with the creation of the map in this chapter.

Chapter 4: Cappuccitti S, Tobin D, Clark A.F., O'Connor C, Doherty S, Sadler R, Wilk P, Rinaldi S, Gilliland J. The Development and Evaluation of an Adolescent Smartphone Nutrition Intervention: A Pilot Study.

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Chapter 1

1 Introduction

1.1 Research Context

Several critical health problems facing Canadians today, such as obesity, cardiovascular disease, numerous types of cancers, and type 2 diabetes, are often associated with an unhealthy diet (Flores Mateo, Granado-Font, Ferré-Grau, & Montaña-Carreras, 2015; O'Connor et al., 2015; Swinburn et al., 2011). With the rise in prevalence and earlier onset of many chronic diseases, there are major impacts on health care spending (Public Health Agency of Canada & Canadian Institute for Health Information, 2011; Roberts, Rao, Bennett, Loukine, & Jayaraman, 2015). It is estimated that obesity and diet-related diseases cost the Canadian health care system up-to \$7.1 billion annually (Public Health Agency of Canada & Canadian Institute for Health Information, 2011). Currently in Canada, 29% of youth aged 12-17 are overweight or obese, and this number continues to rise (Public Health Agency of Canada, 2012). Parallel to this rise in obesity, Canadians aged 12 or older have been consuming more calories daily and fewer fruits and vegetables (Statistics Canada, 2009). Although a diet high in fruit and vegetables is associated with the prevention of many chronic diseases, most Canadian adolescents are still not consuming adequate amounts of fruits and vegetables (Boeing et al., 2012). For example, previous research conducted in London, Ontario illustrated that only 38% of adolescents aged 11-14 were meeting the minimum recommended intake of fruits and vegetables a day (Gilliland, 2014). With the declining diet quality, rising levels of obesity, and increased costs on our health care system, the need for effective nutrition interventions is critical (Childhood Obesity Foundation, 2015; Public Health Agency of Canada, 2012; Statistics Canada, 2009). Implementation of multi-faceted strategies in childhood can help by focusing on prevention (Whittemore, Jeon, & Grey, 2013) rather than treatment of health problems in later life (Childhood Obesity Foundation, 2015).

Many traditional nutrition interventions succeed in increasing adolescent nutrition-related knowledge but fail to connect that knowledge to the skills and decision making required

to change behaviour (Vaitkeviciute, Ball, & Harris, 2015). Food literacy encompasses both the knowledge and understanding of nutrition and the capability to translate that information to healthy behaviours (Vaitkeviciute et al., 2015). Food literacy has been defined as “the ability of an individual to understand food in a way that they develop a positive relationship with it, including food skills and practices across the lifespan in order to navigate, engage, and participate within a complex food system” (Cullen, Hatch, Martin, Higgins, & Sheppard, 2015). Food literacy programs can provide adolescents with the awareness and nutrition knowledge to avoid the temptation of fast food marketing and supplement with healthier alternatives. These changes made through adolescence reflect food behaviours in adulthood (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004).

Adolescence is the unique stage of life between childhood and adulthood where individuals start to develop a level of autonomy and make more decisions on their own (Vaitkeviciute et al., 2015). There are many factors related to an adolescents’ environment and new found independence that often translate to increased intake of fast food (Bowman et al., 2004). This stage of life is associated with increasing levels of independent mobility (Loebach & Gilliland, 2016; Mitra, 2013), meaning parents often give their adolescents permission to travel to/from school and throughout their neighbourhoods without parental supervision. Furthermore, an adolescents’ food environment, particularly the area immediately surrounding their home and school, also has direct effects on their food purchasing habits (He, Tucker, Irwin, et al., 2012), particularly when a parent and guardian is not present (He, Tucker, Gilliland, et al., 2012). Coupled with this newfound independence, many people begin their first paid employment in adolescence, thereby acquiring some form of income for the first time, which also affects their food purchasing habits and ultimately their food intake (Vaitkeviciute et al., 2015). Many uni-dimensional nutrition interventions fail to connect knowledge to the skills required to equip adolescents to change their behaviour (Vaitkeviciute et al., 2015) and make the healthier choice when faced with a saturated food environment (Gittelsohn & Lee, 2013).

Today's adolescents are known to be a technologically savvy generation. In 2015, nearly three-quarters of all North American adolescents aged 13-17 had access to a smartphone in 2015 and this number continues to rise (Pew Research Centre, 2015; Poushter, 2016). Recognizing the large presence smartphones have in today's culture, many researchers and health professionals are using smartphones as a tool to educate large groups of people, and improve and monitor individual health (Hingle & Patrick, 2016). Smartphones are an advantageous medium for nutrition interventions based on their relatively low cost and minimal burden for the participants (Coughlin et al., 2015), and they are particularly effective at engaging the adolescent population (Dute, Bemelmans, & Breda, 2016). Although there have been many technological advancements in nutrition interventions, there still is a lack of peer-reviewed literature surrounding multi-dimensional smartphone food literacy interventions. Most of the literature available focuses on weight loss interventions with few aiming to improve food literacy and impact purchasing habits in adolescents.

This thesis aims to contribute to the growing body of knowledge evaluating the use of smartphones as a medium for health and nutrition interventions, particularly for an adolescent demographic. Using adolescent insights on content and functionality gleaned from the focus groups conducted for Study 1, Study 2 involved conducting a pilot intervention to determine what elements of the SmartAPPetite intervention need to be redeveloped before a full-scale study.

1.2 The SmartAPPetite Project

SmartAPPetite is a smartphone application (app) that was designed through a cross-sector collaboration between researchers and community stakeholders to address the rising rates of childhood obesity and to help revitalize the local food economy. Based out of Western University, the SmartAPPetite team has received community support from the Old East Village Business Improvement Area (OEVBIA), Western Fair Farmers' Market, the London Training Centre, and many others, including dietitians, public health professionals, and community groups. In 2013, the team ran a pilot test of the smartphone-based messaging concept in the Western Fair Farmers' Market in London,

Ontario with a sample of 208 adults. Findings from this pilot intervention identified that the app was successful at drawing awareness and intake of healthy foods and also drew people to healthy food vendors with greater frequency (Gilliland et al., 2015). In 2014, SmartAPPetite partnered with the London Training Centre and received 1-year funding from the Ministry of Training, Colleges and University to conduct field research to help support the development of technology that would help strengthen the struggling local food economy in Southwestern Ontario. Seven focus groups were run with farmers, retailers, and other food providers across six Southwestern Ontario counties to stimulate concepts on how technology could help shift more of Ontarian's consumption habits to include more healthier, local food. Using the information gathered from this background research, an alpha version of the SmartAPPetite app was created for Apple's iOS platform and publicly released through the Apple App Store. The alpha version of the app holds many of the design features to be included in the final version of the app; however, there are some limitations with technological glitches that will be resolved in a final version. With time and funding, the app will be redesigned to include more features and an Android version of the app will be created.

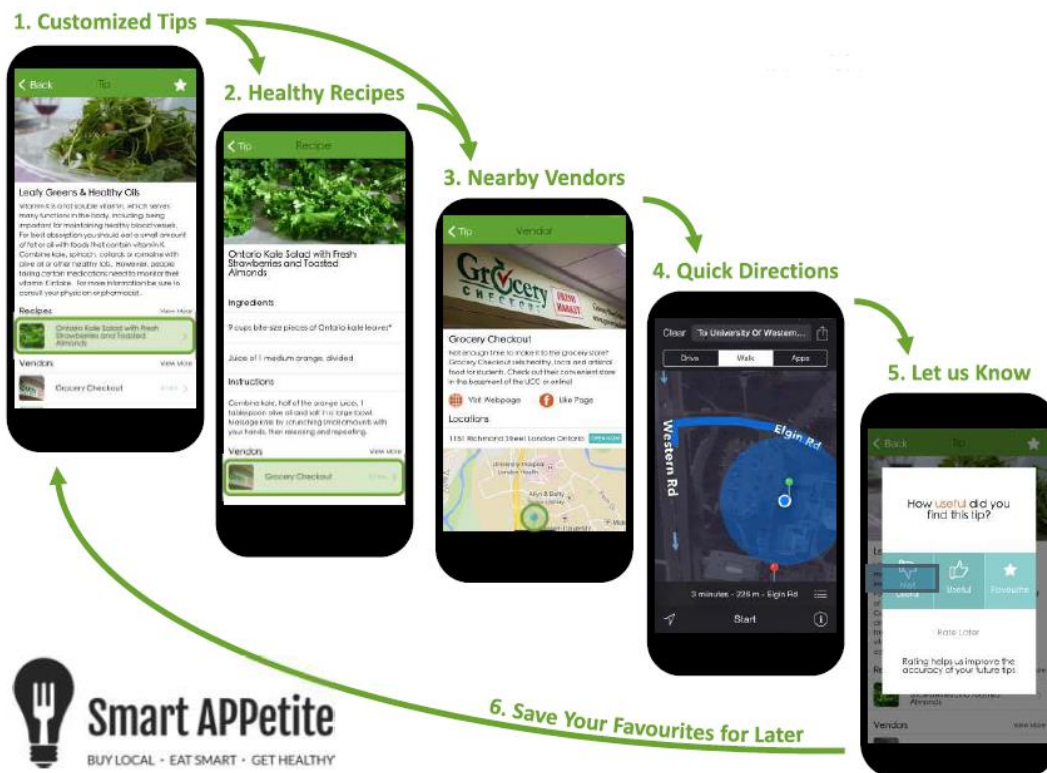


Figure 1.1 Example of a SmartAPPetite ‘message chain’

SmartAPPetite is a multi-dimensional intervention to help users make the healthier choice the easier choice. The SmartAPPetite app sends users personalized food tips (about nutrition, seasonal availability, healthy behaviours, food handling), as well as related recipes and vendors to inform and subsequently ‘nudge’ users from their personally-defined food goals to making healthier food choices and smarter purchases at pre-screened local vendors (*Figure 1.1*). Users who enable locational monitoring using their smartphones Global Positioning System (GPS) will receive messages that are paired with the three closest food vendors. Additionally, users who enable location monitoring will receive location-based messages when they enter in a ‘geofence’, a virtual zone that surrounds the participating food vendor (*Figure 1.2*). These features that compose SmartAPP collectively set this app apart from others food apps. Upon download and set up, users are provided with a short ‘profile survey’ to identify their sex, age, food preferences, goals, and dietary restrictions. Based on the information from the survey an algorithm determines which food tips are most suitable to the individual user. Food tips

are sent as a multi-dimensional ‘message chains’. Short tips are sent to the phone’s lock screen, which then prompt the user to open the app. When a new tip is selected, the longer version of the message is available in addition to three recipes matched to the message based on the algorithm, and the three closest local vendors that sell the featured item. Users are able to personalize message delivery to specific times that are most appropriate for them. All of the messages within the app are compiled from scientifically reliable sources, written by nutrition research assistants, and then approved by registered dietitians to ensure all information shared through the app is evidenced-based.



Figure 1.2 Day in the Life of SmartAPPetite User with ‘Geofences’ Enabled

Given the success of SmartAPPetite with the general population, the next step was to engage specific sub-populations. Within the literature of adolescent health, the need for nutrition interventions appear to be critical with the increase in obesity, increase in food purchasing, and decrease in fruit and vegetable intake. Based on the need for adolescent food literacy interventions it was determined that the next phase of SmartAPPetite, and a goal of this thesis, was to make the app more appropriate for adolescents.

1.3 Research Objectives and Questions

The **purpose** of this thesis is to determine how to make the SmartAPPetite intervention most applicable and effective for adolescents by using insights from focus groups and a pilot study intervention with adolescents in London, Ontario. The overarching **aim** of this research is to contribute to the growing body of knowledge evaluating the use of smartphones as a medium for health and nutrition interventions, particularly in this demographic. The primary research question addressed in this thesis is **“how can a smartphone nutrition intervention help to improve adolescents’ food literacy, food purchasing habits, and ultimately their food behaviours?”** Subsequent research questions and objectives were developed to help answer the overarching research question:

- (1) What is the desired content and functionality to include when developing a nutrition app for adolescents?
 - a. To determine what content can help engage adolescents and what features they want from a nutrition app.
 - b. To determine what types of messaging are relevant, interesting, and useful to adolescents.
- (2) What elements of the SmartAPPetite intervention need to be redeveloped before undertaking a full-scale intervention study?
 - a. To evaluate the effectiveness of recruitment and retention procedures, performance of app features, suitability of the study instruments, and the overall feasibility of undertaking the intervention to improve upon the study design prior to undertaking a full-scale intervention study.

- b. To examine potential differences in food literacy, food purchasing habits, and food behaviours pre- and post-intervention.

By answering these questions, we will gain the knowledge required to be able to write nutrition messaging specific to adolescents and redevelop the current SmartAPPetite app to resonate with an adolescent population. The information gathered from this research will help the research team to run a full-scale study to test the effectiveness of using the SmartAPPetite app as an intervention with adolescents in Southwestern Ontario. The learnings gathered from this thesis can also help to guide other health professionals and researchers when creating health promotion messaging and app-based interventions for adolescents.

1.4 Theoretical Framework

The field of behavioural economics, derived from conventional economic theory, has recently come into prominence in many policy discussions (Rice, Hanoch, & Barnes, 2017; Thorgeirsson & Kawachi, 2013). Behavioural economics draws from psychology, neuroscience, sociology, and institutional economics to help explain a variety of health related behaviours (McDonald, 2008; Rice et al., 2017). Traditionally in the economic model, individuals are considered to be rational beings, the perfectly informed *homo economicus*, who make decisions that are in their own best interest (Arno & Thomas, 2016; Bragg & Elbel, 2017; Gittelsohn & Lee, 2013; Thaler & Sunstein, 2003; Thorgeirsson & Kawachi, 2013). Within behavioural economics, the theory of bounded rationality explains our decision making is more complicated than that because of our limited processing capabilities, lack of time, and complex environments (Rice et al., 2017; Thorgeirsson & Kawachi, 2013). Simon proposed that instead humans rely on heuristics or rules of thumb to help make decisions and often individuals are fine with making satisfactory decisions that are ‘good enough’ (Rice et al., 2017; Simon, 1955; Thorgeirsson & Kawachi, 2013). Unfortunately, these satisfactory decisions often result in unhealthy behaviours (Thorgeirsson & Kawachi, 2013).

To date, traditional health interventions have been focused on education, although, it has been well established that education does not always translate into the desired behaviour

(Downs, Loewenstein, & Wisdom, 2009; Gittelsohn & Lee, 2013; Roberto & Kawachi, 2014; Thorgeirsson & Kawachi, 2013). Behavioural economics accepts that human behaviour is complicated and that decision making is not always based on the perceived long-term value of a current behaviour (Gittelsohn & Lee, 2013). Often people make decisions based on the *status quo* (people stick to the norm or what they know) or present bias (place more value on immediate gratification than events that happen in the future) (Rice et al., 2017; Roberto & Kawachi, 2014). For example, most individuals choose the default side order of French fries with their meal over asking for a salad at a restaurant, even though they know that the salad will be better for their health in the long term (Thorgeirsson & Kawachi, 2013).

The environment around us is composed of structural elements, financial constraints, policies, and cultural norms among other factors that all directly influence our dietary behaviours and other health-related behaviours, such as physical activity levels (Bragg & Elbel, 2017). Food and beverage companies have shaped our current food environment based on the large portion sizes that have become the norm, high calorie default side options, and the convenient placement and cost of energy-dense nutrition-poor (EDNP) foods (Bragg & Elbel, 2017). It is not practicable to change the current environment, but we can create interventions to help consumers better navigate the food environment and help them make healthier choices (Khan, 2011). Within behavioural economics and the theory of bounded rationality, there are many tools to help improve healthy decision making some of which include ‘nudging’ (e.g., choice architecture and defaults), commitments, and anchoring (*Table 1.1*) (Bragg & Elbel, 2017; Rice et al., 2017; Thorgeirsson & Kawachi, 2013). In order to persuade individuals to make the healthier choice, it is suggested to develop environments that ‘nudge’ them to freely make the choice that is better in the long run rather than restricting select behaviours (Roberto & Kawachi, 2014). The idea of nudging was coined by Thaler and Sunstein (2008) as a form of libertarian paternalism that will make it easier for an individual to choose the healthier behaviour - the behaviour they would choose if they were thinking rationally about the outcome (Thaler & Sunstein, 2003, 2008). Nudge theory is successful based on its use of defaults, which requires little to no effort from the user (Khan, 2011).

Unable to change the physical construct of the environment, SmartAPPetite was developed to be able to ‘nudge’ users with information about where the healthier choices are located and how to access them. This gentle reminder helps the user to easily make the healthier choice without being persuaded by marketing and incentives. SmartAPPetite provides a mixed educational-environmental-behavioural economic approach by providing multi-dimensional ‘message chains’ of a healthy food tip paired with recipes and local food vendors to help nudge the education into action. Furthermore, as a participant comes within a specified ‘geofence’ (virtual zone encompassing the vendor) for a local vendor, they are nudged with the information using a pop-up on their home screen. SmartAPPetite also uses anchoring as a tool in messages to help bring awareness of growing portion sizes and by reminding users how appropriate portion should look. In the future, SmartAPPetite could incorporate other behavioural economic tools such as commitments through social sharing to encourage participants to engage in healthier behaviours.

Table 1.1 Behaviours Economics Tools to Help Improve Dietary Behaviours

Term	Explanation	Example
Nudging	Concept derived from libertarian paternalism (Bragg & Elbel, 2017; Gittelsohn & Lee, 2013). Nudges are used to push individuals towards a specific behaviour while keeping choices unrestricted (Bragg & Elbel, 2017; Gittelsohn & Lee, 2013; Khan, 2011; Thaler & Sunstein, 2008). Nudging allows policymakers to guide individuals to freely choose the option that will be better for them in the long-term (Roberto & Kawachi, 2014).	Choice architecture and defaults are examples of nudging.
Choice Architecture	To determine on behalf of others what good decision making looks like, reduce the volume of information, and presents one’s options in a way to subtly guide decisions in ‘better’ direction (Arno & Thomas, 2016; Johnson et al., 2012; Rice et al., 2017; Thaler & Sunstein, 2008). Takes into account bounded rationality	Grocery store owner who places specific foods on the end of aisles (i.e. ‘endcaps’) so that more people see the item and more people purchase that item.

	and an individual's cognitive biases to acknowledge that what is chosen is often based on the way a chose is presented (Johnson et al., 2012; Rice et al., 2017; Thaler & Sunstein, 2008).	
Defaults	An example of choice architecture that takes advantage of our status quo bias and inertia to stick to decisions we already know we like (Rice et al., 2017). A default is an option that is assigned to a person who does not make an active choice (Rice et al., 2017). A default is a form of a nudge (Rice et al., 2017).	Default fries with fast food meal combo. To receive a side salad you specifically need to ask for one
Commitments	Acknowledges that some people are not motivated by money or other incentives, however, many individuals are concerned about impacting their reputation (Rice et al., 2017). This concept asks individuals to publically precommit to a specific behaviour and finds success in changing behaviours by putting one's reputation at stake (Rice et al., 2017; Thorgeirsson & Kawachi, 2013)	Website called stickk.com requires individuals enter a goal, their credit card number, a charity they support, and a charity they would not want to support. Each person needs to identify a sponsor who will hold him or her accountable to the behaviour. If it is determined the person did not meet their goal, their preselected donation will not go to their desired charity, but rather a charity they do not wish to support (e.g. National Rifle Association) (Rice et al., 2017).
Anchoring	Tendency to base decisions based on initial format provided (Roberto & Kawachi, 2014).	People base their consumption on package size. People tend to eat more from a larger plate or a larger bag of chips.

This conceptual approach to behaviour change is complemented by the social-ecological theory of health promotion. Originally created by Bronfenbrenner in the 1970s, social-ecological model emphasizes that there are multiple levels of influences on an individual's health-related behaviours (Bronfenbrenner, 1979, 1992; Story, Kaphingst, Robinson-O'brien, & Glanz, 2008). The methodology used for the SmartAPPetite

project considers how healthy eating is influenced by many factors across the three inner domains as seen in Figure 1.3. First, at the personal level, there are individual factors that affect a person's health behaviours such as biology, attitudes, knowledge, values, skills, behaviours, lifestyle, and demographics (Story et al., 2008). SmartAPPetite helps to build behavioural capacity as it provides users with the knowledge to boost their food behaviours and the opportunity to develop their skills with recipes. Furthermore, it addresses biology by pairing users with messages based on their age and sex. With time, the participants would develop a deeper knowledge about nutrition, which could change their attitudes and the 'nudge' delivered from the recipes and vendors could help change behaviour.

At the network level, an individual's social environment, such as their friends, peers, family, and neighbours, influences their ability to make healthy behaviours (Story et al., 2008). This social environment can have an even stronger influence on adolescents, which is one of the reasons SmartAPPetite was adapted specifically for this population. SmartAPPetite can help address social norms if an individual's family and friends also use the app to learn and change their behaviours together. Individuals are more likely to change their behaviour if they have social support from their peers or a role model, for example a parent or guardian, who demonstrates and encourages that same behaviour.

The third tier that affects an individual's ability to make healthy behaviours is their settings or their physical environment (Story et al., 2008). Even if an individual has committed to a behaviour change internally and has social support, they still encounter factors (barriers and enablers) posed by the physical environment in which they live. For example, changing attitudes and knowledge might not be enough to change behaviours for individuals living in a food desert with limited accessibility to fresh and affordable produce. Interventions at this level need to take into consideration opportunities, availability, accessibility, and barriers to be successful (Story et al., 2008). SmartAPPetite links users to healthy local vendors in their neighbouring food environment where they can visit to purchase healthy foods. The benefit from this interaction is two-fold as it

helps the individual to access more healthy foods and it helps the local business and supports the local food economy.

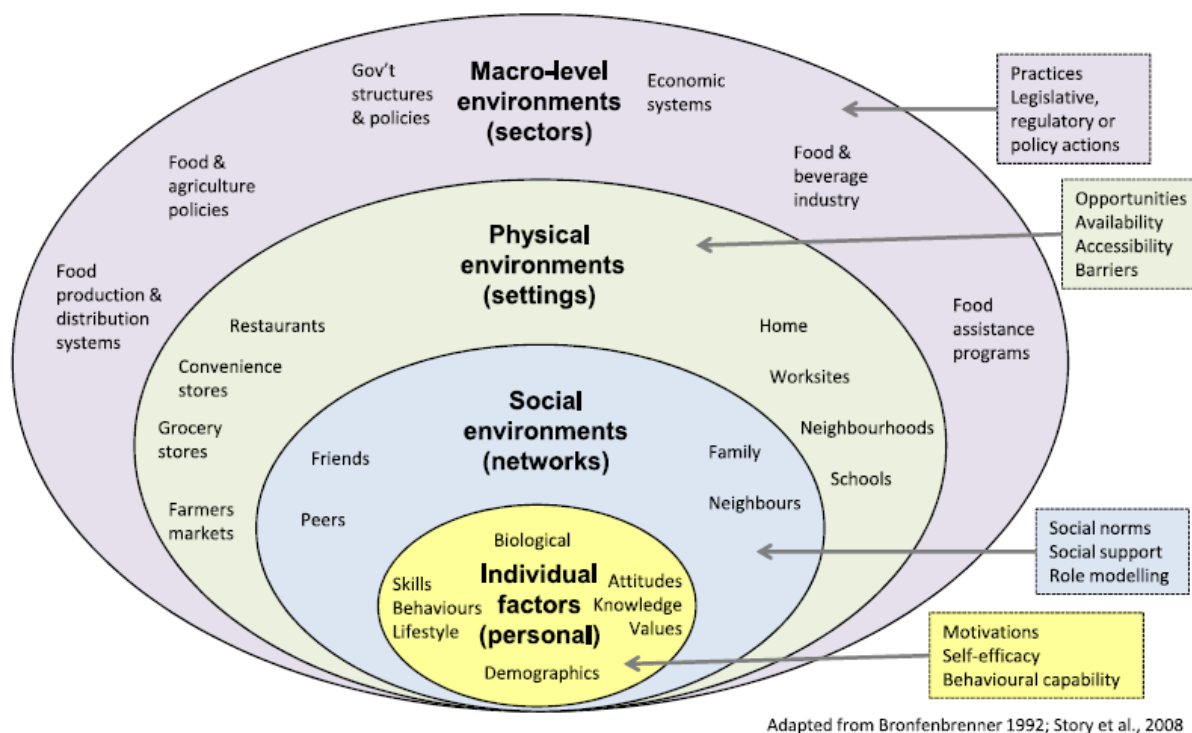


Figure 1.3 Social-Ecological Model Adapted for Healthy Eating

1.5 Thesis Format

This thesis was written in integrated article format and will address the results from two separate but related studies that help to redevelop and evaluate the SmartAPPetite app to be more appropriate for an adolescent population. The two studies are independent of one another; however, they are complementary, as their findings collectively will be used to advance the SmartAPPetite project. Each study uses different methodologies to be able to provide both a qualitative and quantitative assessment of developing a smartphone app for adolescents. Additionally, each study used a different sample of adolescents from London, Ontario.

The thesis is organized into five chapters, with this introduction representing Chapter 1.

Chapter 2 reviews the existing literature available on smartphone nutrition interventions for the adolescent population. The literature review further discusses food literacy interventions and the development of messaging specifically for adolescents. This literature review identifies gaps in the literature and justifies the need for further research in the area.

Chapter 3 examines adolescent perspectives on the content and functionality to be included in a nutrition smartphone application. This study used semi-structured focus groups and short surveys to determine what topics of nutrition and healthy living adolescents want to learn about and what features in a smartphone app would benefit this demographic. The information from the paper can help guide health professionals and researchers how to write health and nutrition messaging for adolescents and provide insight into the desirability of providing education to adolescents through smartphone apps.

Chapter 4 reports on the development and pilot evaluation of a food literacy intervention for adolescents utilizing a full-featured smartphone app that addresses key gaps in the literature. This study was conducted to evaluate the overall feasibility of running a full-scale study by assessing the recruitment and retention procedures, performance of app features, and appropriateness of the study instruments. This intervention required participants to use the app for eight weeks and complete a survey before and after to determine any differences in food literacy, food purchasing, and overall food behaviours. Lessons learned from the pilot study suggested ways to improve the overall intervention prior to a full-scale study.

Chapter 5 synthesizes the findings from each of the studies and connects the results to draw a cohesive conclusion. This chapter identifies limitations in the current research, suggests future areas of study, and provides recommendations for policy and practice.

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Chapter 2

2 Literature Review

2.1 Overarching Problem

In the past decade, there has been a steady rise in obesity rates among children and adolescents (Burrows et al., 2015; Burrows, Martin, & Collins, 2010; He et al., 2012). In 2012, 29% of all Canadian youth aged 12 to 17 were overweight or obese and this number continues to rise (Public Health Agency of Canada, 2012). Along with physical inactivity, this rise in obesity can be partly attributed to the transition in North American diets that include increased calories and energy-dense nutrition-poor foods (EDNP) (Gilbert, Miller, Olson, & St-Pierre, 2012; Pujadas Botey, Bayrampour, Carson, Vinturache, & Tough, 2016). Although a diet high in fruit and vegetables is associated with prevention of many chronic diseases (Boeing et al., 2012), only one in ten Canadian students from grade 6 to 12 consume the recommended intake for fruits and vegetables (Minaker & Hammond, 2016). Adolescence is a pivotal time for interventions as at this stage individuals develop an increased autonomy (Brooks & Begley, 2014; Vaitkeviciute, Ball, & Harris, 2015), mobility (Loebach & Gilliland, 2016; Mitra, 2013), and experience increased influence from peers and social norms (Salvy, de la Haye, Bowker, & Hermans, 2012). These factors among others often translate into unhealthy behaviours (Brooks & Begley, 2014; He et al., 2012; Salvy et al., 2012). Eating behaviours developed during adolescence continue into adulthood and have significant impact on health as an adult (Brooks & Begley, 2014). It is critical to initiate interventions during adolescence to promote healthy dietary behaviours from the start (Pelletier, Graham, & Laska, 2014).

The purpose of this chapter is to examine the literature on the importance of food literacy as a point of intervention and the value of using smartphones as a tool to engage adolescents. This chapter reviews the current body of knowledge related to nutrition smartphone interventions, determines gaps in the literature, and validates the need for further research in the area. Reviewing previous food literacy and nutrition interventions

for adolescents can help determine successful aspects in tested methodologies and areas for improvement.

The chapter is divided into five overarching sections. Section 2.1 explains the concept of food literacy, reviews previous food literacy interventions, and identifies gaps within those studies. Section 2.2 examines dietary behaviours of adolescents and justifies the need for interventions within the stage of life. Section 2.3 investigates the current literature available on writing nutrition and lifestyle messaging for adolescents. Section 2.4 reviews nutrition interventions that have been conducted using smartphones or mobile phones to determine areas of success and areas for improvement. Finally, Section 2.5 concludes by reviewing the gaps in the literature that this thesis aims to fill.

2.2 Food Literacy

Over 60% of the foods Canadians purchase are considered “ultra-processed”, meaning they exceed the recommended upper limit for fat, saturated fat, sugar, and sodium and fall short of the fibre recommendation set by World Health Organization (Cullen, Hatch, Martin, Higgins, & Sheppard, 2015). With this rise of processed and prepared foods, there has been observed transition in our diet and many researchers speculate has provoked a general decline in food skills (Government of Canada, 2010; Howard & Brichta, 2013). However, Health Canada confirmed there is not enough evidence to determine if household “deskilling” is actually occurring (Howard & Brichta, 2013). In a 2014 study done in Waterloo, Ontario, Canada, only half of participants reported cooking five or more meals in the past week that were “at least partly from scratch”, which is shocking as most adults consume about 21 meals a week (Region of Waterloo Public Health, 2015). Regardless of the discrepancy in evidence, we know these changes in our diets contribute to the rise in obesity in North America and earlier onset of some chronic diseases (Cullen et al., 2015). This calls for a nationwide change in eating behaviour and stresses the need to educate Canadians to develop food skills and improve their overall food literacy (Cullen et al., 2015).

It is well acknowledged that an individual's knowledge and perceptions of nutrition affects their food choices (Howard & Brichta, 2013). For over twenty years, Canadian researchers have been running the Tracking Nutrition Trends (TNT) survey to gain insight into self-reported knowledge, attitudes, and behaviours of Canadian adults. Based on this survey, it appears Canadians are very confident about their nutrition knowledge. However, their scores for knowledge did not always reflect that confidence (Howard & Brichta, 2013). For instance, results from the TNT showed that Canadians seem to understand the importance of a balanced diet but very few were able to explain what that would look like (Howard & Brichta, 2013). Furthermore, only 9% of Canadians responded to the same survey that they were extremely confident reading food labels, which indicates room for further education (Howard & Brichta, 2013).

Food literacy is a productive point of intervention because it encompasses both the knowledge and understanding of nutrition and the ability to translate that information into healthy dietary behaviours (Vaitkeviciute et al., 2015). Food literacy is a fairly new term and has been defined as “the ability of an individual to understand food in a way that they develop a positive relationship with it, including food skills and practices across the lifespan in order to navigate, engage, and participate within a complex food system” (Cullen et al., 2015). Food literacy programs with adolescents can provide essential information to help youth know how to avoid the temptation of marketing of fast food and supplement with healthier alternatives. These changes made through adolescence can help shape their food behaviours in adulthood (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004).

To further explain the interaction between food literacy and nutrition, Australian researchers conducted a study with food experts and another with youth to gain insight on this relationship (Vidgen, 2016; Vidgen & Gallegos, 2014). The information from the two studies was collated to create a model (*Figure 2.1*) that illustrates the multifaceted relationship between food literacy and nutrition (Vidgen, 2016; Vidgen & Gallegos, 2014). In these studies, food literacy was described as the ability to manage, select, prepare, and eat food (Vidgen, 2016; Vidgen & Gallegos, 2014). The participants

believed being food literate improved diet quality through the mechanisms of certainty, choice, and pleasure (Vidgen, 2016). Each individual's diet is also subject to their personal context such as the food supply available to them and their own early childhood experiences with food, which can be seen in the second layer (Vidgen, 2016). The outer layer portrays the social determinants of health that further influence an individual's food literacy and diet quality such as an individual's geography and social support (Vidgen, 2016). Overall, this model helps to illustrate the complex relationship between nutrition and food literacy and can be used to build successful food literacy interventions.

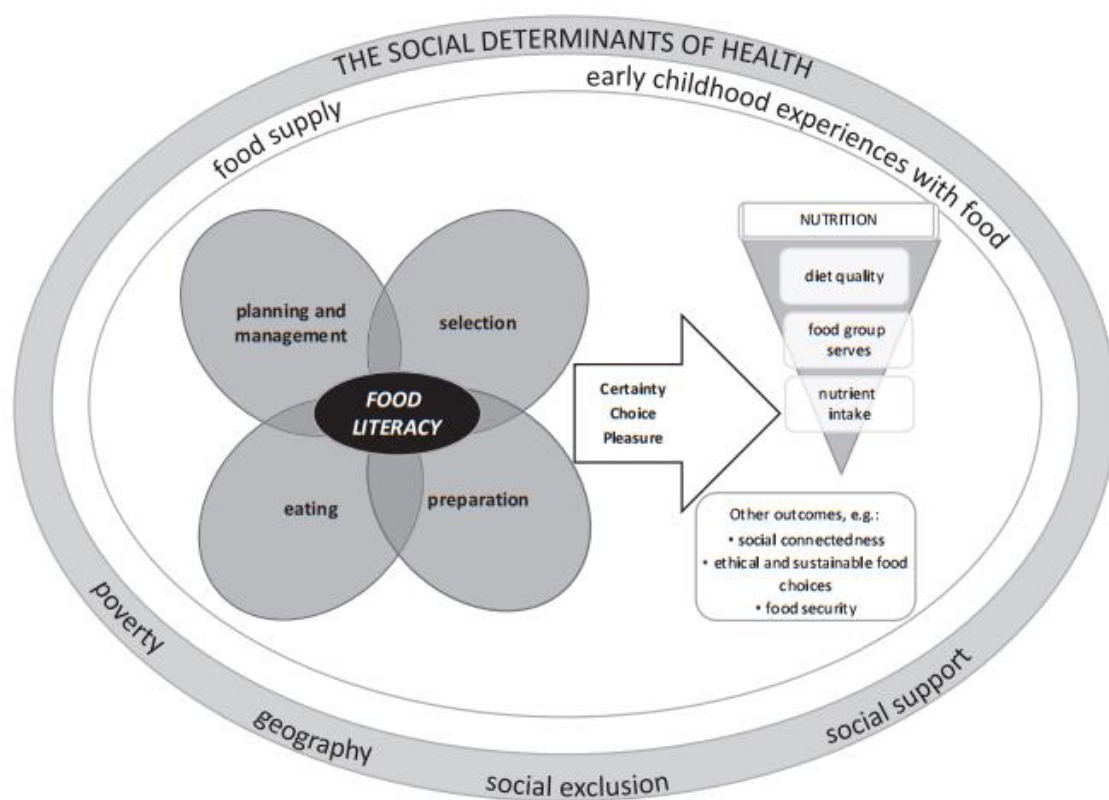


Figure 2.1 Model describing the relationship between food literacy and nutrition

In 2013, Brooks and Begley conducted a systematic review of food literacy programs for adolescents aged 13-17 (Brooks & Begley, 2014). From the review, they noted many gaps in the literature, such as a lack of innovative interventions; most interventions involved traditional teaching methods and were in the school setting (Brooks & Begley,

2014). It was reported that there was also a lack of interventions targeted towards older adolescents, culturally diverse groups, and gender-specific interventions (Brooks & Begley, 2014). Overall, the results from this systematic review show that the ability for food literacy interventions to provoke a behaviour change needs to be further examined (Brooks & Begley, 2014). Many of the studies focused on the ability to improve self-efficacy and food-related knowledge among other positive psychosocial constructs related to food preparation (Brooks & Begley, 2014). Additionally, the majority of studies used interventions and programs that were not rooted in a theoretical model; however, the authors noted most of the theory based interventions were more effective at eliciting a change in dietary behaviour (Brooks & Begley, 2014). Specifically, interventions grounded in behavioural theories such as the social cognitive theory, theory of planned behaviour, and the trans-theoretical model have all been successful when used in program development because they focus on specific desired behaviour change (Vidgen, 2016). Finally, the authors of the review noted the difficulty in designing and implementing food literacy interventions that are able to increase motivation, target determinants of dietary behaviours, and decrease barriers to healthy eating at a group level (Brooks & Begley, 2014).

Since the systematic review conducted in 2013, there have been more food literacy interventions undertaken with adolescents, although most are cross-sectional studies that are not of high rigour (Ming & Chung, 2017; Ronto, Ball, Pendergast, & Harris, 2016; Vaitkeviciute et al., 2015). Many interventions and reviews address the need to develop a validated tool to measure adolescent food literacy that can be used for future research in this field (Brooks & Begley, 2014; Ming & Chung, 2017; Vaitkeviciute et al., 2015). Overall, based on the limited studies available in this emerging area of research, more rigorous research is needed to determine the extent of the relationship between adolescent food literacy and diet quality (Brooks & Begley, 2014; Vaitkeviciute et al., 2015).

2.3 Adolescence

Adolescence is a unique period of life marked with rapid physical and psychological development (Demory-Luce et al., 2004). Along with this development comes an increased autonomy and progressively more independent decision making, particularly related to their dietary intake (Vaitkeviciute et al., 2015). Generally, adolescence is associated with increasing levels of independent mobility (Loebach & Gilliland, 2016; Mitra, 2013), meaning children are being afforded more freedom of movement to travel to/from school and move about their neighbourhoods without parental supervision. This new sense of independence allows adolescents the opportunity to make their own food choices and provides easy access to many unhealthy dietary choices (Askari Majabadi et al., 2016; Bowman et al., 2004). During adolescence, many individuals also start their first job and experience having a disposable income for the first time, which often translates to an increase in fast food intake (Vaitkeviciute et al., 2015). Furthermore, proximity and density of fast food outlets permits increased purchasing among adolescents when a parent or guardian is not present (He et al., 2012). Specifically, the location of fast food vendors or convenience stores within a one kilometre radius of an adolescents' home or school increased the likelihood of adolescents purchasing from these vendors at least once per week (He et al., 2012). This relationship was amplified especially when children walked to and from school compared to being transported by school bus (Sadler, Clark, Wilk, O'Connor, & Gilliland, 2016).

An adolescent's eating behaviours are impacted by their parents, peers, social norms, and their environment (Salvy et al., 2012). The strongest influence on adolescents eating behaviours is often from their parents and guardians (Brooks & Begley, 2014; Lau, Quadrel, & Hartman, 1990; Salvy et al., 2012). Although adolescence is associated with increased independence, the literature has placed a strong emphasis of the importance of the family meal during this time for emotional and social development (Brooks & Begley, 2014). Secondary to parental influence, adolescents are particularly influenced by their peers' food choices and physical activity levels (Contento, Williams, Michela, & Franklin, 2006; Salvy et al., 2012). At this stage in life, many individuals develop a greater reliance on their friendships and start to spend more time with their peers (Lam,

McHale, & Crouter, 2014). It was noted that the direction of this influence from their peers is dependent on many factors and can change in different settings (Salvy et al., 2012).

In adolescence, individuals experience an increased independence (Brooks & Begley, 2014; Vaitkeviciute et al., 2015), mobility (Loebach & Gilliland, 2016; Mitra, 2013), and peer influence (Salvy et al., 2012), which often translates into unhealthy behaviours (Brooks & Begley, 2014; He et al., 2012; Salvy et al., 2012). These factors among others contribute to the known inverse relationship between diet quality and age during adolescence (Brooks & Begley, 2014; Demory-Luce et al., 2004); however, most of the food literacy interventions are focused on early adolescence (Brooks & Begley, 2014). Diets during adolescence can be generally characterized by low consumption of fruit and vegetables, increased sugar-sweetened beverage intake, frequent snacking, increased fast food intake, and meal skipping (Pelletier et al., 2014; Vaitkeviciute et al., 2015). Focusing on eating behaviours during adolescence is critical to help shape healthy behaviours at a young age that will continue through adulthood (Brooks & Begley, 2014). An individual's diet quality through childhood can have long-term impacts on adult health, primarily in regards to the incidence of obesity, which is also related to type 2 diabetes and cardiovascular disease (Brooks & Begley, 2014). Providing interventions tailored at this stage of life are needed to promote healthy dietary behaviours (Pelletier et al., 2014).

2.4 Message Writing

Researchers synthesize the scientific evidence available to create dietary guidelines for the use of policymakers and health professionals (Pollard et al., 2016). Often public health interventions focus on promoting healthy diets by encouraging individuals to boost intake of fruits and vegetables, decrease intake of EDNP foods, and decrease intake of sugar-sweetened beverages (Pollard et al., 2016). The challenge lies in taking the sometimes complex nutrition recommendations and transforming them into simple messaging that is meaningful to the public (Pollard et al., 2016). Adolescents are a specifically hard to reach demographic using conventional health promotion techniques

because they do not see messaging as particularly relevant and these methods are not as effective at engaging this group (Pollard et al., 2016). Faced with this challenge, researchers have begun to study ways to write appropriate messaging for adolescents and have made recommendations to effectively achieve this goal.

2.4.1 Type

Successful nutrition education interventions require messages that are interesting, relevant, and useful to adolescents, which can be a challenge to develop. Some of the articles in this review discussed their process and guidelines for creating appropriate messages for adolescents. The article “Texting for Health” by Hingle et al. (2013) conducted a three-phase process to determine how to appropriately develop messages for adolescents. Their findings, similar to that of other researchers, suggested that adolescents prefer short and simple messages that were to the point (Hingle, Nichter, Medeiros, & Grace, 2013). Messages in the format of ‘factoids’ and quizzes also had great success at attracting attention (Hingle et al., 2013). Providing facts that are specific to adolescent demographic was shown to have more of an impact rather than general statistics (Hingle et al., 2013). Surprisingly, it was mentioned specific messages stating what other teens were doing had the ability to elicit feelings of guilt and was not motivating for some (Smith, Kerr, Fenner, & Straker, 2014). Another common theme that arose was that messages should be ‘action-oriented’ and prompt the individual to engage in a behaviour (Hingle et al., 2013; Turner, Spruijt-Metz, Wen, & Hingle, 2015). For example, if a message discussed that most teens do not eat enough fruits and vegetables it would be beneficial to include easy suggestions to be able to incorporate more vegetables in your diet or a recipe. Many participants mentioned they would like the message to link to simple and practical recipes that they could easily make in their own home (Hingle et al., 2013).

2.4.2 Voice & Tone

Writing messages for adolescents can be especially challenging to be able to convey in a voice that is both informative but not authoritative (Hingle et al., 2013). The use of an authoritative voice can have a negative effect and can cause adolescents to disregard the recommendation entirely (Smith et al., 2014; Woolford et al., 2011). Messages should

focus on giving the individual the choice rather than telling them they should engage in a specific behaviour more often (Smith et al., 2014). In order to avoid this ‘preachy’ tone in messaging do not use words such as ‘always’ or ‘never’, rather try to substitute those with ‘try’ or ‘consider’ (Hingle et al., 2013). Contrary to what other studies had mentioned, a study evaluating nutrition messages with adolescents who are overweight or obese reported that the participants preferred messages that were directive and would tell them what to do so they would not have to think themselves about what behaviours would be more conducive to weight loss (Woolford et al., 2011). This is an interesting perspective and might indicate that writing for adolescents in general may be different than writing for specific groups such as individuals who are overweight or obese (Smith et al., 2014; Woolford et al., 2011).

Across the literature, there was a general consensus that it is important to have messages that are ‘gain-focused’ and positive to promote the benefits of engaging in that behaviour rather than a focus on ‘loss-frame’ messages and prevention (Hingle et al., 2013; Kerr et al., 2012; Smith et al., 2014; Woolford, Clark, Strecher, & Resnicow, 2010). Similarly, there was a lot of discussion about if there should be any mention of unhealthy behaviours (Smith et al., 2014; Woolford et al., 2011). Adolescents from two different focus groups reported that any mention of engaging in an unhealthy behaviour resulted in them wanting to engage in that specific behaviour, even though the message suggest otherwise (Smith et al., 2014; Woolford et al., 2011). For example, participants from Curtin University’s Activity, Food and Attitudes Program (CAFAP) said that messages that said “don’t eat junk food” made them more likely to eat those foods which supports findings from other studies (Smith et al., 2014; Woolford et al., 2011). It was also mentioned that starting a message with “did you know” automatically made adolescents less interested in reading the remainder of that message (Hingle et al., 2013). Furthermore, the participants in the MPOWER study stated that they thought emoticons should be used to convey enthusiasm, but they also thought that it would be inappropriate to use colloquial abbreviations often used by adolescents, such as LOL and OMG (Woolford et al., 2011).

After consulting with adolescents, researchers suggested making messages less formal to make it appear as if it was not sent from an adult (Smith et al., 2014). Participants from those focus groups mentioned the use of personal pronouns helped make messages more ‘human’ and as if they writers are speaking directly to the reader (Smith et al., 2014). Results from CAFAP showed that there was an increased acceptability of messages if they used of pronouns such as “you” (Smith et al., 2014). Likewise, Kerr et al. (2012 & 2016) found success with message acceptability by selecting which messages were sent to their participants based on age, sex, BMI, dietary intake, and other behavioural characteristics of the individuals.

2.4.3 Time & Frequency

Within the literature, everyone had different ideas as to what time to send messages and how many messages to send per day or per week. Hingle et al. (2013) suggested sending a maximum of two messages per day. However, participants in the CAFAP program received only three messages a week and commented that messages were sent far too frequently (Smith et al., 2014). Those participants said that the excessive volume of messages made the content less effective and they suggested sending no more than one message a week (Smith et al., 2014). Furthermore, it has been suggested that for adolescents that are overweight or obese the acceptable frequency of messages might also be different because the personalized messages about engaging in healthy behaviours sent directly to their phones might invoke negative or guilty feeling (Smith et al., 2014). Further research is required to decipher if these health messages reduce their motivation or inspire them to engage in healthier behaviours and at what frequency would be most appropriate (Smith et al., 2014; Woolford et al., 2010). As for the timing of messages most adolescents differed based on personal preferences and schedules (Smith et al., 2014). Overall, in the literature there was no consensus as to how many messages to send per week and at what time to send the message, which is an area that might need to be further explored (Hingle et al., 2013; Kerr et al., 2012; Smith et al., 2014).

2.4.4 Topics

Most of the literature surrounding writing health messages for adolescents was focused on voice and tone, although some adolescents specific topics to were addressed. Overall,

adolescents mentioned wanting to learn about making healthy choices at restaurants or convenience stores, information on vegetarian eating, physical activity messaging, and other random fun facts such as “ears of corn have even numbers of rows” (Hingle et al., 2013). Other topics differed based on gender; for example, boys were interested in learning what to eat to help build muscle and girls wanted to know what to eat to boost skin and nail growth (Hingle et al., 2013).

In summary, the literature outlines some successful strategies for developing adolescent nutrition messages particularly regarding type, tone, voice, time, frequency, and topics. Further research is still required regarding content and functionality from nutrition smartphones applications (apps). Both Keating et al. (2015) and Smith et al. (2014) discussed that it appears adolescents are unsure of what they want from messages suggesting more testing and focus groups should be conducted with adolescents.

2.5 Smartphone Nutrition Interventions

Acknowledging the role that smartphones play in today’s culture and their current use for health, many researchers have developed health interventions utilizing cell phones to help improve individual health (Hingle & Patrick, 2016). Smartphones have proven to be an ideal medium for health interventions based on their relatively low cost and minimal burden on the participant (Coughlin et al., 2015). Furthermore, they can be particularly useful in reaching adolescents who frequently engage with smartphones (Dute, Bemelmans, & Breda, 2016). As of 2015, 73% of North American adolescents aged 13 to 17 had access to a smartphone, and this number continues to climb (Pew Research Centre, 2015; Poushter, 2016). With the rising rates of adolescent obesity (Statistics Canada, 2016) and this demographics’ increasing interest in technology, smartphones seem a particularly convenient and effective way to communicate information on healthy living (Dute et al., 2016).

This section reviews the literature available to provide an understanding of the role that personal technologies such as cell phones, smartphones, and tablets play in being able to provide nutrition interventions. As of 2013, there were 97,000 mHealth (mobile health)

applications available on app stores with the majority focused on general health and fitness (Research2Guidance, 2013). The biggest barrier to this grossly expanding market is that many mHealth apps and interventions are missing regulations and evaluations (Research2Guidance, 2013). Through the literature, there is a rise in evaluations of health interventions that use smartphones as an education tool. To date, researchers have evaluated the use of smartphones to be able to educate individuals in the areas of dental health, sexual health, physical activity, smoking cessation, and diabetes management (Flores Mateo, Granado-Font, Ferré-Grau, & Montaña-Carreras, 2015; Jones, Eathington, Baldwin, & Sipsma, 2014; Khaton, Hill, & Walmsley, 2015; Mason et al., 2015). However, the use of smartphones as a medium to deliver nutrition interventions is an emerging area of research and has not been fully evaluated in population-based approaches (Hingle et al., 2013; Pollard et al., 2016). The author of one paper discussing messaging for nutrition interventions argued that this area of mHealth is so new that most programs should be described as pilot projects because the ability to measure these program's success it yet to be defined (Hingle et al., 2013).

Of the nutrition interventions that have been conducted using smartphones, nearly all were focused solely on weight loss and did not focus on food literacy or provide a substantial educational component that promotes healthy dietary behaviours. Within those interventions, smartphone apps and text messaging were utilized as methods to keep participants on track with their dietary and physical activity goals. Some text based interventions focused on feedback; participants were asked to submit goals and were then sent follow-up text messages to see how they were progressing and encourage them to reach their goals (Abraham, Chow, So, Yip, & Nelson, 2015; Dute et al., 2016; Pedersen, Grønhøj, Thøgersen, Gronhoj, & Thogersen, 2016; Turner et al., 2015). Other interventions had success by utilizing apps that had capabilities for participants to record a food diary (Zhu et al., 2011) or others that were more dynamic and had those features in addition to others such as a recipe bank, goal setting, and a physical activity trackers (DiFilippo, Huang, Andrade, & Chapman-Novakofski, 2015; Dute et al., 2016; Flores Mateo et al., 2015; Siopis, Chey, & Allman-Farinelli, 2015; Turner et al., 2015). Most

studies differed in their study design and functionalities, which made it difficult to compare between interventions.

Keating and McCurry (2015) conducted a systematic review based on using text messaging as an intervention for adolescent obesity. Results from the review determined that text messaging was an acceptable form of obesity treatment for adolescents; however, results were unable to determine if the effects of the text messaging were able to elicit a change in BMI (Keating & McCurry, 2015). Also in 2015, a literature review by Coughlin et al. (2015) and a systematic review by DiFilippo et al. (2015) explored the use of smartphone applications to improve nutrition outcomes, but in adult populations. Of the 13 studies explored in the two reviews, 12 had their primary outcome as weight-loss measured by body weight, waist circumference, or BMI (Coughlin et al., 2015; DiFilippo et al., 2015). Rather than focusing on treatment and weight-loss, it might be more effective to provide food literacy interventions in adolescents that can shape eating behaviours and promote healthy diets at a young age.

Many articles were required to paint an appropriate picture of what background exists on the topic of smartphone or Short Message Service (SMS) interventions for adolescents on nutrition education. Based on my review of the literature, I did not find any studies that evaluated the use of text messaging or smartphone interventions to promote food literacy in an adolescent population. However, the review did identify seven studies that assessed the use of mobile phones to conduct nutrition education interventions with adolescents. The interventions fit into one of the following categories: SMS tips/education intervention or SMS tips/education to supplement a larger intervention. Surprisingly, of the included articles, none included a nutrition education intervention through a smartphone app.

2.5.1 Types of Nutrition Education Interventions

2.5.1.1 SMS Education Interventions

The articles written by Hingle, Nichter, Medeiros, and Grace (2013) and Brown, O'Connor, and Savaiano (2014) evaluated nutrition interventions utilizing text messaging

to improve education in adolescents. Hingle et al. (2013) conducted a three-part study that included focus groups, classroom discussions, and an eight-week pilot study to be able to develop healthy lifestyle messages for adolescents. Thirty-two participants took part in the pilot study and were sent no more than two healthy lifestyle text messages a day. Results from the pilot study, in addition to the focus groups and class discussions helped to develop significant information on what adolescents want to learn from nutrition messages, how to best develop messages for adolescents, and how to best deliver them (Hingle et al., 2013).

Brown et al. (2014) conducted a study with 150 undergraduate students to evaluate the acceptability and effectiveness of sending repetitive nutrition messages to improve their knowledge of fruit and vegetable consumption. Participants were sent one of seven messages bi-weekly for seven weeks. The messages sent to participants were called behaviour-directed motivational dietary guideline messages, and each message included a photo of the MyPlate logo. After the seven weeks participants had a increased knowledge and recognition of the MyPlate food groups and a statistically significant increase in fruit consumption compared to the control (Brown, O'Connor, & Savaiano, 2014).

The main objective of both articles was to pilot using text messaging as a medium to conduct a nutrition education intervention with other outcomes being secondary. As this is still a new area of study, most articles in the field are being published as either pilot studies or protocol papers in order to evaluate and assess the use of the tools and text messaging before expanding the intervention to a larger population (Hingle et al., 2013).

2.5.1.2 SMS as an Element of a Multicomponent Intervention

Although some interventions use text messaging as the main component of the educational intervention, others utilize SMS as just one element of a multi-component nutrition education intervention. Abraham, Chow, So, Yip, & Nelson (2015) conducted a randomized control trial to assess the feasibility of using an internet curriculum in addition to SMS follow-up to be able to help adolescents living with obesity stay focused on healthy behaviours. The internet curriculum involved twelve 15-minute interactive sessions and this education component was complemented with personalized text-messages

as follow-up to keep participants on track. Overall, the results from the study suggested including internet education and text messaging is a feasible addition to a traditional lifestyle modification program (Abraham et al., 2015).

Kerr et al. (2016) conducted a six month RCT with 247 participants that were between the ages of 18-30 years. Participants were randomized into one of three groups: dietary feedback and text intervention, dietary feedback only, or control group. Participants in the dietary feedback and text intervention group were sent one or two text messages weekly to assess if mobile devices can be an effective way to deliver nutrition messages and if those messages would have the capability to improve fruit and vegetable intake while reducing non-core food intake. Participants in the intervention group that included text messages had a significant decrease in EDNP foods suggesting the potential of education text messaging to improve diet (Kerr et al., 2016).

The CAFAP intervention was mentioned in two articles, one by Smith, Kerr, Fenner, and Straker (2014) and the other by Straker et al. (2014). This intervention was a wait-list controlled trial with various levels of the intervention that tapered off throughout the study period. The study started with an intense twice a week group education session for participants and their parents. Following this 8-week program, participants engaged in follow-up education activities, including receiving text messages to promote individual healthy lifestyle goals and participants received phone calls from research assistants that were able to answer any questions the individuals might have had. Overall, the project was successful and resulted in a statistically and clinically significant increase in fruit intake and decrease in junk food intake for up to twelve months after the intervention (Smith et al., 2014; Straker et al., 2014).

In the study conducted by Woolford, Clark, Strecher, and Resnicow (2010), participants were part of a larger weight reduction program called MPOWER. Participants who signed up to receive messages were sent one text message a day about healthy behaviours for 90-days. The study team had developed 90 messages focused on one of five evidence based topics and rotated daily to provide a broad base of knowledge. The study met its

objectives and determined that sending text messages to adolescents enrolled in a weight management program was both feasible for the team and acceptable for the participants as it reminded them of their nutrition and healthy lifestyle behaviour goals (Woolford et al., 2010).

Providing nutrition education through short text messages has proved to be beneficial in nutrition interventions (Kerr et al., 2016; Smith et al., 2014; Straker et al., 2014). However, a review by Keating et al. (2015) stated that using text messaging as a component within a larger nutrition intervention can make it difficult to determine if the text-messaging component alone was actually able to elicit a change in BMI and nutrition education or if it was the intervention as a whole that produced these outcomes. Further research conducted on text messaging nutrition education interventions on their own will be necessary to determine the effect of this relationship.

2.5.1.3 Smartphone Apps with Nutrition Education

Through this literature review, it appears as though there was no published peer-reviewed literature available specifically on a food literacy or nutrition education intervention utilizing a smartphone app. This review identified that there are numerous diet tracking apps available that have been evaluated, but none of them focus on nutrition education. This is a gap in the literature that could have great potential to improve food literacy and provide nutrition information to a large group of individuals with minimal burden to participants. Currently, there are several apps available on the Apple and Android App Store that provide users with this nutrition information; however, the accuracy and effectiveness of the apps is unknown as the app might not come from a credible source. A literature review evaluating mobile technology for nutrition education stated that with all of the current nutrition apps on the market we are still lacking apps that are credible and evidence-based (Hingle, Nichter, Medeiros, & Grace, 2013). Some professional associations and government organizations have created apps that have been documented in the grey literature. These apps are more reputable and could have the potential to be used in larger scale interventions. For example, Dietitians of Canada (EaTipster) (no longer available) and the USDA (MyPlate) both created apps that provide users with

nutrition tips. The USDA created a report titled “Survivor’s Guide to Healthy Web Surfing and Phone Apps” to provide Americans with guidance on where to find credible information (Schafer, Miller, Gatewood, & Litchfield, 2013). Academic interventions using these apps would provide more details to determine if the apps are able to elicit changes in food literacy or dietary behaviours.

2.6 Conclusions and Review of Gaps in the Literature

In conclusion, the use of smartphone applications to conduct a food literacy intervention with adolescents is an unexplored area in the literature. Currently text messaging and smartphone apps are being used as a medium to administer health interventions and have begun to be used for nutrition interventions (Flores Mateo et al., 2015; Hingle & Patrick, 2016). However, nearly all nutrition interventions using mobile devices explored in this review have been focused on eliciting weight loss and are not focused on food literacy or nutrition education. Many food literacy interventions available to adolescents are conducted in schools and lack innovative approaches to engage this population (Brooks & Begley, 2014). Furthermore, adolescence is the time for interventions because in this stage of life individuals develop an increased autonomy and mobility, which often allows them the freedom to make more of their own food choices (Brooks & Begley, 2014; He et al., 2012; Loebach & Gilliland, 2016; Mitra, 2013; Salvy et al., 2012; Vaitkeviciute et al., 2015). Providing food literacy interventions tailored at this stage of life can help adolescents develop healthy dietary habits from a young age to help shape their dietary behaviours into adulthood. Overall, further research is needed to evaluate appropriate content and functionalities to include in a nutrition smartphone intervention and the feasibility of running such interventions.

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Chapter 3

3 Adolescent Perspectives on Nutrition Apps: Identifying Desired Content and Functionality

3.1 Introduction

Currently in Canada, 1 in 4 adolescents are overweight or obese and the numbers continue to rise (Public Health Agency of Canada, 2012). This rise in obesity can be accredited to changing Canadian lifestyles associated with a general increase in caloric intake, especially the consumption of energy dense nutrition poor (EDNP) foods, as well as the decrease in physical activities and rise in sedentary behaviours (Gilbert, Miller, Olson, & St-Pierre, 2012; Pujadas Botey, Bayrampour, Carson, Vinturache, & Tough, 2016). These unhealthy habits that begin in childhood and adolescence generally translate to similar behaviours in adulthood (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Pearson, Atkin, Biddle, & Gorely, 2010). New kinds of interventions to help improve food literacy and promote healthy diets are critical to help adolescents make healthier decisions and behavioural changes that will last through adulthood.

Text-messaging and smartphone application (app) interventions appear to be a fruitful point of intervention for adolescents based on their low-cost, minimal burden (Coughlin et al., 2015), and appeal to this younger generation (Dute, Bemelmans, & Breda, 2016). The challenge lies in developing an app with appropriate content and functionality that would be meaningful for this demographic. The purpose of the qualitative research reported in this chapter was to gather and analyze field data to support the redevelopment of an existing smartphone app called 'SmartAPPetite' (The Human Environments Analysis Laboratory, 2015) to serve as an intervention tool to improve food literacy, food purchasing and dietary behaviours among adolescents. The specific aim of this study was to obtain adolescent perspectives on what content and functionality to include when developing a nutrition app for adolescents. To help achieve this aim, we conducted a series of focus groups and short surveys with adolescents in London, Ontario, Canada. The objective of undertaking focus groups was to determine what content can help engage adolescents and what features they want from a nutrition app. The objective of

the short surveys was to determine what specific types of nutrition and health-related messaging are interesting, useful, and relevant to adolescents.

Following a brief review of previous studies focusing on nutrition messaging for adolescents, this chapter will outline the qualitative methodologies used to collect and analyze the focus group and survey data. Following presentation of the study findings, the final discussion and conclusion sections revolve around the key themes identified and recommendations for future research.

3.1.1 Literature Review: Nutrition Messaging for Adolescents

Successful nutrition education interventions require nutrition messages that are interesting, relevant, and useful to adolescents, which can be a challenge to develop. In the current literature, some preliminary work has determined how to write public health messaging for adolescents. Studies have demonstrated that adolescents prefer short and simple messages, as well as brief teaser messages to entice them to read the rest of the message (Hingle, Nichter, Medeiros, & Grace, 2013; Kerr et al., 2012; Smith, Kerr, Fenner, & Straker, 2014). Studies have shown that adolescents want ‘factoids’ and quizzes, but the facts should be specific to adolescents, so that they find them more relatable (Hingle et al., 2013). On the other hand, research has also shown that specific messages stating what others their age are doing may elicit feelings of guilt and is not motivating for some (Smith et al., 2014). Writing nutrition education and health promotion messages for adolescents can be particularly challenging, as messaging must be able to communicate in a voice that is both informative but not authoritative (Hingle et al., 2013). Using an authoritative voice can actually have a negative effect and can cause adolescents to not want to listen to the recommendation. Messages should focus on giving the individual choices rather than telling them they should engage in a particular behaviour more often (Smith et al., 2014). Research has also consistently identified that it is important to have positive messages to promote the benefits of engaging in healthy behaviours, rather than focussing on avoidance or prevention (Hingle et al., 2013; Kerr et al., 2012; Smith et al., 2014; Woolford, Clark, Strecher, & Resnicow, 2010). One study also noted that starting a message with “did you know” automatically made adolescents

less interested in reading the remainder of that message (Hingle et al., 2013). Previous literature has suggested writing messages in a less formal tone makes them more appealing to adolescents and makes it appear as if it was sent from a peer (Smith et al., 2014).

Previous research has established that topics of interest for adolescents include making healthy choices at restaurants or convenience stores, information on vegetarian eating, what to eat to help build muscle, and what to eat to help your skin and nails for girls (Hingle et al., 2013). Contrary to expectations, adolescents from two different focus groups reported that the mention of unhealthy behaviours and junk food ended up causing them to want those food (Smith et al., 2014; Woolford et al., 2011). Although useful information can be gleaned from previous studies about developing nutrition education messages for adolescents, there are still many unknowns, particularly regarding content and what functionalities to include in nutrition smartphones apps. Both Keating et al. (2015) and Smith et al. (2014) stated that it appears adolescents are unsure of what they want from messages, suggesting more testing and focus groups should be conducted with adolescents.

3.2 Methods

3.2.1 Preparation of SmartAPPetite Message Databases

To support the redevelopment of the SmartAPPetite app as a nutrition intervention for adolescents, an initial database of messages was created to provide adolescent users with information on nutrition and healthy food. Under the supervision of registered dietitians, the messages were created by a team of undergraduate and graduate student trainees, therefore ensuring that the messages were created for youth by youth. Messages were created as part of tip chains, which included short messages (80 characters) to entice the user to open the app and view the longer (250-350 character) messages. The longer messages included links to appropriate recipes, nearby vendors, and external links for the user to learn more about the topic. Since the initial (alpha) version of the SmartAPPetite app was created to promote the purchase and consumption of healthy local food (currently specific to Ontario, Canada) (The Human Environments Analysis Laboratory,

2015) most of the early messages created for the app were about seasonality and nutritional information of locally-produced food, with some healthy lifestyle messages to promote a balanced diet and physical activity. As the smartphone app shifted to provide information on adolescent health, a new set of messages were developed specifically for adolescents. These adolescent messages were guided by recommendations from previous literature about tone and content.

3.2.2 Participant Recruitment

After receiving approval from the Research Ethics Board of Western University (NM-REB#:107034), three recreational facilities in Southwestern Ontario were contacted to discuss our plan to conduct semi-structured focus groups with adolescents. Based on the literature, it was recommended to conduct focus groups with adolescents rather than interviews to make them feel most comfortable and to stimulate thought that would be difficult to obtain from individual interviews (Peterson-Sweeney, 2005). A researcher from the project team spoke to managers from each facility to explain the purpose of the focus group, and arrange times to visit the facilities for project recruitment. One team member spoke to different groups of youth (e.g., camps, youth councils, and cultural groups) at each facility and then those who were interested were provided with a letter of information to read and an assent form to sign. Recruitment and focus groups took place at the recreation centres and stopped when saturation was reached, meaning no new information was being gathered as all responses were repetitive from other focus groups (Krueger & Casey, 2015). Focus groups ranged in size from two to nine participants and the duration varied from 10-45 minutes. A \$10 (CAD) bookstore gift card incentive was provided for participating in the focus group.

3.2.3 Focus Group Guide

A semi-structured focus group guide was used for all focus groups and consisted of three parts: the opening, open-ended questions, and the closing section, as suggested in the literature (*Appendix D*) (Baxter & Eyles, 1997; Krueger & Casey, 2015). The opening section included a welcome to all participants, an overview of the topic, guidelines on how to proceed through a focus group, and an opportunity for all participants to introduce themselves, including a small icebreaker related to the topic. There were six open-ended

questions to guide the conversation and gauge what the participant would want in terms of content and functionality for an adolescent nutrition smartphone app. Related to the first research objective, five questions were asked based on content to determine their interest on different nutrition topics, recipes, cooking skills, seasonality, and food purchasing. The last question was related to research objective #2 and asked users if they were to design a nutrition app what features would they want to include. This question was used to establish what adolescents wanted in an app, what features were interesting to them, and when they wanted to receive information. Probes were used when necessary to provide participants with further information or to clarify a specific response and allow the participant to explain further (Krueger & Casey, 2015). The closing section allowed the interviewer the opportunity to review the main discussion points of the focus group with the participants and allowed them to add any final comments before concluding the focus group. All focus groups were audio recorded, transcribed verbatim, and reviewed by two team members to ensure that all information was documented completely and accurately.

3.2.4 Message Rating

Once saturation was reached for app functionality and content from the focus groups, we proceeded to ask adolescents to rate specific sample messages. This allowed us to dig deeper into the content and to determine what sample messages were appealing to adolescents. Handouts were created with sample messages to be rated by adolescents to supplement the information gathered from the focus groups (*Appendix E*). Each handout had eight different messages to be rated, four general healthy local food messages and four written specifically for adolescents. Each message was to be rated according to the how the participant perceived them to be interesting, useful, and relevant on a Likert scale of one (not at all) to five (very). Following each message, there was a section for comments to allow the participant to indicate why they may or may not have liked that specific message. Overall, there were four handouts for a total of 32 different messages that were rated.

3.2.5 Data Analysis

After all focus groups were transcribed, two independent coders reviewed the transcripts for overarching themes and subthemes that were identified among the data set. Thematic analysis was used by the two coders to determine themes through inductive and deductive approaches (Braun & Clarke, 2006). The two coders consulted each other to compare findings and finalize the codes for the transcripts. After determining codes, a qualitative data analysis software, NVivo Pro (version 11), was used to aid in the process of itemizing the data to complete a thematic analysis (“NVivo qualitative data analysis Software, Version 10,” 2014; Zamawe, 2015). Message ratings were analyzed using basic descriptive statistics on SPSS (IBM SPSS Statistics 22) (IBM Corp., 2013).

3.3 Results

3.3.1 Focus Group Results

Forty participants partook in the focus groups (*Table 3.1*). Participation was equally distributed between sexes with 22 of the participants identifying as male. The participants were between the ages of 13 and 20 with the mean age of 15.42 ± 1.76 .

Table 3.1. Focus Group Demographics

	All Participants
n	40
Sex	
Male	22 (55.00%)
Female	18 (45.00%)
Age	15.42±1.76
13	3 (7.50%)
14	11 (27.50%)
15	9 (22.50%)
16	7 (17.50%)
17	2 (5.00%)
18	3 (7.50%)
19	2 (5.00%)
20	1 (2.50%)
Not Available	2 (5.00%)

Overall there were two main categories of themes, which could then be divided into 7 overarching themes and 27 subthemes (*Figure 3.1*). The two main categories that were

identified from the focus groups were content and functionality. Within content the themes were developed related to topics of interest, where adolescents are currently getting their information, recipes, cooking skills, seasonality, and food purchasing. Themes that were developed within functionality included what adolescents want in an app, features, and when to receive information.

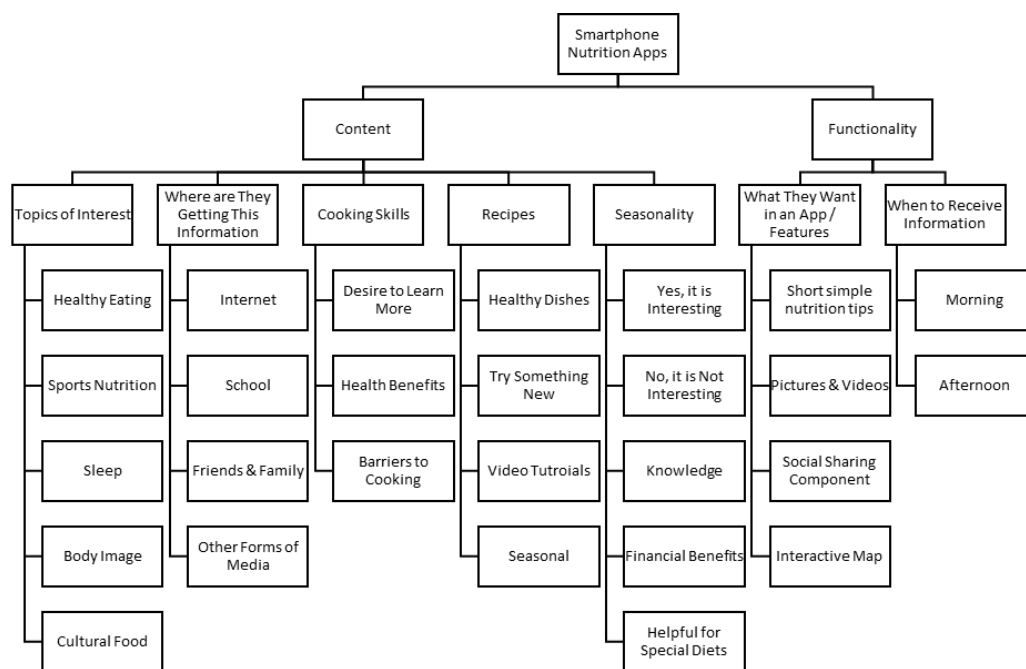


Figure 3.1 Qualitative Theme Tree

3.3.2 Content

3.3.2.1 Topics of Interest

Regarding content, the first theme that was recognized was *topics of interest* related to nutrition. Within the theme of topics of interest, five subthemes emanated across the focus groups: healthy eating, sports nutrition, sleep, body image, and cultural foods. The most prevalent topic (subtheme) was healthy eating, particularly how to achieve a balanced diet. Almost all participants mentioned this topic of interest. Participants voiced their concerns about maintaining a healthy diet and healthy behaviours into adulthood, as one male put it: “because it’s important to be healthy. If you grow up all the time eating pizza and watching Netflix, instead of exercising then your life isn’t gonna go so great.”

Another individual mentioned that, “I think everyone needs to work on their portion sizes. When you go to a restaurant you get a huge portion and you’re like ‘oh am I supposed to eat that all?’ or you think ‘what portion should I be eating?’ I think it would be beneficial to learn a bit more about that.” Some participants mentioned being unsure about how to achieve a healthy diet and being confused by all of the information out there. For example, one participant mentioned that he wanted to learn about “the types of food that people should avoid. Like some foods they say that we should avoid but not everyone knows that.” Another participant had similar thoughts and said, “I’m not quite sure, kind of like what I should eat or where I should find it.”

Many participants noted that they were very involved with sports and wanted to learn more about what to eat to be able to perform at their best. Others mentioned that they wanted to know what to eat to be able to be healthy for the specific sports they are involved with. One participant mentioned, “I want to know it because I am going on the swimming team and I want to be healthy. Like, I do not want to be super fat or super skinny, I would just like to be medium.” Another male participant mentioned, “I play sports everyday, I have football practices now for high school every single day of the week. It would be good to know what a football player, sports player, athlete, should eat as you work out, what you should eat before and after.” One participant noted a strong tie between nutrition and exercising and wanted messaging to reflect that:

Yeah, nutrition and exercising is also important to me. I feel like those kind of go hand in hand. Maybe if there is a little bit about exercising on the app that would be beneficial. A lot of people think “maybe if I eat healthy I will be healthy,” but that is not the case. Exercise and nutrition go hand in hand, so maybe emphasizing that?

Adolescents seemed to be interested in learning about other topics in maintaining a healthy lifestyle like sleep. Sleep was identified as an important topic because of the stress of high school and having to juggle many priorities. One participant mentioned, “I think sleep is really important cause high school, well I know especially for high school, it’s like really stressful so you’re up late with like homework and stuff so you forget you

need sleep”. Some participants had questions pertaining to healthy sleeping habits like when to stop eating before going to bed and when to begin eating in the morning:

I’ve always wondered, is over sleeping a problem or no? or if sleep tying in with eating like, it’s a good idea to eat to stop eating so many hours before sleep because some people get more restless sleep even if they don’t eat especially certain things like I have really weird dreams if I eat right before I go to bed

Other participants were interested in learning about eating after you wake up. One individual mentioned, “I’ve heard things about like eating within a certain time that you wake, because it starts your metabolism, and your brain power, and things like that right?”

With the adolescents who participated in the focus groups, body image and dieting was specifically mentioned by one-quarter of the individuals. One participant commented on issues with body image and adolescents:

About body image because I know a lot of people who are friends with me who struggle with that kind of stuff. And then maybe more about myths and facts about dieting and eating healthy because I know a lot of people who say they are dieting and aren’t going to eat any lunch and that is not good for you. Just like some misconceptions about nutrition would help cause a lot of days girls just research “how to get thin” and that kind of thing whereas if you had actual concrete evidence and facts about eating healthy I think that would be more beneficial.

A number of the participants reported that they wanted to learn more about different cultures and cultural food. One participant said, “I think like a cross-cultural kind of section like food. Like I would like to try it out but like I wouldn’t eat it everyday.” Some other participants shared how their culture impacts what they eat and their ability to maintain a healthy diet. One participant commented on his struggles to maintain a healthy diet:

It’s like really hard, and too much work. Where I’m from, where my parents are from, Middle East and Europe where meat is like every day. Meat is like a thing

that you eat like every day and vegetables are not a big thing in my house. Like if it's like a vegetarian dish like once a month we're gonna [sic] have, so like healthy no.

3.3.2.2 Where are Adolescents Currently Getting This Information?

Following a discussion about what topics adolescents wanted to learn more about, the participants were asked where they are currently getting their information on nutrition and health. The most common answer was that they are getting their information from the internet or from school. A participant mentioned a change in behaviour after taking a nutrition class and stated, "Now I cut some of the stuff I choose and what and when I eat it and stuff like that. So I think because of that class I make some small changes." Some other participants mentioned they get their information from family, friends, magazines, cookbooks, or TV shows. Some participants mentioned struggling with all of the conflicting information and that websites "sometimes have different information on them. It'll say its good but then different places will say it's not good." Other participants shared their concerns about identifying what information is true among all of the misinformation available. Among the focus group discussions, others shared strategies to be better able to identify valid information. One individual mentioned, "If a site does not have a publisher, it's probably not the one you should trust." One participant mentioned another strategy, stating, "I read more than one site so I see different publishers, to see if they have the same idea or something."

3.3.2.3 Cooking Skills

In regards to the topic of cooking, 7 out of the 40 (17.50%) participants said they didn't know how to cook. Many reported not having the skills or having a lack of confidence in the kitchen and half of all the participants mentioned wanting to learn more cooking skills. One participant said, "I don't have these skills and I think you need these skills to actually go out and be successful on your own. So yeah." Learning how to cook was particularly important to some adolescents who recognized they would have to cook on their own soon. One participant voiced his concern, "In like 5 years, we're gonna [sic] be going off to university and colleges and we are gonna [sic] be on our own, like having to

cook for ourselves, and we shouldn't be just living off like microwave Kraft dinner.”

Another mentioned the health benefits of being able to make homemade meals:

Yeah and how to like make more like homemade stuff, because like I know a lot my mom she doesn't know how to make a lot of stuff so she just kind of buys it from the store and then cooks it but even when it's healthy, its not as healthy if you but like a lasagna pre-made, but if you make a lasagna its actually better for you.

Although most participants were eager to learn more, some identified barriers that prevent them from experimenting in the kitchen. Some of the most common barriers were no knowing enough about cooking, not having the time to make the meals, not having the ingredients or money to buy the ingredients, being too tired or lazy to make a meal, and not having permission from their parents to cook.

3.3.2.4 Recipes

The next key theme to appear in the focus groups was recipes. Participants noted that having recipes on the app would prove to be useful as it would help to eliminate a barrier of accessing recipes. Some adolescents mentioned they find it hard to find good recipes on their own because “a lot of recipes on the internet are a like a hit or miss cause, sometimes they'll work and a lot of times they wont work. So it's not easy to find valid recipes.” Furthermore, participants expressed an interest in videos being added to recipes “like that tasty video and like I don't know, it all comes together and it's like you want to make it”. Overall participants were interested in receiving recipes to be able to try something new, such as substituting common ingredients with others (i.e., applesauce rather than butter). The most popular topics were foods that are healthy, and dishes that would be easy and quick to make. In multiple focus groups, it was mentioned that adolescents wanted the recipes to be attached to seasons and holidays, “Have all of them year round but maybe like at the top of the list if its like near Easter ‘Oh quick and easy Easter cookies!’ or ‘Quick and easy spring dessert’, ‘Quick and easy spring.’”

3.3.2.5 Seasonality

A common theme that was noted was adolescents' interest in learning about seasonality. Not every participant voiced their opinion, but 18 participants said they would want to

know about seasonality, while the other 8 who responded said that it wouldn't be interesting to them. Those who weren't interested in seasonality said it was because they don't do the grocery shopping, they don't like fruits and vegetables, or they just didn't care. There were three main reasons why they did want to know about seasonality: (i) it would be good knowledge to have; (ii) it will help save costs to buy in season; and (iii) it would be helpful for those on special diets or picky eaters. Many mentioned it would be good to know "when it's freshest, not when it's molding, or when you can like go to the like the local farmer and just get it from them." Some also noted that it would be helpful "so you know which ones will taste better that time of year. Or like which ones are like are more, I don't know, more available." It was well noted that buying produce in-season also has its financial benefits, as stated by one participant:

My mom just gets the regular meat stuff and all that I'm just like, I usually pick out my own stuff so um to be honest I'm not very educated I guess so like I don't when stuff are in season and when it's not so I end up buying like during the winter get a \$5 mango by accident.

Additionally, another noted that:

It would also help financially because like things are cheaper when they are in season "slash" when they are not in season like that. So like if I'm in the mood for a fruit cobbler but I don't know what fruit, I can be like well what's in season, what would be cheaper to go get?

Some participants also mentioned it would be helpful to learn about what is in season for those who are picky eaters and those on special diets. One adolescent mentioned that they are a "very picky eater and my parents hate shopping for me so knowing what is good right now would be very helpful."

3.3.3 Functionality

3.3.3.1 What Adolescents Want in an App?

When asked what adolescents would like in a nutrition smartphone app, the participants had many thoughts to share. The most common idea that came up was that they wanted nutrition tips and they wanted to learn about healthy eating in general:

I also think like something like substitutions but like substitutions of what we drink cause sometimes I feel like I crave a pop but like mentally I know I shouldn't probably be drinking it... We are all guilty of it, like you're not going to order a water at a fast food restaurant like you're going to get that coke and you are going to get that dollar coke that's on sale 'cause it's just there.

Building off the nutrition tips, many participants clarified that they wanted to make sure that the tips provided would be short and simple. One participant was very clear that “if it's for teens than I think that it should be simple... Not complicated words. It should be like quick because sometimes we get bored really easily.” The adolescents in the focus group really liked the idea of having lots of pictures or videos, and being able to connect to social media and engage with their friends. One participant proposed the idea to “add either kind of like a chat on the app so people can talk and rave about the different aspects of the app or have them [write] reviews on the different meals and stuff. Pictures, Instagram, link it to Instagram.” Many participants also indicated that they wanted to receive nutrition feedback. One participant requested a feature in which he “would say what [he] would eat in a day and then it would judge if it's good or bad, what should [he] improve? Why you should substitute something?”

Lastly, a few participants mentioned that an interactive map would be helpful to suggest places to eat around their school and a conversation initiated because many students felt their school was located in an unhealthy food environment. One participant discussed the food environment as a whole and how it can affect purchasing habits for adolescents:

I'm sitting there thinking, no wonder, no wonder healthy eating isn't a thing for kids because it's not accessible. You can't walk around... Variety stores, gas stations, everywhere, yup. You can't go anywhere without seeing a fast food place.

A few participants mentioned they needed a tool to help navigate their food environment and one individual suggested to “put like a map section on it where it shows you like healthy places from where you are, to go eat.” Rather than just suggesting vendors, this participant recommended that the app should help you if you were looking for a specific

item, “check out where the directions are, kind of like google maps as well, but it also shows the price, how much like a certain amount is”.

3.3.3.2 When to Receive Information

When the participants were asked when they would want to receive this information there seemed to be a divide. Some participants mentioned, “morning because I wake up pretty early. After school I have homework and probably won’t have time to check my emails.” While others said that they were not morning people and that would not be an appropriate time. Other participants like the idea of, “after school ‘cause like when people come from school they are hungry so they can, or might have the time to look at those things.”

3.3.4 Message Ratings

There were 37 participants who rated messages and participation was almost equally divided between males (18) and females (19) (*Table 3.2*). The average age of the participants was 15.42(± 1.39) years, and ranged from 13 to 19 years old. Each of the 32 different messages on the handouts were rated on how interesting, useful, and relevant they were based on a scale from 1 (not at all) to 5 (very). Overall, across all three categories of evaluation adolescent messages were rated more favourably than the healthy local food messages (*Table 3.3*). The average message was rated a 3.34 ± 0.84 on how interesting the content was. When comparing the adolescent specific messages to the local food messages, the former were rated more favourably (3.50 ± 0.89 adolescent; 3.18 ± 0.78 local food) for their interest level. The average message was rated 3.42 ± 0.89 out of 5 for how useful the information was for adolescents. The messages specifically written for adolescents were rated higher (3.57 ± 0.98) than the local food messages (3.26 ± 0.82) based on how useful they were. Similar to interest and usefulness, the messages received an overall average rating of 3.36 ± 0.95 with respect to their relevance for adolescents. For relevance, the adolescent messages (3.65 ± 0.86) were rated higher than the local food messages (3.07 ± 1.04).

Table 3.2. Message Rating Demographics

	All Participants
n	37
Sex	
Male	18 (48.65%)
Female	19 (51.35%)
Age	15.42±1.39
13	2 (5.41%)
14	8 (21.62%)
15	7 (18.92%)
16	8 (21.62%)
17	7 (18.92%)
19	1 (2.70%)
Not Available	4 (10.82%)

Table 3.3. Message Rating Data

	Interesting	Useful	Relevant	Overall
All Messages	3.34±0.84	3.42±0.89	3.36±0.85	3.37±0.86
Adolescent Specific Message	3.50±0.89	3.58±0.96	3.65±0.86	3.58±0.90
Healthy Local Food Messages	3.18±0.78	3.26±0.82	3.07±0.85	3.17±0.82

Participants who filled out the message rating handouts were encouraged to leave comments on what they liked or what they thought could be improved. Coincidentally, the messages that were rated the lowest had the fewest or no comments at all. Messages rated more favourably had more comments indicating what they liked about it. There were no comments related to the two lowest rate messages (*see Table 3.4*), while the comment about kale availability had one annotation that read, “This can encourage people to have more variety when they prepare kale.” This comment was positive and not indicative of what most of the raters thought about the message based on the lower rating it had received (interesting 2.33±1.21; useful 2.71±1.25; relevance 2.86±1.35). The highest rated message was about sugar in pop (interesting 4.20±0.84; useful 4.20±0.84; relevance 4.80±0.45), which had many positive remarks suggesting it was both interesting and informative. One participant mentioned, “Pop is very popular and many people remain ignorant about how unhealthy it is.” Another participant mentioned enjoying drinking

pop and suggesting “this should be out there for people to know.” For the message about hunger cues, the participants mentioned, “I liked it because I did not know about that” and, “People need to know this.” The adolescents also liked the message about iron (interesting 3.67 ± 0.58 ; useful 4.00 ± 0.00 ; relevance 4.00 ± 0.00) and they stated it was important to know because “vegetarians often don’t get the iron they need.” The message about zucchini (interesting 4.00 ± 0.00 ; useful 4.00 ± 0.00 ; relevance 3.67 ± 0.58) was local food based and still received high ratings from the adolescents. One participant mentioned, “I just find this interesting, there should be more focus on stuff like this”, while another said, “It informs people about the many wonderful benefits.”

Table 3.4. Highest and lowest rated messages for the level of interest, usefulness, and relevance to adolescents.

Short Message	Long Message	Interesting Rating	Useful Rating	Relevance Rating
<i>Highest Rated Messages</i>				
Do you know how much sugar is in one can of pop?	One can of pop contains about 10 teaspoons of sugar. Drinking one can of pop makes up about 75% of a person's recommended daily limit of sugar! Next time try a beverage with little to no added sugar, like water or unsweetened fruit juice. Or, check the nutrition facts table to help choose options with less sugar.	4.20±0.84	4.20±0.84	4.80±0.45
Are you getting enough iron?	Iron is important for brain development early in life and helps with brain function throughout life. Iron also plays a crucial role with red blood cells. It helps them carry oxygen through your body. Iron is found in every cell in the body. It is important to make sure you get enough! Check the links below to make sure.	3.67±0.58	4.00±0.00	4.00±0.00
Zucchini has folate, an important B vitamin.	Zucchini contains folate, an important B vitamin, required for most basic cell functions. Folate is especially important for women between the ages of 14 and 50 to reduce the risks of birth defects during pregnancy. It is also helpful for heart health.	4.00±0.00	4.00±0.00	3.67±0.58
<i>Lowest Rated Messages</i>				
Remove bitterness out of Kale with this tip	Did you know that you can get the slight 'bitterness' out of kale by simply rubbing its leaves together. This process will also make the leaves a bit more tender. This makes including kale in your salads easy, even for picky eaters	2.33±1.21	2.71±1.25	2.86±1.35
Do you ever wonder about the difference between plums and prunes?	Prunes are actually dried plums. A machine called a dehydrator removes the water from fresh plums. Prunes are a more concentrated source of many nutrients, such as fibre and iron. They are also higher in sugar so remember one serving size is 1/4 cup.	2.71±0.95	2.57±1.27	2.43±1.27
Cabbage is available locally 11 months of the year.	Cabbage is grown locally from June to April. In the summer, try fresh cabbage salads. In the winter, try warm cabbage soups. Cabbage is a low costing vegetable that can be enjoyed during every season.	2.29±1.25	2.83±1.47	2.17±1.17

3.4 Discussion

From the focus groups and message rating, it was evident that adolescents had many preferences as to what they would want from a nutrition smartphone app. The adolescents in this sample had countless comments as to the content and functionality that would be most appropriate and relevant to adolescents like themselves.

The five main themes that were identified within **content** were *topics of interest, where adolescents are currently getting their information from, cooking skills, recipes, and seasonality*. When asked about what topics would be of interest to them nearly all of the participants mentioned healthy eating. The quotes from the focus group indicated that the adolescents were not just concerned with the immediate benefits of healthy eating but that they recognized the diet they eat now would directly impact their health in the future. Some participants identified that they have a base knowledge about nutrition but raised concerns that many of their peers do not know this same information. Within the general topic of healthy eating, many participants identified a desire to learn more about sports nutrition. The participants identified that they want to know about general sports nutrition and information specific to the sports they play, like football and swimming, to help improve their performance. One participant was very insightful about the relationship between nutrition and physical activity and the need to focus on both to maintain a healthy lifestyle. That participant mentioned that within her peers it is a common fallacy that if you simply eat healthy you will be healthy and she felt that this misconception needed to be disproved with education on physical activity.

Other topics the adolescents wanted to learn more about were sleep, body image, and cultural food. Similar to unhealthy diets and physical inactivity, sleep deprivation has been consistently linked to many negative outcomes and particularly so during adolescence (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). Accordingly, sleep was frequently brought up as a topic that the participants wanted to learn about. Many addressed that high school is a stressful time in their lives that they struggle to be able to get adequate amounts of sleep. Acknowledging this is a problem, many wanted to learn strategies to achieve a healthy sleep pattern and how their diet can affect their sleep.

Much like sleep, issues with body image are also very common during adolescence as they experience significant physical changes (Singh, Ashok, Binu, Parsekar, & Bhumika, 2015). Many adolescents mentioned knowing friends who struggle with body image and turn to unhealthy diets to achieve the results they want. Guiding messaging around changing perceptions on body image and help to build the conversation that everyone's body is different and being able to accept your body. Providing messaging to disprove myths about nutrition can help turn individuals away from these unhealthy behaviours and promote focusing on a balanced diet. It is important that adolescents are more aware of these issues within their peers and that they want education to help steer the conversation away from dieting and more towards healthy behaviours.

As multiculturalism in the Canadian population continues to rise there is a greater availability of cultural foods. The adolescents in these focus groups were interested in learning more about cultural foods and learning how to cook different cuisines. Other participants shared how their own culture and cuisines inhibited them from achieving a healthy diet. Anecdotes from the focus groups suggest providing information on achieving a healthy diet through different cuisines can be both interesting and useful for adolescents in Canada.

In the literature, it is suggested that the internet is the number one place adolescents go to get overall health information, which coincides with our findings (Ettel et al., 2012). Our participants suggested they also get a large portion of their information at school from their health or nutrition classes. Some other sources of information for participants were their family members, friends, and other forms of media. This information complements existing literature because we know from previous studies that adolescent food behaviours are directly influenced by their peers (Salvy, de la Haye, Bowker, & Hermans, 2012).

The majority of the participants in the focus group admitted to having some limited knowledge on cooking. Some participants mentioned they can only prepare meals that are ready-to-eat (i.e., frozen dinners or store prepared meals) and others had a lack of

confidence in their cooking abilities. Most of the participants did want to learn more about cooking skills and were very perceptive to the fact that cooking skills are essential in adulthood. Several participants mentioned the concern that shortly they would be moving out on their own and will need to be able to support themselves. They were aware that preparing premade meals would not be appropriate all the time and that the homemade versions of these foods tend to be healthier. Although most of the adolescents did want to enhance their cooking skills, many barriers were addressed which prevent them from experimenting in the kitchen. Most notably, was the lack of knowledge; participants mentioned not having the skills and not knowing the techniques required to make the recipes. Although hands-on learning can often be most beneficial, providing adolescents with simplified information on common cooking techniques with instructional videos can help adolescents to be more involved in the kitchen.

With their desire to learn more cooking techniques, giving adolescents simple recipes could be a good opportunity for them to learn how to cook. Sending them recipes for foods they enjoy might motivate them to try it out on their own rather than purchasing the food. From the focus groups, the adolescents mentioned they wanted to receive recipes for quick healthy dishes. The adolescents also wanted to be able to try something new, some mentioned substitutions like avocados in brownies, and they really wanted seasonal and holiday inspired recipes. It was mentioned that having a video showing you how to make the recipe made it more interesting and made them more likely to want to try the recipe. Providing a video tutorial was something that many adolescents mentioned they wanted. Being able to watch the recipe come to life demonstrates that the recipe will actually work and it would be realistic for them to replicate it as well.

In recent years, there has been an increased awareness about the distance some of our food travels to reach our plates (Pelletier, Laska, Neumark-Sztainer, & Story, 2013). With this awareness, there has been increased demand and interest in eating foods that are local to one's environment and which support local businesses. We know there is a push to consume more seasonal and local foods within the adult population but there is less literature available to determine if adolescents in Canada share this same interest and

concern. During the focus groups, adolescents were asked if they are interested in knowing more about food seasonality. The majority of the participants were interested in learning about seasonality for various reasons. The first reason they wanted to learn about seasonality was because they recognized it as good information that they should know. Notably the adolescents recognized that purchasing foods in season would result in produce that is superior in both flavour and quality. Additionally, aside from the better quality produce, the participants acknowledged that buying local seasonal produce yields financial benefits. The group seemed to be cognisant of the cost of groceries regardless if they were the ones shopping for their own groceries or if they were making requests to their parents to purchase for them. Furthermore, those who identified themselves as picky eaters or on a special diet (i.e., vegan) noted that being aware of seasonality of foods in their area was particularly advantageous to help them plan meals that fit their dietary constraints.

From the conversation relating to **functionality**, two main themes prevailed: *what adolescents want in an app* and *when they want to receive the information*. Adolescents mentioned that they wanted short and simple nutrition tips and having those tips connected to pictures and videos. Other suggested techniques to help engage this generation of adolescents include connecting the app to social media or adding a chat function so that users can engage with their peers and share their learnings. This finding is not surprising, as this generation has been referred to as the 'iGeneration' due to their comfort with technology and the fact that a significant portion of their socializing is by interacting on social networks (Rosen, 2010). Participants also wanted nutrition advice specific to them and wanted to be able to receive feedback specific to what they are eating. Lastly, many participants suggested having an integrated map component to be able to suggest nearby food vendors and provide information on what they sell, pricing, and directions. During childhood, individuals are often only exposed to the places that they attend with their family and guardians. Adolescence is a life stage when one is afforded greater freedom to explore the environments around them and often some money to be able to make their own purchases. The adolescents from these focus groups mentioned not always knowing what is available around them, which can limit their

options for food vendors. Many participants mentioned that they felt their school food environment was saturated with unhealthy fast food vendors and were vocal about their desire for more options available to them that were both healthy and affordable. An interactive map feature was identified as a solution to help them navigate their surrounding food environment and receiving suggestions from the app would help them day-to-day to explore new places and develop their own preferences.

There was a divide in responses when the participants were asked when they would like to receive messages. It appeared that sending all of the messages at one specific time would not be appropriate. Some participants preferred the morning while others wanted the afternoon, suggesting that adolescents would want to be able to personalize the delivery to their own schedules. Providing this opportunity to individualize the app to the participant's schedule could make a significant difference in engagement and affect the ability for messages to resonate with the user. This finding supports what has been previously established in the literature (Smith et al., 2014).

Overarching topics that were identified were issues of contradicting information, misconceptions, and reflection of their own knowledge compared to that of their peers. The adolescents in these focus groups mentioned struggling with the volume of information available to them and quite often this information can be conflicting, thereby raising questions as to the validity of the information. This frustration of sorting through contradicting information has been previously identified in the literature and participants stated that they wanted guidance to be able to find answers to their nutrition related questions (Cline & Haynes, 2001; Skinner, Biscope, Poland, & Goldberg, 2003). Within the focus groups, many nutrition myths and misconceptions were also addressed. Some individuals were cognisant that this information was a myth but others shared nutrition misinformation with the group that they believed to be true. Adolescents in high school tend to look to their friends as a source of health information (Ackard & Neumark-Sztainer, 2001; Racey, Machmueller, Field, Kulak, & Newton, 2016), which stresses the need to provide them with valid, research-based information and tips to filter through all of the misinformation available and help them decipher what is accurate. Within the

focus groups, the adolescents also addressed their perceptions of their own knowledge compared to what their peers know. Many stated having a more advanced understanding of topics of healthy living than their friends and knowing more about certain concepts than their peers did. Some research has been done comparing adolescent nutrition perceptions to their dietary behaviours; however, further research could be conducted to determine how their perceptions of their own knowledge and that of their peers compares to their food literacy scores (Velazquez, Pasch, Ranjit, Mirchandani, & Hoelscher, 2011).

The information from the focus groups and the results from the message rating suggest that adolescents are more receptive to messages that are written specifically for their demographic. The messages were rated based on the criteria of how interesting, useful, relevant they were for adolescents and the adolescent specific messages received higher ratings across all three categories. Unfortunately, not all participants provided comments explaining their choice of rating and coincidentally the messages with the lowest rating received the least amount of feedback. The feedback that was received indicated that participating adolescents wanted to learn information that would affect their current lifestyle. For example, the participants were particularly receptive to the message about sugar content in pop, mentioning this is something they think everyone should know. Similarly, they liked the message about listening to your body's hunger cues, remarking that they did not know that information and it directly applies to them. Participants did not always see how messages about local food were relevant to themselves, which made them less desirable overall. Based on the information from the focus groups and message rating, providing messaging that is relevant to daily life and proposing changes in behaviour seem to be most acceptable for adolescents and will resonate more than general healthy food messaging.

3.4.1 Limitations

Within this study there were some limitations that were encountered. First, there were no note takers at the focus groups; however, all focus groups were digitally recorded and transcribed verbatim to ensure nothing was missed. Having a note taker would be beneficial for future focus groups to be able to take the information from the focus group

and apply it when moderating the next session. Furthermore, multiple focus groups were conducted in the same room affecting the sound quality and the ability to recall and identify specific participants from one another in the audio recording. For this reason, we did not conduct a detailed sex-based analysis, as it was not always possible to identify the sex of the participant who made each statement. Another limitation was the size of two of the focus groups. One focus group was too small and only had two participants and the other focus group had nine, which was larger than planned. Although these focus group sizes were not preferable, we had to settle with these numbers in order to be accommodating to our hosts. The focus group with only two participants occurred because two individuals wanted to join late, after the other focus groups had already started. At another recreation centre, the larger focus group could not be divided because they were unable to accommodate us with another space and specifically asked we not separate the group in two. When possible it would be better to groups with four to eight participants to stimulate conversation as much as possible without making participants feel uncomfortable in front of a large crowd (Kitzinger, 1995). Another limitation was the fact that more than one interviewer was used to conduct the focus groups. Although the two interviewers received the same instructions and training and consulted each other during debriefing, it has been recommended in the literature to consistently use one interviewer as each individual has their own style of phrasing questions which influences how questions were asked and interpreted (Baxter & Eyles, 1997). The use of multiple interviewers could not be avoided in this particular scenario as the recreation centre had a large group of interested participants and a small window of time to conduct the focus groups, which required that more than one take place at the same time. A final limitation was that there was a high non-response rate for the open-ended comments sections on the message rating forms; that is, many comments sections were left blank. Moving forward we would want the participants to rate messages in a focus group setting and have them speak aloud what specifically they liked or disliked and probe them towards providing more of an explanation. More critical feedback would help guide message writing to be most appropriate for adolescents.

3.5 Conclusion

In conclusion, the focus groups helped identify adolescent perspectives on nutrition apps and what adolescents wanted from nutrition apps regarding content and functionality. Overall, the participating adolescents wanted to learn more about nutrition, to expand their cooking skills, and to receive information on recipes and seasonality. Many adolescents seemed to be overwhelmed with the vast amount of nutrition information available and they struggle to determine which information is credible. The focus group participants liked the idea of having a nutrition app at the touch of their fingertips that would provide them with simple nutrition messaging, recipes with video tutorials, interactive maps to suggest healthy vendors, and social sharing components. The information from these focus groups can help researchers and public health professionals to develop appropriate messaging on nutrition and overall healthy living that will resonate with adolescents.

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Chapter 4

4 The Development and Evaluation of an Adolescent Smartphone Nutrition Intervention: A Pilot Study

4.1 Introduction

Many critical health problems facing North Americans today such as obesity, cardiovascular disease, cancer, and type 2 diabetes can be linked to an unhealthy diet (Flores Mateo, Granado-Font, Ferré-Grau, & Montaña-Carreras, 2015; O'Connor et al., 2015; Swinburn et al., 2011). These diet-related illnesses also have a major impact on health care spending. It is estimated that obesity and diet-related diseases cost the Canadian health care system \$7.1 billion in 2016 (Government of Canada & Public Health Agency of Canada, 2011). One likely contribution to the rise in diet-related illnesses is the increasing caloric intake and reduced fruit and vegetable consumption among adolescents and adults (Belanger, Poirier, Jbilou, & Scarborough, 2014; Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Statistics Canada, 2009). National surveys in Canada have shown that only one in ten adolescents in grades 6 to 12 were meeting the minimum recommended daily intake of fruits and vegetables (Minaker & Hammond, 2016). This is concerning, given that diets high in fruits and vegetables are associated with the prevention of many chronic diseases (Boeing et al., 2012).

Adolescence is a unique stage of life, wherein individuals start to develop a level of autonomy, which affects their food purchasing habits and ultimately their food intake (Vaitkeviciute, Ball, & Harris, 2015). Adolescence is the life stage at which many people begin their first paid employment, thereby acquiring disposable income for the first time. Additionally, adolescence is associated with increasing levels of independent mobility (Loebach & Gilliland, 2016; Mitra, 2013), meaning they are being afforded more freedom of movement to travel to and from school and move about their neighbourhoods without parental supervision. This new sense of independence affords adolescents the ability to make their own food choices, which often translates to increased intake of fast food (Bowman et al., 2004). Furthermore, the relatively close proximity and high density of fast food outlets permits increased purchasing among adolescents when a parent or

guardian is not present (He et al., 2012), and when walking as compared to being transported to school (Sadler, Clark, Wilk, O'Connor, & Gilliland, 2016). Many traditional nutrition interventions succeed in increasing adolescent nutrition-related knowledge but fail to either connect that knowledge to the skills and decision-making required to change behaviour (Vaitkeviciute et al., 2015), or to address the environmental heuristics that predispose individuals to make suboptimal decisions (Gittelsohn & Lee, 2013).

Food literacy is a potentially fruitful point of intervention because it encompasses the knowledge, skills, understanding, and the ability to translate that information into healthy dietary behaviours (Vaitkeviciute et al., 2015). Food literacy programs involving adolescents can provide essential information to empower youth to avoid the temptation of marketing and fast food and to supplement with healthier alternatives. These changes in food behaviours can be sustained well into adulthood (Bowman et al., 2004; Pearson, Atkin, Biddle, & Gorely, 2010).

The tools for intervening in food literacy have expanded with recent advancements in technology. As of 2015, 73% of North American teenagers (ages 13-17) had access to a smartphone (Pew Research Centre, 2015). Acknowledging the ubiquitous role that smartphones play in today's culture, many researchers have developed health interventions utilizing smartphones to help improve individual health (Hingle & Patrick, 2016). The relatively low cost of smartphones and minimal burden on the participant make them an ideal medium for delivering health interventions (Coughlin et al., 2015), and particularly useful in reaching the adolescent population (Dute, Bemelmans, & Breda, 2016). With the rising rates of obesity among this population (Statistics Canada, 2016), smartphones seem a particularly convenient and effective way to communicate information on healthy living within this demographic.

Several nutrition interventions utilizing smartphones have been reported in the literature, but most focus solely on weight loss and do not concentrate on an educational food literacy component (Aguilar-Martínez et al., 2014; DiFilippo, Huang, Andrade, &

Chapman-Novakofski, 2015; Flores Mateo et al., 2015; Stephens & Allen, 2013). Within those reported interventions, smartphone software applications (“apps”) and text messaging were utilized to keep participants on track with their dietary and physical activity goals. Many studies differ in their study design and app functionalities, which make it difficult to compare between interventions. Some interventions sent users text messages asking them to submit goals, and follow-up questions to gauge progress (Abraham, Chow, So, Yip, & Nelson, 2015; Dute et al., 2016; Pedersen, Grønhøj, Thøgersen, Gronhøj, & Thøgersen, 2016; Turner, Spruijt-Metz, Wen, & Hingle, 2015). Other interventions utilized apps allowing participants to record a food diary (Zhu et al., 2011), and included features such as recipe banks, goal setting, and physical activity trackers (DiFilippo et al., 2015; Dute et al., 2016; Flores Mateo et al., 2015; Siopis, Chey, & Allman-Farinelli, 2015; Turner et al., 2015). Studies that did include food literacy interventions were often text messaging-based, or used text messaging as an element of a larger multicomponent intervention (Brown, O’Connor, & Savaiano, 2014; Kerr et al., 2016; Pedersen et al., 2016; Siopis et al., 2015). As many of these interventions were not a stand-alone treatment, it is hard to infer their effect (Turner et al., 2015); however, smartphone nutrition apps do show potential as a feasible and acceptable form of intervention (Coughlin et al., 2015; Turner et al., 2015).

Despite the technological advances in nutrition interventions, there is still a lack of peer-reviewed literature on smartphone-based food literacy interventions for adolescents. Currently, some apps are available on the Apple and Android App Stores that provide users with nutrition information, but the accuracy of nutrition information and effectiveness has not been rigorously studied. A literature review evaluating mobile technology for nutrition education found that credible and evidence-based apps are still lacking (Hingle, Nichter, Medeiros, & Grace, 2013) especially concerning their ability to elicit changes in food literacy and dietary behaviours.

This paper reports on the development and pilot evaluation of a food literacy intervention for adolescents utilizing a full-featured smartphone app that addresses key gaps in the literature as outlined in Chapter 2. The study helps to determine which elements of the

SmartAPPetite intervention need to be redeveloped before undertaking a full-scale study. The primary objective of this adolescent pilot study was to evaluate the effectiveness of participant recruitment and retention procedures, suitability of the study instruments, performance of app features, and the overall feasibility of the intervention to improve upon the study design prior to undertaking a full-scale intervention study. A secondary objective was to examine potential differences in food literacy, food purchasing, and food intake behaviours pre- and post-intervention.

4.2 Methods

4.2.1 The Intervention: SmartAPPetite App

“SmartAPPetite” is a smartphone app designed to expand local food literacy and promote smarter food purchasing and healthier eating habits. SmartAPPetite is the product of a cross-sector collaboration, which includes interdisciplinary group of academic researchers, registered dietitians, and community stakeholders and was designed to help address both the rising rates of obesity and to help revitalize the local food economy. Due to limited resources, the alpha version of the app was initially designed for Apple devices only. Extensive preliminary research was conducted with food providers, adult consumers, and adolescents in Southwestern Ontario to inform the design and features of the app (Gilliland et al., 2015; Human Environments Analysis Laboratory, 2014). In particular, focus groups with adolescents revealed what aspects of nutrition interested them and what they wanted to learn more about. This information was ultimately used to develop adolescent specific content for the app that is aligned with their interests and stage of life.

SmartAPPetite is a multi-dimensional intervention designed to encourage users to make healthier food choices. The SmartAPPetite app sends users “chains” of personalized *food tips* (about nutrition, seasonal availability, healthy behaviours, and food handling), as well as related *recipes* using featured food items and nearby *vendors* selling featured items. It is designed to both inform and subsequently ‘nudge’ users towards making healthier food choices and smarter purchases at pre-screened local vendors (Roberto & Kawachi, 2014). This information initially appears as a short text message sent at user-

defined times (typically before meal times) or when users are within a pre-defined distance of a featured healthy food vendor. If the short message is clicked upon (indicating interest by the user), the full screen SmartAPPetite app appears with more extensive information and links. Underlying the app is an algorithm that determines which food tips are most suitable to the individual user, based on an initial 'profile survey' of users to food preferences, goals, and dietary restrictions. These features collectively set this app apart from other food apps.

All messages and information within SmartAPPetite are composed by nutrition student research assistants, compiled from scientifically reliable sources, and then approved by at least one registered dietitian to ensure all information is accurate and evidenced-based. At the time of the pilot study, there were approximately 750 messages in the SmartAPPetite database and each can be classified as either a lifestyle, location-based, adolescent health, or healthy local food message. Within the local food category, there are sub-groups such as availability, nutritional benefits, varieties & flavours, selection, preparation, and storage. Table 4.1 includes sample messages from each of the four categories.

Table 4.1 Sample SmartAPPetite Messages

Message Categories		Short Tip	Full Message
Lifestyle		Are you a mindless eater? Find out why and what you can do!	Sometimes we eat, not because we are hungry, but because we are bored, sad, excited, distracted, stressed or even thirsty. This can cause us to eat without thinking about it, and it can lead to overeating. Next time you reach for a cookie, stop and ask yourself if you are actually hungry. Check out the links below to learn some great ways you can become a more mindful eater!
Adolescent Health		Do you know how much sugar is in one can of pop?	One can of pop contains about 10 teaspoons of sugar. Drinking one can of pop is about 75% of a person's recommended daily limit of sugar! Next time try a beverage with little or no added sugar, like water or unsweetened fruit juice. Or, check the nutrition facts table to help choose options with less sugar.
Healthy Local Food	Availability	Tis the season for Ontario-grown nectarines!	August marks the beginning of Ontario-grown nectarine season! Make sure to grab some delicious nectarines this month from a local vendor.
	Nutritional Benefits	Powerful and purple! Do you know the health benefits of this fruit?	Grapes are a delicious snack packed with nutrients. Purple grapes contain thousands of phytonutrients, a compound in plants, which can help maintain a healthy heart! Grapes also contain Vitamin C, an important antioxidant that helps to maintain your teeth and skin.
	Varieties & Flavours	Did you know cantaloupes are actually muskmelons?	The "cantaloupes" grown in Ontario are actually muskmelons. Although true cantaloupes evolved from the muskmelon species, they are mainly only found in Europe. Muskmelons and true cantaloupes differ in appearance. True cantaloupes are smaller with deep grooves and muskmelons found in North America are larger and have the familiar netted outer skin.
	Selection	Follow these simple tips for picking the freshest celery.	When buying celery, look for stalks that are straight and firm. Fresh stalks should not appear to be limp, soft or damaged. The stalks should have a bright colour and fresh green leaves attached. Try not to choose celery that smells musty, instead, it should have a fresh scent.
	Preparation	Remove bitterness out of Kale with this tip.	Did you know that you can get the slight bitterness out of kale by simply rubbing its leaves together? This process will also make the leaves a bit more tender. This makes including kale in your salads easy, even for picky eaters.
	Storage	How to store cucumbers to preserve freshness.	Cucumbers can be kept for up to 10 days if properly stored. Store in a cool, dry place such as the fridge. To prevent early spoilage, do not wash your cucumber until right before eating. If you don't use the entire cucumber, wrap it with plastic wrap before storing in the fridge and eat within 5 days.
Location-Based		You are close to the Covent Garden Market. Open Year Round!	Covent Garden Market began in 1835! It continues to build upon a long history of selling fresh produce & gourmet foods offering a family atmosphere. It has an ice rink in the winter and a seasonal farmers' market in the summer months. In the Public Square, you will find many public events, such as music & theater festivals. Don't miss it! Open: Mon-Thurs 8am-6pm; Fri 8am-7:30pm, Sat 8am-6pm, Sun 11am-4pm.

4.2.2 Adolescent Pilot Study: Participant Recruitment and Retention

After approval from both the university (NNREB:107034) and school board research ethics committees, we approached a public secondary school to participate in the study. Recruitment of adolescents aged 14 to 17 began in March 2016. Two representatives of the SmartAPPetite team joined a student council meeting to tell the council about the project and gain insight on how best to engage their student body. The council recommended four key strategies: having a display booth during the lunch period, circulating a study poster in all the classrooms, advertising on televisions in the hallways, and offering monetary incentives. The council advised our team that audio announcements would not be appropriate at their school as all communications happened through the hallway televisions rather than over the public-address system. This information was used to help engage the students at the high school.

The school's student success coordinator invited nine classes to participate in the intervention, totaling 239 students. Those classes were given a short presentation about SmartAPPetite, including pictures and explanations of how users were able to engage with the app, and the details of what they were asked to do in the study. To be eligible to participate, the students had to own or have access to an Apple device, such as an iPhone, iPod touch, or iPad. Eligible students in the selected classes were provided with a letter of information and consent form for their parents to sign. Students with consent were asked to complete an assent form and the first survey before downloading the app. During the intervention, participants were sent up to three time-triggered message chains per day and up to five location-triggered vendor messages per day based on their location. Following an eight-week intervention ending in June 2016, participants completed a second survey in addition to open-ended questions about their experience with the app. A \$15 (CAD) bookstore gift card incentive was provided to participants for completing each of the surveys.

4.2.3 Adolescent Pilot Study: Survey Instruments

The first youth survey (pre-intervention) consisted of multiple choice questions, while the second youth survey (post-intervention) contained similar multiple choice questions and

open-ended questions about their experience with the app. The surveys included questions on seven main areas: (1) individual/family characteristics, (2) food preferences, (3) nutrition perceptions, (4) food intake behaviours, (5) food literacy, (6) food purchasing behaviours, and (7) in the second survey only, user engagement. The first section asked participants standard demographic questions, such as age and sex, as well as family characteristics, such as ethnic background and how many people live in their primary household. Participants were asked food preference questions to determine allergies, intolerances, and general eating patterns of the study population. Nutrition perception questions were asked to gauge participants' interest in overall health and nutrition. Participants were asked their level of agreement with statements such as *"Eating healthy is important to me"* and *"I like to cook"*. In the food intake behaviour section, participants were asked questions pertaining to how many meals and snacks they ate a day, and whether they generally cooked or bought those meals. This section acted as a modified food frequency questionnaire to determine how often they consumed fruits and vegetables, common energy-dense nutrition-poor (EDNP) foods, and beverages. The food literacy section consisted of six questions adapted from other food literacy and nutrition knowledge surveys (Levy & Auld, 2004; Vereecken, De Pauw, Van Cauwenbergh, & Maes, 2012) and were used to assess the participants' level of knowledge and perceptions of nutrition and healthy eating. Questions in this section asked participants to match nutrients to their benefit and identify the recommended number of Canada's Food Guide servings for their age group. The final section related to food purchasing behaviours asked participants to identify frequency of food purchasing from nearby retail food outlets. This section displayed a large (2-page) table of food vendors within approximately 5 km of their high school, on which participants were asked to record how often they purchased food from each location on weekdays and weekends on a scale from 0 to 5 or more times. Maps of food vendor locations were also provided as visual cues to help participants recall purchasing behaviour. For the second survey only, individuals were asked nine questions related to their experience using the app, how often they interacted with it, what they liked, what they wanted improved, and if they would recommend it to a friend.

4.2.4 Data Analysis Methods

The quantitative information provided from the youth survey was analyzed using descriptive statistics in SPSS (IBM SPSS Statistics 24). Open-ended questions were coded and analyzed using NVivo for a basic thematic analysis. The focus was on evaluating recruitment and retention procedures, suitability of the study instruments, performance of the app features, and overall feasibility. Additionally, we examined potential changes in food literacy, food purchasing, and food intake; however, particular caution was exercised in drawing conclusions concerning statistical significance of any identified changes (Leon, Davis, & Kraemer, 2011), given the primary objectives and relatively small sample size of the pilot study. The food purchasing map was created using ArcGIS (version 10.5, ESRI, Redlands, California). The Network Analyst function in ArcGIS was used to make network buffers to show walkable distance around the pilot high school. Points were added to the map to indicate food purchasing locations and point size indicates the frequency of purchasing at the locations by the survey participants during a typical week; larger points indicate more purchases. Five different colours were used to indicate the type of food vendor where participants purchased food: fast-food restaurants (dark blue); full-service restaurants (red); grocery stores (green); convenience stores (orange); and pharmacies (light blue).

4.3 Results

4.3.1 Methodological Effectiveness

4.3.1.1 Recruitment and Retention

Before beginning the intervention, all students in the selected classrooms were asked in a hands-up survey how many had an Android, Apple, or other smartphone device. Of the total 239 eligible students, 108 had Apple iPhones (45.5%), 78 had Android devices (32.5%), 1 had another type of smartphone (0.2%), and 52 did not have a smartphone (21.8%). Of the 108 iPhone users eligible for the study, 59 students received parental consent and gave personal assent to participate in the study, representing a participation rate of 54.6% (number of study participants divided by the number of eligible students). All 59 participants completed the first youth survey and 54 out of the 59 completed the second survey (91.5%). The five participants without data for the follow-up survey were

absent on the day the SmartAPPetite team visited the school to administer the second survey, as well as an attempted makeup date a few days later. All five participants lost to follow-up were male; two were in grade ten and three were in grade eleven.

The mean age of participants was 15 years and 56% of participants were female. The majority of participants were in grade ten (61%), with almost equal numbers in grades nine and eleven (*Table 4.2*). Nearly one-third (32.2%) of participants were visible minorities, and three-quarters (74.6%) reported living in a household of four or more people. In addition to being smartphone owners, about half (52.5%) of the participants stated that they owned a tablet (e.g., iPad) or other handheld device (e.g., iPod). Most participants (86%) reported that they did not use any other food, nutrition, or health apps on their smartphone or other handheld devices.

Table 4.2 Baseline Characteristics of Study Participants

	All Participants
Male	26 (44.1%)
Female	33 (55.9%)
Age (Mean \pm SD)	15.4 \pm 0.8
Ethnicity	
White/Caucasian	40 (67.8%)
Visible minorities	19 (32.2%)
Grade	
9	11 (18.6%)
10	36 (61.0%)
11	12 (20.6%)
How many people live in their household	
2	4 (6.8%)
3	11 (18.6%)
4	25 (42.4%)
5	13 (22.0%)
6 or more	6 (10.2%)
Mobile Device Ownership	
Smartphone	59 (100.0%)
Other (e.g. Tablet/Touch/.mp3)	31 (52.5%)
Current use of any food, nutrition, or health apps	
Yes	14 (13.6%)
No	45 (86.4%)

4.3.1.2 Suitability of Study Instruments

Survey response rates and completion rates were analyzed to identify any issues participants had with certain questions or survey sections. Response rate was calculated as the number of participants who took the survey (or responded to the section / question) divided by the whole study sample (n=59). Completion rate was the number of participants who completed a section or question divided by all of the participants who started the survey (n=59 for survey one and n=54 for survey two). The majority of participants filled out sections on demographics (98.8% completion rate), food preferences (93.2% completion rate), nutrition perceptions (100% complete at both survey times), food intake behaviours (survey one 99.8% complete; survey two 98.9% complete), and user experience (94.7% complete).

While completing the survey, quite a few participants had questions about the formatting of the food literacy and food purchasing sections. Subsequently, these sections had lower response rates and completion rates. The food literacy section had an overall completion rate of 85% (84.5% at survey one and 85.6% at survey two); however, the high level of inaccuracy in responses suggests that the participants struggled with the formatting of two particular questions. One question had three rows and asked participants to rank each item in the row from healthiest (1) to unhealthiest (3). Most participants completed this section using numbers one through nine, incorporating the surrounding rows or many placed duplicate numbers on the row (e.g., 1,2,2). The second question asked participants to select one of three options to complete the sentence. Even though there was a high completion rate with this question, the difficulty encountered was that many participants circled more than one answer. Based on the inaccuracy in responses, it was difficult to analyze the results for the food literacy section. In the food purchasing section, participants were asked to indicate how many times they visited a selection of food vendors located around the school. In the first survey, 83.8% of participants filled out this section completely; however, this figure dropped to 76.5% for the second survey. The food purchasing section was divided into questions about purchasing on weekdays versus weekends. The weekend data had significantly lower response rates with only 67.5%

completed responses on the first survey and 51.7% in the second survey and many participants raised questions as to if they were supposed to complete both sections.

The second youth survey included open-ended questions, which allowed participants to provide more information about their general perceptions and experiences after using SmartAPPetite for 8 weeks, as well as specific comments about what they liked or disliked about the app. Of the 54 participants who completed the second survey, 51 (96.2%) provided written feedback.

4.3.1.3 Performance of App Features

Information regarding performance of the app and engagement came from the self-reported answers in the open-ended questions in the follow-up survey. Of the 54 participants who were retained to follow-up, 53.7% of participants stated that they interacted with the app at least once a week, while 38.9% of participants stated they clicked on links within the app once a week or more. The majority of follow-up participants (74.1%) stated that the app benefitted them in some way, and 92.6% stated that they would recommend the app to a friend. When asked why they would recommend SmartAPPetite to a friend, many stated they *“enjoyed the experience”*, they found it *“easy & beneficial”*, and *“my friends need to be more aware of what they eat”*. Similar to these responses, the participants had many comments about their interest and engagement with the app overall, indicating they were generally pleased with SmartAPPetite.

Participants were also asked what suggestions they would make to improve SmartAPPetite. One-third (32.6%) of participants who answered the question stated they would not change anything, and that the app was perfect as it was. The most common responses were that participants wanted the app available on other platforms, they wanted more recipes, and that they would like SmartAPPetite to be more interactive with a *“social media aspect where you can share and compare with friends.”* A couple of participants noted wanting more messages that are adolescent specific and said that they

would change *“the ones about adults because it doesn’t apply to us and are not that helpful”*. Additionally, few participants commented that they would have preferred fewer notifications per day.

Almost one-third of participants (31%) stated that what they liked most about SmartAPPetite was the information the app provided. Participants liked that it was, *“relate-able [sic] to people who are around my age”* and that, *“the information was useful, and educational for teens”*. The participants also noted that they enjoyed that, *“the information was concise and to the point so you aren’t overloaded with information”* and that *“it came up in your notifications so that it was easy to access.”* Many participants noted that they liked receiving recipes and that the app provided, *“good recipes that were both healthy and tasted good.”* Overall, the participants provided constructive feedback through the open-ended responses that will help shape SmartAPPetite for future interventions.

4.3.2 Potential Differences

By having participants complete surveys before and after the SmartAPPetite intervention, we were able to use descriptive statistics to identify potential differences in nutrition perceptions, food intake behaviour, food literacy, and food purchasing behaviours before and after the intervention (*Tables 4.3&4.4*).

4.3.2.1 Food Perceptions

Before receiving the intervention, most participants agreed (98.4%) that healthy eating was important to them. Similarly, following the intervention, 100% of participants agreed that healthy eating was important to them (See Table 4.3). Most of the adolescents in the study also noted that they liked to cook, with a higher proportion agreeing after the intervention (76.2% pre-intervention vs 87.0% post-intervention). Additionally, approximately 88% of participants (before and after the intervention) agreed that, *“cooking or preparing meals helps me eat more healthy”*. At both time points, over 90% of participants also agreed that *“cooking or preparing meals at home helps me save money”* and that time was a barrier to cooking or preparing lunches at home (50.8% before the intervention to 61.1% after the intervention). The majority of participants also

stated that they feel comfortable reading food labels (86.4% pre-intervention, 88.9% post-intervention).

Table 4.3 Participant Perceptions on Nutrition & Cooking

	<i>Pre (n=59)</i>		<i>Post (n=54)</i>	
	Agree	Disagree	Agree	Disagree
“Eating healthy is important to me”	58 (98.3%)	1 (1.7%)	54 (100.0%)	0 (0.0%)
“I like to cook”	45 (76.2%)	14 (23.8%)	47 (87.0%)	7 (13.0%)
“Cooking or preparing meals helps me eat more healthy”	52 (88.1%)	7 (11.9%)	48 (88.9%)	6 (11.1%)
“Cooking or preparing meals at home helps me save money”	57 (96.6%)	2 (3.4%)	50 (92.6%)	4 (7.4%)
“Cooking or preparing lunch to take to school takes too much time”	30 (50.8%)	29 (49.2%)	32 (61.1%)	21 (38.9%)
“I feel comfortable reading food labels”	51 (86.4%)	8 (13.6%)	48 (88.9%)	6 (11.1%)

4.3.2.2 Food Intake

Overall, participants ate approximately three meals and three snacks a day (before and after) (*Table 4.4*). Following the intervention, there were slight increases in participants’ weekly frequency of eating breakfast (4.7 ± 2.6 pre, 4.9 ± 2.3 post), lunch (4.9 ± 1.7 pre, 5.1 ± 1.5 post), and dinner (6.4 ± 1.5 pre, 6.7 ± 0.9 post). Regarding self-reported food intake, results from the intervention show slight increase in fruit (3.4 ± 1.4 pre, 3.5 ± 1.2 post) and vegetable intake (2.9 ± 1.3 pre, 3.1 ± 1.2 post) at the end of the intervention (*Table 4.4*). Participants also decreased instances of EDNP food consumption such as candy, chocolate bars, cookies, cakes, brownies, and doughnuts. For instance, participants reported consuming candy and chocolate bars only once a week, down from nearly twice a week prior to the intervention. Regarding beverages, participants consumed water 2.7 times per day at baseline and 2.9 times per day after the intervention. Secondary to water, participants consumed milk the most often (1.5 ± 1.2 pre, 1.4 ± 1.2 post) and juice after that (1.3 ± 1.0 pre, 1.3 ± 1.1 post). Sports drink consumption also decreased when compared to before the intervention (0.6 ± 0.9 pre, 0.4 ± 0.8 post).

Table 4.4 Participant Food Intake Behaviours

	<i>All Participants</i>			
	Pre	Missing	Post	Missing
<i>During a typical day, how many...</i>				
Meals do you eat	3.0±0.8	0	3.3±0.8	5
Snacks do you eat	2.8±1.2	0	2.7±1.3	5
<i>During a typical week, how many times a day do you consume...</i>				
Fruit	3.4±1.4	0	3.5±1.2	6
Vegetables	2.9±1.3	0	3.1±1.2	5
<i>During a typical week, how many times do you consume...</i>				
Chips	1.2±1.3	1	1.2±1.4	5
French fries	0.7±0.8	0	0.9±1.3	5
Candy or chocolate bars	1.8±1.5	0	1.0±1.3	5
Cookies, cakes, brownies or doughnuts	1.5±1.5	1	1.2±1.4	5
Ice cream	1.0±1.6	0	1.3±1.4	5
Sweetened cereals	0.9±1.5	0	0.9±1.6	5
<i>During a typical day, how many times do you drink...</i>				
Water	2.7±0.6	0	2.9±0.3	7
Juice	1.3±1.0	0	1.3±1.1	6
Milk	1.5±1.2	0	1.4±1.2	6
Chocolate milk	0.4±0.8	0	0.3±0.7	6
Regular pop	0.4±0.7	0	0.4±0.6	7
Diet pop	0.1±0.4	0	0.1±0.3	7
Sports drinks	0.6±0.9	0	0.4±0.8	7
Coffee	0.3±0.7	0	0.3±0.6	6
<i>During a typical week, how many days do you...</i>				
Eat breakfast	4.7±2.6	1	4.9±2.3	5
Make your own breakfast	3.2±2.7	0	3.6±2.6	5
Buy breakfast	0.6±1.5	0	0.3±0.8	5
Eat dinner	6.4±1.5	0	6.7±0.9	5
Make your own dinner	2.8±2.6	0	2.7±2.6	5
Prepare or help prepare dinner	3.1±2.2	1	3.1±2.1	5
Eat pre-made dinner (i.e. frozen meals)	1.1±1.4	0	1.1±1.4	6
Eat out or take-out food for dinner	0.9±0.9	0	0.8±0.7	7
<i>During a typical school week, how many days do you...</i>				
Eat lunch	4.9±1.7	0	5.1±1.5	5
Make your own lunch	2.6±2.3	0	2.8±2.4	6
Eat a packed lunch (prepared at home)	3.5±2.1	0	4.0±1.9	7
Buy a lunch	1.2±1.7	0	0.9±1.2	6

In addition to the quantitative data, approximately 30% of participants self-reported that engagement with the app also helped to change their food behaviours. Many participants noted, “*It makes you rethink your food choices*”, and examples of how they used the information learned through the app to directly change behaviours such as eating less junk food and applying their knowledge of nutrition while shopping at the grocery store.

A few other participants commented that they experienced an increase in intake of local foods and gained more awareness about healthy recipes. One participant mentioned, “*I now eat more local foods and I eat more variety*”.

4.3.2.3 Food Preparation and Food Purchasing Behaviours

At the end of the intervention, participants reported making their own breakfast (3.2 ± 2.7 pre, 3.6 ± 2.6 post) and lunch (2.6 ± 2.3 pre, 2.8 ± 2.4 post) more frequently each week.

Accordingly, there was also an increase in eating of packed lunches pre/post intervention (3.5 ± 2.1 pre, 4.0 ± 1.9 post). Participants also reported purchasing breakfast (0.6 ± 1.5 pre, 0.3 ± 0.8 post) and lunch (1.2 ± 1.7 pre, 0.9 ± 1.2 post) less often after the intervention.

Analysis of food purchasing data from the pre-intervention survey indicates that 88.1% (52/59) of participants purchased food from nearby vendors within 1500 metres from their school at least once per week during weekdays. At the end of the intervention only 75.9% (41/54) of participants reported purchasing food from a vendor within a 1500-metre radius of the school at least once during the school week. Figures 4.1 and 4.2 illustrate the frequency of food purchasing around the high school and identifies where adolescents were making food purchases based on vendor type and geography. Figure 4.2 provides geographic context to the data by illustrating where exactly participants are purchasing and how often they are frequenting each of the vendors. The streets were removed while creating the map (*Figure 4.2*) to help maintain the anonymity of the school.

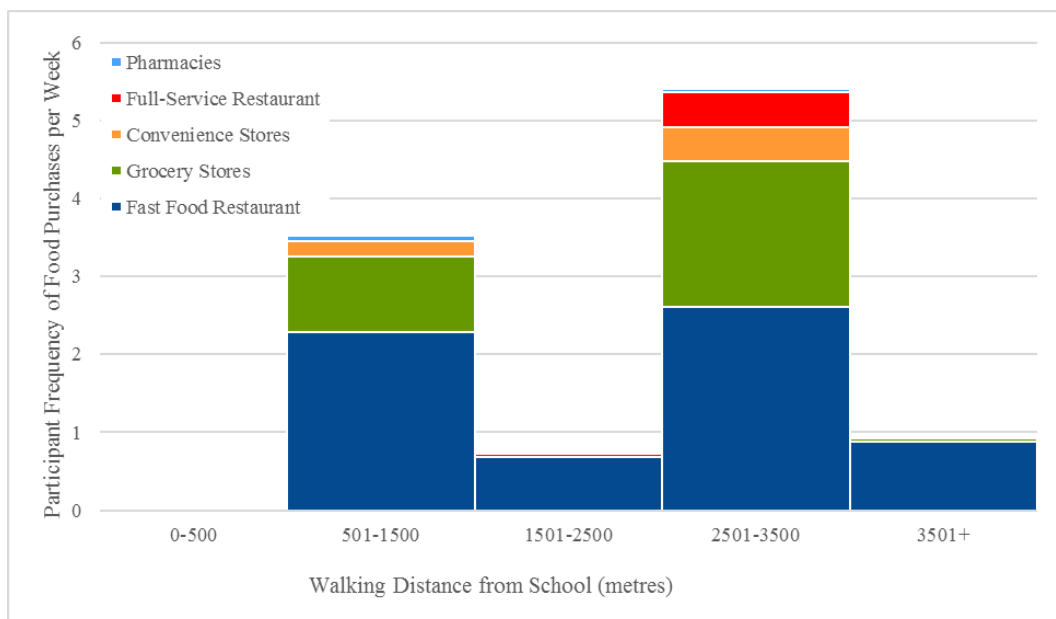


Figure 4.1 Frequency of Participant Self-Reported Food Purchasing during Weekdays*

* Note: Participants were asked to self-report frequency of food purchases by vendor type based on a typical week. Therefore, frequencies represent the average number of food purchases across the 59 participants.

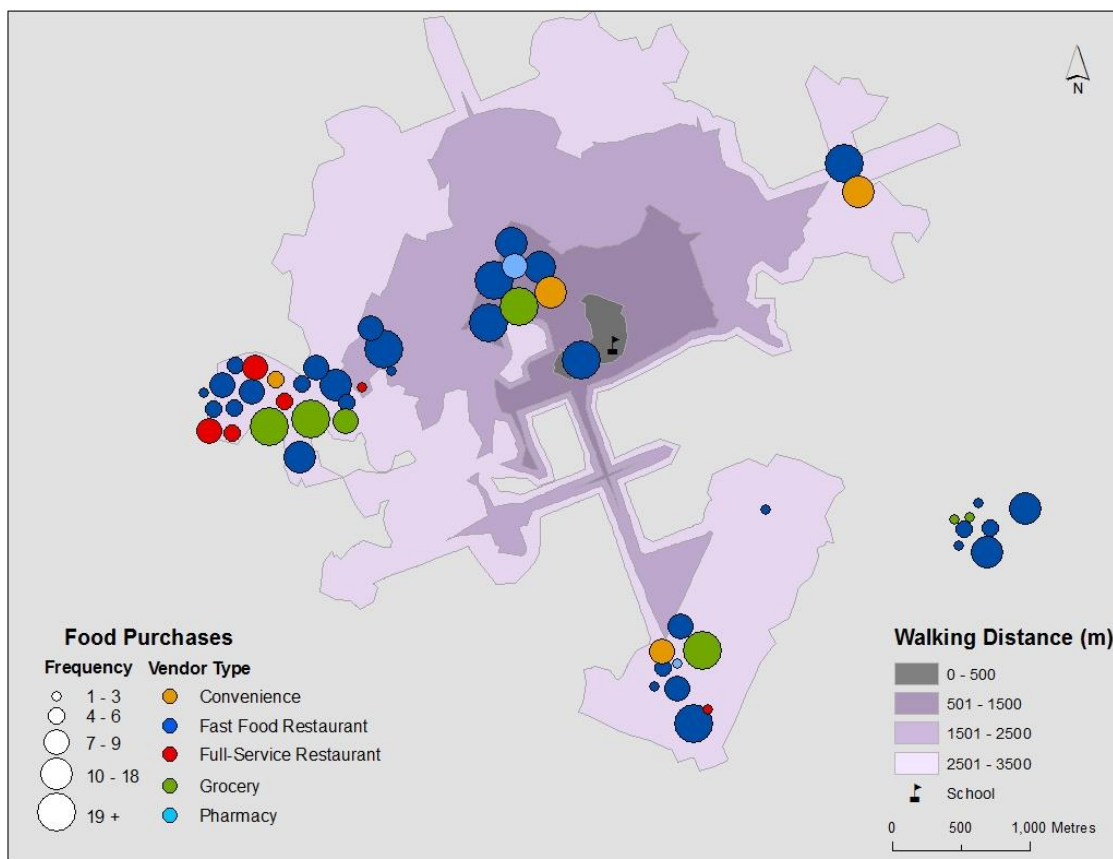


Figure 4.2 Vendor Locations and Frequency of Self-Reported Food Purchasing by Study Participants during Weekdays*

*Note: All participant (n=59) self-reported food purchasing responses were aggregated by vendor and illustrated based on vendor type and frequency. Therefore, frequency values represent totals by all 59 participants.

Table 4.5 indicates what percent of purchases were made within the five selected buffers that are used in Figure 4.1 and 4.2. It appears that the adolescents from this high school make about 35% (35.8% pre and 34.1% post) of their purchases within a 1500-metre radius from their high school. There was also a significant amount of food purchasing done about 2500 to 3500 metres away from the school, which corresponds with the location of a large shopping mall. Additionally, Figure 4.3 displays all weekday food purchases divided by vendor type. The majority of all purchases were made at fast food restaurants before (61.7%) and after (64.7%) the intervention. About one quarter of all

purchases were made at grocery stores (26.1% pre; 24.8% post). Note for the purpose of this analysis convenience store data also includes stores attached to gas stations. Due to low response rates in the weekend food purchasing data, it was excluded for all analyses.

Table 4.5 Frequency of Food Purchasing Outside the School during Weekdays

	Pre-Intervention		Post-Intervention	
	% of Purchases	Mean	% of Purchases	Mean
Within 500 Metres	2.9	19	3.1	14
501 - 1500 Metres	32.9	30	31.0	20
1501 - 2500 Metres	6.6	11	9.6	11
2501 - 3500 Metres	49.2	10	49.6	7
Beyond 3500 Metres	8.3	5	6.7	3
All	100.0	12	100.0	8

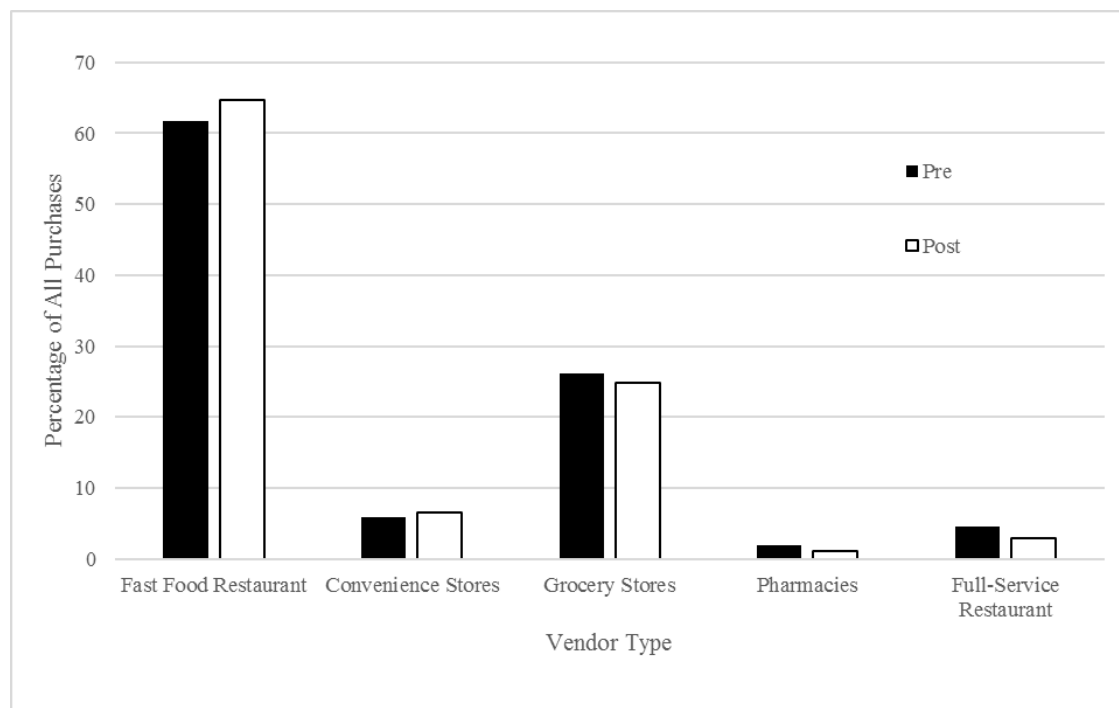


Figure 4.3 Percent of Adolescent Weekday Food Purchasing by Vendor Type

4.3.2.4 Food Literacy

The food literacy section had an overall completion rate of 85%; however, the participants struggled with the formatting of two particular questions. Although the food literacy section of both surveys had high completion rates, there was some confusion

from the participants about the questions, which resulted in the high level of inaccuracy in responses. For this reason, responses were not analyzed statistically; nevertheless, useful qualitative information can be gleaned from the open-ended text provided by 94.7% of participants who completed the open-ended questions on the post-intervention survey. The majority of participants (49.1%) noted that the app helped improve their knowledge about food and nutrition. For example, one 16-year-old female participant stated, *“a lot of information on the internet is not accurate. It was helpful to know that the information about health and eating habits was true and reliable”*. Additionally, 16-year-old male participant mentioned that SmartAPPetite, *“helped me be more aware of what I’ve been putting into my body and made me more likely to read the nutrition label on the back of the package.”* A 15-year-old female participant noted, *“I started to be even more aware and had a healthier perception on the types of food that I am eating. I am also more focused and dedication [sic] in actually caring about my own health rather than what I physically look like”*.

4.4 Discussion & Conclusion

Regarding the first objective to evaluate the effectiveness of the SmartAPPetite methodology, we assessed participant recruitment and retention procedures, suitability of the study survey instruments, performance of SmartAPPetite features, and the overall feasibility of the intervention to improve upon the study design and respective elements prior to undertaking a full-scale intervention study.

Support from the school board and the secondary school to participate in the study was easily attained. As an educational intervention, the research committee of the board and the school Principal were eager to provide the students with the opportunity to learn more about healthy living in general, particularly healthy eating. Engaging with the Student Success Coordinator, teachers, and the Student Council was critical to the recruitment process, as it helped find school champions who could encourage students to participate in the project. Each high school functions differently, thus it was particularly beneficial to confer with members of the Student Council to understand what works best with their

student body and formulate an engagement strategy that would be successful in that school.

The SmartAPPetite app was only available on the Apple iOS platform, which limited the number of students who could potentially participate in the study to less than half (45.5%) of students from the included classes. As of 2016, the North American smartphone market overall saw sales of Android smartphones surpass Apple at 54.4% of market share compared to 44.4% (Kantar Worldpanel ComTech, 2016). Development of an Android version of SmartAPPetite would mean that virtually all students would have an eligible device with which to participate in the intervention, therefore improving future recruitment levels.

The pilot study was successful at retaining 91.5% of participants for the eight-week duration, with only five participants lost to follow up due to absence from school. The follow-up survey was conducted the week before final exams, a time when many students were away from school because of end-of-year sports tournaments or preparing for final exams. We attempted to return to the school one more time to allow participants another opportunity to complete the follow-up survey, but did not pursue these students further during exam time. To avoid loss to follow up in the future, data collection should finish earlier in the school year, so as not to conflict with exams and known extra-curricular activities.

Through the open-ended questions the participants provided invaluable feedback on what they liked about the app and what they would want to see improved. Overall, participants seemed very positive with their experience with the app and most of the participants reported that the app benefitted them in some way and that they would recommend the app to a friend. There were many positive remarks about SmartAPPetite, and majority stated that what they liked most was the information, ease, and design of the app. Offering messages that are specific to adolescents helped them relate to the messages and ultimately allowed the information to resonate. Similar to the literature about nutrition messaging, the adolescents in this study were very receptive to SmartAPPetite's use of

short messages with just enough information and the user-friendly design features, which made it easy for the users to engage with the app. Constructive feedback from the open-ended questions indicated that future versions of the app should be available on Android platforms, include more recipes, and allow participants to engage with others through the app. Providing a feature that can allow participants to connect with one another or share what they have learned over social media might attract more users and boost engagement particularly with adolescents. Another comment that a few participants mentioned was that they would have preferred fewer notifications per day; revisions will therefore aim to make this setting more apparent. Overall, participants provided positive anecdotes that they enjoyed the app and delivered feedback that can help SmartAPPetite progress in the future.

The majority of sections in the surveys were filled out with high completion rates indicating participants were able to work through most sections with ease. Some participants had questions based on the formatting of the food literacy and food purchasing sections, which corresponds to the sections that had low response rates. Participants' insights identified the need to keep question formatting as simplistic as possible so that instructions are not left to interpretation. For example, students got confused when asked to rank three items in a row from one to three, and consequently many ranked all items in the question from one to nine or put multiple of the same numbers. Furthermore, viewing how participants responded to the questions identified some things to consider when interpreting the results. For example, one question from the section asked participants to check all of the healthy snacks in the list below. The difficulty with a question formatted this way is that if a participant does not respond to a question, there is no way to determine if they did not fill out the question or if they simply believed all options were unhealthy. In the future, questions will have more direct instructions and questions asking participants to rank items will not be used. Additionally, the final section of the survey featured a large table identifying the food vendors near the school. Students were asked to select the frequency that they attend almost 60 vendors on weekdays and weekends. Concerns were raised on the extensiveness of this question by a few participants, and participant burden ultimately

resulted in missing data, particularly there was low response rates from the section on frequency of weekend food purchasing (67.5% first survey completion rate; 51.7% in the second survey). Moving forward, food purchasing habits will have to be identified using another method, such as using GPS trackers and food purchasing data or readjusting the existing table to reduce encumbrance.

Although the objective of a pilot study is not formal hypothesis testing, basic descriptive statistics provide us with trends as to what can be anticipated from the full-scale study. The responses from survey questions about nutrition perceptions and food intake behaviours indicated the participant's general interest in health and nutrition. Most participants identified that healthy eating was important to them and that cooking or preparing meals helps them to eat a healthy diet. This willingness and interest in health translated to dietary behaviours in the questions related to food intake behaviour. At the end of the intervention, participants reported that they ate breakfast more frequently than at the beginning of the study. This correlates to our messaging on the importance of eating breakfast and quick breakfast recipes. There was also an increase in participants who made their own breakfast and decrease in those who purchased breakfast. Similarly, participants making and packing lunch increased, and participants going out for lunch and dinner decreased. SmartAPPetite messaging provided participants with easy tips to prepare their own meals and avoid the high calorie options available at many of the fast food chains, thus allowing knowledge to translate to behaviour change.

As indicated from the food purchasing questions, the adolescents participating in this study frequently purchase food in their school neighbourhood. About one-third of all purchases were within 1500 metres of school, or a 15 minute walk zone; whereas almost half of all purchases occurred at vendors located between 2501 - 3500 metres of school. Based on the literature it was anticipated that adolescents would have high levels of food purchasing within one kilometre from their school (He et al., 2012). This school was located by a large plaza (within 1500 metres) and near a large regional mall (within 2501-3500 metres), which resulted in many students purchasing food in those areas. Unfortunately, time was not considered when collecting the food purchasing data in this

survey, so it is unclear when these purchases were made. However, based on the distance from the school it is possible that many students are frequenting the mall at the end of the school day when they have more time to bus, walk, or drive to the further location. Overall, when assessing adolescent's food purchasing it is important to consider large plazas and malls not within the direct proximity to the schools as adolescents may be purchasing in those areas during their lunch breaks or after school.

The majority of all purchases were made at fast food restaurants; however, based on our limited information it is uncertain as to what was purchased at these vendors (e.g. drinks, meals, snacks). The volume of purchases made at fast food restaurants indicates the need to provide adolescents with messages when they are around these food vendors to help guide them to healthier food choices. Furthermore, results suggest that many adolescents purchase food at groceries stores. Further research may be needed to determine the nature of their purchases at these vendors, the time adolescents purchase there, and if they are shopping with their parents.

Our sample reported only consuming vegetables three times a day and instances of fruit intake was on average 3.5 times per day. Based on the use of instances rather than serving sizes, intake of fruit and vegetables cannot be compared to that of the average Canadian. Thus, it is not possible to determine if the 7.5 instances of fruits and vegetables a day would equate to the recommended seven fruit and vegetables a day for females and eight for males. While there were no discernable changes in fruit and vegetable intake after the intervention, there were decreases in many EDNP foods, such as candy, chocolate bars, cookies, cakes, brownies, and doughnuts. Similarly, results from the Connecting Health and Technology (CHAT) study also was able to show a decrease in participant consumption of energy-dense nutrition-poor foods, which was able to boost the overall nutrition quality of their participant's diets (Kerr et al., 2016). Consuming fewer of these high calorie foods coupled with more fruits and vegetables could help improve the nutritional quality of the adolescents' diets and have overall positive implications on their health.

Although there were many inaccuracies in the food literacy survey responses, the open-ended responses identified that many participants reported that SmartAPPetite helped them to expand their knowledge about nutrition and many noted that engagement with the app helped shape their food behaviours. Participants also valued knowing that the information was credible and used this information to help motivate them to change their behaviours. More profound than gaining knowledge and changing behaviour, some adolescents mentioned a change in perspective, that SmartAPPetite helped them to gain a new outlook on healthy living. Other participants commented that their engagement encouraged them to eat more local food and learn about new recipes.

If the insight provided by participants and the trends from the pilot are indicative of what is possible for the full-scale study, then SmartAPPetite shows potential to provide adolescents with nutrition education, which can ultimately improve their food literacy levels, dietary perceptions and behaviours. To-date there are few peer-reviewed studies evaluating if nutrition apps are able to change dietary behaviours or food literacy levels in adults and even fewer for adolescents (DiFilippo et al., 2015). Most interventions currently focus on food records and dietary feedback to help participants lose weight. Furthermore, based on limited research and the difference in study design and app functionalities between interventions it is difficult to conclude the effectiveness of using smartphone apps to change dietary behaviour (Coughlin et al., 2015). Further research is needed to help determine the effectiveness of smartphone app interventions, particularly of nutrition interventions not focused solely on weight loss.

4.4.1 Feasibility & Limitations

This pilot study provided substantial methodological contributions and demonstrated the feasibility of conducting the full-scale SmartAPPetite study through an evaluation of the recruitment and retention procedures, performance of app features, and the suitability of the study instruments. Furthermore, based on the teams' knowledge, the required resources, the responses from the study participants it appears feasible to conduct the full-scale study. Understanding adolescents' willingness to engage with smartphone

applications, this app could have the potential to reach many adolescents, within and beyond Southwestern Ontario. Providing this education at such a crucial phase in life could help shape the food literacy and food behaviours of Canadians into adulthood. Adding this educational and interactive technology into high school health curriculum could ensure that all students are receiving evidenced-based nutrition education.

This pilot study identified what tools and elements worked well and what should be altered before undertaking a full-scale study. A few limitations were encountered throughout the study or at the time of analysis, which provided opportunity to improve the methodology for the full-scale intervention.

For the pilot study, a modified food frequency questionnaire (FFQ) was administered to minimize participant burden, while still allowing us to gather essential information. The modified FFQ asked questions about instances of fruit and vegetables in addition to a variety of EDNP snacks, and a selection of beverages. Participants were asked instances of foods rather than servings to avoid user misinterpretation of an accurate serving size. For adolescents, conceptualizing a serving is more difficult than recollection of frequency because calculating servings requires a complex cognitive task in which many are unfamiliar (Livingstone, Robson, & Wallace, 2004). Unfamiliarity with the task or confusion with the instructions often results in misreporting or electing to skip the question altogether. Asking participants to only report instances does simplify participant burden, but data derived from instances of consumption is less substantial. Regarding policy implications and comparing data to national averages, we now acknowledge the need for serving sizes to have data that are more meaningful. In the full-scale study, a 24-hour recall would be more appropriate to adequately determine what and how much adolescents are eating, which would help to determine any change from the beginning to the end of the study. Using a smartphone app to administer a 24-hour recall in the full-scale study could help appeal to the adolescent demographic, receive accurate portion sizes, and prompt users to ensure no required information is missing. Using a more in-depth analysis of their diet will be able to identify if there are any changes in dietary behaviours and overall nutrition.

As addressed above, the food literacy section had many questions that were filled out inaccurately and would need to be changed before undertaking a full-scale study. Another limitation with the section was the questions were more focused on nutrition knowledge and less about food literacy as a whole. Food literacy encompasses knowledge in addition to food skills, attitudes, self-efficacy, behaviours, and food security (Cullen, Hatch, Martin, Higgins, & Sheppard, 2015). Gearing questions in this section to include more than just nutrition knowledge will help to accurately measure food literacy levels in participants. Some questions should encompass food skills such as which of the following photos is a picture of a minced onion, or julienned pepper and if a recipe says “1 $\frac{3}{4}$ cup sugar divided” what does it mean (Chambers, 2012). Other questions can be tailored towards participants perceptions and knowledge of food security, such as how many kilometres does most of our food travel from farm to plate, and how much food does the average Canadian waste (Meyer, n.d.). Some questions should be focused on understanding of the food system and food production such as what season are zucchini harvested in Ontario and where does asparagus grow (underground, above ground, in a tree) (Meyer, n.d.). Including questions from all facets of food literacy would be a more appropriate representation of participant food literacy levels for the full-scale study.

This study began in March, after the spring break, and concluded in June. In Southwestern Ontario high schools, the spring semester has many interruptions that made conducting research within the schools more challenging. Some interruptions that affected entering the classrooms included standardized testing, school carnivals, sports events, and other activities towards the end of the year. Five participants were lost to follow-up because they were absent at the time the researchers entered the school. Teachers at the school remarked that many students skipped classes or were absent more frequently towards the end of the semester. With this in mind, starting the study earlier in the year could help counter this loss to follow-up. Furthermore, conducting one study in the spring and one in the fall would account for any changes in seasonality.

Feedback on the performance of the app through app analytics is important to help identify areas for improvement. Further funding for development could help smooth out some bugs in the current alpha version, add more of the desired features to the app, and will help to keep regular maintenance to avoid expected technological glitches.

Qualitative responses from the open-ended questions also identified specific features and functionalities, such as including more recipes and added features to engage with other, which could help improve the app in the future. In addition, the app is currently only available for Apple devices, but with supplementary funding, the team hopes to make SmartAPPetite available for Android devices.

In conclusion, this pilot study provided the opportunity to learn many important lessons that may ultimately improve future applications. SmartAPPetite shows the potential to improve food literacy, food behaviours, and food purchasing habits in adolescents. Participants seemed very receptive to the medium of a smartphone app and had many positive remarks about their engagement with SmartAPPetite. This pilot study suggests the potential for a larger scale SmartAPPetite intervention with an adolescent population and the feasibility of using smartphones to deliver nutrition interventions.

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Chapter 5

5 Conclusion

5.1 Summary of Studies

The overarching aim of this thesis research was to contribute to the growing body of literature using smartphones as a medium for health and nutrition interventions. Specifically, this thesis aimed to fill a key gap in the literature by conducting qualitative and quantitative research to identify the appropriate content and functionalities to include when designing a smartphone intervention for adolescents. Specific research objectives were examined using mixed methods in two separate but complementary studies. The objective of the qualitative research conducted in Study 1 (Chapter 3) was to gain adolescent perspectives on the desired content and functionality to include when developing a nutrition smartphone app for adolescents. Using the findings from Study 1, adolescent specific messages were developed to be used for an intervention study. Study 2 (Chapter 4) involved the implementation and evaluation of a pilot intervention study using SmartAPPetite in a London, Ontario high school to determine what elements of the intervention were effective and what areas need to be improved before a full-scale study.

The first study, outlined in Chapter 3, incorporated a mixed-method approach using focus groups and a short survey to gain insights from adolescents as to the content and functionality to include when redeveloping a nutrition app for the adolescent demographic. The primary objective was to determine what content can help to engage adolescents and what features they want from a nutrition app. The specific objective of the short surveys was to identify if the messages were interesting, relevant, and useful for adolescents. This was explored from conversations in seven semi-structured focus groups and from a short survey where participants rated a sample of healthy local food messages and other messages written specifically for adolescents.

From the focus groups, seven overarching themes were identified within content and functionality: topics of interest, where are they getting information from, cooking skills, recipes, seasonality, what they want in an app, and when to receive information. There

was a consensus from the focus group participants that they wanted to learn more about healthy eating, sports nutrition, sleep, body image, and cultural foods. Participants said that they currently get their nutrition information from the internet but also reported getting information from school, their parents, and friends. Furthermore, majority of the adolescents mentioned having some knowledge of cooking, although, most did want to learn more about cooking and wanted to be given simple recipes to try out in their own kitchen. The participants did say they were interested in learning more about food seasonality and the participants felt that it was important information to know and eating in-season produce would be of better quality and have financial benefits.

The participants had many ideas about how to make a nutrition app interesting and appropriate for adolescents. They stressed the importance of making any nutrition tips short and simple, and suggested adding features in the app to keep adolescents engaged such as social media sharing, adding a chat function, and incorporated an interactive map function that can suggest healthy vendors and provide information like directions, what they sell, and prices. The adolescents could not come to an agreement as to what time would be best to send messages, which suggests that timing should be individualized. Lastly, results from the message rating suggested that adolescents are more receptive to messages written specifically for their demographic and less receptive to general healthy local food messages, even though majority of participants in the focus groups said they wanted to learn more about seasonality. Overall, the focus group participants had many ideas about what content and functionality would be well-received by adolescents.

The second study, (Chapter 4) paper reports on the development and pilot evaluation of a food literacy intervention for adolescents in a London, Ontario high school. Participants were asked to complete a survey before and after the intervention and were asked to use the SmartAPPetite app for eight weeks. The primary objectives of the study were to evaluate the recruitment and retention methods, performance of app features, suitability of study instruments, and overall feasibility of the intervention. The secondary objective was to explore potential differences in food literacy, food purchasing, and food intake that may suggest what to expect in the larger-scale study.

From the pilot study, recruitment strategies were successful overall and conferring with the schools' Student Council prior to the study helped to ensure the intervention was tailored to the school. Furthermore, it is anticipated that recruitment will rise once the intervention is available on the Android platform in addition to the current Apple iOS app. From the open-ended responses, there were many positive anecdotes suggesting participants enjoyed their experience with the app. There were some suggestions for improvement, such as having the app available for Androids, adding a social media component, and having fewer notifications. The majority of the sections in the survey had high response and completion rates, although, there were lower response rates and inaccuracy in responses in the food literacy and food purchasing section, suggesting the need to simplify the questions for those sections. Based on the evaluation of the pilot study implementation, recruitment and retention rates, performance of app, and suitability of study instruments, there are some improvements to make to the intervention before the full-scale study. Nevertheless, overall it appears that it would be feasible to conduct a full-scale SmartAPPetite intervention study with a larger group of adolescents.

The purpose of the pilot study was not formal hypothesis testing; however, some basic descriptive statistics were completed to propose potential differences between pre and post-intervention results that might appear in the full-scale study. At the end of the intervention, participants reported eating breakfast more often, packing meals more often, and purchasing less frequently. Additionally, based on weekday food purchasing data, it appears adolescents are purchasing in their school food environment and majority of their purchases occur at fast food restaurants. Although there were no discernable changes in fruit and vegetable intake, there was a decreased intake of many energy-dense nutrition-poor (EDNP) foods such as candy, chocolate bars, cookies, cakes, brownies, and doughnuts. Based on open-ended responses participants also reported that SmartAPPetite helped them to expand their knowledge about nutrition and many mentioned that engagement with the app helped shape their food behaviours. Overall, results from this pilot help to identify areas of improvement for future research and suggests many potential positive outcomes that might be seen from the full-scale study.

5.2 Research Contributions

This thesis contributes to a growing body of research on nutrition interventions for adolescents using smartphone applications. Chapter 3 utilizes focus groups and short surveys with message rating to determine what adolescents want from a nutrition smartphone app in terms of content and functionality. Results from this study contribute to the health promotion literature on adolescents, specifically in the area of nutrition and health messaging. This literature has typically focused on the type of messages and voice and tone to use when writing for adolescents (Hingle, Nichter, Medeiros, & Grace, 2013; Pollard et al., 2016). The findings of Study 2 in conjunction with the existing literature help to identify what areas of nutrition adolescents want to learn about and how best to write messages that resonate with them. Researchers can use the findings from this study and the existing literature to develop their own messaging-based health interventions for adolescents. Furthermore, the study findings can inform researchers as to what features adolescents want from a smartphone app when developing nutrition interventions.

Currently there is a gap in the literature regarding nutrition smartphone apps for adolescents that are not focused on weight loss. SmartAPPetite is very unique app and has many features that set it apart from other available apps. SmartAPPetite was designed to help inform users on healthy eating and healthy living while guiding them to healthier behaviours using the recipes and vendors provided with each message. This project was developed by a large interdisciplinary team utilizing knowledge and resources from many researchers across several different disciplines (i.e., geography, nutrition, epidemiology, consumer behaviour) to equip individuals with the tools to make healthier behaviours. Furthermore, all the information in the SmartAPPetite app is evidenced-based and approved by a registered dietitian to ensure its credibility. SmartAPPetite sends users personalized information based on a user preference survey that is filled out upon downloading the app to ensure messaging is appropriate for each user. Additionally, SmartAPPetite is rooted in geography, behavioural economics, and ‘nudge’ theory to help individuals make healthier behaviours based on their environment.

The results from the study in Chapter 4 suggests what can be expected from the full-scale study. However, as this is a pilot study, detailed statistical analyses were not completed and inferences should not be made based on these results. This pilot study provided substantial methodological contributions and verified the feasibility of running a full-scale intervention. This study afforded me the opportunity to run the intervention on a small-scale and determine limitations with the methodology, develop solutions, and understand how to improve these dimensions before undertaking a full-scale study. By conducting this research, I was able to determine aspects of the study instruments that did not perform as anticipated and caused confusion among the participants. Accordingly, recommendations have been made to redevelop the food literacy, food intake, and food purchasing sections of the survey to be able to better assess participant knowledge and behaviours without imposing too much burden or confusion on the participants. Additionally, positive anecdotes from the open-ended questions suggested the acceptability of the app from an adolescent population. This pilot study was also able to confirm that many aspects of the study did perform well and are appropriate to use in a full study. Some areas of success were the recruitment and retention procedures, survey sections on individual/family characteristics, food preferences, nutrition perceptions, and user engagement, and the overall knowledge and resources available from the large interdisciplinary SmartAPPetite team. The methodological contributions from this pilot study will not only help to develop the SmartAPPetite intervention to be more successful in a larger setting, but will also help inform other intervention research with adolescents. Furthermore, there were encouraging quantitative and qualitative responses from the open-ended questions, which confirmed the acceptability of the app with adolescents and the feasibility of conducting the full-scale study.

Behavioural economics is a rapidly expanding area of research with many useful applications based on its breadth of theories and the tools that it is built upon. SmartAPPetite was developed with a grounding in behavioural economics and uses elements of nudging and anchoring in its study design to help combat tendencies to make decisions based on present bias. SmartAPPetite's study design sets it apart from other apps and interventions rooted in behavioural economics. A full-scale study will more

firmly establish if SmartAPPetite can improve food literacy, food purchasing, and dietary behaviours in adolescents. Nevertheless, results from this pilot study do demonstrate how different tools and theories within behavioural economics can be used together in an intervention to improve health behaviours.

Many recent studies in health geography research focus on evaluating food environments and how an individual's environment affects their food purchasing. This thesis research makes additional contributions to the geographic literature as it explores a tool created to help individuals navigate their neighbourhood food environment and ultimately improve their dietary behaviours. This research confirmed that adolescents are purchasing in their school food environments and a full-scale study will help us to determine the effectiveness of SmartAPPetite as a tool to alter food purchasing habits by decreasing food purchasing at fast food vendors or substituting purchases with healthier alternatives.

This thesis fills a current gap in the literature. The lessons learned from this pilot study can help guide researchers who are creating other smartphone nutrition interventions and will directly influence the implementation of the full-scale SmartAPPetite study. Understanding what elements of the intervention were and were not appropriate for adolescents can help other researchers developing adolescent interventions using smartphones and those implemented in high schools.

5.3 Implications for Policy & Practice

The results from Chapter 3 have direct implications for practice and can be used to guide public health professionals on how to write nutrition messaging for adolescents.

Adolescents are a particularly challenging group to engage using traditional interventions, as they often do not see it as relevant to them (Pollard et al., 2016).

However, using the suggestions directly from the adolescents in these focus groups could help improve the acceptability of the messaging and help the information resonate with this demographic. Additionally, results from this study can be used to inform other types of health promotion initiatives, campaigns, and interventions for adolescents.

Understanding what adolescents want to learn about will improve the effectiveness of the intervention.

At this stage, the results from this thesis will not have immediate and direct impacts on policy; however, findings from both studies have provided information that can lead to additional work, which could have policy impacts. Results from a full-scale intervention using SmartAPPetite, for example, could have impacts on public health policy by showing how the use of smartphone interventions have the ability to elicit a change in adolescent's dietary behaviours, food purchasing habits, and food literacy levels. Public health practitioners and policymakers might take interest in the use of a smartphone app to provide a nutrition intervention based on its potential for wide reach because of its minimal burden and the fact that many adolescents already own a smartphone.

SmartAPPetite was developed with the understanding that we are unable to change the built environment to help adolescents make healthier behaviours. Instead, SmartAPPetite equips adolescents with the tools to be able to navigate their food environment. Based in behavioural economics, this program believes that the daily nutrition knowledge as well as the location-based messages that nudge participants will help adolescents make the better decision amidst a saturated food environment. Cumulatively, these features encourage individuals to make healthier food choices and has the potential to shape their overall food purchasing patterns, which could ultimately affect the options that are available in their environment. On a broader scale, menu labeling is an example of a tool conceptualized to influence individual decision making by allowing consumers to make informed decisions while dining out and as a result has influenced the food environment (Bleich, Wolfson, & Jarlenski, 2017). Menu labelling was introduced in Ontario, Canada in 2017, although it has been in parts of the United States since 2006 (Government of Ontario, 2017; Nestle, 2010). Currently, there is still some debate in the literature as to if the implementation of menu labelling in North America has been able to impact short-term and long-term consumer purchasing (Bleich et al., 2017; Bruemmer, Krieger, Saelens, & Chan, 2012). However, the positive effects of menu labelling have been evident through industry reformulation to alter existing items to be lower in energy, fat,

and sodium (Bleich et al., 2017; Gerend, 2009). Although on different scales, tools such as menu labelling and the SmartAPPetite app both encourage users to make healthy food choices when confronted with saturated food environments. They also have the ability to influence consumer behaviour resulting in potential changes in the surrounding food environment.

Using smartphones to deliver health interventions to improve individual health has been well documented in the literature and with government support these apps can have an even broader reach. In March 2016, a smartphone app called Carrot Rewards, was released in British Columbia, Canada to encourage users to increase health knowledge and encourage healthy behaviours (Mitchell et al., 2017). This app is rooted in behavioural economics to encourage users to engage in healthy behaviours (increase their daily physical activity – measured by steps) through the use of financial incentives (loyalty points) (Mitchell et al., 2017). Within the first three months of release, the app had over 67,000 downloads (Mitchell et al., 2017). Since then, the app has expanded to two other provinces and has received substantial funding from the Public Health Agency of Canada and provincial governments (Carrots Insights, 2017). With the help of public health support, the Carrot Rewards app has successfully been able to scale-up their intervention and demonstrated their broad reach, which shows the potential for other smartphone health intervention, like SmartAPPetite (Mitchell et al., 2017). Further research is needed to determine if apps like Carrot Rewards have potential to influence population health.

Additionally, SmartAPPetite may have the potential to be used in high school curriculum. The findings of this research provided a considerable amount of information from the adolescent perspective on what types of messaging are most interesting, useful and relevant to them, and whether the approach may be most effective for encouraging healthier eating behaviours. Despite positive findings, additional research is required to determine whether or not SmartAPPetite is a useful tool for improving food literacy and food knowledge among adolescents. Additionally, further research will need to be conducted with teachers, school board officials, education ministries and any other

stakeholders involved in curriculum development to determine its applicability as a tool in the classroom. Overall, there are many potential impacts for policy and practice, however, more research needs to be conducted using SmartAPPetite for a longer duration and with a larger sample size to determine its full potential.

5.4 Limitations

One of the main research questions in this thesis was to identify what elements of the SmartAPPetite adolescent intervention need to be redeveloped before undertaking the full-scale study. Each study had its own limitations and recommendations of how to improve in the future.

In the study in Chapter 3, seven focus groups were conducted at three different recreation centres in Southwestern Ontario. The first limitation with the focus groups was that there were no note takers, although all focus groups were audio-recorded and transcribed verbatim to ensure nothing was missed. In future, having an additional researcher at the focus groups to take notes would be beneficial to review topics of discussion before moderating the next session.

One of the recreation centres invited me to conduct focus groups during their staff training session but only had a forty-five minute time slot for the focus groups. In this one instance, multiple focus groups had to take place at once, which required more than one interviewer to conduct the focus groups to accommodate the large group of interested participants. Although the interviewers consulted for training and debriefing, it has been recommended to consistently use one interviewer as each individual has their own style of phrasing questions which can influence how questions are asked and interpreted (Baxter & Eyles, 1997). Additionally, in this one instance, multiple focus groups were conducted in the same room, which affected the sound quality and the ability to identify participants from one another in the audio recordings. For this reason, no sex-based analysis was completed, as the information might not have been accurate when identifying exactly which participant made each statement. These limitations could not be

avoided in this situation based on the need to accommodate the recreation centres availability.

The pilot study in Chapter 4 reported on the effectiveness of using SmartAPPetite as a nutrition intervention with adolescents and evaluated the methods of the intervention. A few limitations were encountered throughout the study and at the time of analysis, which provided an opportunity to improve the methodology for the full-scale SmartAPPetite adolescent intervention.

For the pilot study, a modified food frequency questionnaire (FFQ) was included as part of the survey rather than a 24-hour recall to minimize participant burden, while still collecting essential information. The modified FFQ asked questions about how many instances a day participants had of fruit and vegetables in addition to a variety of EDNP snacks and a selection of beverages. Participants were asked instances of foods rather than servings to avoid user misinterpretation of an accurate serving size. For adolescents, conceptualizing serving size is more difficult than recollection of frequency because calculating servings requires a complex cognitive task that many are unfamiliar with (Livingstone, Robson, & Wallace, 2004). Unfamiliarity with the task or confusion with the instructions often results in misreporting or electing to skip the question altogether. Asking participants to only report instances does simplify participant burden, avoids low response rates, and inaccuracy, but the data derived from instances of consumption is less meaningful than serving sizes. In a full-scale study, a 24-hour recall would be more appropriate to adequately determine what and how much adolescents are eating, which would help to determine any change from the beginning to the end of the intervention.

In the food literacy section, three of the six questions were filled out inaccurately and would need to be changed for the full-scale study. Another limitation with the section was that the questions were more focused on nutrition knowledge and less about overall food literacy. Food literacy encompasses many aspects in addition to knowledge, such as food skills, attitudes, self-efficacy, behaviours, and food security (Cullen, Hatch, Martin,

Higgins, & Sheppard, 2015). Adapting questions in this section to include more than just nutrition knowledge will help to accurately measure food literacy levels.

Another limitation in Study 2 was the timing of the intervention. Recruitment for the intervention began in March, after the spring break, and concluded in June. In Southwestern Ontario high schools, the spring semester has many interruptions that made conducting research within the schools challenging. A few interruptions that affected entering the classrooms included standardized testing, school carnivals, sports events, and other activities towards the end of the year. In the pilot study, five participants were lost to follow-up as they were absent from school during the second period of data collection. Acknowledging potential interruptions, starting the study earlier in the year could help counter loss to follow-up.

5.5 Future Research

The results from this thesis research helps to inform future research for the SmartAPPetite study and other smartphone nutrition interventions for adolescents. The results from Study 1 drove the development of adolescent specific messages to alter the existing app to be more appropriate for an adolescent population. A base of evidence-based nutrition messages were created for the pilot study and continue to be expanded to have a large enough database of messages for a longer full-scale study. The research conducted in Study 2 helped to identify areas of success, limitations, and ways to improve the methodology for the full-scale SmartAPPetite adolescent intervention. From the pilot study, food purchasing survey section we know that during weekdays adolescents are purchasing food in their school neighbourhood and that the majority of these purchases are being made at fast food restaurants. Accordingly, before the beginning of the larger scale study environmental audits will be conducted in the selected school's neighbourhood food environment to assess the food options available. Using this information messages specific to the options available will be created to help guide adolescents to make healthier decisions when they purchase. Additionally, using the recommendations from the pilot, an improved version of the SmartAPPetite app will be available for both Apple and Android platforms. This new version will have the ability to

connect through social media so that users can share what they learn with their friends. In addition, the new version of the app will be able to produce app analytics to inform the team what messages are being sent to users and to determine that the app is functioning as planned.

The results from the pilot study also helped to determine hypotheses and objectives for the full-scale study. Our primary objective is to examine the effects of the SmartAPPetite intervention among adolescent participants on (a) food literacy, (b) food purchasing behaviours, and (c) diet quality compared to a control group. We hypothesises that youth who receive and use the intervention will exhibit greater improvements in food literacy, food purchasing behaviours, and diet quality. Our secondary objective will be to look how the potential impacts of the intervention are impacted by their level of engagement with SmartAPPetite and by factors at the individual level (i.e., age, sex, BMI, socioeconomic status), social environment level (i.e., family meal habits, family and friend/peer use of app), and physical environment level (i.e., density and proximity of health and unhealthy food outlets in home/school neighbourhood). Other objectives of the full-scale study will be to assess the long-term efficacy of the intervention and to determine what elements of the intervention are most effective at engaging adolescents and their parents to support future research.

Future research could focus more deeply on food literacy, which is a current gap in the literature, particularly for adolescent populations. Currently, there is not a validated food literacy tool available and researchers are still trying to develop a consistent definition for food literacy. In future, the implementation of a validated food literacy tool would improve validity and accuracy of measurements across studies. However, until a validated food literacy tool is developed, the food literacy section in the SmartAPPetite survey will be redeveloped to accurately assess many aspects of food literacy such as knowledge and perceptions on food skills, food choices, food security, and food systems. Survey questions regarding food skills can address different cooking methods, food preservation methods, and participants' ability to understand a recipe (Chambers, 2012). Some messaging and questions can be geared towards participants perceptions and

knowledge of food security such as what are the benefits of buying local, what percent of their income does the average Canadian spend on food, and how much food does the average Canadian waste (Meyer, n.d.). Other questions should be focused on expanding and grasping participants current understanding of the food system and food production such as in what season are Brussels sprouts harvested in Ontario, and which vegetables and fruit grown locally in Ontario (Meyer, n.d.). Including questions from all facets of food literacy would be a more appropriate representation of participant food literacy levels for the full-scale study.

Another area of future research could be focused on food intake and food purchasing study tool development. There are currently very few, if any, easy-to-use tools for capturing adolescent food intake and food purchasing. Ideally, tools could be built into the app, which make it easier for participants to complete food frequency surveys that accurately record serving sizes. Using apps to capture food intake and food purchasing, particularly in adolescent is still an emerging area of research (Biltoft-Jensen, Holmgaard Nielsen, Hess Ygil, Christensen, & Fagt, 2017; Doumit et al., 2016). Additionally, we need to conduct research into how to more efficiently and accurately capture data on participants' food purchasing, as recall surveys can be burdensome for participants, thereby leading to inaccurate or incomplete data. Alternatively, using some combination of the smartphone's GPS functions with built-in food purchasing diaries could be developed to capture data on location, timing, frequency, and types of adolescent food purchases. Research on tool development in this area will help researchers gather the necessary information to determine if smartphone nutrition interventions are able to elicit positive changes in food literacy, food purchasing, and dietary behaviours.

Another area for further research is to determine if the SmartAPPetite app could be used in high school curriculum. While conducting the pilot in the school the intervention classroom teachers were very supportive of the study and appreciated the opportunity for their students to learn more about healthy eating and healthy living. The gym and science teachers mentioned the importance of nutrition education; however, they mentioned finding it difficult to find time in the semester to talk a lot about the subject. Some

teachers mentioned how they thought SmartAPPetite could be incorporated into the curriculum to allow students to learn more about nutrition outside of class time. One teacher thought it would make most sense to ask students to use the app for the course of the semester and create a project related to SmartAPPetite at the end of the semester to ensure they were engaging with the app. To explore this opportunity further, interviews should be conducted with high school teachers to determine how they could use SmartAPPetite in the classroom, if it could fit within school curriculum, and any recommendations they may have to help improve the success of the app with adolescents. This information coupled with the results of the full-scale SmartAPPetite study could help inform policymakers and school board officials about the potential use of a program like SmartAPPetite in the classroom setting.

5.6 Conclusion

In conclusion, the purpose of this thesis was to determine how to make the SmartAPPetite intervention most applicable and effective for adolescents by using insights from focus groups and a pilot study intervention with adolescents in London, Ontario. Findings from the focus group research helped to identify what adolescents want in a nutrition smartphone app in regards to content and functionality. These results have direct implications for health professionals and were used to guide adolescent message writing to improve the effectiveness of the SmartAPPetite intervention for adolescents. The pilot study provided the opportunity to run the intervention on a small-scale and determine limitations with the methodology, develop solutions, and understand how to improve for the full-scale study. The pilot study provided substantial methodological contributions for the project and verified the feasibility of running a full-scale intervention. Findings from a future full-scale SmartAPPetite adolescent intervention will determine if the intervention is able to elicit a change in food literacy, food purchasing, and dietary behaviours. Positive results from this thesis have demonstrated the feasibility of using smartphones to deliver nutrition interventions and the potential for important implications for public health policymakers and practitioners working to improve adolescent health and wellbeing.

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Appendices

Appendix A Research Ethics Approval Forms for the Use of Human Participants (Redacted)



Western
Research

Research Ethics

Western University Non-Medical Research Ethics Board
NMREB Full Board Initial Approval Notice

Principal Investigator: Dr. Jason Gilliland
Department & Institution: Social Science\Geography, Western University

NMREB File Number: 107034
Study Title: SmartAPPetite Adolescent Study
Sponsor:

NMREB Initial Approval Date: September 28, 2015
NMREB Expiry Date: September 28, 2016

Documents Approved and/or Received for Information:

Document Name	Comments	Version Date
Instruments	Parent Survey	2015/07/29
Instruments	Youth Survey	2015/07/29
Instruments	Focus Group Guide	2015/08/18
Revised Assent	SmartAPPetite Teen Assent	2015/09/01
Revised Western University Protocol		2015/09/01
Revised Letter of Information & Consent		2015/09/17

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the above named study, as of the NMREB Initial Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

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 [REDACTED]

Ethics Of [REDACTED]

For Further Information

Erika Basile	Grace Kelly	Mina Mekhail	Vikki Tran
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This is an official document. Please retain the original in your files.



**Western
Research**

Research Ethics

**Western University Non-Medical Research Ethics Board
NMREB Amendment Approval Notice**

Principal Investigator: Dr. Jason Gilliland

Department & Institution: Social Science\Geography, Western University

NMREB File Number: 107034

Study Title: SmartAPPetite Adolescent Study

NMREB Revision Approval Date: July 14, 2016

NMREB Expiry Date: September 28, 2016

Documents Approved and/or Received for Information:


Document Name	Comments	Version Date
Revised Western University Protocol	Received July 14, 2016	
Revised Letter of Information & Consent		2016/07/14

The Western University Non-Medical Science Research Ethics Board (NMREB) has reviewed and approved the amendment to the above named study, as of the NMREB Amendment Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

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 

Ethics Officer, on behalf

Ethics Officer: Erika Basile ___ Katelyn Harris ___ Nicole Kaniki ___ Grace Kelly Vikki Tran ___ Karen Gopaul ___

Appendix B Research Ethics Youth Focus Groups Letter of Information (2 pages)



Youth Focus Groups Letter of Information SmartAPPetite Adolescent Study

To whom it may concern,

[REDACTED] and his research team from Western University invite you to participate in a focus group to help his research team develop effective healthy eating and healthy lifestyle messages for adolescents. In order to create messages that appeal to adolescents, we would like to get input and feedback from high school-aged adolescents. All of the information that will be asked is based on opinion and preference, but will not include sensitive information. In the future, our team would like to use these messages as part of a nutrition smartphone-based intervention in high schools to improve the food literacy and healthy eating habits of adolescents (more information about intervention development at [REDACTED]). The focus groups will involve high school-aged adolescents in [REDACTED].

Purpose of the Letter

The purpose of this letter is to provide you with the information required for you to make an informed decision regarding your participation in our research.

Inclusion Criteria

Any high school-aged adolescents are welcome to take part in our research.

Who is our team?

Our team is staffed by a team of university partners, including research support from [REDACTED]

What would you have to do?

If you choose to participate you will be asked to talk to us for approximately 35 minutes with three or four other students. All you have to do is give us your opinions and preference regarding healthy living and healthy eating. We will not ask you any sensitive information, like where you live or your health status.

All focus groups will be audio recorded and unidentified direct quotes may be used later. In order to participate in the focus group or interview, you must be willing to be audio recorded and have unidentified direct quotes potentially used later in academic publications only.

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.

Risks

There are no known or anticipated risks or discomforts associated with participating in this study.

Confidentiality

Should you agree to participate, any information you provide will be kept strictly confidential and used only for research purposes, and names will be changed to maintain privacy. Your identity will be known to other focus group participants and the researchers cannot guarantee that others in these groups will respect the confidentiality of the group. By consenting you are agreeing that all comments made during the focus group and everything that happens during the focus group remain confidential and are not discussed outside of the focus group meeting. Representatives of The University of Western Ontario Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research.

Contact

If you have any further questions about the project we encourage you to please contact the research team at the phone numbers and emails listed below.



If you have any further questions regarding your rights as a study participant, please contact the Office of Research Ethics at [redacted]. This letter is for you to keep. Please return the attached Registration form. You will also receive a copy of the registration form once it has been signed. You may also make general inquiries about this research by e-mailing [redacted].

Appendix C Research Ethics Youth Assent Form for Focus Groups**Youth Focus Groups Consent Form
SmartAPPetite Adolescent Study**

I have read the letter of information, have had the nature of the study explained to me and I agree to participate in the focus groups. All questions have been answered to my satisfaction.

Participant's Name: _____

Date: _____

Signature: _____

Date: _____

Investigator's Signature: _____

Date: _____

Appendix D Research Ethics Focus Group Guide

Focus Group Guide

1. **Welcome:**
 - a. Thank you for taking the time to join the discussion group on healthy living and healthy eating. My name is _____.
2. **Overview of the Topic:**
 - a) Before we get started, I will tell you about why we want to speak to you. We have created a smartphone app called SmartAPPetite, which sends messages to users on various topics regarding healthy living and eating. We created the app for adults, and now we want to adapt it for teenagers, just like you. We are looking for your input on what topics would be interesting for you about healthy living and healthy eating. Today, we will be talking about the following themes: healthy eating, cooking skills, food literacy, healthy lifestyle and eating habits. We are looking for your input on what topics are important and interesting to you. We are interested in your thoughts and your opinions so we can make this app appropriate for teenagers. There are no right or wrong answers we just want to hear what you have to say.
3. **Guidelines:**
 - a. Let me suggest some ways in which the discussion will go smoothly. Be sure to speak loudly enough and only one at a time. We will use your first names here today, but in anything that we write after we collect all our data, your names will not be used so that no one will know who made the comments.
 - b. My role is to ask questions and listen. I won't be participating in the conversation, but I want you to feel free to talk with one another. I will be asking about 6-8 questions and I'll be moving the discussion from one question to the next. We will be done in about 30 minutes. It is important that I hear from each of you because you each have different experiences.
4. **Getting to Know You: (approx. 5 minutes)**
 - Let's find out some more about each of you by going around the table. Before we get started, does anyone mind if we audio record our conversation so we don't miss any of your comments. Please state your first name, age, and your favourite food? (each person must respond).
5. **Questions:**

Thank you for sharing. Now I want to move on to our focus group questions.

 - a) If you were going to subscribe to a teen nutrition app, what topics would you want to learn about?
 - o Probe examples (if no topics are given): Would you be interested in topics on healthy eating? Cooking tips and/or recipes? Sports nutrition? Sleep?
 - o Probes: Why are these topics important to you? What makes them interesting to you? What information on those topics would you want to receive (e.g., facts, tips)?
 - b) Where do you currently get your information on these topics?
 - o Probe: Peers? School? Internet?

- c) How often do you make yourself a snack or meal?
 - o Probe: Would learning a new skill or technique in the kitchen be something that would interest you, such as learning how to debone fish, roll out pasta, or how to poach an egg?
 - o Probe: How willing would you be to try a new recipe?

- d) Are you interested in learning what fruits and vegetables are in season? Why or why not?
 - o Probes: If yes: Would learning about seasonality make you want buy or cook with produce that is in season? Or do you think you would be interested in learning about it but it wouldn't impact your behaviour?
 - o Probes: If no: Why is seasonality not interesting or relevant to youth like yourself?

- e) During a typical school day do you purchase any snacks or lunch?
 - o Probe: Do you buy food at the school cafeteria or outside of the school? Are there food vendors near your school? What motivates you to bring a lunch or buy food?

- f) Our app provides information on nutrition, food seasonality, food skills, recipes, and information on where to purchase food. If you were to design a nutrition app are there any other features or information you would want it to have?

Appendix E Sample Message Rating Handout

Title: Make your life simpler and get into the habit of planning lunches for the week.					
Message: Are you always rushing in the morning and struggling to make your lunch in time to catch the bus? We have the perfect solution! On Sunday, plan lunches for the upcoming week. Look at what you have in the fridge and try to plan meals with foods from each of the four food groups. Try making your lunches the night before to save yourself the added stress in the morning. And don't forget to pack an icepack.					
	1 (Not at all)	2	3 (Somewhat)	4	5 (Very)
Is this message interesting?					
Is this message useful?					
Is this message relevant?					
Comment (Why you liked it or why you didn't):					

Title: Drink up more of that sunshine vitamin in every glass of milk!					
Message: Vitamin D, a.k.a. the sunshine vitamin, isn't found in many foods. For this reason, it is added to foods like cow's milk. Vitamin D is important when it comes to building strong bones. Drinking two glasses of milk each day is a great way to meet your daily vitamin D needs.					
	1 (Not at all)	2	3 (Somewhat)	4	5 (Very)
Is this message interesting?					
Is this message useful?					
Is this message relevant?					
Comment (Why you liked it or why you didn't):					

Title: Beat late night hunger without gaining weight using these snack ideas!					
Message: Healthy late night snacking is a great way to blast away hunger! Snacks such as vegetables, chocolate milk or whole grain toast and peanut butter are fast and easy healthy choices. Rather than reaching for a bag of chips, look for a snack that is lower in calories, sodium, and fat as a healthy choice.					
	1 (Not at all)	2	3 (Somewhat)	4	5 (Very)
Is this message interesting?					
Is this message useful?					
Is this message relevant?					
Comment (Why you liked it or why you didn't):					

Title: Cinnamon rolls smell great, but pack a lot of calories!					
Message: Cinnamon rolls from fast food restaurants provide on average 400 calories per bun, but may be upwards of 800 calories! Considering the average diet is 2000 calories per day, you can do the math on how quickly the calories can add up. Instead of eating one roll to yourself, as an occasional treat, try sharing one roll between friends. The taste doesn't change and you will eat much less calories.					
	1 (Not at all)	2	3 (Somewhat)	4	5 (Very)
Is this message interesting?					
Is this message useful?					
Is this message relevant?					
Comment (Why you liked it or why you didn't):					

Appendix F Research Ethics Letter of Information for Parents (3 pages) for SmartAPPetite Intervention

Letter of Information



Dear Parents,

[REDACTED] and his research team from Western University invite your high school-aged child to participate in a nutrition and healthy living program 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. SmartAPPetite is designed to help users gain important knowledge for improving their health through the receipt of messages that include tips about healthy eating and healthy lifestyle for teens, recipes, and vendors that sell healthy foods. SmartAPPetite has prepared messages tailored especially for youth based on focus groups with high school-aged youth and contributions of experts in adolescent health, including registered dietitians. This study will involve high school-aged youth in London, Ontario during the Spring of 2015.

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.

Purpose of the Letter

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.

Who is our team?

Our core research team includes: [REDACTED]

Inclusion Criteria

Any high school-aged adolescents who can speak and read English are welcome to take part in our research. Any parents/guardians of high-school aged adolescents.

What will happen in this study?

If you and your child agree to participate, you will be asked to:

1. **Complete the Parent SmartAPPetite Survey.** This short 5 minute survey will ask questions about your family demographics. 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, your child will be asked to:

1. **Complete the Youth SmartAPPetite Survey.** Before and after using SmartAPPetite, your child will be asked to complete a 15 to 20 minute survey asking questions about demographics, food purchasing behaviours, food consumption, and food knowledge. The survey is to be taken online at home. Upon completion of each surveys, your child will receive a \$5 gift card (\$10 total).
2. **Receive SmartAPPetite Messages for 8 Weeks.**
 - a. **If your child has an Apple device**, such as an iPhone, iPad, or iPod Touch, they will be asked to download the free SmartAPPetite app from the AppStore. They will receive up to 3 healthy eating and healthy lifestyle messages per day for 8 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 my child does not have an Apple device** they will have the option of receiving a daily message through email for 8 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. Email addresses will not be used for other purposes and will not be shared with third party
3. **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. The focus groups will be autorecorded to ensure we catch the whole conversation. If you want to participate you must be aware that all conversations will be recorded. If you do not want to be audio recorded you may not want to participate in the focus group portion of the study. All data collected will remain confidential and accessible only to the investigators of this 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 would like to 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 child's name will not be used

Benefits

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.

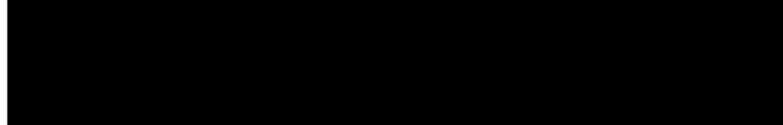
Risks

You and your child may be hesitant to disclose personal information for example, email address, postal code, or use a GPS-enabled application. 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.

Does my child have to participate in this study?

Your consent to allow your child to participate in the study is completely voluntary. Your child does not have to participate and will only be able to participate after they receive parental consent. They can refuse to answer any survey or focus group question, and can choose to leave the study at any time.

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 Research Ethics at [REDACTED]. This letter is for you to keep. Please return the attached Registration form. You will also receive a copy of the registration form once it has been signed. You may also make general inquiries about this research by e-mailing [REDACTED]. If you do wish for your child to participate, please read the following consent statement:

Appendix G Research Ethics Parent Consent Form for SmartAPPetite Intervention

Consent Form

Should you agree to participate, any information you provide will be kept strictly confidential and used only for research purposes, and names will be removed and/or changed to maintain privacy. Completion of the following consent form indicates your agreement to allow your child to participate in this study. If you do not wish your child to participate simply discard this consent form and do not return it.

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

If student is under 18 years of age,

Parent's Name: _____ Date: _____

Parent's Signature: _____ Date: _____

If student is 18 years of age or older,

Student's name: _____ Date: _____

Student's Signature: _____ Date: _____

Investigator's Signature: _____ Date: _____

Student's Email Address (to receive email based messages): _____

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

Appendix H Research Ethics Youth Assent Form for SmartAPPetite Intervention

SmartAPPetite Letter of Assent



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 during the Spring of 2015.

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?

1. **Complete the Youth SmartAPPetite Survey.** Before and after using SmartAPPetite, you will be asked to complete a brief 15-20 minute survey asking questions about demographics, food purchasing behaviours, food consumption, and food knowledge. The survey will be completed in class. Upon completion of each of the two surveys (one in March and one in May after the study), you will receive \$15 gift card (\$5 for the first one and \$10 for the second).
2. **Receive SmartAPPetite Messages for 8 Weeks.**
 - a. **If you own an Apple device**, such as an iPhone, iPad, or iPod Touch, you will be asked to download the free SmartAPPetite app from the AppStore. You will receive up to 3 healthy eating and healthy lifestyle messages per day for 8 weeks. These messages will include a tip about healthy eating and healthy lifestyle about teens, often a recipe related to the tip, and a list of related vendors based on their current geographic location. The app also provides GPS-enabled messaging to tell you if you are close to any local vendors.
 - b. **If you do not own an Apple device** you will have the option of receiving a daily message through email for 8 weeks. These messages will include a tip about healthy eating and healthy lifestyle about teens, often a recipe related to the tip, and a list of related vendors close to your school. Email addresses will not be used for other purposes and will not be shared with third party.

3. *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. We would like to audio record our conversation from the focus group to make sure we don't miss any suggestions and comments.

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.

If you would like to participate in the study please write your first name, last name, email, your signature, and today's date.

Student's First Name: _____

Student's Last Name: _____

Student's Signature: _____

Student's Email Address: _____

Date: _____

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

- Through an Apple device (iPhone, iPod, iPad)
- By email

Focus Groups in June:

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

Curriculum Vitae

Name:	Sarah Cappuccitti
Post-secondary Education and Degrees:	<p>The University of Western Ontario London, Ontario, Canada 2011-2015 B.Sc.F.N. (Hons)</p> <p>The University of Western Ontario London, Ontario, Canada Sept 2015- Aug 2017 (Expected) M.A.</p>
Honours and Awards:	<p>Federated Women's Institutes of Ontario (FWIO) Helen M. McKercher Scholarship 2016</p> <p>Undergraduate Student Research Award (USRA) from NSERC Extending the Shelf Life of Fresh Fruit to 63 Days 2013</p> <p>Undergraduate Student Research Award (USRA) from NSERC Using Starches and Fibres to Substitute Soy in Natural Nuggets 2012</p>
Related Work Experience	<p>Teaching Assistant The University of Western Ontario 2015-2017</p> <p>Research Associate, Project Coordinator Human Environments Analysis Laboratory 2015-Present</p> <p>Lab Assistant Brescia University College 2013-2015</p>
Conference Publications:	<p>Canadian Nutrition Society (CNS) 2017 Montréal, Quebec <i>"Investigating the use of a smartphone-based dietary intervention within an adolescent population"</i></p>

Canadian Association for Food Studies (CAFS) 2017

Toronto, Ontario

“Evaluating a Smartphone-Based Nutrition Intervention in an Adolescent Population”

Children's Health and the Environment Workshop and Symposium (CHEWS) 2017

London, Ontario

“The development and evaluation a messaging-based nutrition smartphone intervention in an adolescent population”