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Development and Application of a Teen-Informed Tool for Measuring the Power of Food-Related Advertisements in Canadian Environments

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Abstract

Food environments are influential in shaping dietary behaviours of adolescents. Exposure to food and beverage marketing is known to impact food knowledge, behaviours, and health outcomes, yet food environment research largely overlooks advertisements. Given that marketers tend to advertise less healthy foods to teens and teens predominantly purchase low-nutrient foods, it is crucial to study the information environment in the context of secondary school environments. This thesis uses a sequential mixed-methods approach, including environmental audits and teen consultations, to develop and apply a teen-informed tool to measure the *power* of advertisements surrounding secondary schools. Results indicate that exposure to and power of advertisements increases closer to schools, and total advertising power is highest within schools. This research offers a novel methodology and provides a more nuanced understanding of food marketing to teens. This thesis urges policymakers to consider the impacts of teen-directed marketing to help protect teens from food advertising.

Keywords

Food environment; information environment; teen-directed marketing; advertising perceptions; exposure; power; teenager; measurement tool; mixed methods; health geography

Summary for Lay Audience

There are many factors that contribute to dietary health outcomes, including individual, biological, and environmental factors. However, *food environments*, which include all surroundings and conditions that affect one's dietary behaviours, are increasingly recognized as critical determinants of health. Although food environments are made up of various elements, this thesis concentrates on measuring the food-related *information environment*, which consists of all food and beverage advertising and marketing within a community. This component of the information environment is important to study, as it is interweaved within many other aspects of the food environment (e.g., in schools, community spaces, outside food stores). Environmental audits were conducted to photograph outdoor food-related vendor signage, billboards, and transit shelters within the study area, and teens were consulted to more deeply understand how food advertising and marketing techniques affect teens' food perceptions and purchasing behaviours. The two related studies in this thesis aimed to 1) develop a teen-derived coding tool to measure the marketing *power* (i.e., creative content, design and execution) of food and beverage advertisements, and then 2) apply this coding tool to the information environment both surrounding and within a sample of Canadian secondary schools. Spatial analyses showed that vendor exposure (i.e., # of food vendors per km^2), advertising exposure (i.e., # of food advertisements per km^2), and total advertising power (i.e., sum of advertisement power per km^2) is higher near secondary schools. This methodological contribution adopts a teen-specific perspective, and advances this field by providing researchers with a tool to assess how the information environment is presented to teens. These findings demonstrate the pervasiveness of teen-directed food and beverage marketing across contexts, and advocates for the restriction of food and beverage marketing to this vulnerable population. The outcomes from this thesis support the need for food marketing policies that reduce marketing exposure within communities and promote healthier dietary behaviours within daily food environments.

Co-Authorship Statement

This thesis is presented in an integrated article format. Both articles within this thesis will be submitted for publication in peer-reviewed academic journals. Below are the details of co-authorship for each of the integrated articles.

Chapter 3: Bowman, D.D., Minaker, L.M., Simpson, B.J.K., & Gilliland, J.A. (2019). Developing a Teen-Informed Coding Tool to Measure the Power of Food Advertisements.

Chapter 3 was written by Drew Bowman (DB) with Dr. Leia Minaker (LM), Dr. Bonnie Simpson (BS), and Dr. Jason Gilliland (JG) as advisors and co-authors. The primary author (DB) designed the auditing protocol, led the data collection and analysis, and drafted the manuscript. DB worked with the Human Environments Analysis Laboratory Youth Advisory Council (HEALYAC) over several sessions to develop a tool that measures the information environment and quantifies the power of food and beverage advertisements. LM, BS, and JG provided guidance throughout the process of developing the coding tool. JG, the primary supervisor of DB, was involved in conceptualization of the project, as well as advising on all aspects of the methods, data analysis, and manuscript writing. All co-authors offered suggestions on successive drafts of this paper.

Chapter 4: Bowman, D.D., Minaker, L.M., Simpson, B.J.K., & Gilliland, J.A. (2019). Measuring Food and Beverage Advertising Surrounding Canadian Schools Using a Teen Coding Tool.

Chapter 4 was written by Drew Bowman (DB) with Dr. Leia Minaker (LM), Dr. Gina Martin (GM), Dr. Bonnie Simpson (BS), and Dr. Jason Gilliland (JG) as advisors and co-authors. DB is the primary author and performed the conceptualization, data collection, analysis, and writing of this article. DB performed field data collection with the help of research assistants from the HEAL. LM assisted with developing the food auditing protocol. All authors were involved in the application of the tool and the analysis of the advertising data. JG supervised the project and assisted with the conceptualization, methods, data analysis, and application of the teen-informed coding tool that was developed in Chapter 3. All co-authors helped proofread and edit drafts of the paper.

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Chapter 1

1 Introduction

1.1 Research Context

The nutritional health of Canadian children is a public health concern that needs to be addressed, as one third of children between the ages of five and seventeen years are living with overweight or obesity (Bancej et al., 2015; Rao et al., 2016; Roberts et al., 2012). Although the determinants of diet and associated health outcomes are multifactorial (Glanz, Sallis, Saelens, & Frank, 2005; Story, Neumark-Sztainer, & French, 2002), *food environments*, which are typically characterized in terms of neighbourhood food access and availability, play an important role in the food purchasing decisions and health outcomes of adolescents (Caspi et al., 2012; Day & Pearce, 2011; Engler-Stringer, Shah, Bell, & Muhajarine, 2014a; Gilliland et al., 2012; He et al., 2012a; He et al., 2012b; Rideout, Mah, & Minaker, 2015; Soltero et al., 2017; Velazquez et al., 2015a). The food environments in many Canadian neighbourhoods do not support teenage wellbeing; these spaces are often highly obesogenic, lack nutritious food options, and expose teens to a wide selection of energy-dense, nutrient-poor foods (Black, 2014; Health Canada, 2013; Minaker & Raine, 2013; Sadler et al., 2016; Velazquez et al., 2015a). Thus, food environments are known to contribute to the prevalence of type 2 diabetes, cardiovascular disease, and other diet-related health conditions (Ball & McCargar, 2003; Glanz et al., 2005; Lamichhane et al., 2012; Morenga et al., 2014; Public Health Agency of Canada, 2017).

Poor quality food environments are more likely to be found in low income neighbourhoods, (Day & Pearce, 2011; Kestens & Daniel, 2010; Soltero et al., 2017; Yancey et al., 2009) and are often concentrated around elementary and secondary schools (Austin et al., 2005; Dubreck, Sadler, Arku, & Gilliland, 2018; Engler-Stringer et al. 2014a; Kelly, Cretikos, Roger, & King, 2008; Velazquez et al., 2019). This is especially important, since teens often visit food retailers on their way to and from school, making them an extremely vulnerable population in terms of food vendor exposure and marketing

impacts (Ahmadi et al., 2014; Cowburn et al., 2016; He et al., 2012a; Sadler et al., 2016; Velazquez et al., 2015a). The evidence also suggests that diet quality declines after the age of 14 years, as teens enter secondary school and begin to make independent choices about food purchases and consumption (Bowman et al., 2004; Health Canada, 2017; Kraak & Pelletier, 1998). This is concerning, since dietary habits established in childhood and adolescence tend to carry forward into adulthood (Craigie et al., 2011; Giles et al., 2013; Kelishadi & Poursafa, 2014; McKeown & Nelson, 2018; Singh et al., 2008).

The information environment, broadly defined as all food and beverage advertising and media in one's surroundings (Glanz et al., 2005), is increasingly pervasive and has proven to be a major contributor to nutrient-poor, calorie-dense dietary choices among Canadian adolescents (Dubreck et al., 2018; Health Canada, 2017; Heart & Stroke, 2017; Terry-McElrath et al., 2014; Thai et al., 2017). Food marketing is a growing concern within the public health field and has been shown to disproportionately target children and adolescents (Elliot, 2014; Harris, Brownell, & Bargh, 2009a; Powell, Harris, & Fox, 2013; Velazquez et al., 2019; Weber, Story, & Harnack, 2006), but especially teenagers (Institute of Medicine [IOM], 2006). Furthermore, there is limited research that has been conducted within the field of health geography on the information environment and its effects on teens' food purchasing (Elliot, 2016; Engler-Stringer et al., 2014b; IOM, 2006), or how it influences teens' perceptions of food (Glanz, 2009; Elliot, 2014; Engler-Stringer et al., 2014b; Velazquez, Black, & Potvin Kent, 2017; Wills et al., 2019). Consequently, there is a call for food environment research that encompasses the information environment element. Additionally, there has been a call for researchers to create validated tools that effectively reveal the impact of food ads within different geographic settings, while adopting a teen specific perspective (Prowse, 2017).

The literature highlights an urgent need to intervene early in adolescence to encourage teenagers to make smarter dietary choices while living in an environment overwhelmed with unhealthy food options (Chrisinger & King, 2018; Kelishadi & Poursafa, 2014; McKeown et al., 2018; Roberto & Kawachi, 2016). In order to develop such an intervention for teenagers, it is imperative to first conduct research to better understand their food exposure in a range of built environments and explore how this vulnerable

demographic perceives food and beverage advertising to impact them. Thus, my master's thesis involves the developing and testing of a teen-informed coding tool that allows for a more comprehensive understanding of teens' information environments.

1.2 Conceptual Framework

Given that this research is interdisciplinary, drawing from geography, sociology, economics, marketing, psychology, and nutrition, it is embedded in multiple epistemological approaches. Behavioural economics will be used in this thesis to better understand how teens perceive the information environment, including outdoor food and beverage advertising, as well as how this element is perceived to affect their food purchases. Glanz et al.'s (2005) food environment model is also a foundational element of this thesis that will be used to comprehensively capture the extent of the information environment, and to understand how the information environment fits into the larger food environment.

1.2.1 Behavioral Economics

Daily habits and behaviours form the underlying basis for achieving optimal mental and physical health (Roberto & Kawachi, 2016). Behavioral economics is often used in research to explain human behaviours, and the process by which individuals come to make certain health-related decisions (Leonard & Shuval, 2017; McDonald, 2008; Rice, Hanoch, & Barnes, 2017). This theory originally evolved from conventional economics, which suggests that individuals are well-informed, and thus engage in rational behaviours and actions that align with their best interests and produce optimal health (Arno & Thomas, 2016; McDonald, 2008). However, it is increasingly evident that food knowledge does not often translate to practice, and despite teenagers' awareness of the unhealthiness of certain calorie-dense, nutrient-poor foods, this demographic continues to regularly purchase and consume these types of foods (Cowburn et al., 2016; Cummins, Findlay, Petticrew, & Sparks, 2005; Heart & Stroke, 2017; Public Health Agency of Canada, 2017; Sadler et al., 2016; Velazquez et al., 2015a).

The theory of bounded rationality, drawn from the field of behavioral economics, is suitable to guide my research, considering that this approach expands on the complicated

nature of decision-making processes (Flaherty et al., 2018; Kahneman, 2003; Rice et al., 2017; Thorgeirsson & Kawachi, 2013). This theory suggests that individuals tend to make irrational food-related decisions due to various factors, including proximity, time constraints, and the multiplexity of local environments (Cappuccitti, 2017; Flaherty et al., 2018; Kahneman, 2003; Rice et al., 2017; Thorgeirsson & Kawachi, 2013). To expand on the theory of bounded rationality and the limitations of human decision-making processes, Simon (1955) states that humans tend to make judgements and actions based on the idea that these decisions are "good enough" (p.118), which results in purchasing behaviours that are satisfactory, but not necessarily healthy. Thus, this research will further investigate the thought processes of local teenagers to better understand how the information environment influences their food purchasing perceptions. This thesis will also include collaborating with teenagers themselves to understand how food and beverage advertising draws them inside local food vendors, encouraging them to make a purchase.

According to Roberto and Kawachi (2016), behavioral economics also supports the notion that individuals are greatly affected by the way options are presented within any given environment. This thinking is in line with my thesis research, as it focuses heavily on quantitatively analyzing various elements of the food environment and qualitatively examining how these features influence teenage food perceptions and vendor engagement. These research outcomes will enhance our understanding of how teenagers interact with their food environments and shed light on how certain environmental variables, including food and beverage advertising within the community, affect their food perceptions. Exploring this relationship will allow researchers to better predict how food advertising shapes food choices within teens' local food environments.

1.2.2 Glanz Model of Food Environments

It is evident that food options are embedded within local neighbourhoods, and thus, the food environment shapes the type and quality of foods that are purchased and consumed by its inhabitants (Sobal & Wansink, 2007). This thesis will use Glanz et al.'s (2005) comprehensive model of food environments as an epistemological basis and a guiding framework (Glanz, 2009; Kelly et al., 2011; Velazquez et al., 2019). This model posits

there are are multiple environmental variables that make up the food environment; these include the community, consumer, organizational, and information environments (See Figure 1.1). Together, these elements influence how individuals interact with and perceive their food environments, and collectively link the built environment to dietary behaviours (Glanz et al., 2005). Glanz and colleagues (2005) argue that all four of these environmental variables need to be considered to comprehensively understand a community's food environment as a whole.

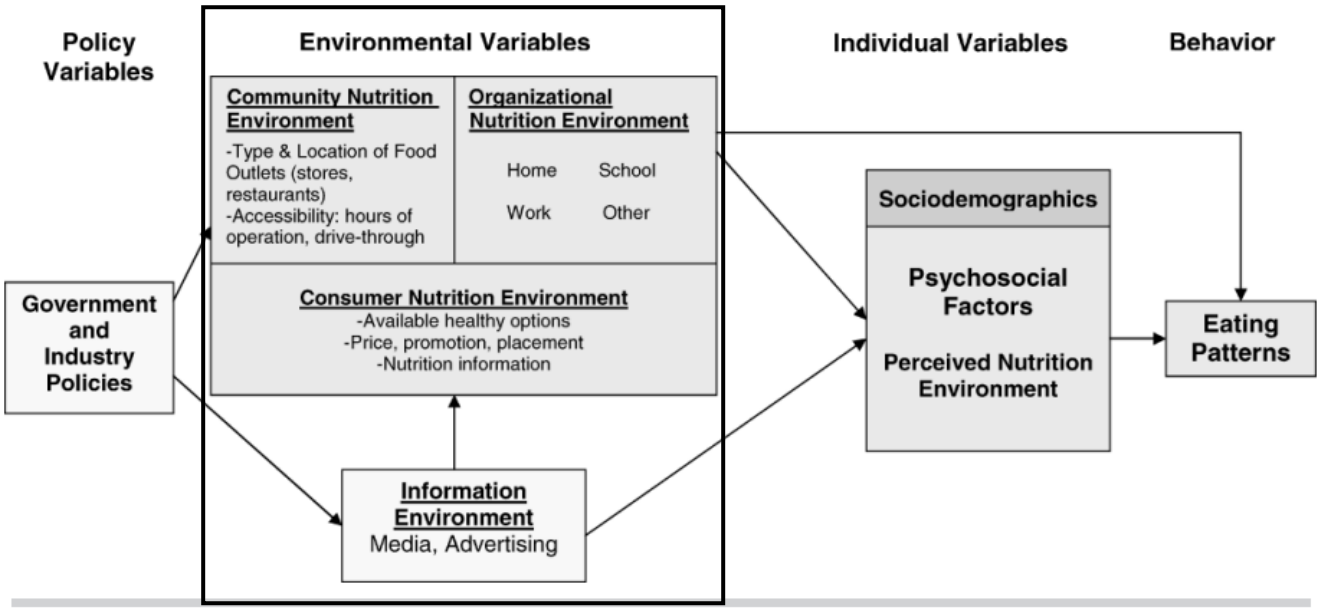

Figure 1.1 Glanz' Food Environment Model (Glanz et al., 2005, p. 331)

While there has been extensive research focusing on the community, consumer, and organizational environments (Dubreck et al., 2018; Engler-Stringer, Le, Gerrard, & Muhajarine, 2014b; Glanz, 2009; Kelly, Flood, & Yeatman, 2011; Tabak et al., 2016; Terry-McElrath et al., 2014), the food-related information environment element of the model is understudied (Engler-Stringer et al., 2014b; Minaker et al., 2016; Velazquez, Black, & Ahmadi, 2015b; Velazquez et al., 2019). This thesis is novel because it considers macro-system influences that are pervasive within local food environments, including food advertising exposure and how it relates to current food marketing policy (Story et al., 2002; Glanz et al., 2005).

From this model, it is evident that the information environment component is particularly significant and relevant to dietary health, as it is embedded within most daily spaces (Glanz, 2009; Glanz et al., 2005). Glanz and colleagues highlight that environmental variables collectively shape individual-level variables, such as one's perceived nutrition environment (Glanz et al., 2005). Therefore, qualitative insight relating to teens' food environments and their advertising preferences and perceptions is explored in this thesis to further uncover more intrapersonal marketing influences. Ultimately, considering Glanz' food environment model allows for a more comprehensive understanding of how this exposure affects teenagers' dietary behaviours and purchasing perceptions as they navigate their community spaces. The focus of this thesis is investigating and measuring the information environment, since this aspect is so pervasive, yet often neglected in food environment research (Engler-Stringer et al., 2014b; Minaker et al., 2016; Velazquez et al., 2019).

1.3 The SmartAPPetite Project

The studies presented within this thesis are part of a larger project called SmartAPPetite for Youth, being led by Western's Human Environments Analysis Laboratory (HEALab) and other collaborative partners (Gilliland et al., 2015). The SmartAPPetite for Youth project uses a nutrition-focused smartphone application as an intervention to promote healthier food choices for teens via targeted messaging; the app provides this population with evidence-based information and tips related to healthy living and healthy eating with the goals of: (1) improving their knowledge about healthy foods (food knowledge), (2) encouraging healthier food and beverage purchases (food purchasing), and (3) improving diet quality (diet quality). This app provides teenagers with recipes, nutritional tips, nearby vendor locations, and healthier food options, in effort to improve their purchasing decisions.

The larger study plan is to implement this nutrition intervention in various secondary schools across Southwestern Ontario over a period of five years (2017-2022). Six secondary schools from the London District Catholic School Board have been part of the SmartAPPetite study thus far. My research will inform this larger project by conducting food information environment audits to provide contextual information involving the

food environments around a diversity of schools within the study area. In particular, my quantitative research will focus on investigating the food environment around the six secondary schools that have been involved in the SmartAPPetite project thus far. This research will paint a comprehensive picture of the information environment, including food items that are advertised and sold in and around each school. This data will lead to a greater understanding of the food environment as a whole, including the types of food vendors that are located near schools, the food options that are available and accessible to teens, as well as the food and beverages that are promoted and advertised to them both surrounding and within their schools. This data will also allow the SmartAPPetite team to develop spatially-targeted messages that are better tailored to local teenagers' personal food environments.

1.4 Research Purpose

The purpose of this thesis research is to examine how food and beverage advertising influences teenagers' perceived food purchasing behaviours, through an investigation of the food environments surrounding and within a sample of Canadian secondary schools. It will reiterate the need to assess all elements of Glanz et al.'s (2005) food environment model, but will particularly shed light on the importance of measuring the information environment. Given that the information environment is so broad, this research will focus on outdoor food and beverage advertising and signage within the community, and signage within school cafeterias. For the purpose of this thesis, the examination of food packaging, digital media, and television will be excluded, as these aspects have received more attention in the literature (Boyland & Halford, 2013; Potvin Kent et al., 2018; Harris et al., 2009b; Hastings et al., 2003).

Investigating diverse elements of teenagers' food environments and how they are perceived to influence teens' dietary behaviours will capture a more nuanced understanding of the food environment within the Canadian context. This thesis will produce a measurement tool that allows for a more comprehensive depiction of the power of food marketing to teens in Canada, as well as support policies and interventions that promote healthier behaviours within food environments. This evidence is needed to advocate for additional nutrition and zoning policies that restrict the selling and

promotion of unhealthy foods to teens surrounding secondary schools. It will also serve to urge municipal and federal decision-makers to consider the implications of teen-directed marketing when designing healthy communities.

This thesis aims to answer two key research questions:

1. What features of food and beverage advertisements are perceived to be most effective at drawing teenagers inside food vendors?

   Objective (1a): To identify the elements of food advertisements that teens perceive to be important in persuading them to visit a food vendor or make a food purchase.

   Objective (1b): To create a teen-informed coding tool to measure the power (i.e., content, design, and execution) of food and beverage advertisements from a teen perspective.
2. How does the community food environment and information environment differ across schools in the city of London, Ontario, Canada and the neighbouring town of Strathroy?

   Objective (2a): To examine how exposure to vendors and billboards around all schools varies by socio-economic status and school level.

   Objective (2b): To examine how exposure to vendors, vendor signage, and billboards, varies across a sample of secondary schools.

   Objective (2c): To examine how the power of advertisements in and around secondary schools varies across contrasting school environments.

1.5 Research Setting & Population

The target population of this research is youth in secondary school (typically 13 to 18 years of age). For the purpose of this thesis, the terms youth, adolescent, and teen will be used interchangeably to represent the study population. The study area for this research includes the city of London, Ontario, Canada and the neighbouring town of Strathroy. This study area encompasses a wide range of physical and social environments, including suburban, urban, and small town settings, as well as a range of low, middle, and high socio-economic status neighbourhoods.

1.6 Thesis Format

This thesis takes the form of an integrated article format and includes two separate, yet complementary studies. The first study aims to gain subjective insight from teenagers themselves to create a teen-informed coding tool to measure the power of food advertisements from a teen perspective. The second study then applies this tool to analyze the exposure and power of the information environment within London and Strathroy, Ontario. An overview of the sequence of methods used to carry out this research can be seen in Figure 1.2 below, with more detailed explanation of the study methods appearing in respective chapters.

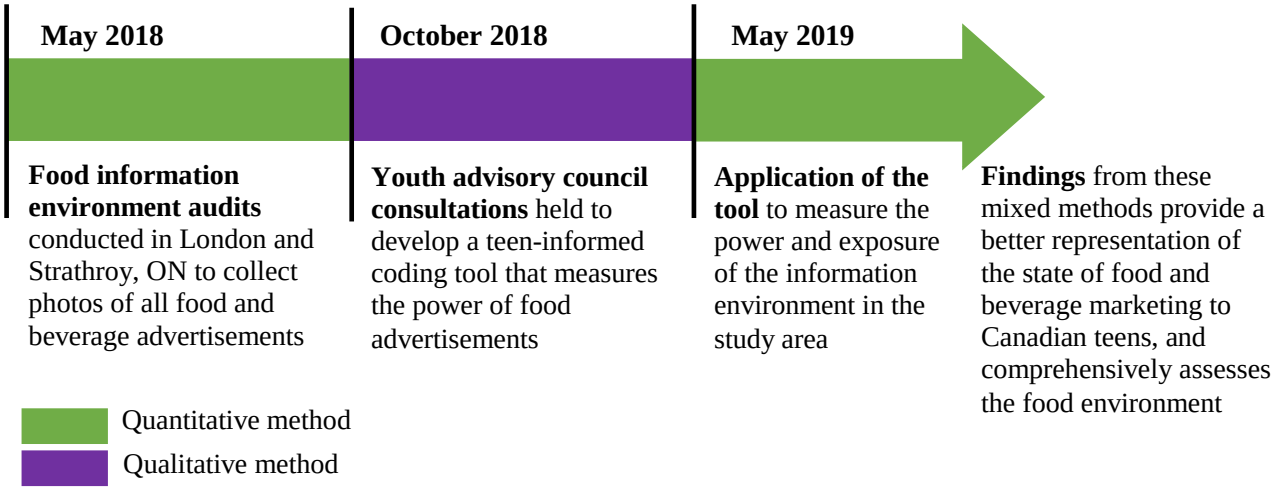

Figure 1.2 Sequence of mixed-methods

The thesis outline is as follows:

Chapter 2 reviews the existing literature on food environment research, especially those studies that focus on measuring exposure surrounding schools. Studies that encompass elements of the information environment are also explored, and methodological approaches are reviewed. Research involving current marketing policy and the impacts of advertising on young people's dietary behaviours and perceptions will also be discussed.

Chapter 3 investigates the content of local food advertisements with a local youth advisory council to gain teen perspective on the design, content, and ad features that are

perceived to be most effective at drawing them inside food vendors. This study uses consultations with local teenagers to identify teen-directed coding criteria, and develop a validated, teen-informed coding tool to objectively analyze the power of food advertisements within the information environment.

Chapter 4 examines the application of this coding tool to analyze the exposure and power of food advertising surrounding six diverse secondary schools. This study ultimately reveals the extent and power of food marketing to teens in a Canadian context, and a provides a more fulsome representation of the information environment.

Chapter 5 summarizes the results from these two studies and links the findings to previous research to draw broader conclusions about the overall impact of the information environment on teens' dietary behaviours. This chapter also identifies the limitations of this research, offers suggestions for future research, as well as recommendations for food environment and marketing policy.

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Chapter 2

2 Literature Review

2.1 Introduction

Food environments are often defined broadly as the surroundings and conditions that affect an individual's dietary decisions and nutritional health outcomes (Vandevijvere et al., 2015; Glanz, Sallis, Saelens, & Frank, 2005). Food environments include the availability of, and accessibility to, food retailers, including spatial proximity and dispersion of food vendors, as well as vendor type and nutritional quality of foods offered by each food vendor (Centers for Disease Control and Prevention, 2014; Glanz et al., 2005). Minaker and colleagues (2016) consider food environments to not only include geographic access to food retailers, but also the food- and beverage- related marketing within and surrounding these settings. While there has been a proliferation of research on retail food environments in recent years (Minaker et al., 2016), important dimensions remain understudied and the field lacks a comprehensive understanding from a geographer's perspective (McKendrick, 2004).

The vast majority of food environment research is conducted in North America, primarily in the United States (Engler-Stringer, Le, Gerrard, & Muhajarine, 2014a; Williams et al., 2014). According to Minaker et al. (2016), retail food environment research is an emerging field within the context of Canada, and many researchers stress the importance of conducting geographic research to address the poor nutritional health of children (Cunningham, 2003; Dubreck et al., 2018; He et al., 2012; McKendrick, 2004). Health Canada (2013) argues that because this field of research is new, further exploring food environments in geographically unique locations is necessary and may lead to sustainable solutions that both transform the design of communities and improve the dietary health of Canadians. Thus, it is essential for geographers to investigate the food environments within and across Canada to unravel the effects of food environments on food purchasing, and to better understand the population health impacts associated with living in poor quality food environments (McKendrick, 2004). For the purpose of this literature review, previously published works were categorized into five main sections: 1) food

environments; 2) the information environment; 3) methodological approaches; 4) policy impacts; and 5) discussion and conclusion.

2.2 Food Environments

As previously discussed in Chapter 1 (Figure 1.1, p. 5), a comprehensive model of the food environment was developed by Glanz and colleagues (2005), and since then has been used as the conceptual foundation for several studies (He et al., 2012; Minaker et al., 2013; Velazquez et al., 2019). It is evident that all four environmental elements (i.e. community, consumer, organizational, and information) of the food environment model collectively affect the purchasing decisions and dietary health of adolescents. However, much of this research measures only one or a few aspects of the food environment, typically the community and/or consumer environment (Engler-Stringer et al., 2014a; Holsten, 2009; Kelly, Flood, & Yeatman, 2011; Velazquez et al., 2019). These studies tend to focus on the type and number of food outlets and the pricing and availability of food products (Austin et al., 2005; Bivoltsis et al., 2018; Caspi et al., 2012; Glanz, 2009; Sturm, 2008; Seliske et al., 2013; Velazquez, Black, & Potvin Kent, 2017). Additionally, several studies have targeted the organizational food environment (Glanz, 2009), including analyses of in-home and in-school settings (Gustafson et al., 2017; Johnston et al., 2007; Larson et al., 2015; Lytle et al., 2006; Potvin Kent et al., 2019; Seliske et al., 2013; Tabak et al., 2016; Terry-McElrath et al., 2014).

Despite the studies involving the community, consumer, and organizational environment, there is limited research conducted by geographers on the *information environment* surrounding schools and how this relates to food purchasing (Engler-Stringer et al., 2014a; Velazquez et al., 2017; Yancey et al., 2009). This is concerning, given that unhealthy retail food environments are consistently found to be concentrated around schools (Day & Pearce, 2011; Sadler et al., 2016; Zenk & Powell, 2008), and that teenagers frequent these places on their way to and from school (Sadler et al., 2016; Kwate & Loh, 2010; Velazquez et al., 2015a). This is a notable gap in the literature, given that the information environment component includes all food and beverage marketing and advertising within a community and it is present across all other environmental variables, including in and around schools, workplaces, food stores, and

even on food packaging within these food stores (Elliot, 2012, 2014; Glanz, 2009; Glanz et al., 2005). Thus, this environmental variable is particularly significant and relevant to dietary health, as it is embedded within people's daily spaces.

2.2.1 Food Environments and Children and Youth

Food environment studies conducted around schools have increased drastically in recent years (Engler-Stringer et al., 2014b; Minaker et al., 2016; Browning, Laxer, & Janssen, 2013). However, these studies largely focus on measuring the distance between schools and food sources (Engler-Stringer et al., 2014b; Jia, Cheng, Xue, & Wang, 2017; Cobb et al., 2015; Charreire et al., 2010; Zenk & Powell, 2008). The most common circular buffer size used in the literature was a radius of 800 metres, followed by 1600 metres (Bivoltsis et al., 2018; Cobb et al., 2015; Jia et al., 2017; Charreire et al., 2010). Although several buffer sizes and distances have been applied in food environment studies (Nordbø et al., 2018), Jia and colleagues (2017) expressed that when examining food environments surrounding teen-centred settings (e.g. secondary schools), larger buffer sizes should be used to appropriately capture its effects, given that this population has higher mobility levels compared to children.

Studies have predominantly investigated the food environment surrounding elementary school settings rather than secondary schools (Engler-Stringer et al., 2014b; Kelly et al., 2008; Minaker et al., 2016), and have focused on the dietary habits of young children rather than teenagers (Barquera et al., 2018; Elliot, 2016; Engler-Stringer et al., 2014b). However, studies have shown that food environments vary between elementary and secondary school settings (Black & Day, 2012; Terry-McElrath et al., 2014; Velazquez et al., 2015a), and secondary schools generally have higher food retailer exposure (Black & Day, 2012; Zenk & Powell, 2008) and food access (Velazquez et al., 2015a). There is also evidence indicating that diet quality declines after 14 years of age (Bowman et al., 2004; He et al., 2012; Kraak & Pelletier, 1998), which is when teenagers enter secondary school and are able to make more independent decisions regarding their food purchasing and consumption (Velazquez et al., 2015a). Thus, food environment exposure and its impacts need to be further studied in relation to teenagers (Elliot, 2016), and in the context of secondary schools (Velazquez et al., 2017).

The majority of food environment studies focusing on teenagers have also included children (Engler-Stringer et al., 2014a; Williams et al., 2014). This poses a challenge for developing interventions since there is mounting evidence that children and teenagers are impacted by their food environments in different ways (Engler-Stringer et al., 2014a; Kraak & Pelletier, 1998; Institute of Medicine [IOM], 2006; Watts et al., 2018). Williams and colleagues (2014) highlighted the importance of age in determining how children engage with their food environments. They suggested that children's growth and development shapes the types of daily interactions that they have within their local communities. On a biological level, Allen et al. (2016) found that as children age, their neurological responses to food cues evolve, which could influence their food purchasing perceptions as they reach their teenage years. Consequently, Engler-Stringer and colleagues (2014a) stress the need to study these age groups separately.

This literature highlights the need for studies that focus on examining the retail food environments surrounding secondary schools, exploring beyond the home and school environments. These institutions, as well as the areas that surround them, are particularly important to study considering that unhealthy food retailers are consistently found to be concentrated around schools (Day & Pearce, 2011; Sadler et al., 2016; Zenk & Powell, 2008). Consequently, teens regularly frequent these places on their way to and from school (Sadler et al., 2016; Kwate & Loh, 2010; Velazquez et al., 2015a; Velazquez et al., 2019). The vast majority of previous works that examined secondary school food environments were conducted outside of Canada (Engler-Stringer et al., 2014a; Minaker et al., 2016; Williams et al., 2014). International research has consistently found that many students frequently buy and consume unhealthy foods during lunch, which likely contributes to teens' poor dietary outcomes (Crawford, Mackison, Mooney, & Ellaway, 2017; Jones et al., 2015; Macdiarmid et al., 2015; Maher, Signal, & Wilson, 2005). Relatedly, it has also been found that high-school aged adolescents spend most of their own money on food and beverages, which further supports the need to comprehensively study, understand, and address this retail food environment issue in the context surrounding Canadian secondary schools (Harris, Brownell, & Bargh, 2009a; IOM, 2006; Story & French, 2004). A systematic review of studies examining the obesity-related implications of retail food environments around schools (n=30) revealed that there was

limited evidence related to how these spaces impact food purchasing and consumption, which warrants further investigation across diverse geographic areas (Williams et al., 2014).

2.2.2 Food Environments in Canada

The lack of research involving the retail food environments around secondary schools is apparent across a diverse range of geographical settings. However, the vast majority of studies have been conducted in urban as opposed to rural locations, and this trend is particularly pronounced within the context of Canadian food environment studies (Minaker et al., 2016). This gap in rural Canadian research is noteworthy, given that one in five citizens live in a rural area, and urban studies are not generalizable to these geographically unique settings (Minaker et al., 2016).

The terminology used to describe food environments is diverse and nuanced. Within Canada, food environment research has traditionally focused on *food deserts*, which are disadvantaged areas characterized by poor access to supermarkets and nutritious food (Larsen & Gilliland, 2008; Rideout et al., 2015; Lu & Qui, 2019). These are major areas of concern in the United States, but there has been conflicting evidence as to whether food deserts are an issue in Canada, especially in London, Ontario (Larsen et al., 2008; Minaker et al., 2016). More recently, researchers have coined other terminologies to describe food environments, such as *food swamps* (Minaker, 2016) and *food mirages* (Breyer & Voss-Andreae, 2013; Short, Guthman, & Raskin, 2007).

Food swamps are a growing concern in Canada, which are areas that offer an overabundance of low quality, unhealthy fast food options (Bridle-Fitzpatrick, 2015; Luan et al., 2015; Minaker, 2016; Minaker & Raine, 2013). Breyer and Voss-Andreae (2013) added to the complicated nature of geographic food environments by introducing *food mirages*, or areas that have grocery stores and healthy food sources available to the community, but the pricing of these nutritious options are too high for household food purchasing, ultimately making them inaccessible to many families. These areas seem to be beneficial and advantageous to community health, but instead, they hinder nutritious dietary choices, especially for those of lower socio-economic status. Breyer and

colleagues (2013) consequently argued that *food mirages* are essentially like food deserts, considering the extra time and effort it takes for individuals and families to access these nutritious and affordable food options. However, there is evidence that food swamps are significantly stronger predictors of obesity rates in American adults than the absence of grocery stores, especially in lower income counties (Bridle-Fitzpatrick, 2015; Cooksey-Stowers, Schwartz, & Brownell, 2017). Other researchers have found that adolescents' duration of exposure to junk food sites significantly correlated with the likelihood of purchasing unhealthy foods (Gustafson et al., 2017; Sadler et al., 2016); these findings validate the positive association between availability or concentration of junk food sources within the food environment and junk food purchases (He et al., 2012). Although food deserts, swamps, and mirages are all linked to health inequalities and affect dietary choices and behaviours (Balcaen & Storie, 2018; Freedman et al., 2019; Minaker et al., 2013), food swamps should be further explored and measured, given that fast food vendors have been shown to be significantly indicative of poor dietary health outcomes (Cooksey-Stowers et al., 2017; Luan et al., 2015).

A limitation of these studies reveals that there is not a single, standardized method for identifying and classifying food deserts, food swamps, and food mirages (Caspi et al., 2012; Lytle et al., 2006; McEntee et al., 2010). As food environments are a growing public health concern, Canadian research should consistently define and measure the characteristics of diverse geographic areas in order to better understand the impacts of food environments on teenage health, and to support effective food environment policy to prevent rising obesity rates (Kelly et al., 2011).

2.3 The Information Environment

The information environment, which includes food and beverage marketing, advertising, and vendor signage within a geographic setting, is considered to be a leading contributor to the worldwide obesity epidemic (Andreyeva, Kelly, & Harris, 2011; Cassady, Liaw, & Miller, 2015; Chandon & Wansink, 2012). This component is embedded within the other three food environment variables (Glanz, 2009; Glanz et al., 2005), including in and around schools, workplaces, food stores, and even on food packaging (Elliot, 2012, 2014) within these food stores. Evidence also indicates that teens are exposed to higher levels of

food and beverage advertising in (Terry-McElrath et al., 2014) and around secondary schools (Kwate et al., 2010; Velazquez et al., 2019). Despite its significance and pervasiveness, there is limited research within the field of health geography on the outdoor information environment (Egli et al., 2019; Velaquez et al., 2019; Yancey et al., 2009) and its purchasing effects on young people, or how marketing influences teenagers' perceptions of food (Bibeau et al., 2012; Elliot, 2016; Engler-Stringer et al., 2014a; Thai et al., 2017; Velazquez et al., 2017; Williams et al., 2014). Thus, there is a call for research that focuses on this component of Glanz et al.'s (2005) food environment model to understand how geographic exposure and marketing techniques uniquely influence teenagers' perceived dietary behaviours (Health Canada, 2017a; Hillier et al., 2009; Prowse, 2017; Velazquez et al., 2017; WHO, 2012, 2019).

2.3.1 Teenagers Vulnerable to Marketing

Food marketing is particularly a rising concern within the public health field, as it has been shown to disproportionately target children and adolescents (Cairns et al., 2013; Harris et al., 2009a; Health Canada, 2019a; Leibowitz et al., 2012; Weber et al., 2006), especially teens (IOM, 2006). Teenagers are extremely susceptible to food advertisements and industry marketing strategies (Harris & Graff, 2012; Harris, Heard, & Schwartz, 2014; Pechmann, Levine, & Loughlin, 2005), which is demonstrated by the fact that secondary school-aged students spend most of their own money on low-nutrient and high calorie food and drink purchases (Harris et al., 2009a; IOM, 2006; Story & French, 2004).

The IOM (2006) argues that the purchasing influence of young adults is correlated with increasing age, which also suggests that teenagers are at a heightened susceptibility to marketing influences, as opposed to young children, who are still very much constrained by parental authority (Engler-Stringer et al., 2014a; Muhajarine, 2012; Velazquez et al., 2019). Del Vecchio's (1997) definition of an "influence curve" supports this idea as well, which refers the increase in purchasing influence as children grow older (p.22). Moreover, as children transition into teenage years, their food environments are likely to change due to increased access to the built spaces around them (Crawford et al., 2014; Kraak & Pelletier, 1998). This life stage is generally characterized by increased

personal income due to part-time employment, driving opportunities, and a greater ability to make their own food choices (Bowman et al., 2004; Kraak & Pelletier, 1998).

The majority of marketing studies (n=25) examine food packaging (Elliot, 2012, 2014), social media/digital marketing (Buchanan et al., 2018; Leibowitz et al., 2012), and television exposure (Boyland et al., 2013; Sadeghirad et al., 2016; Hastings et al., 2006). Television advertising has been shown to be highly effective at influencing children's diet and food preferences (Folkvord et al., 2016; Masterson et al., 2019; Sadeghirad et al., 2016), yet researchers have found that this advertising method is not as powerful when it comes to influencing teens (IOM, 2006; Watts et al., 2018). Additionally, Pechmann and colleagues (2005) conducted a review of adolescents' susceptibility to advertising techniques and found that teens are possibly more vulnerable to marketing strategies than adults due to their impulsive tendencies. This compilation of evidence possibly suggests that teens are the most vulnerable demographic when it comes to advertising influence. Despite the extent of marketing research, few studies investigate the effects of advertising on teens' purchasing perceptions (Bibeau, 2012; Elliot, 2014), and how this type of exposure relates to neighbourhood demographics and dietary outcomes (Hillier et al., 2009; Velazquez et al., 2019; Velazquez et al., 2017; Yancey et al., 2009).

The new Canada's Food Guide, released in early 2019, warns young people about the dangers of food marketing, and encourages adolescents to be conscious of pervasive advertising techniques (Health Canada, 2019a). These national recommendations also include ways for young people to reduce their advertising exposure, including limiting television, using ad-free platforms, and downloading software that eliminates ad pop-ups. However, this document makes no reference to the outdoor food environment, which begs the question: how can teenagers truly lessen their exposure if their everyday spaces are saturated with these advertisements? Despite this growing knowledge base, the impacts of various outdoor marketing techniques (e.g. billboards, transit shelters, signage), need to be further explored from a geographic health perspective to uncover how the outdoor information environment links to obesity and child-related health outcomes (Herrera et al., 2017; Health Canada, 2017b; Isgor et al., 2016; Larsen et al., 2015; Lesser, Zimmerman, & Cohen, 2013; Sallis & Glanz, 2006). This research is

critical, since it has been demonstrated in certain contexts that food advertising exposure is especially prevalent around schools, putting young people directly at risk (Egli et al., 2019; Maher et al., 2005; Velazquez et al., 2019).

2.3.2 Marketing Exposure Surrounding Schools

Most studies of food environments surrounding schools examine general geographic factors, like the density, proximity, and distribution of food advertisements within communities and across neighbourhood types (Cassady et al., 2015; Egli et al., 2019; Kelly et al., 2008; Kwate & Loh, 2010; Minaker et al., 2016; Zenk & Powell, 2008). In recent years, however, food environment studies have become more comprehensive, taking into consideration capturing advertisements near schools, including billboards, vendor signage, and transit shelters (Lesser et al., 2013; Parnell et al., 2018; Velazquez et al., 2019). Nevertheless, Elliot (2014, 2016) highlights that these studies typically do not measure the impact of these advertisements on young people's perceptions or food purchasing decisions (Engler-Stringer et al., 2014a; Velazquez et al., 2019).

Evidence from a household travel survey suggests that "90% of all trips longer than 2 kilometres are undertaken with the automobile as the means of travel" (Sadler, Gilliland, & Arku, 2011, p. 4), whereas walking seems to be appealing for trips under two kilometres (City of Kingston, 2015). Recent food environment studies that measured food adverting exposure surrounding schools used buffer distances of under 500m (Liu et al., 2019; Parnell et al., 2018; Velazquez et al., 2019), yet teenagers have greater mobility than children (Jia et al., 2017) and often congregate in areas of the community that are further away from their school (Day & Pearce, 2011; Velazquez et al., 2019; Zenk & Powell, 2008). Crawford and colleagues (2014) argue that teens' daily activity spaces often cover a much wider geographic area than just neighbourhood-level institutions, like schools; thus, measuring the broader activity spaces and settings of teenagers' everyday lives could uncover a more holistic understanding of the various food environment exposures. Thus, these findings support the use of larger buffer distances (≥ 2000 metres) than what have been traditionally used to fully capture the effects of food environment exposure. Additionally, given that teenagers tend to use a range of travel modes (biking, walking, bus, vehicle) to navigate their food environments, major food retailer clusters

that are located outside of walking distance of their schools should also be included in food environment studies (Cowburn et al., 2016; Wilson et al., 2018).

Researchers solely investigating food marketing surrounding schools have stated that their results misrepresented food environment exposure (Egli et al., 2019; Velazquez et al., 2019). For example, Egli and colleagues (2019) noted their study's lack of comprehensiveness when examining the information environment surrounding schools; these researchers only looked at advertisements along footpaths and walkways, which likely underestimated the level of marketing exposure in their findings. Velazquez and colleagues (2019) also expressed that the extent of exposure was misjudged in their study involving Vancouver secondary school students, given that they only examined the outdoor information environment near these schools and did not capture any marketing exposure directly inside of these institutions (i.e., organizational environment). This limitation supports the need for future research to investigate advertising both around and within schools.

There is also a growing number of studies that aimed to quantify and map other characteristics of food advertising exposures, including the geographic placement of billboards within different cities and contexts (Cassady et al., 2015; Lesser et al., 2013; Luke, Esmundo, Bloom, 2000). However, many of these studies examine risk exposure to tobacco and alcohol advertisements (Hackbarth et al., 1995; Lowery & Sloane, 2014; Luke et al., 2000), as opposed to food. Additionally, most of these studies focus on exploring socio-demographic characteristics and social and spatial inequities in relation to advertisements (Adeigbe et al., 2015; DyckFehderau et al., 2013; Isgor et al., 2016; Yancey et al., 2009). A growing body of literature supports the relationship between advertising exposure and socio-economic variables, with low income and minority populations often exposed to higher amounts of advertising (Cassady et al., 2015; Herrera et al., 2017; Yancey et al., 2009). A scoping review conducted by Prowse (2017) sums up the literature, indicating that although there are several studies (n=25) focusing on exposure to food and beverage advertising in a variety of Canadian settings, apart from product packaging and television, the research evidence is limited.

2.3.3 Child-Directed Marketing

Marketing research mainly has predominantly focused on measuring attributes associated with child-directed marketing, such as the presence of kids' meals, toy giveaways, and the presence of play areas (Boyland & Halford, 2013; Emond et al., 2019; Harris et al., 2009b; Ohri-Vachaspati et al., 2015). Despite the strong interest and growing literature base concerning the effects of food marketing on child health, there is limited evidence that focuses on how food and beverage marketing influences teenage dietary health, including their purchasing perceptions (Bibeau et al., 2012; Elliot, 2016) and food choices (Cassady et al., 2015; Engler-Stringer et al., 2014a; Velazquez et al., 2017).

Many researchers have assessed the impacts of child-directed food advertisements in a variety of settings, including schools (Velazquez et al., 2015b), food supermarkets (Bragg et al., 2012; Elliot, 2012), and other community spaces (Liu et al., 2019; Lucan et al., 2017). Research on the impact of food and beverage marketing in schools is becoming increasingly common, considering students are generally exposed to an abundance of school-based commercialism (Potvin Kent et al., 2019; Terry-McElrath et al., 2014; Velazquez et al., 2017). Other researchers, including Dixon et al. (2014), focus solely on measuring the advertising impacts of food promotions and premium offers within food environments. These researchers found that exposure to certain advertisement features on food packaging, including sports celebrity endorsements, influences children's preferences for nutrient poor food products (Dixon et al., 2014). Federal and global organizations, including Health Canada (2017b, 2019b) and the World Health Organization (2019), continue to stress the importance of eliminating child-directed advertisements from child-related settings.

In recent years, researchers have recognized the importance of studying consumers' perspectives and preferences in relation to food marketing and purchasing (Bibeau et al., 2012; Elliot, 2014; Lusk & McCluskey, 2018). Advertising elements with 'child appeal' have been identified by Health Canada (2019b) as features such as images, colours, music, language, and the use of characters and premium offers. While Health Canada (2017b) and other organizations have established the broad elements of "child-directed" marketing, there are no corresponding "teen-directed" marketing guidelines. Studies

conducted by Elliot (2014, 2016) found that there is a consistency of views amongst teens in terms of their food perceptions and attitudes, so it is encouraged that their perspectives need to be better understood and considered to support interventions and strategies aimed at improving the dietary health of teens. Teenagers need to be actively consulted in research to evaluate how food and beverage marketing affects their perceived food habits. Additionally, teens should be involved in the identification of "teen-directed" advertising techniques so that policymakers can appropriately protect this vulnerable population from food marketers.

2.3.4 Marketing Impacts

Further research is necessary to generate a more complete picture of food marketing to teens in Canada, given that recent studies show that it is likely to be underestimated (Prowse, 2017; Velazquez et al., 2019). This potential underestimation is likely due to a lack of research in this area, as well as a lack of comprehensiveness in previous studies. When it comes to measuring the overall *impact* of the information environment within communities, researchers have recognized the importance of two key components: the *exposure* to, and *power* of, advertisements (Potvin Kent et al., 2014; Prowse, 2017; WHO, 2012, 2019). Prowse (2017) states that the *impact* of food and beverage advertising techniques depends on "the media in which the communication message appears and its creative content" (WHO, 2012, p.8). The *exposure* of an advertisement is generally quantified by its geographic reach and frequency, and the *power* is related to the content, design, and execution of the message (Potvin Kent et al., 2014; Prowse, 2017; WHO, 2012). Thus, the impact of food marketing is a "function of both exposure and power" (WHO, 2012, p. 10). Figure 2.1 illustrates the relationship between exposure and power, and how it relates to the overall impact of food and beverage marketing on food purchasing and consumption behaviours.

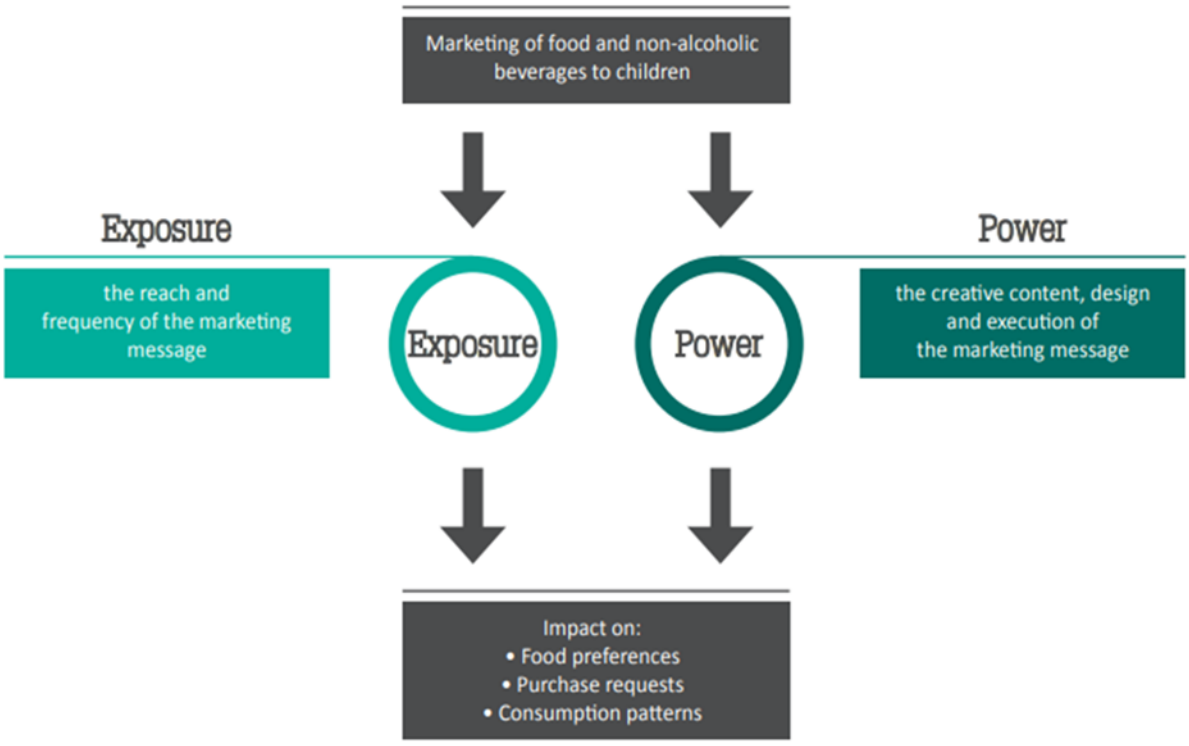

Figure 2.1 Marketing communications as a function of exposure and power (WHO, 2012, p.11)

Health Canada supports measuring these two elements of food and beverage advertising to determine how food marketing impacts young people (Hooper, 2018). An update prepared by Health Canada in October, 2018 advocated for the combination of the *power* of advertising techniques and geographic *exposure* to food and beverage marketing to determine the overall impact of food marketing (Hooper, 2018). Integrating health geography and marketing to explore this public health issue is highly beneficial, as Hooper (2018) explains that this approach aims to address: (1) settings (e.g., schools, public events); (2) advertising channels (e.g., print, TV, digital); and (3) marketing techniques (e.g., movies, toys, mascots, vending machines) that appeal to certain populations, such as children.

2.4 Methodological Approaches

As established in the previous chapter, food environments are complex elements within the overarching built environment, and there are numerous elements that make up the

food environment within any given community (Glanz et al., 2005). Thus, researchers aiming to examine these environments have utilized a wide range of study designs and methodologies to characterize these elements. This section will explore the different methodologies used in food environment research and highlight the methodological gaps in this field. More specifically, this section will introduce evidence that supports the development of objective tools to measure the food information environment. Furthermore, it will highlight the benefits of incorporating qualitative insight into food environment methodologies, shedding light on the benefits of consulting teens themselves.

2.4.1 Quantitative Methods

Most food environment studies tend to be quantitative assessments of retail food environments, including the associations between retail food environments and factors such as socio-economic trends, diet, or health-related outcomes (Minaker et al., 2016). Spatial analyses using geographic information systems (GIS) are the most commonly used methods to quantitatively measure certain aspects of the food environment, including density and location of food vendors (Jia et al., 2017; Wilkins et al., 2017). Studies measuring the community, consumer, and organizational food environments generally use some variation of GIS-based methodology (Charreire et al., 2010; He et al., 2012; Larsen et al., 2008; Wilkins et al., 2017). Many researchers that examined the relationship between food environment exposure and dietary health also measured Body Mass Index (BMI), which is a measure of body fat, to show an association between unhealthy food access and obesity rates (Black & Macinko, 2008; Chen et al., 2019; Cobb et al., 2015; Gilliland et al., 2012; Hager et al., 2017; Holsten, 2009; Seliske, Pickett, Boyce, & Janssen, 2009; Shier et al., 2016).

Researchers have also used objective, quantitative NEMS tools in food environment research to quantify aspects of the consumer and community food environments, including restaurants (Saelens et al., 2007), retail food stores (Glanz et al., 2007), corner stores (DeWeese et al., 2016), and vending machines (Horacek et al., 2019). These tools focus on measuring the nutrition quality and availability of healthy foods at vendors; this tool particularly focuses on low-fat foods and nutritious food options, as opposed to

unhealthy, energy-dense, nutrient-poor food options (Lo et al., 2016). The numeric score generated from this tool is somewhat arbitrary and does not have any associated meaning tied to it; that is, the NEMS scores are only meaningful in relation to one another (Lo, Minaker, Chan, Hrgetic, & Mah, 2016).

Other researchers have used the retail food environment index (RFEI) to capture the comparative availability of several types of food sources within a neighbourhood or community (Bivoltsis et al., 2018; Koleilat et al., 2012; Zhang & Huang, 2018). However, the RFEI measure, calculated as the ratio of the number of fast food vendors and convenience stores to supermarkets and produce vendors, captures only community and consumer level components of the food environment, much like the NEMS tools (Minaker et al., 2013; Zhang et al., 2018).

The Fast Food Observation Form (BTF-FFOF) is an auditing tool developed to measure various food environment influences, including food advertising and promotions, food availability, pricing, and nutrition information (Rimkus et al., 2015). However, this tool was specifically tailored for auditing fast food restaurant chains and excludes consideration of other vendor types. Additionally, the BTF-FFOF tool simply measures the frequency of food and beverage advertisements located at a fast food vendor, and overlooks the content of the ads, as well as the target audience (Rimkus et al., 2015). This is a methodological limitation when trying to capture the information environment's scope and impact within the community food environment.

Researchers have begun to recognize the importance of measuring the exposure and power of the information environment within communities (Prowse, 2017) and recommend the development of methods that capture the impacts of food and beverage marketing in different geographic settings, across various media channels, and across sub-populations (Potvin Kent et al., 2014; Prowse, 2017; Velazquez et al., 2017). Critically however, the food information environment, including the impacts of food and beverage marketing, is often overlooked in food environment assessments, and methodologies do not often capture this aspect of the food environment (Engler-Stringer et al., 2014a; Velazquez et al., 2019).

While the coding of various child-directed advertising criteria (e.g., price, humour, giveaways) has been conducted within several disciplines, including food environment research (Elliot, 2012; Potvin Kent et al., 2012; Potvin Kent et al., 2014), the vast majority of these studies simply coded for the presence or absence of each criterion. Furthermore, previous research has used general criteria rather than tailoring the criteria to the specific population of interest (Elliot, 2012; Kelly et al., 2008; Kelly et al., 2010; Potvin Kent et al., 2012; Velazquez et al., 2019); this tailoring of criteria is important to fully understand how advertising influences unique populations (Elliot, 2016; IOM, 2006; Lusk & McCluskey, 2018). Additionally, researchers have not considered the relative influence of each criterion when using coding methods; this deserves attention since some advertisement features could be more impactful on food purchasing than others. Researchers thus continue to stress the lack of research conducted within food environment research and health promotion that specifically explores the information environment and demographic-specific perspectives involving the specific marketing techniques that influence individual food and beverage purchases of different populations (Cassady et al., 2015; Engler-Stringer et al., 2014b; Prowse, 2017; Velazquez et al., 2017). There is a call for further research on the information environment using validated tools to effectively quantify the exposure and power of food ads within different geographic settings. Additionally, as it is clear that teens are influenced by advertising, there is a clear need for tools that adopt a teen specific perspective.

2.4.2 Combining Methods

Findings from a systematic review of cross-sectional studies and natural experiments (n=38) that explored the association between food environments and diet suggest that in order to obtain accurate classifications of neighbourhood food environments, future research should incorporate a mixture of store audit measures coupled with GIS-based methodologies (Caspi et al., 2012). Riggsbee and colleagues (2019) offer a slightly different perspective, arguing that to achieve a more accurate representation of young people's food environments and their associated purchasing behaviours, studies should involve a combination of qualitative methodologies, like story mapping, coupled with GIS technology. Knigge and Cope (2006) also support this notion of qualitative

visualization, as it adds to the idea of ‘situated knowledge’ by converging various geographical, personal, and cultural components of research.

In previous work, there is a clear divide in qualitative and quantitative research methodologies; few studies use a mixed-methods approach to examine the retail food environment and teenagers' perceptions (Bridle-Fitzpatrick, 2015; Macdiarmid et al., 2015). However, much of the qualitative research validates the complex relationship between the food environment and teenagers’ decision-making processes. Several researchers have expanded on the important role that individual, familial, and social factors play in influencing teen diet; intentions (Pasch & Poulos, 2012), attitudes (Wu et al., 2009), and social norms (Ball et al., 2006) were commonly discussed as key elements of teenage decision-making processes (Kraak et al., 1998; Story et al., 2008). These various factors, coupled with geographic food environment exposure, are important in shaping teenagers’ dietary decisions. McPhail et al.’s (2011) research contests most food environment research, claiming that the relationship between the retail food environment and adolescent consumption of unhealthy foods is not linearly related. However, the absence of a direct connection between the food environment and purchasing behaviours of teens also supports the idea that there is an array of factors that contribute to food choices, purchases, and consumption of certain foods (McPhail et al., 2011; Kraak et al., 1998). This uncertainty warrants further inquiry.

Elliot (2014) specifically highlights the importance of understanding teen perspectives when it comes to food marketing and purchasing perceptions. In a qualitative study that explored how African American girls’ viewed food advertising, Bibeau et al. (2012) stressed the need to study the “consumer’s perspective”, which in this case, is the teenage demographic (p. 396). These researchers discovered valuable food preference insight, including their appeal for convenient and tasty foods (Bibeau et al., 2012). The teens also reported that the places where foods are marketed influence their perceived food choices; for instance, food and beverage advertisements located in the settings where teens hang out were thought to be especially important in affecting their own food choices (Bibeau et al., 2012). These researchers stressed the need for this qualitative marketing insight to be generated across different research settings and contexts to understand its complete

impact (Bibeau et al., 2012). Consequently, understanding how and why teens select certain foods, as well as investigating advertising in teen-centred settings, is an important area for future research (Lusk & McCluskey, 2018; Velazquez et al., 2019).

2.4.3 Youth Engagement

Youth make up a large proportion of our communities, and are greatly susceptible to change within their environments, but their views are often not considered in research (Arunkumar et al., 2019; Checkoway, 2011; Jacquez, Vaughn, & Wagner, 2013; Osborne, Baldwin, Thomsen, & Woolcock, 2017). Osborne et al. (2017) highlights the vulnerabilities of youth, considering that teenagers interact with their local food environments on a daily basis, and are highly affected by the spaces that surround them (Bogar et al., 2018; Horgan et al., 2017). According to Ergler (2017) and Arunkumar et al. (2019), many children's geographers who focus on improving child and adolescent health aim to do research *with* youth and *for* youth, as opposed to *on* youth. Youth advisory councils are a type of participatory approach that has the potential to generate many community health benefits (O'Connor, 2013). Incorporating the voices and unique perspectives of this particular demographic allows for the generation of research findings that align with the perspectives of teenagers themselves (Jacquez et al., 2013).

The diversity of many youth councils is advantageous when conducting community health research with young people, as it allows for the inclusion and incorporation of a wide range of unique perspectives from young people within a given context (Arunkumar et al., 2019); this element also ensures a more accurate understanding of the needs of teenagers within their own neighbourhoods (Richards-Schuster, 2012), and ensures that social and environmental inequities are not reinforced (Nolas, 2015; Wyness, 2009). On a broader scale, the inclusion of youth in research can allow for more efficient and effective community-level outcomes, including appropriate policies, practices, and research programs that directly improve the lives of this sometimes marginalized demographic (Arunkumar et al., 2019; Head, 2011).

Most food environment investigators who analyze the presence of fast food locations, convenience stores, and other vendor types around schools do not consider adolescents'

individual perceptions of their local food environments, despite evidence showing that environmental perceptions shape nutrition (Williams et al., 2014; Williams, Thornton, Ball, & Crawford, 2012). To better understand this complex relationship, acknowledging the importance of the perceptions of secondary school students and their reasoning behind their purchasing decisions is key (Velazquez et al., 2019; Williams et al., 2014). Retrospectively, researchers have become increasingly aware of the need to incorporate this qualitative aspect into future research designs and nutrition interventions (Asada et al., 2017; Wu et al., 2009).

2.4.4 A Call for Standardization

Glanz and colleagues (2005) not only introduce the various elements of the food environment, but also stress the need for a more comprehensive and standardized auditing tool for measuring the various elements of the food environment. For instance, studies have shown that the presence and distribution of diverse store types (e.g., grocery stores, convenience stores, full service restaurants), and their unique advertising techniques have differing impacts on adolescent purchasing (Timperio et al., 2008; Velazquez et al., 2019). This has significant implications for future research, which should aim to evaluate the exposure and influence of various food retailer types (e.g., school cafeterias, grocery stores, fast food restaurants, full-service restaurants, convenience stores) on teen purchasing, and compare this impact across a diversity of neighbourhoods.

As discussed earlier, there are existing methodologies in place that measure certain aspects of the food environment, including varying versions of the Nutrition Environment Measures Survey tool (NEMS) (Lo et al., 2016; Partington et al., 2015), the Fast Food Observation Form (BTF-FFOF) (Rimkus et al., 2015), and the retail food environment index (RFI) (Bivoltsis et al., 2018; Koleilat et al., 2012). Researchers have also used other technological methods, including wearable cameras (Signal et al., 2017), as well as Google Street View (Egli et al., 2019) to track daily food environment exposure. However, there is no single, standardized tool for measuring all aspects of the food environment, including fast food vendors, convenience stores, grocery stores, and full service restaurants (Kelly et al., 2011; Rimkus et al., 2015). According to Lytle & Sokol

(2017) and other researchers, the vast majority of food environment measures and methods also lack validity (Rimkus et al., 2015; Williams et al., 2014).

A systematic review of cross-sectional and longitudinal studies (n=26) conducted by Engler-Stringer et al. (2014a) yielded similar findings, including limitations concerning the heterogeneity of food environment research methodology, as well as the identification of gaps within the food environment literature (Cobb et al., 2015). The findings suggested that although there are the various methods used by researchers to quantify food environment exposure and dietary outcomes (e.g., GIS, pricing, self-report outlets, food outlet audits), there is a particularly evident gap concerning the lack of evidence on the effects of food purchasing behaviour (Engler-Stringer et al., 2014a). Together, these methodological limitations often pose challenges to researchers when attempting to make rigorous research observations and conclusions (Williams et al., 2014).

Kelly et al. (2011) argues that a novel, "multi-dimensional" (p. 8) approach to conducting food environment research needs to be developed; one that comprehensively captures various components of the food environment. Other researchers support this notion of multidimensionality, claiming that it would produce evidence that is more rigorous and advise public health professionals on how to create effective interventions (Black, Moon, & Baird, 2014; Minkler et al., 2018, p. 856). There is a call for food environment research that encompasses the outdoor information environment, and to create validated tools that effectively quantify the exposure and power of food ads within different geographic settings (Velazquez et al., 2017). Moreover, while research in this domain as a whole is critical, as derived from the literature above there is a clear need for tools that adopt a teen specific perspective (Cassady et al., 2015; Engler-Stringer et al., 2014a; Prowse, 2017; Velazquez et al., 2017).

2.5 Policy Impacts: Restricting Food and Beverage Marketing in Canada

2.5.1 Current Canadian Initiatives

Global food environment policy, as well as advertising research has heavily focused on the protection of children under the age of 13 (Hawkes, 2014; Health Canada, 2017a). Apart from Quebec's Consumer Protection Act, which bans food marketing to children under 13, the federal government currently lacks regulation that restricts advertising of food and beverages to young children in Canada (Health Canada, 2017a; Hooper, 2018; Parliament of Canada, 2019; Potvin Kent et al., 2018). According to Health Canada (2017a), the Canadian food marketing industry remains heavily self-regulated. For example, food and beverage companies implemented the Children's Food and Beverage Advertising Initiative (CAI) in 2007, which aimed to limit the amount of marketing to kids (Advertising Standards Canada, 2011; Mulligan et al., 2018). Under this initiative, Canadian companies had the option to voluntarily pledge to restrict their marketing to children under 12 years-old, however research has shown that it has been very inadequate and ineffective at reducing exposure (Health Canada, 2017a; Mulligan et al., 2018).

2.5.2 Child Health Protection Act

Bill S-228, otherwise known as the Child Health Protection Act, aims to restrict food and beverage marketing to Canadian children under the age of 13 (Dallaire, 2018; Canadian Parks and Recreation Association, 2018; Parliament of Canada, 2019; Vergeer et al., 2018). It is currently stalled in Senate, following an age amendment requested by the House of Commons in April, 2018 (Dallaire, 2018; Heart & Stroke, 2018; Vergeer et al., 2018; Yan & Hutchinson, 2018). Conversely, there is growing concern that this recent age amendment, reduced from 17 to 13 years, will result in increased marketing targeted at teenagers (Yan et al., 2018; Health Canada, 2019b; Hooper, 2018, Parliament of Canada, 2019; Potvin Kent, Cameron, & Philippe, 2017). As a result, a second amendment was put in place to monitor the policy impacts and then revisit the legislation after five years to review the contested age definition of *children* (Dallaire, 2018; Yan et al., 2018). According to MP Doug Eyolfson (2018) this age amendment made by the

House of Commons was prompted by concern that it would impose legal risks and infringe on teenager's legal rights as citizens. Thus, there is recent attention drawn to the importance of monitoring current advertising efforts to determine whether this lower age limit leads to an increase in food marketing to teens (Health Canada, 2019b; Parks and Recreation Ontario, 2019; Hooper, 2018). The controversial adjustment to Bill S-228's age definition has also led to the large movement in recent literature and public policy that aims to highlight the vulnerabilities of teenagers and support food environment policies that improve dietary health (Health Canada, 2017a; Potvin Kent et al., 2017; WHO, 2019).

2.5.3 Consultations with Canadians

Health Canada (2019b) and the World Health Organization (2010, 2012) describe the *impact* of food/beverage advertising as a product of both the *exposure* to marketing techniques via various communication channels, and the *power* of these strategies that are implemented. The World Health Organization (2010, 2012) advocates for strategies that aim to reduce both the exposure to, and power of, food advertisements found within communities, arguing that marketing techniques that provide young people with the most exposure should be prioritized. On a policy level, Health Canada (2017b, 2019b) stresses that their upcoming approach will address the food and beverage marketing issue through examining three primary factors, including: 1) settings; 2) media channels; and 3) advertising techniques.

However, Health Canada's consultation report (2017b) on restricting marketing of unhealthy food and beverages to children in Canada highlighted that many Canadians are dissatisfied with the guidelines. Specifically, participants expressed concerns relating to the definition of *child-directed advertising (*Health Canada, 2017b). In this report, Health Canada (2017b) only addressed restricting child-directed advertising via digital channels, including television and internet, and did not attempt to tackle marketing strategies that are embedded within the outdoor food environment. Many respondents advocated for a broader definition; one that includes additional advertising channels, such as public transit advertisements, store displays, and signage within the community environment (Health Canada, 2017b). These are important considerations, since billboards and other

external signage cannot necessarily be turned off or restricted in the same way that can be done with television, internet, and other types of exposures (Luke et al., 2000). These findings reiterate the importance of expanding beyond the internet and television focus, since there is apparent concern that this federal policy may leave out important marketing techniques that significantly influence Canadians.

Overall, evidence provided in this section has demonstrated that food advertising plays a role in shaping the food choices of young people, often encouraging the purchasing of nutrient-poor foods (Dixon et al., 2014; Health Canada, 2019a; Sadler et al., 2016; Sadeghirad et al., 2016). Therefore, there is also potential for food and beverage marketing to be used as a tool to promote nutritious food options instead and reverse its negative health impacts (Harris et al., 2009a; Parnell et al., 2018). For instance, a study conducted by French et al. (2001) showed that promotional signage can effectively encourage the purchasing of healthier foods and lead to increased sales of more nutritious food items. The literature reviewed in this chapter collectively reveals the importance of conducting further research to understand how food advertising affects teen purchasing; this information could allow the public health field to use this method to both create effective behavioural interventions, promote healthy foods and encourage smarter purchasing decisions within teenagers' environments (Boyland et al., 2013; Cairns et al., 2013; Just, Mancino, & Wansink, 2010).

2.6 Discussion and Conclusion

The purpose of this chapter was to provide an overview of food environment research, focusing attention on studies 1) conducted in the context of *school settings*, and 2) that involve the *information environment*. The sections in this chapter highlighted several gaps in the literature. First, it is evident that there is no strategy to capture the relationship between the food environment and the purchasing and consumption patterns of teenagers. The literature revealed the need to comprehensively measure food environments from multiple angles, measuring the consumer, community, institutional, and information environments. It also stressed the need to measure all food vendor types within a given study area, not just convenience and fast food outlets, to capture the full impact of the food environment on teen food-related behaviours.

It became especially evident that the food information environment component is a significant and relevant threat to teen dietary health, as it is deeply pervasive within community spaces. However, this review revealed the limited research that has been conducted on this component of the food environment, or on how food and beverage marketing impacts teens' purchasing perceptions. Conducting comprehensive investigations that reveal how unique food environments influence teen dietary health, and how exposure changes across geographically and socio-economically diverse neighbourhoods, will contribute to various health-related fields, including public health, marketing, and health geography. This review demonstrated that more extensive food environment research needs to be conducted around *Canadian secondary schools* in diverse geographic settings, especially in rural locations. The literature also verified that larger buffer distances (≥ 2000m) should be used when measuring the information environment surrounding secondary schools.

The lack of *mixed methods* literature within the discipline of health geography also highlights the demand for this type of study design when exploring complex food environments and dietary behaviour issues. Researchers argued that to generate a more complete representation of young people's food environments and their associated purchasing behaviours, research should involve a combination of qualitative methodology, mixed with GIS technology. It was discovered that few studies incorporate both GIS technology and store auditing techniques (Caspi et al., 2012; Engler-Stringer et al., 2014a). The evidence also demonstrated that there is a lack of consistent and validated food environment *measurement tools* that can be used across different contexts in the literature. Furthermore, the information environment element, including the impacts of food and beverage advertising, is often excluded from these food environment assessments (Engler-Stringer et al., 2014a). As a result, there is a call for additional food environment research that encompasses the information environment, and to create validated tools that effectively quantify the *exposure* and *power* of food advertisements within diverse geographic settings. Moreover, while research in this domain as a whole is critical, as derived from the literature above there is a clear need for tools that adopt a *teen specific perspective*.

Lastly, this literature review highlighted the importance of this thesis from a broader, Canadian policy standpoint. In the context of current food environment policy aiming to restrict food and beverage marketing to children under 13 years, this thesis involving the teenage demographic is necessary, given that it responds to the global and national organizations that have called for evidence-informed guidance to support the development of an enabling food environment that promotes healthy diets and adequate nutrition (Health Canada, 2017a; WHO, 2012, 2019).

Overall, this thesis will address the abovementioned gaps in food environment research by adopting a comprehensive approach that considers all four aspects of food environments: (1) the community (e.g., density, proximity, vendor type); consumer (e.g., loyalty programs, student discounts); organizational (e.g., secondary school cafeterias); and information environment (e.g., food advertising) components. This research will investigate the food environment surrounding a diversity of secondary schools in London, Ontario, Canada, and include the development and application of a validated, *teen-informed coding tool* that specifically measures the information environment element of Glanz et al.'s (2005) conceptual model. This research will particularly investigate the *exposure* and *power* of food and beverage advertising, as well as qualitatively explore how marketing techniques influence teens' purchasing perceptions. Food vendor type and distribution, the exposure and power of advertising, as well as how this exposure leads to vendor engagement, will be examined. This research is crucial to better understand the food environment in the context of a Canadian city, and reveal the state of food marketing to teens and how the information environment impacts teens' dietary perceptions.

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Chapter 3

3 Developing a Teen-Informed Coding Tool to Measure the Power of Food Advertisements

3.1 Introduction

Poor nutrition contributes to several negative health conditions (e.g., obesity, cardiovascular disease, and type 2 diabetes) and is a leading cause of premature death (Ball & McCargar, 2003; Lamichhane et al., 2012; Morenga et al., 2014; Public Health Agency of Canada, 2017). The nutritional health of Canadian adolescents is a substantial public health concern, with an estimated one third of youth between the ages of 5 and 17 years living with overweight or obesity (Bancej et al., 2015; Rao et al., 2016; Roberts et al., 2012). An increasing body of literature recognizes the health impacts of food environments (Barrett et al., 2017; Dubreck et al., 2019; Engler-Stringer et al., 2014), which are defined as the surroundings and conditions affecting one's dietary patterns and nutritional health outcomes (Vandevijvere et al., 2015). Studies show that Canadian youth's food environments can be highly obesogenic, as they tend to lack easily accessible, nutritious food options, and expose teens to a wide selection of energy-dense, nutrient-poor foods (Minaker & Raine, 2013; Sadler et al., 2016). This is especially concerning, since dietary habits formed early in life carry into adulthood (Craigie et al., 2011; McKeown & Nelson, 2018; Singh et al., 2008).

Glanz and colleagues (2005) consider food environments, which they also refer to as "nutrition environments", to contain a combination of four unique environmental elements: community (i.e., type and location of food vendors), consumer (i.e., pricing and availability of food items), organizational (i.e., school, work, home), and information (i.e., food advertising). While food environments are increasingly recognized as key determinants of community health (Glanz et al., 2005; Kirk et al., 2010), researchers have not yet considered the *information environment* to the same extent that they have considered other elements of the food environment (Velazquez et al., 2019). Nevertheless, the information environment, which includes all food and beverage marketing and advertising within a community, is embedded within most daily spaces,

such as those in and around schools, workplaces, and food stores (Glanz, 2009; Glanz et al., 2005). Given the extent of the information environment, it is particularly important to understand its role in dietary health.

While there are several factors within food environments that could influence nutrition (Engler-Stringer et al., 2014; Glanz et al., 2005), research indicates there is an increase in the prevalence of calorie-dense, nutrient-poor food items being advertised to, and consumed by, young people (Bugge, 2016; Institute of Medicine [IOM], 2006; Sadeghirad et al., 2016; Harris, Brownell, & Bargh, 2009a; Thai et al., 2017; Velazquez et al., 2015). Teenagers are particularly susceptible to food advertisements and marketing strategies, and there is evidence indicating that high school-aged adolescents spend most of their own money on low quality food and drink purchases (Harris et al., 2009a; IOM, 2006; Story & French, 2004). It is suggested that teenagers are at a heightened risk of being influenced by marketing, as opposed to young children, who are still very much constrained by parental authority (Bowman et al., 2004; Engler-Stringer et al., 2014; Kraak & Pelletier, 1998). Studies have also demonstrated that children's purchasing behaviours, perceptions, and consumption patterns are impacted by their food environments quite differently than teenagers (Engler-Stringer et al., 2014; IOM, 2006; Kraak & Pelletier, 1998; Williams et al., 2014). Consequently, these two age groups should be studied separately (Engler-Stringer et al., 2014). Nevertheless, Elliot (2016) highlights that many of the food environment studies that include teenagers also include children under 13 (Elliot, 2014; Engler-Stringer et al., 2014; Laska et al., 2010; Williams et al., 2014). Despite the strong interest and emerging research concerning the effects of food marketing on child health, there is limited environmental and public health research that focuses on its potential impacts on teenage food purchasing perceptions and dietary behaviours (Cawley, 2006; Elliot, 2014, 2016; Engler-Stringer et al., 2014; Velazquez et al., 2017; Williams et al., 2014).

When it comes to measuring the information environment within communities, there are two key components: the *exposure* to and *power* of advertisements (Hooper, 2018; Potvin Kent, Martin, & Kent, 2014; Prowse, 2017; WHO, 2019). The exposure to an advertisement can be quantified by its geographic "reach and frequency", whereas the

power is related to the "content, design, and execution" of the message (WHO, 2012, p. 11). According to Prowse (2017), the impact of food and beverage advertising techniques depends on these elements, or in other words "the media in which the communication message appears and its creative content" (WHO, 2012, p.8). However, given that food environment research is still an emerging area, validated and standardized tools to measure and compare the four elements of food environments have not yet been developed (Caspi et al., 2012; Glanz et al., 2005; Kelly et al., 2011; Lytle & Sokol, 2017; Williams et al., 2014). Furthermore, the information environment is often excluded from past food environment assessments and reviews in the geographic and public health literature (Engler-Stringer et al., 2014; Minaker et al., 2016; Velazquez et al., 2019).

Researchers have highlighted the scarce evidence involving adolescents' exposure to outdoor food and beverage advertisements (Egli et al., 2019; Herrera et al., 2017; Velazquez et al., 2019; Yancey et al., 2009). Many of the studies that do explore this exposure simply examine general geographic factors, like the pervasiveness and distribution of food advertisements within communities and across neighbourhood types (Cassady, Liaw, & Miller, 2015; Egli et al., 2019; Kelly et al., 2008; Minaker et al., 2016; Parnell et al., 2018). While coding schemes to classify various child-directed advertising criteria have been developed (Elliot, 2012; Herrera & Pasch, 2016; Potvin Kent et al., 2012; Potvin Kent et al., 2014), the vast majority of these studies simply coded for the presence or absence of each criterion (Elliot, 2012, 2014; Potvin Kent et al., 2012; Potvin Kent et al., 2014; Velazquez et al., 2019). Further, these coding schemes applied predetermined criteria instead of consulting target populations to determine what factors are important to them; this tailoring of criteria is important to fully understand how advertising influences specific populations of interest (Elliot, 2016; IOM, 2006). To date, researchers have not yet considered the relative influence of each criterion on teens' perceived purchasing behaviours. This is an important gap, given that some features could be more conducive to teen food purchasing than others.

There are several changes underway regarding food policy in Canada, with a focus on improving the food environment and restricting food and beverage marketing to children under 13 years (Health Canada, 2019; Hooper, 2018; Parliament of Canada, 2019; Potvin

Kent et al., 2018). Advertising elements with child appeal have been identified by Health Canada (2017) as features such as images, colours, music, language, use of characters, and premium offers. While organizations have established the broad elements of "child-directed advertising", there are no corresponding teen-directed marketing guidelines (Health Canada, 2017, p. 7; Elliot, 2016). Elliot (2014, 2016) highlights the importance of understanding teen perspectives when it comes to food marketing perceptions, and states that this group should be consulted before marketing policy is developed. Other researchers support studying consumers' perspectives (Bibeau et al., 2012), and advocate for qualitative marketing insights as to how and why consumers select certain foods (Lusk & McCluskey, 2018).

There are calls from national and global health organizations (Health Canada, 2017; WHO, 2019) for additional food environment research that encompasses the information environment element, and to create validated tools that effectively quantify the exposure and power of food advertisements within different geographic settings (Prowse, 2017; Velazquez et al., 2017; WHO, 2019). There is also a clear need for development and deployment of measurement tools that directly consider teen perspectives (Velazquez et al., 2017). In an attempt to answer the calls of health organizations and fill existing research gaps, the purpose of this sequential mixed-method study was to use an evidence-based approach, incorporating an environmental audit and youth engagement, to develop and validate a user-friendly tool for coding and quantifying the *power* of food and beverage advertisements in and around environments frequented by teens. The overarching aims of this research are twofold: 1) To identify the elements of food advertisements that teens perceive to be important in persuading them to visit a food vendor or make a food purchase; and 2) To create a teen-informed coding tool to measure the power (i.e., content, design, and execution) of food and beverage advertisements from a teen perspective.

3.2 Methods

This paper uses a sequential mixed-method approach (Leech & Onwuegbuzie, 2009; Schoonenboom & Johnson, 2017) to develop a food information environment measurement tool: 1) conducting inventories of food advertisements through an

environmental audit (quantitative); 2) developing initial tool criteria through a collaborative and participatory approach engaging teens from a Youth Advisory Council (qualitative); and, 3) validating and weighing the power of individual elements of food advertisements using online surveys administered to a diverse group of teens (quantitative). The outcomes will be incorporated into a user-friendly, teen-informed coding tool for assessing the exposure and power of food and beverage advertising in the retail food environment. Ethics approval for this study was granted by Western University's Non-Medical Research Ethics Board (NM-REB# 107034).

3.2.1 Food Information Environment Audit

A food information environment audit was conducted within London, Ontario, Canada between May and October 2018. This audit generated a comprehensive collection of photos of outdoor advertisements for all food vendors, billboards, and transit shelters. A local food retailer database was first used to identify vendors and location information within the study area. The vendor types included in the audit were: full-service restaurants; fast food restaurants; convenience stores; and grocery stores. These types were chosen based on consultations with local high school students, which included discussions regarding where they go to buy food and were analogous to those in previous studies (Dubreck et al., 2018; Velazquez et al., 2019). A geographic information system (GIS) database was used to locate and map all billboard and transit shelters within the study area to capture additional sources of advertising, and then a GIS-enabled smartphone application called ArcGIS Collector (ESRI, Redlands, CA) was used by research assistants to collect the advertising data in the field (i.e. on site). The purpose of this quantitative phase was to provide us with geographic exposure data involving the information environment, including a sample of outdoor food and beverage advertisements collected directly from the study area, to be used for additional qualitative exploration with local teenagers. The data collected in the audits will be used in this paper to provide examples during the consultations with youth.

3.2.2 Consultations with Youth

A local youth advisory council was consulted to qualitatively examine the photos of food advertisements that were collected in the community via the audit. This council, made up of 14 high school students aged 13-19, represented a diversity of age, gender, and ethnicity (Arunkumar et al., 2019); members also attended a variety of secondary schools from around the city, which allowed for the generation of teen insight involving the city's information environment. A more detailed discussion of how this YAC was created can be found in Arunkumar et al. (2019).

Participatory Method

A collaborative participatory approach was used to uncover teen perceptions of food and beverage advertising influences to be able to conceptualize the power of marketing techniques (Jagosh et al., 2012). The council worked with the primary author during multiple council meetings (held from October 2018 to March 2019) to develop a validated, teen-informed coding tool that could be used to measure the information environment. During the first few meetings, the council was introduced to the tool-development project and discussions were held to better understand the information environment's impact on teens. Through the collaboration process, the council inspected a variety of food and beverage advertisements that were collected in the audit to uncover teens' perceptions of food advertising. The youth engaged in a variety of structured discussions and activities aimed at identifying which features of food advertisements are most important at capturing their attention and drawing them inside food vendors. The council members were provided with an initial list of existing coding criteria (e.g., health appeal, novelty, humour) used in the literature to review and discuss features perceived to be important from a teen perspective, and to establish criteria they felt were missing from previous coding techniques (Chang et al., 2018; Health Canada, 2017; Potvin Kent et al., 2014; WHO, 2012). The qualitative discussions with the youth advisory council were recorded with written notes (i.e. meeting minutes). Table 3.1 includes a detailed collaboration timeline between the primary author and the youth advisory council.

Table 3.1 Youth advisory council collaboration timeline

Date	Description
Oct. 2018	• Introduced council to the tool-development project at orientation
Nov. 2018	• Discussed information environment and how food marketing impacts teens • Explored a sample of ads to capture teens' general advertising perceptions • Completed photo analysis survey • Explored food environment coding literature • Reviewed survey findings with the council
Dec. 2018	• Developed draft of key teen-directed coding criteria for the tool • Reviewed the coding guidelines and provided feedback • Finalized the coding criteria and guidelines
Jan. 2019	• Tested and finalized the weighting survey to determine the relative importance of each criterion • Council completed the weighting survey and then it was administered to a larger group of Canadian teens
Feb. 2019	• Finalized the teen-developed weights for each criterion based on the survey results • Discussed the sizing of ad features and weights for size were created • Tested the coding tool to ensure consistency and inter-rater reliability
Mar. 2019	• Council applied the tool by coding a sample of ads that were collected from the food information environment audit

Identifying Teen-Directed Coding Criteria

For the purpose of this paper, teen-directed refers to features of food advertisements that the youth advisory council consider to be targeted at teens and that influence them or their peers. To develop a teen-directed coding scheme, a photo analysis survey was first used to explore the features of food and beverage advertisements that draw teens into food stores, and better understand how local marketing exposure influences students' food perceptions and their perceived level of engagement with local food vendors. The youth advisory council completed this survey on tablets during one of their meetings (see Table 3.1). Members were given a random sample of ten food and beverage advertisement photos (out of a total sample of 25) to reflect on and assess the marketing techniques used to capture their attention and attract them inside food vendors (ten questions per advertisement). The advertisements in the survey were collected from the audit described previously. Each random sample included a variety of advertisement types (i.e., billboards, transit shelters, and vendor signage) and marketing techniques

(e.g., celebrity tie-ins, deals, company logos). The survey was designed to have each photo assessed by at least four different youth council members.

A heat map technique was used to generate hotspots (depicted in Figure 3.1) on the ads representing the specific features that teens perceive to be the most important at capturing their attention. The teens generated these hotspots by clicking on the area of the advertisement that first captured their attention (i.e., *What is the first thing that you see?*). The colours represent the frequency of the teens' responses; the more red on the heat map, the greater number of respondents selected that specific area of the image.

Figure 3.1 Teen-generated hot spots on vendor signage (a), transit shelters (b), and billboards (c)

Additional open-ended survey questions captured the parts of ads that 1) catch their attention the most and 2) catch their attention the least. The teens were also asked to highlight the parts of the advertisements that are 1) appealing or 2) not appealing. Other questions used a 7-point Likert scale (i.e., 1 = "not at all" and 7 = "very much so") to capture the perceived impact of viewing the advertisements, including perceived motivations to visit the featured store or buy a featured food item. To further develop the tool's coding criteria, youth advisory council members were also asked to independently write down the top five features of food and beverage advertisements that 1) attract them, and 2) draw them inside of food establishments (see Figure 3.2). The top ten teen-directed coding criteria that were identified by the local teens will be discussed in the results section, however, these criteria were then used in the creation of the teen-developed weights discussed next.

3.2.3 Creating Teen-Developed Weights for Coding Tool Development

Upon consideration of the photo analysis survey results, coding literature, and structured discussions, the top ten criteria were identified by the youth advisory council. After these criteria were identified, a second online weighting survey was developed and administered to a larger sample of Canadian teens (n=44) to create teen-developed weights for each criterion. This sample included the youth advisory council (n=14) as well as local secondary school students who agreed to participate in focus groups for a larger project involving teens (n=30). Other than age, no demographic information was collected on this sample. This weighting survey was necessary, as it was evident from the youth advisory council discussions that some criteria are generally more influential, or *powerful*, than others.

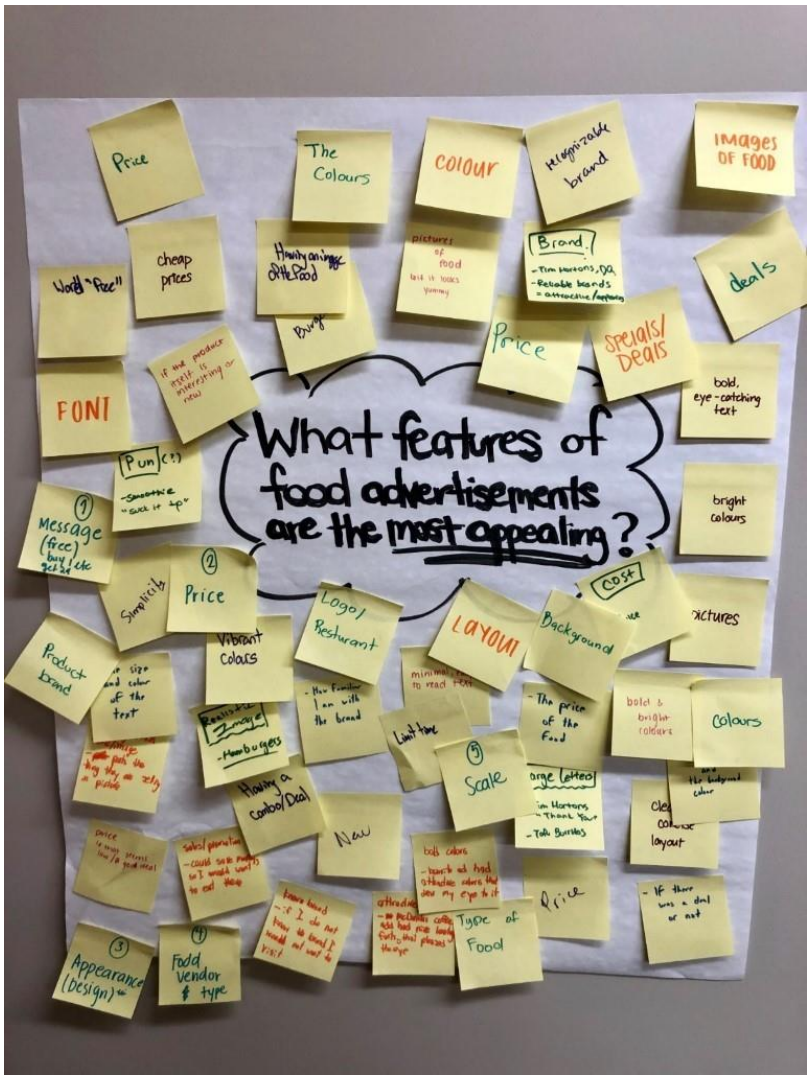

Figure 3.2 Youth advisory council members depict the top advertisement features that attract them and draw them inside food vendors

The online weighting survey was designed to have participants weigh the ten criteria in three unique ways: 1) general ratings of importance, 2) relative rankings, and 3) point allocation. As Booysen (2002) has noted, "[a]nalysts today tend to experiment with a variety of weighting techniques and compare results across these techniques before selecting either one or a combination of techniques in deriving index estimates" (p. 128). All three methods were used to determine how to assign weights to the coding tool, as described in the survey questions below.

Q1) Assign each ad feature an individual rating out of 10 to describe its general level of importance. A score of 10 would indicate that the ad feature is extremely important.

Q2) Rank the relative importance of each ad feature by arranging them in order from 1-10. 1 represents the MOST important ad feature and 10 represents the LEAST important ad feature.

Q3) Distribute 100 points between the ad features, giving the most important feature(s) the greater number of points. When thinking about these ad features, please rate them according to their relative importance.

3.2.4 Analysis

The qualitative discussions with the youth advisory council were recorded with handwritten notes, and reviewed by the primary author. The weighting survey data was exported into SPSS software for analysis. The relative weights for each teen-directed feature were captured in three different survey questions. When comparing the criteria, this notion of relativeness, or relative importance, refers to the idea that some criteria may be more important than others. All three methods provided valuable information regarding these teen-directed coding criteria, but the point allocation captured specifically how much more or less important the features are in comparison to one another. This weighting method was ultimately used to develop the weights because it was an indication of relative importance; alternatively, the first survey question looked at general importance, and the second ranking question revealed the order of importance amongst the ten features.

After the criteria were identified and the tool was developed, two research assistants independently applied the coding tool to code the food and beverage advertisements (n=1178). An inter-rater reliability (IRR) analysis was performed to evaluate the degree that three coders consistently measured the advertisement features (according to presence and size) using the developed tool. Kappa was calculated for each coder pair and the mean was used to produce a single index of IRR (Hallgren, 2012; Light, 1971).

3.3 Results

3.3.1 Teen-Directed Marketing Criteria

Ten advertisement features identified by the youth advisory council as key *teen-directed* marketing techniques that attract teenagers to food establishments are shown below, in order of importance:

- Price
- Image of Food/Beverage
- Taste Description
- Sale/Deal/Special Offer
- Slogan/Description
- Logo/Company Name
- Geographic/Online Location or Directions
- Gamification
- Loyalty Points/Rewards
- Character, Celebrity, or TV/Sports tie-in

Both the online survey results as well as the discussions with the youth revealed that these features are perceived by teenagers to be highly influential when it comes to their perceptions involving food purchases. Additionally, certain criteria researchers consider to be teen-directed were actually not perceived to be important from a teen perspective. For instance, 13 of 14 youth advisory council members indicated that health appeal is not an important consideration in choosing where to eat out, and thus, it did not make the top ten criteria. Based on discussions with the youth advisory council, teens do not seem to be influenced by the healthfulness of the food items they purchase, as reflected in the comment, *"[i]f I'm going to eat out, I want to go all out*". Social media was another criterion that was not perceived by teens to be influential in regarding their food purchases. In a structured discussion, the youth advisory council determined definitions for the coding criteria, including inclusion/exclusion criteria and examples of these advertisement features. These criteria are outlined in Table 3.2 below.

Table 3.2 Teen-developed coding guidelines

Ad Feature	Definitions, Examples, Inclusion/Exclusion Criteria
1. Price	The price is present if it is available for a food/beverage item(s). Any other prices indicated on an ad (e.g., non-food items), are excluded. For example, *$1 trading cards with beverage purchase* would not be coded as "Price", see features 4 & 8.
2. Image of Food/Beverage	The food/beverage image is present if there is a photo of a food or beverage on the ad. This does not include foods present in the logo of a vendor or brand.
3. Taste Description	The taste description/sensory appeal is present on the ad if there is a word(s) describing the taste. (e.g., *Fresh, Tasty, Yummy, Flavour, Crunchy, Delicious, Ooey, gooey, savory, delicious).* Note: Only words pertaining to taste are included.
4. Sale/Deal/ Special Offer	There is a sale, deal, or special offer present if there is either: 1) a deal/discount towards a food or beverage item(s); or, 2) a limited time/special offer *(*e.g., *limited time offer, this food is back from Oct.-Nov. 11th, get this summer special, seasonal offer, 2/$5, buy one get one free, reduced price, etc.).* Exclusive specials on certain days of the week day are also included (e.g., *Tuesday sub of the day is lower price).* Note: this is only for food/beverage items (i.e., if you get a free dilly bar with next purchase, this qualifies). However, if there is a limited time offer for a contest/giveaway that is not food or drink-specific (e.g., McDonalds Monopoly), but it also has a limited time date for the contest itself and not a specific food item, this is excluded- see feature 8.
5. Slogan/ Description	The slogan/description is present if there is either: 1) a general ad description; 2) slogan or catchy phrase; or 3) a food or beverage item description (e.g., *My Summer Tastes, Handmade Fresh Tastes Better, Crispy chicken and waffle fries*). Also see feature 6. Note: most ads will have this feature present.
6. Logo/ Company Name	The logo/company name is present if either the logo, company name, or food brand is included on the ad. (e.g., *Metro, President's Choice, Dairy Queen, Loblaw's)*
7. Geographic/ Online Location	The location is present if there is either the store address, directions, or website for ordering from the vendor. This ad criterion is more relevant for coding billboards & transit shelters. When coding food vendor signage that is already located at/on the property of the food store, this feature will be coded as N/A (0), unless it specifically has other location addresses on it or directions to other addresses. Online addresses qualify for ordering food/drinks online, like a web address or ordering app for a vendor, not a link for contests/giveaways- see feature 8.
8. Gamification	Gamification is present on this ad if there is a contest/game, giveaway, chance to win something (e.g., *NHL trading cards, chance to win a dirt bike or trip with the purchase of certain food/beverage items*). This is also likely coded as a description - see feature 4.
9. Loyalty Points/ Rewards Program	Loyalty points/rewards program is present only if the ad mentions collecting points towards free food or being a member of a loyalty program (e.g., *Petro Points, SPC card, Scene points, PC Optimum Points, MyWay Rewards, Pita Points).* This is also likely coded as a slogan/description- see feature 5.
10. Character, Celebrity, or TV/ Sports tie-in	Characters, celebrities, or TV/sports tie-ins are present if any of the following are present. This includes both people (e.g., a teenager) and cartoon characters on logos, including non-human characters used to promote a brand or food vendor (e.g., *man on the KFC logo, Little Caesars pizza character, the slush puppy dog*). Other examples that would qualify include*: a person in the ad, Michael Jordan eating a burger, a photo from the Jurassic World movie, a professional chef, etc.*

Additionally, teens recognized that the appearance or layout of the ads (i.e., size, placement, and colour) plays a key role in the appeal of the food or beverage advertisement, with size being identified as the most important appearance-related feature. This became evident through the online photo analysis survey, with teens commonly indicating that the most attention-grabbing features of ads were often chosen because they are *"the biggest part of the ad"*, or because they "take up the most space" on the advertisement. Similarly, the least attention-grabbing features of ads were mainly selected due to their small size, often making them *"too small in comparison to the rest"* of the ad and *"hard to read"*. This reveals that the power of marketing techniques is not only a function of presence (whether each feature is present on the ad, and its relative importance), but also *size*.

3.3.2 Teen-Developed Weights

Table 3.3 shows the teen-developed weights. The "order" refers to the order of importance, with 1 being the most important feature and 10 being the least important. Although point allocation was the weighting method chosen for this tool, teens rated the importance of the criteria similarly and consistently across all three survey questions (see Table 3.4). There was a high correlation between the three weighting methods (.872-.966). This adds to the rigor and reliability of the results and reveals that the three weighting methods are related.

Table 3.3 Weights by point allocation (n=44)

Criteria	**Weight (mean)**	**Order**
Price	29.1136	1
Image of Food/Beverage	20.7955	2
Taste Description	11.7273	3
Sale/Deal/Special Offer	9.9773	4
Slogan/Description	8.5227	5
Logo/Company Name	6.9318	6
Location/Directions	4.2727	7
Gamification	3.8409	8
Loyalty/Rewards	3.2955	9
Character, Celebrity, or TV/Sports tie-in	1.5227	10
Total	/100 points	

Table 3.4 Weighting methods for the coding tool (n=44)

Ad Feature	General Rating		Rank			Point Allocation (PA)	
	mean	order	mean	inverted order	order	mean	order
Price	7.5909	2	1.8	8.2	1	29.1136	1
Image	7.8409	1	2.09	7.91	2	20.7955	2
Slogan/Description	4.8409	6	5.36	4.64	6	8.5227	5
Logo/Company	5.4318	5	5.25	4.75	5	6.9318	6
Location	4.3864	7	6.89	3.11	7	4.2727	7
Deal/Sale	6.7500	3	4.48	5.52	3	9.9773	4
Loyalty/Rewards	4.8409	6	7.16	2.84	8	3.2955	9
Gamification	4.3182	8	7.59	2.41	9	3.8409	8
Taste	6.1591	4	5.07	4.93	4	11.7273	3
Character, etc.	2.7955	9	9.32	0.68	10	1.5227	10

The sizing diagram for the coding tool was originally developed by the research team (see Figure 3.3). However, after additional consultations with teens, it was decided the medium and large categories would be combined. The online hot spot activity particularly shed light on the importance of weighting on the basis of sizing, with teens rarely selecting the advertisement features that fell into the small categories as being attention-drawing. Thus, the following weights for sizing were created: small features get multiplied by 0.25, and anything larger (medium and large features) get multiplied by 1.00. Absent features are coded as N/A (or 0).

3.3.3 Teen-Informed Coding Tool

Figure 3.4 illustrates the mechanics of the coding tool, and how the power of each advertisement is generated. The power of an advertisement is derived from its overall score; for instance, a very powerful advertisement would have a high score (closer to 100) and a weak advertisement would have a low score (closer to 0). Based on the assigned weights for both the criteria and its sizing, this coding tool technically allows for the perfect score of 100, given that all 10 features are present and at least medium to large in size.

Results from the IRR analysis in Table 3.5 show that kappa was perfect (0.81-1) for all advertisement types, with kappa ranging from .893-.988 (Light, 1971), and where there

was disagreement, a third coder from the authors acted as the decision maker. Percent agreement ranged from 96.2%-99.3%. This validates the reliability and replicability of this coding tool when measuring the power of several types of outdoor advertisements found within the information environment.

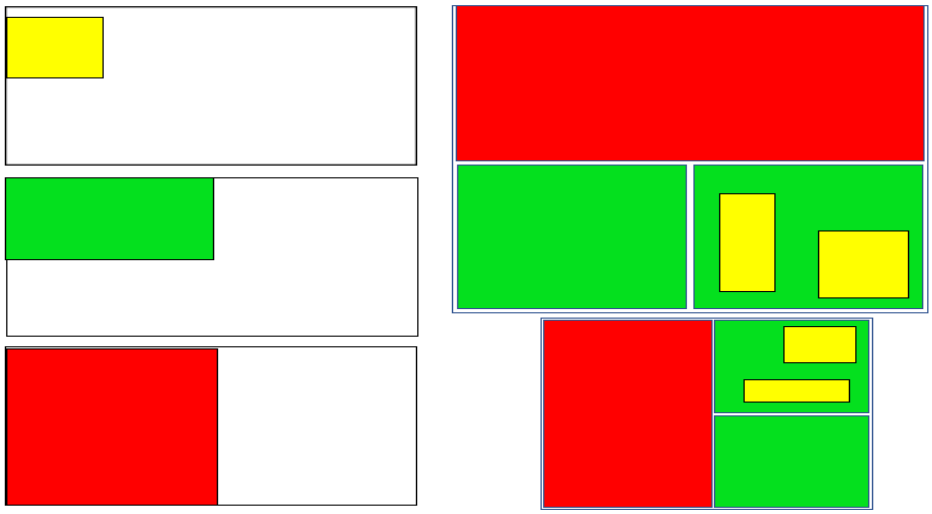

Figure 3.3 Sizing guide for the teen-informed coding tool

Note: There are 3 sizes: 1) Small, takes up less than ¼ of the ad (depicted in yellow), 2) Medium, takes up ¼ of the ad (depicted in green), and 3) Large, takes up ½ of the ad or more (depicted in red).

Ad Feature	**Presence** Yes(1) No (0)		**Size** ☐ **NA** (0)	☐ **S** (0.25)	☐ **M/L** (1)		**Weight Totals** (Presence x Size)
1. Price	____ x 29.1136		☐	☐	☐		
2. Image of Food/Beverage	____ x 20.7955		☐	☐	☐		
3. Taste Description	____ x 11.7273		☐	☐	☐		
4. Sale/Deal/Special offers	____ x 9.9773		☐	☐	☐		
5. Slogan/Description	____ x 8.5227		☐	☐	☐		
6. Logo/Company Name	____ x 6.9318	x	☐	☐	☐	=	
7. Directions/Location	____ x 4.2727		☐	☐	☐		
8. Gamification	____ x 3.8409		☐	☐	☐		
9. Loyalty Points/Rewards	____ x 3.2955		☐	☐	☐		
10. Character, Celebrity or TV/Sports tie-in	____ x 1.5227		☐	☐	☐		
Ad Power							**= score /100**

Figure 3.4 Teen-informed coding tool for quantifying the power of food advertisements

Table 3.5 Testing the inter-rater reliability of advertisement coding using a novel tool

Ad Type: Billboards/Transit Shelters (n=93 ads)		
Feature	**(k)**	**% Agreement**
Price	0.910	96.8
Food/Beverage Image	1.000	100.0
Slogan/Description	0.891	95.7
Logo/Company Name	1.000	100.0
Location/Directions	0.950	97.8
Sale/Deal/Special Offer	0.731	92.5
Loyalty/Rewards	1.000	100.0
Gamification	0.903	98.9
Taste Description	0.678	91.4
Characters, Celebrities, TV, or Sports tie ins	0.863	94.6
Average	0.893	96.8
Ad Type: Secondary School Cafeterias (n=86 ads)		
Feature	**(k)**	**% Agreement**
Price	1.000	100.0
Food/Beverage Image	0.963	98.8
Slogan/Description	0.949	97.7
Logo/Company Name	0.965	97.7
Location/Directions	1.000	100.0
Sale/Deal/Special Offer	1.000	100.0
Loyalty/Rewards	1.000	100.0
Gamification	1.000	100.0
Taste Description	1.000	98.8
Characters, Celebrities, TV or movie tie ins	1.000	100.0
Average	0.988	99.3
Ad Type: Outdoor Vendor Signage (n=999 ads)		
Feature	**(k)**	**% Agreement**
Price	0.923	96.6
Food/Beverage Image	0.936	96.4
Slogan/Description	0.732	82.6
Logo/Company Name	0.884	92.6
Location/Directions	0.923	99.2
Sale/Deal/Special Offer	0.969	98.7
Loyalty/Rewards	0.998	99.8
Gamification	0.984	99.9
Taste Description	0.769	96.7
Characters, Celebrities, TV or movie tie ins	0.980	99.7
Average	0.910	96.2

*For all inter-rater comparisons, $p < 0.001$

Although 100 is the highest score that is, in theory, achievable, it is unrealistic; when exploring and coding the advertisements with teens (n=1178), this perfect score was never attained, and due to limited space on signage, it is unlikely that all ten features would be present as well as be considered 'not small'. To demonstrate how this coding tool can be applied, a sample of three advertisements and the breakdown of their power scores is shown below (see Figures 3.5-3.7). The ads range in power from low (6.932) to high (59.199).

Ad Feature	**Presence Score**	**Size Score**	**Totals** (Presence Score x Size Score)
1. Price	0	0	0
2. Image of Food/Beverage	0	0	0
3. Taste Description	0	0	0
4. Sale/Deal/Special offers	0	0	0
5. Slogan/Description	0	0	0
6. Logo/Company Name	6.93	1	6.93
7. Directions/Location	0	0	0
8. Gamification	0	0	0
9. Loyalty Points/Rewards	0	0	0
10. Character, Celebrity or TV/Sports tie-in	0	0	0
TOTAL POWER			6.93

Figure 3.5 Coding example using the teen developed tool: Advertisement A

Ad Feature	Presence Score	Size Score	Totals (Presence Score x Size Score)
1. Price	0	0	0
2. Image of Food/Beverage	20.80	1	20.80
3. Taste Description	0	0	0
4. Sale/Deal/Special offers	0	0	0
5. Slogan/Description	8.52	1	8.52
6. Logo/Company Name	6.93	0.25	1.73
7. Directions/Location	0	0	0
8. Gamification	0	0	0
9. Loyalty Points/Rewards	0	0	0
10. Character, Celebrity or TV/Sports tie-in	0	0	0
TOTAL POWER			31.05

Figure 3.6 Coding example using the teen developed tool: Advertisement B

Ad Feature	Presence Score	Size Score	Totals (Presence Score x Size Score)
1. Price	29.11	1	29.11
2. Image of Food/Beverage	20.80	1	20.80
3. Taste Description	11.73	0.25	2.93
4. Sale/Deal/Special offers	9.98	0.25	2.49
5. Slogan/Description	8.52	0.25	2.13
6. Logo/Company Name	6.93	0.25	1.73
7. Directions/Location	0	0	0
8. Gamification	0	0	0
9. Loyalty Points/Rewards	0	0	0
10. Character, Celebrity or TV/Sports tie-in	0	0	0
TOTAL POWER			59.19

Figure 3.7 Coding example using the teen developed tool: Advertisement C

3.4 Discussion

The current study investigated the information environment in London, Ontario, Canada to create a validated, teen-informed coding tool that measures the *power* of food and beverage advertisements. The results pinpoint ten teen–directed criteria perceived to be most important in influencing teen purchases and engagement with local food vendors. Relativeness and size are also important factors when it comes to teens' advertising perceptions. For instance, the inclusion of both price and food image were much more important to teens than other advertisement features. Moving forward, this aspect of relative importance, as reflected in the tool's weighting system, should be considered, since most studies solely code for the presence or absence of selected criteria without applying weights (Elliot, 2012; Potvin Kent et al., 2012; Potvin Kent et al., 2014). It was also recognized by the youth advisory council, and consistent with the literature (Hutchings, 1994; Potvin Kent et al., 2014; Prowse, 2017; WHO, 2012, 2019), that the size of ad features is an important consideration.

Our findings are consistent with the notion that children's food purchasing perceptions are not necessarily influenced in the same way as teens' (IOM, 2006; Watts et al., 2018).

For instance, toys and giveaways have been known to influence children's perceptions and preferences (Boyland & Halford, 2013; Harris et al., 2009b; Ohri-Vachaspati et al., 2015), but gamification (defined in the context of this study as giveaways, contests, games) was shown to be of little importance to teens compared to most of the other advertisement features. In addition, our findings demonstrate that researchers' perceptions of teen-directed advertising criteria do not always match up with teens' perceived advertising influences. For instance, the youth advisory council expressed that although social media is an influential feature in connecting teens with other people, it is not as important for connecting them with food vendors or brands. Thus, this study reinforces the importance of conducting qualitative research with teenagers as a separate demographic (Elliot, 2016; Engler-Stringer et al., 2014).

The study makes contributions to both food environment and public health research, and fills methodological and practical gaps within these fields. The findings address the limited research that measures the power of food and beverage related advertisements within different contexts (Prowse, 2017) and how advertising affects teens' purchasing perceptions (Elliot, 2016; Engler-Stringer et al., 2014; Velazquez et al., 2017; Williams et al., 2014). The developed tool contributes to food environment methodology by providing a validated and objective means for quantifying the power of advertisements within and across neighbourhoods, from a teen perspective. Once applied, this coding tool produces an overall score that represents the power of each advertisement. This coding tool can be easily used to compare the power of ads within and across various neighbourhood food environments. Ultimately, the application of this tool can be used in research to demonstrate the pervasiveness of teen-directed food and beverage marketing and advocate for the restriction of marketing to teenagers.

This contribution narrows the gap in food environment methodology, which currently lacks consistent and standardized measurement tools (Caspi et al., 2012; Glanz et al., 2005; Kelly et al., 2011; Lytle & Sokol, 2017; Williams et al., 2014). This tool will prove to be useful in geographic health research, as it allows for the combination of spatial mapping of advertising exposure through GIS technology, coupled with teenage perspectives to better understand the perceived impacts of marketing techniques; this

incorporation of both qualitative and GIS methodology that was suggested by Riggsbee et al. (2019) is necessary to achieve a more complete representation of young people's food environments and their associated purchasing experiences and behaviours.

This research conducted with local teens in London, Ontario was needed to identify key teen-directed criteria to inform future food environment and marketing policy. For example, the results from this study can help inform federal Bill-S228, otherwise known as the Child Health Protection Act, aimed to prohibit food and beverage marketing to Canadian children under the age of 13 (Parliament of Canada, 2019; Vergeer et al., 2018). Currently, there are major concerns that this recent age amendment to Bill-S228, reduced from 17 to 13, will leave teenagers increasingly susceptible to teen-targeted marketing (Elliot, 2016; Health Canada, 2019, Potvin Kent et al., 2018; Yan et al., 2018). Thus, there is an increased focus on monitoring current advertising efforts to determine how advertising impacts teens in particular (Health Canada, 2019; Yan et al., 2018). This controversy has led to large global and national organizations, including the World Health Organization (2012, 2019) and Health Canada (Hooper, 2018), issuing a call for additional research and evidence-informed guidance to support the development of an enabling food environment that promotes healthy diets and adequate nutrition. UNICEF (2018) encourages the equal protection of all children, including teens, against marketing techniques, but expressed that despite this global push for the restriction of unhealthy food advertising to young people, it has not yet led to reduced exposure. Despite these shortcomings, this international organization (UNICEF, 2018) continues to support policy limiting the exposure to, and power of, the information environment. Thus, the findings from this study provide valuable insight on how to measure both the power of food advertisements and the extent of marketing exposure to Canadian teens, so that policymakers can understand how to reduce this type of exposure.

This study has several limitations that must be considered. First, due to a small sample size, and a lack of demographic information beyond age, we do not have certainty that this tool is generalizable to the larger population of teens. The weights for size that are incorporated in this tool are not arbitrary, as they were decided on by a youth advisory council. However, considering teens often navigate their retail food environments from a

distance (i.e., walking/biking from the sidewalk or street, driving by food vendor establishments and billboards) as opposed to viewing advertisements in close proximity, they often do not see the smaller features that could be seen by the youth advisory council in the research setting. This notion is reflected in many studies where they either exclude small advertisements from their design altogether, or code them according to size (Kelly et al., 2008; Yancey et al., 2009). Research also shows that the perceptions of youth in London, Ontario regarding safety and time constraints often limits active travel opportunities and results in increased driving (Wilson et al., 2018). Consequently, this justified our final weighting decisions. Additionally, this study did not assign weights based on the advertisement type (i.e., billboard, vendor signage), but instead focused on exploring the content and size within each advertisement. Finally, this paper did not consider nutritional quality, considering it is already established that most food and beverages advertised to youth are low quality foods (Harris et al., 2009a; Sadeghirad et al., 2016).

Future research should apply this teen-informed coding tool when conducting food information environment audits to quantify the power of food and beverage advertisements in diverse contexts and neighbourhoods surrounding teen-centered settings, such as secondary schools. The application of this tool in geographic research will provide important spatial and marketing information to federal health policymakers on the exposure and power of food-related marketing, and may reveal its potential underestimation (Prowse, 2017). The use of this tool could also advocate for behavioural interventions and policy that reduce this type of exposure. Additional qualitative research is also needed to further explore teens' perceptions and dive deeper into the teen-directed criteria that were identified. For instance, this research clearly demonstrates that price is an important feature to be present on an advertisement, but what is the price range that matters to teenagers and what is the cut off that would deter them from making a food purchase? Studies should further explore the relationship between advertisement power and spatial exposure in proximity to secondary schools. Ultimately, this research provides both methodological and practical contributions that will advance food environment research, and allow for a validated and objective measurement of the information environment.

3.5 Conclusions

This sequential mixed-method study incorporated a geographic food information environment audit and consultations with a local youth advisory council to explore how teens perceive the food information environment to influence their food purchasing behaviours. The youth advisory council explored a diverse sample of food and beverage related advertisement photos collected from London, Ontario, Canada, including billboards, transit shelters, and vendor signage. The coding tool that was developed in this study includes ten marketing criteria perceived to be the most important contributors to teens' food purchase behaviours, and their relative weights. The results show that the importance of these criteria is relative, with some features proving to be more influential than others; thus, this aspect of relative importance should be considered in future food environment projects. Lastly, the findings reveal that the mixing of geographic and qualitative research to understand teens' perceptions can be valuable for the health and wellbeing of teens. Future researchers may apply this tool to more accurately represent the exposure and power of food and beverage advertisements within communities, and to ultimately support policies that promote healthier behaviours within daily food environments.

3.6 References

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Chapter 4

4 Measuring Food and Beverage Advertising Surrounding Canadian Schools Using a Teen Coding Tool

4.1 Introduction

Food environments, which are typically characterized in terms of neighbourhood food access and availability (Rideout, Mah, & Minaker, 2015), play an especially important role in the food purchasing decisions, consumption behaviours, and health outcomes of adolescents (Engler-Stringer, Le, Gerrard, & Muhajarine, 2014a; He et al., 2012a; He et al., 2012b; Sadler et al., 2016). A growing body of research has examined different elements of food environments (Engler-Stringer et al., 2014a; Glanz, 2009), including community environments (e.g., Austin et al., 2005; Day & Pearce, 2011; Dubreck et al., 2018; Holsten, 2009; Kelly, Flood, & Yeatman, 2011; Zenk & Powell, 2008), consumer environments (e.g., Dubreck et al., 2018; Gustafson et al., 2017; Kelly et al., 2011), and organizational environments (Gustafson et al., 2017; Larson et al., 2015; Potvin Kent et al., 2019; Tabak et al., 2016). On the other hand, much less has been written about the food-related *information environment*, including outdoor food and beverage advertising within a community (Minaker et al., 2016; Prowse, 2017; Velazquez, Daepp, & Black, 2019). This is a notable knowledge gap, given that the information environment is pervasive within communities and embedded within and around most daily spaces, such as schools (Velazquez et al., 2015b; Velazquez et al., 2019), supermarkets (Bragg et al., 2012; Elliot, 2012), and recreational facilities (Liu et al., 2019; Lucan et al., 2017; Prowse, 2017). There are a growing number of studies that quantify and map several types of advertising exposures, including geographic placement of billboards within different cities and contexts (Cassady, Liaw, & Miller, 2015; Lesser, Zimmerman, & Cohen, 2013; Luke, Esmundo, & Bloom, 2000), yet most examine risk exposure to tobacco and alcohol advertisements (Hackbarth, Silvestri, & Cosper, 1995; Isgor et al., 2016; Lowery & Sloane, 2014; Luke et al., 2000), as opposed to food- and beverage-related content.

This study investigates food environments in the mid-sized city of London, Ontario, Canada (population 383,825; Statistics Canada 2016) and the nearby town of Strathroy (population 20,867; Statistics Canada 2016), with the aim of quantifying the exposure to, and power of, food and beverage advertisements surrounding schools. The overarching objectives of this study were to: 1) examine how the vendor and advertising environment differs across all school neighbourhoods in the study area, and 2) apply the tool described in Chapter 3 to examine how food and beverage advertising (i.e., information environment and organizational environment) for teens differs across secondary school neighbourhoods.

4.1.1 The Information Environment and Teen Vulnerability

Although the food environment is made up of various components (Glanz et al., 2005), the information environment is particularly influential in determining adolescents' dietary behaviours and health outcomes (Andreyeva, Kelly, & Harris, 2011; Health Canada, 2019; IOM, 2006; Thai et al., 2017; World Health Organization [WHO], 2019). Research suggests that secondary school-aged adolescents are especially vulnerable to advertising (Harris & Graff, 2012; Harris et al., 2014; Pechmann et al., 2005). The transition from elementary to secondary school is often coupled with teens' having increased freedom and greater spending (Bowman et al., 2004; Kraak & Pelletier, 1998; Velazquez et al., 2015a), which typically includes food and beverages of low nutritional quality (Cowburn et al., 2016; Harris et al., 2009; IOM, 2006; Minaker et al., 2006; Sadler et al., 2016; Velazquez et al., 2015a). A review on the effects of adolescent advertising conducted by Pechmann and colleagues (2005) suggests that teens are more impulsive than adults, and tend to have more intense urges and desires when it comes to purchasing behaviour (UNICEF, 2018). Considering it is likely that teenagers do not yet "possess an adult-like resistance" to marketing strategies, this evidence indicates that teens are perhaps the most vulnerable population to food marketing (Nairn & Fine, 2008, p. 460). Despite the overwhelming evidence that shows the prevalence of calorie-dense, nutrient-poor food items being advertised to young Canadians (Dubreck et al., 2018; Elliot, 2014; Heart and Stroke, 2017; Sadeghirad et al., 2016; Velazquez et al., 2019; WHO, 2019), there is scarce evidence involving adolescents' exposure to outdoor food and beverage

advertisements surrounding and within schools (Hastings et al., 2003; Prowse, 2017; Velazquez et al., 2019; Velazquez et al., 2015b).

4.1.2 School Food Environments

The food environments around some North American schools are extremely obesogenic (Black, 2014; Health Canada, 2013; Minaker & Raine, 2013; Sadler et al., 2016; Velazquez et al., 2015a), and exposure to unhealthy food presents a barrier to making healthy choices (Gittelsohn & Lee, 2013; Just, 2006). Although school food environment studies have increased dramatically in recent years (Engler-Stringer et al., 2014a; Minaker et al., 2016; Browning, Laxer, & Janssen, 2013), they largely focus on investigating the areas surrounding elementary rather than secondary schools (Dubreck et al., 2018; Engler-Stringer et al., 2014b; Kelly et al., 2008; Minaker et al., 2016). The emphasis on younger children while overlooking teenagers is concerning, since studies have shown that secondary schools generally have higher access and exposure to food retailers (Black & Day, 2012; Velazquez et al., 2015a; Zenk & Powell, 2008), and teens are more likely to consume nutrient poor foods than younger children (Velazquez et al., 2015a).

Furthermore, of the few studies that measured advertising exposure surrounding schools, buffer distances of less than 500m were generally used to characterize the area around a school (Liu et al., 2019; Parnell et al., 2018; Velazquez et al., 2019). Meanwhile, teenagers have greater mobility than children (Jia et al., 2017) and often congregate in areas of the community that are further away than 500m from their school (Day & Pearce, 2011; Velazquez et al., 2019; Zenk & Powell, 2008). Findings from a recent study of secondary school food environments in Vancouver, Canada (Velazquez et al., 2019) demonstrated that “store exteriors are a considerable contributor to children’s exposures” (p. 9). Additionally, a recent scoping review investigating the exposure and power of food marketing in Canada highlighted that only one study examined adolescents’ exposure to food and beverage advertising within school settings, with nearly half of these studies (48%) focusing on television and online marketing exposure (Prowse, 2017).

The information environment relates to how advertising is influenced by government policies, which in turn has the potential to affect adolescents' food-related attitudes and the appeal of foods and retailers (Glanz et al., 2005). However, there is limited health geography research on how food advertising exposure influences the purchasing by adolescents, or how marketing uniquely influences teenagers' perceptions of food (Bibeau et al., 2012; Elliot, 2014; Engler-Stringer et al., 2014a; Velazquez et al., 2017; Yancey et al., 2009). Researchers are increasingly recognizing the importance of utilizing a combination of methods (Caspi et al., 2012), especially both GIS-related technology and qualitative measures, to thoroughly capture the link between food environments and adolescents' purchasing behaviours (Knigge & Cope, 2006; Riggsbee et al., 2019; Williams et al., 2014).

Given the rising concern associated with the pervasiveness of food and beverage marketing to teens and its serious health impacts (Health Canada, 2019; Leibowitz et al., 2012; Prowse, 2017; United Nations Children's Fund [UNICEF], 2018), there is an urgent need to quantify the *exposure* to (i.e., geographic density and proximity), and *power* of (i.e. creative content, design and execution) food advertisements across neighbourhoods within the larger food environment. Furthermore, while the impact of outdoor food and beverage marketing on teen food purchasing is poorly understood (Velazquez et al., 2019), the deployment of measurement tools that consider teen perspectives is warranted (Bibeau et al., 2012; Elliot, 2014, 2016; Prowse, 2017; Velazquez et al., 2017). This evidence is needed to determine the overall impact of the information environment in the context of Canada, and to understand how it differs across school neighbourhoods (Health Canada, 2017; Prowse, 2017; WHO, 2019).

This study is comprised of two phases. First, the broader community and information environment will be investigated to uncover school neighbourhood differences in vendor exposure and advertising exposure, and how this relates to characteristics of school catchment areas such as socio-economic status, urbanicity, and proximity to schools (Question 1). Elementary and secondary schools (n=119) will be included in this stage of the study to ensure comprehensiveness in our analysis. The second phase of this study (Questions 2 and 3) is a case study that includes a more in-depth investigation of the

information and organizational food environment (i.e., including billboards, vendor signage, cafeteria signage), both in and around a sample of six secondary schools. Using the teen-informed coding tool developed in Chapter 3, advertising power will also be explored in this phase as an additional descriptor of the information environment.

The following research questions will be addressed in this study:

1) How does exposure to vendors and billboards around all schools vary by (a) socio-economic status and (b) school level?
2) How does exposure to vendors, vendor signage, and billboards vary across a sample of secondary schools in contrasting environments?
3) How does total advertising power vary across these secondary schools by (a) socio-economic status, (b) proximity, and (c) vendor type?

The study area includes the city of London, Ontario, Canada and the neighbouring town of Strathroy. This setting covers a wide range of physical and social school environments, including urban, suburban, and small town settings, as well as a range of low to high socio-economic status catchment areas. This study excluded rural areas, as this research was conducted within the city of London boundary, and the nearby small town of Strathroy. The six secondary schools included in the case study lacked spatial variability (i.e., no urban or rural schools), but from a food environment standpoint, these schools represented three spatially unique environments, ranging from saturated (n=2), to semi-isolated (n=2), to isolated (n=2). These six schools were participating in a larger research project involving teen dietary behaviours.

4.2 Methods

4.2.1 Data Collection

A food information environment audit was conducted by a team of research assistants from May to October 2018 to collect data on food vendors, billboards and transit shelters (hereafter referred together as billboards), and outdoor vendor signage within the study area. The ArcGIS Collector smartphone application was used by the auditing team to

record vendor location information, as well as capture photos of all food- and beverage-related billboards and outdoor vendor signage.

1a) Food Vendors

A health inspector database containing data on all local food retailers was first used to identify vendor information within the study area. The vendor types included in the audit were: 1) full-service restaurants; 2) fast food restaurants; 3) convenience stores; and 4) grocery stores. These types were chosen based on consultations with local secondary school students regarding where they go to buy food, and defined based on previous work (Clary & Kestens, 2013; Dubreck et al., 2018; Fleischhacker et al., 2012; Velazquez et al., 2019). All vendor types that were deemed irrelevant to teen purchasing (e.g., bakery production, church kitchens, cocktail bars, nutrient/supplement stores, and private facilities) were excluded from this study. Relevant food vendors were mapped using ArcGIS software, as shown below.

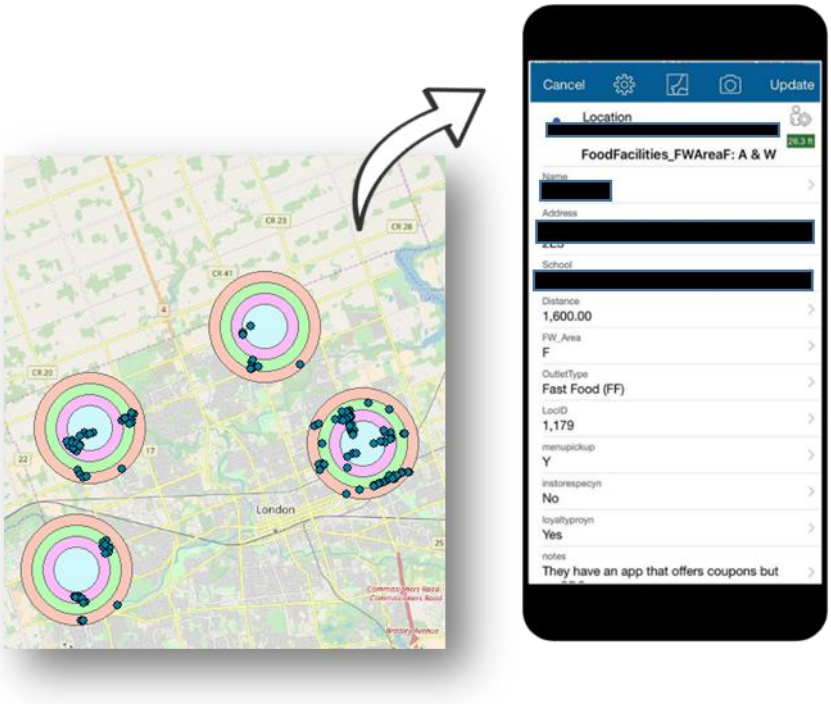

Figure 4.1 Using the ArcGIS Collector phone application to map buffers and audit food vendors around schools in the study area

1b) Billboards

A GIS database was used to locate and map all billboards within the study area. During the food information environment audit, research assistants photographed and audited all billboards for food- and beverage- related content. Collection of this data was necessary to comprehensively capture food and beverage advertising exposure within the broader information environment, and to be able to compare this exposure across a range of school neighbourhoods.

1c) Vendor Signage

Photos of all food- and beverage- related vendor signage was captured at every food vendor surrounding the six secondary schools. Considering that walking is particularly appealing for trips under 2000m (City of Kingston, 2015; Sadler, Gilliland, & Arku, 2011), a 2000m buffer was decided on for capturing vendor signage.

4.2.2 Measures

Several measures were used to capture the impact of the food environment. The three dependent variables that were measured in this study included vendor exposure, advertising exposure, and total advertising power. Circular buffers (400m, 800m, 1200m, 1600m, and 2000m) were used to initially explore and compare the vendor and advertising environments in proximity to all elementary and secondary schools in the study area. Independent variables, including urbanicity, categories of environmental food availability (i.e., saturated, semi-isolated, and isolated), and categories of socio-economic status, were also used to better understand the relationship between socio-economic status within school catchment areas and the food environment.

1a) Vendor Exposure

Vendor exposure was calculated as the number of food vendors (i.e., full-service restaurants, fast food restaurants, convenience stores, and grocery stores) located within each buffer ring (vendor count) divided by the area of the ring (km^2). This variable was measured surrounding each school found within the study area (n=119) to capture vendors located within the community food environment.

1b) Advertising Exposure

Advertising exposure was measured as the number of advertisements within each buffer (advertisement count) divided by the area of the ring (km^2). Note that the advertisement counts only included billboards when calculating this variable for all schools (n=119). However, when exploring the case study of a sample of secondary schools (n=6), the advertising exposure score was more comprehensive in that it included both billboards and vendor signage counts in and around these schools.

1c) Total Advertising Power

For the case study involving secondary schools,
two research assistants coded all outdoor food and beverage advertisements that were collected from the food information environment audits (n=1178) using a teen-informed coding tool (see Chapter 3). Despite the lack of consistent and standardized methodologies that measure the food environment (Glanz et al., 2005; Kelly et al., 2011; Williams et al., 2014), or that adopt a teen perspective (Velazquez et al., 2017), this tool was appropriate for this study involving teens and the information environment surrounding secondary schools. It is unique, given that it measures the *power* food and beverage advertisements by 1) incorporating teens' advertising perceptions, and 2) considers the relative importance and sizing amongst the advertising criteria that they identified as teen-directed. The coding occurred via an online software, and then SPSS statistics software was used to export and analyze the data. An inter-rater reliability (IRR) analysis was calculated to assess the degree that two coders consistently coded the data (Hallgren, 2012). Kappa was calculated for each type of advertisement, and the mean was used to produce a single index of IRR (Light, 1971). Missing codes were recirculated to the coders for coding, and discrepancies were documented and revisited by a third coder to make the final decision. To measure power in relation to geographic exposure, total advertising power was calculated in proximity to each school ($\leq$ 2000m). This was measured in terms of the sum of all individual power scores for each advertisement divided by the buffer area (km^2).

1d) Independent variables

School urbanicity was classified according to urban, suburban, and small town. These definitions were based on the 1959 City of London boundary (Meligrana, 2000), which has been used in previous studies (Dubreck et al., 2018; Larsen & Gilliland, 2008).

The next set of independent variables are created based on the 2016 Census of Canada (Statistics Canada, 2016) at the school catchment area level. Each variable used in the analysis was downloaded as a population count measured at the census dissemination area (DA) level. If the centroid of a DA is within the catchment area of a school, the population for each variable is added to the school. The data is then summarized into the following measures:

- Density of Children: Number of children between 0 and 19 years of age divided by the total area of all DAs
- Recent Immigrants: Number of people who immigrated to Canada between 2011 and 2016 divided by the population
- Visible Minority: Number of people who self-identify as a visible minority divided by the population
- Median Household Income: Average Median Household Income
- Educational Attainment: Number of people who did not graduate from secondary school over the age of 19 divided by the population over the age of 19
- Lone Parent Household: Number of households with a lone parent divided by the number of households

A socio-economic distress index was created to measure the level of distress for each school catchment area. The distress index is created by calculating a z-score for each socio-economic variable in every school catchment area. The resulting z-scores for each school are then summed together (i.e., Recent Immigrant, Visible Minority, Inverse of Median Household Income, Educational Attainment, Lone Parent Household) to create the school-level socio-economic distress index.

4.2.3 Analysis

The analysis for this study uses a combination of descriptive and inferential statistics to address the three research questions. To address research question 1, Spearman's Correlation Coefficient analysis was used to examine the association between socio-economic status measures and exposure variables for all schools, including vendor exposure and advertising exposure. According to Spearman's statistical measure (r_s), the strength of correlations can be classified as *very weak* (.00-.19), *weak* (.20-.39), *moderate* (.40-.59), *strong* (.60-.79), and *very strong* (.80-1.0) (statstutor, n.d.). The range of significance of these coefficients (p) was presented as according to the following cut offs: $p<0.05$, $p<0.01$, $p<0.001$. One-way ANOVA tests were conducted to compare the differences in means amongst urbanicities (i.e., urban, suburban, and small town) for each school in relation to vendor exposure and advertising exposure. To understand how distance influenced these complex relationships, a sensitivity analysis was conducted for various buffer sizes (i.e., 0-400m, 0-800m, 0-1200m, 0-600m, 0-2000m). This analysis ensured that significant relationships were not overlooked.

A Mann-Whitney U Test was conducted to analyze the differences in vendor exposure and advertising exposure between school levels (i.e., elementary and secondary). Given that this sample is not normally distributed, this nonparametric test was appropriate for this study.

To address research questions 2 and 3, vendor exposure, advertising exposure, and total advertising power for the six schools were calculated using SPSS statistics software. Vendor exposure and Advertising exposure were illustrated in maps, depicted by 1) the distribution and type of vendors, and 2) the location of advertisements within 2000m of each secondary school, and individual buffer rings were included (0-400m, 401-800m, 801-1200m, 1201-1600m, 1601-2000m) to show how exposure changes in relation to proximity to schools.

4.3 Results

4.3.1 Community Food Environment & Information Environment Surrounding All Schools

School Characteristics

The study area was comprised of 101 elementary schools and 18 secondary schools. Most schools were suburban (70.6%), with only 23.5% urban, and 5.9% small town. The scope of the study area, along with the level of socio-economic distress for all school neighbourhoods is shown in Figure 4.2.

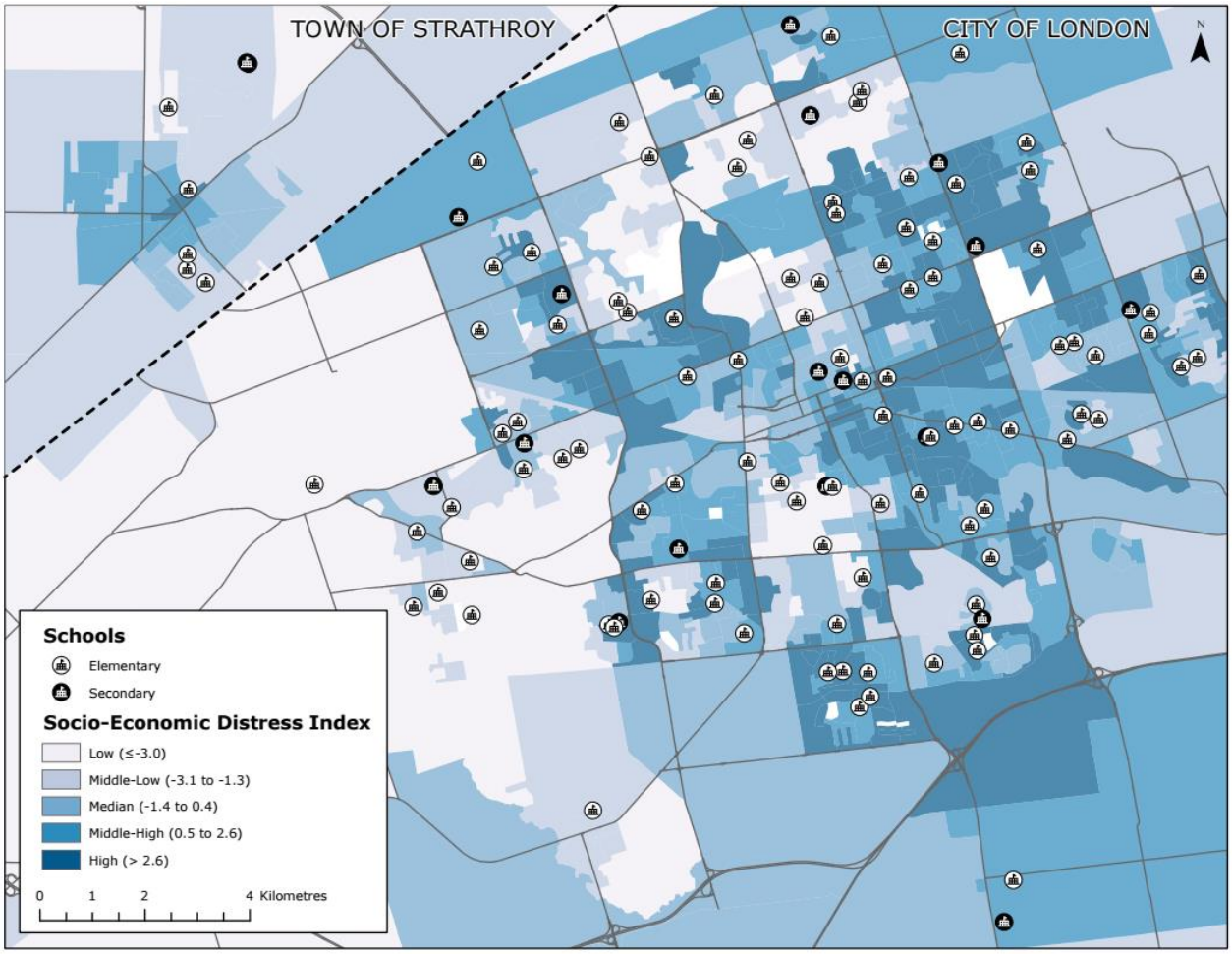

Figure 4.2 Level of socio-economic distress surrounding elementary and secondary schools (n=119) in London, Ontario and Strathroy

Characteristics of the Food Vendor & Food Advertising Environment

Figures 4.3 and 4.4 illustrate both the number and distribution of food vendors and billboards surrounding schools in London and Strathroy, Ontario, Canada, respectively. These figures also show the differences in geographic food environment exposure according to type (i.e., type of food vendor, type of signage). Results show that fast food restaurants are the most common vendor type found within London, Ontario (n=599, 46.3%), followed by full-service restaurants (n=343, 26.5%), convenience stores (n=277, 21.4%), and grocery stores (n=74, 5.7%). Similarly, this spatial data demonstrates that fast food restaurants dominate the foodscape (n=28, 50.0%) in the small town of Strathroy, Ontario, followed by full-service restaurants (n=19, 33.9%), convenience stores (n=5, 8.9%), and grocery stores (n=4, 7.1%). Results from the food information environment audit reveal that, of the 740 billboards located in London, Ontario and the surrounding town of Strathroy, only 12.6% (n=93) included food- and beverage- related content (see Figure 4.3). The City of London contained most of these food-related billboards (n=87), and Strathroy had significantly fewer (n=6). Figures 4.3 and 4.4 also reveal that most billboards are located along major road networks.

Vendor Exposure and Advertising Exposure

The results from the sensitivity analysis show significant correlations between vendor exposure, advertising exposure, and socio-economic variables across several buffer distances and vendor types (see Table 4.1). Average median household income (r_s = -0.600) and lone parent families (r_s = 0.516) are most significantly correlated with vendor exposure for all vendors, especially at 2000m. Average median household income is significantly negatively correlated with vendor exposure across all vendor types and buffer distances, excluding 400m. The percentage of the population that are recent immigrants and visible minorities are not significantly associated with vendor exposure. The positive strength of association between the socio-economic distress index and vendor exposure for all vendors is significant ($p<0.001$), apart from the 400m buffer. The association between vendor exposure for all vendors and the percentage of the population who did not graduate high school ranged from very weak to weak across all vendor types, with the strongest correlation ($p<0.001$) at the 800m (r_s = 0.302).

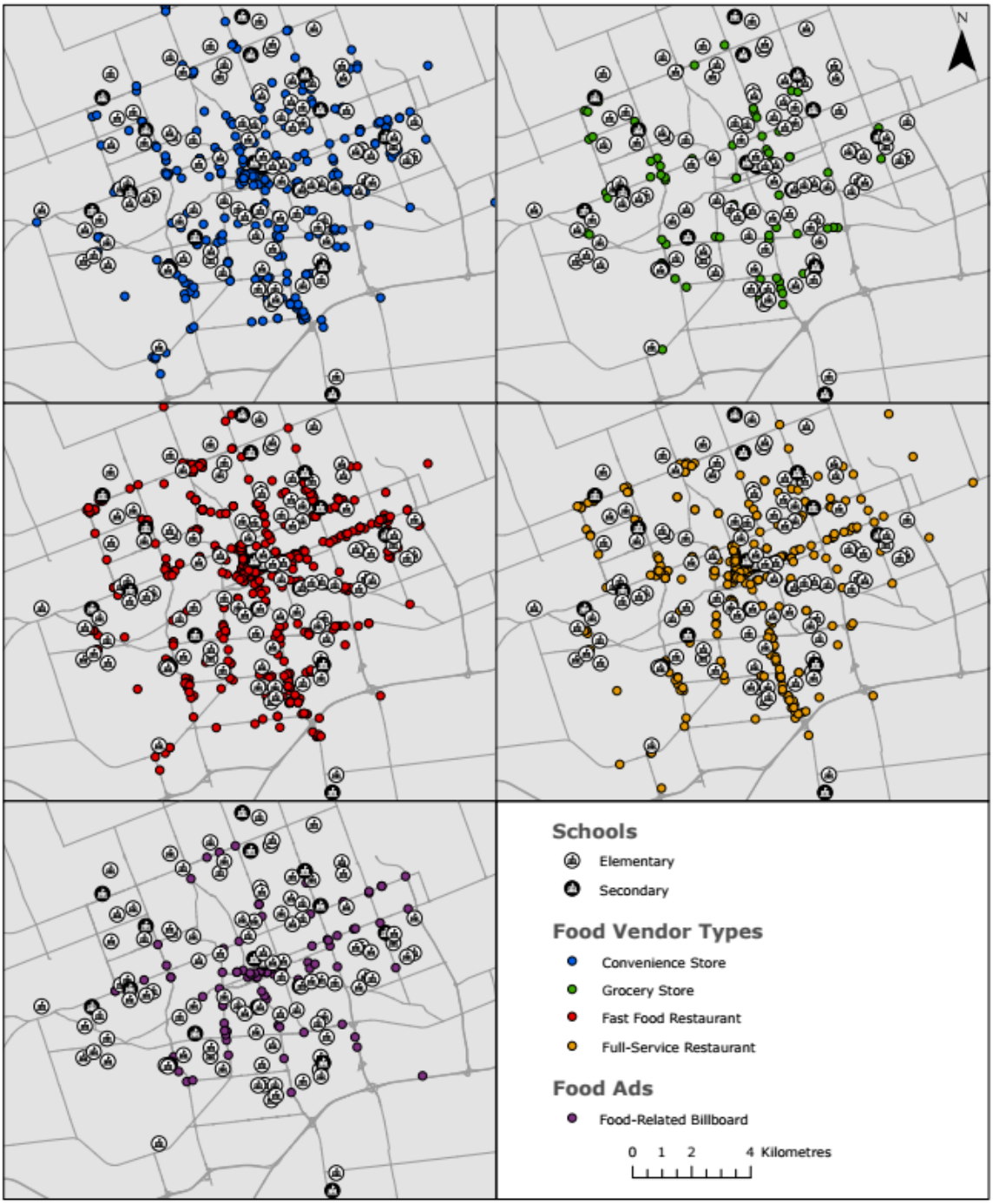

Figure 4.3 Food vendor environment by type and food advertising environment for all schools (n=112) in the city of London, Ontario

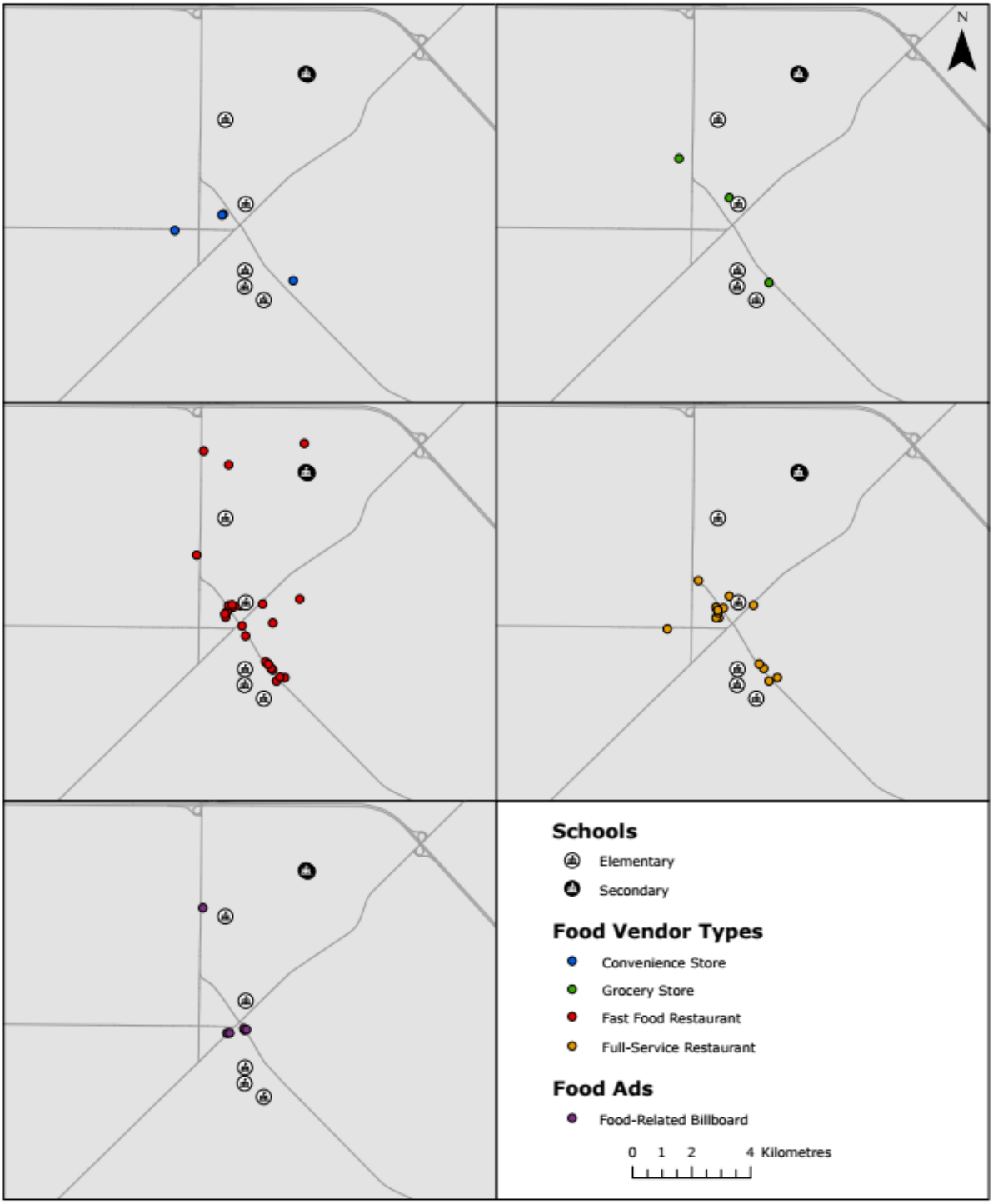

Figure 4.4 Food vendor environment by type and food advertising environment for all schools (n=7) in the town of Strathroy, Ontario

Advertising exposure is significantly correlated ($p<0.01$) with all socio-economic distress index variables at the 2000m buffer distance, excluding the percentage of the population that are recent immigrants and visible minorities. Like vendor exposure, advertising exposure was significantly negatively correlated with average median household income, with the strongest association (i.e., moderate) visible at the 2000m buffer distance ($r_s = -0.496$). Lone parent families showed a moderate positive correlation in relation to vendor exposure at the same buffer distance ($r_s = 0.514$). These findings indicate that as vendor exposure and advertising exposure increases, so does 1) the percentage of families that are headed by lone parents, 2) the proportion of low-income households, and 3) the level of socio-economic distress.

Results from the ANOVA test reveal that there are significant differences amongst the three types of urbanicities (i.e., urban, suburban, small town) when it comes to vendor exposure and advertising exposure (Table 4.2). While there is a non-equal difference between the two groups, the urban schools are much different from the suburban and small town schools. Findings from the Mann-Whitney U Test demonstrated that there was no significant differences in vendor exposure and advertising exposure between elementary and secondary schools.

Table 4.1 Correlations between vendor exposure, advertising exposure, and socio-economic variables using Spearman's Rho (r_s) (n=119)

Vendor Exposure							
Buffer Distance	**Density of Children**	**% of Population Recent Immigrant**	**% of Population Visible Minority**	**Average Median Household Income (CAD)**	**% of Population who did not Graduate High School**	**% of Census Families who are Lone Parents**	**Socio-Economic Distress Index**
Convenience Store							
0 - 400m	0.028	-0.007	-0.038	-0.317***	0.172	0.301***	0.199*
0 - 800m	0.296***	0.026	0.047	-0.477***	0.271**	0.474***	0.389***
0 - 1200m	0.367***	0.086	0.024	-0.588***	0.247**	0.556***	0.468***
0 - 1600m	0.353***	0.052	-0.014	-0.599***	0.212*	0.569***	0.444***
0 - 2000m	0.358***	0.040	-0.020	-0.613***	0.198*	0.572***	0.446***
Fast Food Restaurant							
0 - 400m	-0.089	-0.026	-0.046	-0.118	0.019	0.083	0.054
0 - 800m	0.111	-0.050	-0.027	-0.455***	0.322***	0.368***	0.306***
0 - 1200m	0.230*	0.088	0.015	-0.489***	0.230*	0.429***	0.348***
0 - 1600m	0.235**	0.105	0.059	-0.499***	0.166	0.425***	0.358***
0 - 2000m	0.272**	0.094	0.059	-0.553***	0.141	0.469***	0.381***
Grocery Store							
0 - 400m	-0.056	-0.043	-0.090	-0.030	0.080	0.014	-0.009
0 - 800m	0.179	0.073	0.040	-0.264**	0.119	0.185*	0.168
0 - 1200m	0.312***	0.251**	0.139	-0.275**	-0.021	0.248**	0.224*
0 - 1600m	0.376***	0.243**	0.095	-0.397***	-0.015	0.313***	0.288**
0 - 2000m	0.412***	0.188*	0.046	-0.522***	0.039	0.439***	0.362***
Full Service Restaurant							
0 - 400m	-0.061	-0.122	-0.111	-0.152	0.012	0.087	0.005
0 - 800m	0.135	-0.118	-0.149	-0.428***	0.198*	0.317***	0.196*
0 - 1200m	0.249**	0.038	-0.050	-0.433***	0.088	0.334***	0.239**
0 - 1600m	0.245**	0.083	-0.017	-0.466***	0.075	0.355***	0.280**
0 - 2000m	0.300***	0.105	0.033	-0.571***	0.103	0.456***	0.377***

Vendor Exposure							
Buffer Distance	**Density of Children**	**% of Population Recent Immigrant**	**% of Population Visible Minority**	**Average Median Household Income (CAD)**	**% of Population who did not Graduate High School**	**% of Census Families who are Lone Parents**	**Socio-Economic Distress Index**
All Vendors							
0 - 400m	-0.042	-0.062	-0.076	-0.244**	0.124	0.223*	0.130
0 - 800m	0.177	-0.051	-0.049	-0.495***	0.302***	0.427***	0.326***
0 - 1200m	0.284***	0.083	0.000	-0.530***	0.209**	0.469***	0.373***
0 - 1600m	0.285***	0.103	0.030	-0.532***	0.146	0.457***	0.372***
0 - 2000m	0.315***	0.097	0.037	-0.600***	0.146	0.516***	0.417***
Advertising Exposure							
0 - 400m	-0.007	0.017	-0.015	-0.201*	0.051	0.162	0.135
0 - 800m	0.157	0.060	-0.015	-0.113	0.073	0.162	0.085
0 - 1200m	0.154	-0.023	-0.171	-0.271**	0.129	0.305***	0.125
0 - 1600m	0.154	-0.071	-0.198*	-0.364***	0.190*	0.373***	0.185*
0 - 2000m	0.207*	-0.105	-0.179	-0.496***	0.235**	0.514***	0.296**

*. Correlation is significant at the 0.05 level (2-tailed, $p < 0.05$).

**. Correlation is significant at the 0.01 level (2-tailed, $p < 0.01$).

***. Correlation is significant at the 0.001 level (2-tailed, $p < 0.001$).

Table 4.2 Correlations linking urbanicity, vendor exposure by type, and advertising exposure for all schools (n=119)

	Total mean (s.d.)	Urban mean (s.d.)	Suburban mean (s.d.)	Small Town mean (s.d.)	ANOVA F	p
Vendor Exposure						
Full Service						
0 - 400m	1.438 (2.872)	3.624 (4.300)	0.734(1.795)	1.137(2.256)	12.807	0.000
0 - 800m	1.806 (3.142)	4.263 (5.368)	1.013 (1.336)	1.492 (1.650)	13.701	0.000
0 - 1200m	1.941 (3.124)	4.658 (5.402)	1.124 (1.023)	0.884 (.989)	17.821	0.000
0 - 1600m	2.048 (2.600)	4.903 (3.973)	1.198(.907)	0.835 (.833)	34.809	0.000
0 - 2000m	2.046 (2.228)	4.840 (3.002)	1.221 (.801)	0.762 (.537)	55.866	0.000
Fast Food						
0 - 400m	2.742 (4.380)	4.760 (6.110)	2.061 (3.459)	2.842 (4.276)	4.209	0.017
0 - 800m	3.352 (4.420)	5.755 (6.909)	2.582 (3.056)	2.984 (2.206)	5.889	0.004
0 - 1200m	3.513 (4.278)	6.797 (6.804)	2.563 (2.453)	1.768 (1.345)	13.150	0.000
0 - 1600m	3.609 (3.709)	7.305 (5.470)	2.555 (1.903)	1.474 (1.087)	26.395	0.000
0 - 2000m	3.540 (3.174)	7.324 (4.034)	2.474 (1.600)	1.205 (.642)	47.397	0.000
Convenience Store						
0 - 400m	1.421 (2.122)	2.345 (2.169)	1.232 (2.092)	0.000 (.000)	4.853	0.009
0 - 800m	1.726 (1.548)	2.913 (1.965)	1.457 (1.183)	0.213 (.391)	16.137	0.000
0 - 1200m	1.588 (1.437)	2.913 (1.953)	1.261 (.913)	0.221 (.255)	23.949	0.000
0 - 1600m	1.576 (1.237)	2.882 (1.413)	1.255 (.825)	0.195 (.214)	36.548	0.000
0 - 2000m	1.545 (1.136)	2.907 (1.108)	1.204 (.732)	0.193 (.144)	55.593	0.000
Grocery Store						
0 - 400m	0.418 (1.032)	0.782 (1.363)	0.284 (.881)	0.568 (.971)	2.586	0.080
0 - 800m	0.518 (.629)	0.817 (.732)	0.438 (.585)	0.284 (.266)	4.587	0.012
0 - 1200m	0.466 (.415)	0.797 (.427)	0.382 (.364)	0.158 (.108)	15.754	0.000
0 - 1600m	0.471 (.360)	0.875 (.351)	0.363 (.260)	0.160 (.138)	39.962	0.000
0 - 2000m	0.447 (.303)	0.819 (.249)	0.350 (.213)	0.125 (.090)	57.146	0.000
All Vendors						
0 - 400m	6.019 (8.739)	11.510 (11.867)	4.310 (6.765)	4.547 (7.147)	8.103	0.001
0 - 800m	7.398 (8.829)	13.748 (13.938)	5.489 (5.330)	4.903 (4.387)	11.113	0.000
0 - 1200m	7.506 (8.863)	15.166 (14.267)	5.329 (4.319)	3.000 (2.664)	17.867	0.000
0 - 1600m	7.703 (7.635)	15.964 (10.969)	5.370 (3.562)	2.647 (2.231)	34.102	0.000
0 - 2000m	7.577 (6.605)	15.890 (8.1033)	5.248 (3.057)	2.2736 (1.415)	58.604	0.000
Advertising Exposure (billboards)						
0 - 400m	0.368 (1.241)	1.1368 (2.127)	0.142 (.676)	0.000 (.000)	7.896	0.001
0 - 800m	0.543 (.916)	1.2967 (1.428)	0.272 (.397)	0.782 (1.179)	17.029	0.000
0 - 1200m	0.516 (.716)	1.3263 (1.016)	0.247 (.275)	0.505 (.567)	39.308	0.000
0 - 1600m	0.535 (.624)	1.2967 (.803)	0.295 (.284)	0.373 (.313)	49.955	0.000
0 - 2000m	0.544 (.580)	1.3159 (.636)	0.312 (.283)	0.250 (.213)	71.015	0.000

*Correlation is significant if $p < 0.05$.

4.3.2 Case Study of Six Secondary Schools: Exploring the Information Environment and Organizational Environment

School Characteristics

According to urbanicity, five out of six of these secondary schools are suburban, and one is considered a small town. Table 4.3 shows the characteristics of the six secondary schools which are located in London, Ontario and Strathroy, as well as their levels of socio-economic distress. According to our socio-economic distress index, schools 3 and 5 have the lowest level of socio-economic distress, and schools 1 and 6 have the highest level of socio-economic distress.

Characteristics of the Food Vendor & Advertising Environment Surrounding All Schools

From a food environment standpoint, the six secondary schools represented three distinct types of retail food environments, ranging from saturated (n=2), to semi-isolated (n=2), to isolated (n=2). In terms of vendor and advertising exposure, schools 1 and 2 were the most saturated schools, having the highest numbers of food vendors and advertisements within each buffer ring. Schools 3 and 4 were considered semi-isolated, having slightly lower numbers of vendors and advertisements, and Schools 5 and 6 were the most isolated environments, having the fewest number of vendors and advertisements present within the 2000m buffer. School 6, the most isolated school, had the lowest advertisement and vendor counts.

The most saturated of the schools (school 1) had the highest number of food-related billboards, but results suggest that billboards are not typically present within 2000m of each secondary school. These relationships are shown in Table 4.4. *Total ad count* in this table refers to the combination of billboard and vendor signage counts.

Table 4.3 Socio-economic variables for the sample of secondary schools (n=6)

School	Urbanicity	FE Classification	Density of Children	% of Population Recent Immigrant	% of Population Visible Minority	Average Median Household Income (CAD)	% of Population who did not Graduate High School	% of Census Families who are Lone Parents	Socio-Economic Distress Index
1	Suburban	Saturated	63.2	1.6	12.4	89875.90	23.6	25.1	1.595
2	Suburban	Saturated	25.3	3.4	21.8	118868.95	12.4	13.3	-1.482
3	Suburban	Semi-isolated	304.5	3.0	15.6	137896.87	11.1	12.8	-3.293
4	Suburban	Semi-isolated	146.9	3.5	26.6	120445.31	13.5	14.5	-0.636
5	Small Town	Isolated	5.8	0.2	1.5	109607.86	22.2	13	-3.043
6	Suburban	Isolated	37.9	3.2	22.2	96752.25	19.8	19.7	1.574

Table 4.4 Vendor counts, billboard counts, and total advertisement counts for secondary schools (n=6) within ringed buffers

Buffer (m)	Vendor Count	Billboard Count	Total Ad Count
School 1			
0-400	1	0	14
401-800	23	1	182
801-1200	28	2	96
1201-1600	27	4	132
1601-2000	26	4	124
School 2			
0-400	6	0	83
401-800	7	0	68
801-1200	10	0	78
1201-1600	7	0	29
1601-2000	9	0	25
School 3			
0-400	1	0	15
401-800	0	0	0
801-1200	11	0	29
1201-1600	15	2	64
1601-2000	8	0	40
School 4			
0-400	1	0	15
401-800	2	0	6
801-1200	1	0	16
1201-1600	5	1	27
1601-2000	3	0	25
School 5			
0-400	1	0	18
401-800	1	0	5
801-1200	0	0	0
1201-1600	1	0	4
1601-2000	1	0	11
School 6			
0-400	1	0	14
401-800	0	0	0
801-1200	0	0	0
1201-1600	0	0	0
1601-2000	0	0	0

Vendor Exposure and Advertising Exposure Surrounding Secondary Schools

As expected, results show that vendor exposure and advertising exposure are highest in closest proximity to schools (0-400m), and exposure tends to decrease with distance (see Table 4.5). This trend seems to be especially strong across all six school food environments, apart from the most saturated school (school 1), which had lower vendor and advertising exposure within 0-400m than within the 0-800m buffer. This finding is plausible given the expansiveness of secondary school properties, which tend to be larger in comparison to elementary schools. Thus, it is reasonable that there would be limited vendor exposure and advertising exposure located within 400m of secondary schools. The only data that somewhat opposes this trend is the slight increase in vendor and advertising exposure from 1200-1600m for school 3. Vendor exposure is illustrated in Figure 4.5, which shows the number, type, and distribution of food vendors in proximity to the sample of secondary schools.

When vendor exposure is broken down by type and into individual buffer rings to show how exposure changes in relation to proximity to schools, results show that for fast food restaurants (including school cafeterias), vendor exposure is higher than all other vendor types within all buffer distances surrounding the schools (see Table 4.6). Apart from School 2, school cafeterias are the only type of fast food vendor located within 400m of each secondary school. Despite there being several types of vendors (i.e., fast food restaurant, full-service restaurant, grocery store) located within 400m of school 2, fast food restaurants have the highest vendor exposure compared to the other vendor types.

Advertising exposure is illustrated in Figure 4.6, which shows the number and distribution of all advertisements within 2000m of each school. The number of food advertisements located at each vendor is represented by the size of each circle. Therefore, the larger the circle, the more advertisements are present at that vendor. The results from the visual show that there tend to be larger circles in closer proximity to the schools, and smaller circles on the periphery, which reveals that there are more advertisements located closer to schools than there are farther away.

Table 4.5 Vendor exposure and advertising exposure surrounding secondary schools (n=6)

School 1				
Buffer	Vendor Count	Vendor Exposure	Ad Count	Ad Exposure
0-400m	1	1.99	14	27.85
0-800m	24	11.94	196	97.48
0-1200m	52	11.49	292	64.55
0-1600m	79	9.82	424	52.72
0-2000m	105	8.36	548	43.61
School 2				
0-400m	6	11.94	83	165.12
0-800m	13	6.47	151	75.10
0-1200m	23	5.08	229	50.62
0-1600m	30	3.73	258	32.08
0-2000m	39	3.10	283	22.52
School 3				
0-400m	1	1.99	15	29.84
0-800m	1	0.50	15	7.46
0-1200m	12	2.65	44	9.73
0-1600m	27	3.36	108	13.43
0-2000m	35	2.79	148	11.78
School 4				
0-400m	1	1.99	15	29.84
0-800m	3	1.49	21	10.44
0-1200m	4	0.88	37	8.18
0-1600m	9	1.12	64	7.96
0-2000m	12	0.95	89	7.08
School 5				
0-400m	1	1.99	18	35.81
0-800m	2	1.00	23	11.44
0-1200m	2	0.44	23	5.08
0-1600m	3	0.37	27	3.36
0-2000m	4	0.32	38	3.02
School 6				
0-400m	1	1.99	14	27.85
0-800m	1	0.50	14	6.96
0-1200m	1	0.22	14	3.09
0-1600m	1	0.12	14	1.74
0-2000m	1	0.08	14	1.11

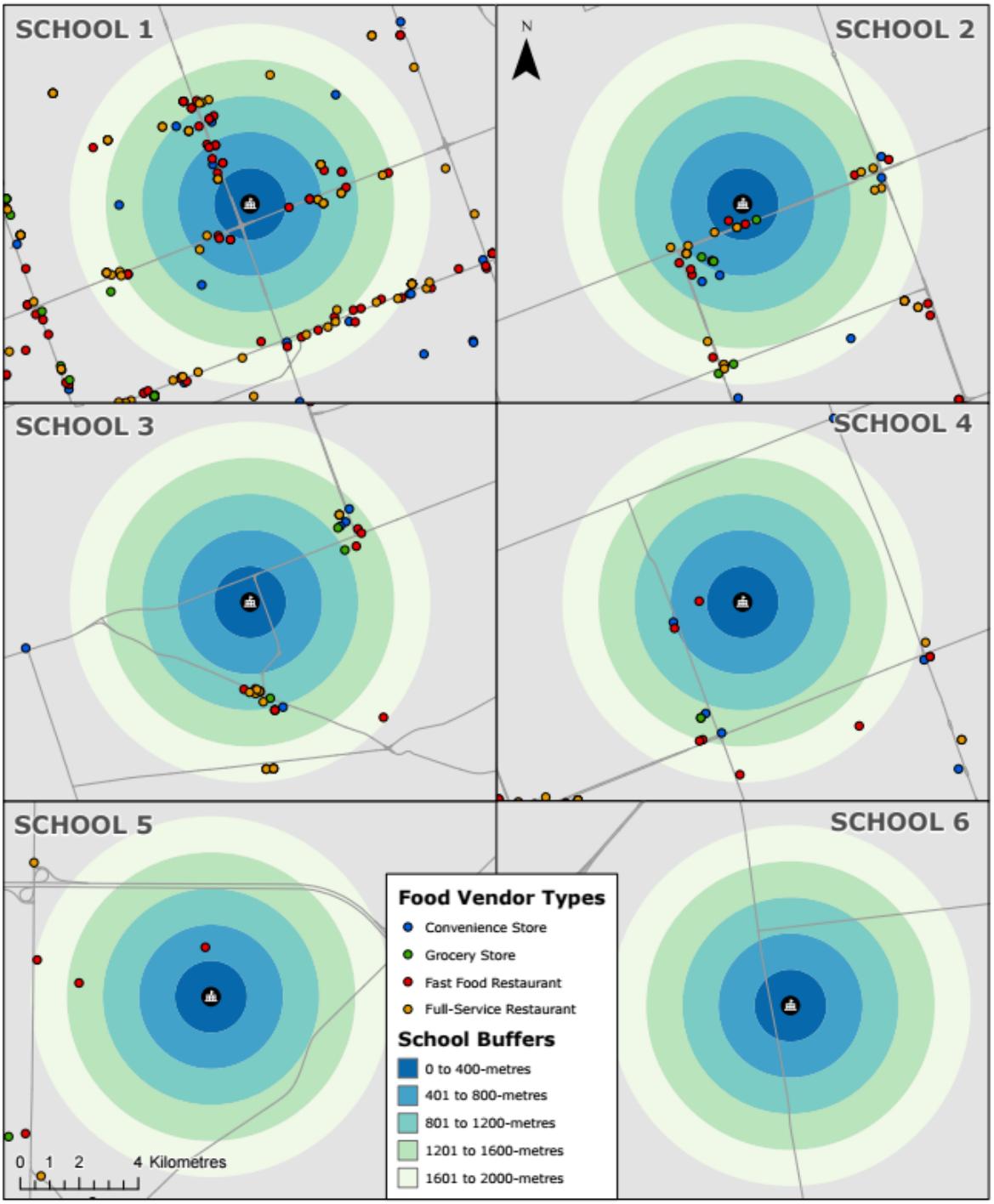

Figure 4.5 Vendor exposure in proximity to secondary schools (n=6)

Table 4.6 Vendor exposure by type in proximity to secondary schools (n=6)

	Fast Food	Full-Service	Convenience	Grocery
School 1				
0-400m	1.99	0.00	0.00	0.00
401-800m	9.95	3.32	1.99	0.00
801-1200m	7.16	1.59	1.99	0.40
1201-1600m	3.98	2.27	1.14	0.28
1601-2000m	2.43	2.43	0.66	0.22
School 2				
0-400m	7.96	1.99	0.00	1.99
401-800m	1.99	1.33	0.00	1.33
801-1200m	1.99	1.19	0.80	0.00
1201-1600m	0.28	1.42	0.28	0.00
1601-2000m	0.44	0.66	0.44	0.44
School 3				
0-400m	1.99	0.00	0.00	0.00
401-800m	0.00	0.00	0.00	0.00
801-1200m	1.59	1.99	0.00	0.80
1201-1600m	1.71	0.28	1.71	0.57
1601-2000m	0.88	0.44	0.44	0.00
School 4				
0-400m	1.99	0.00	0.00	0.00
401-800m	0.66	0.00	0.66	0.00
801-1200m	0.40	0.00	0.00	0.00
1201-1600m	0.28	0.00	0.85	0.28
1601-2000m	0.66	0.00	0.00	0.00
School 5				
0-400m	1.99	0.00	0.00	0.00
401-800m	0.66	0.00	0.00	0.00
801-1200m	0.00	0.00	0.00	0.00
1201-1600m	0.28	0.00	0.00	0.00
1601-2000m	0.22	0.00	0.00	0.00
School 6				
0-400m	1.99	0.00	0.00	0.00
401-800m	0.00	0.00	0.00	0.00
801-1200m	0.00	0.00	0.00	0.00
1201-1600m	0.00	0.00	0.00	0.00
1601-2000m	0.00	0.00	0.00	0.00

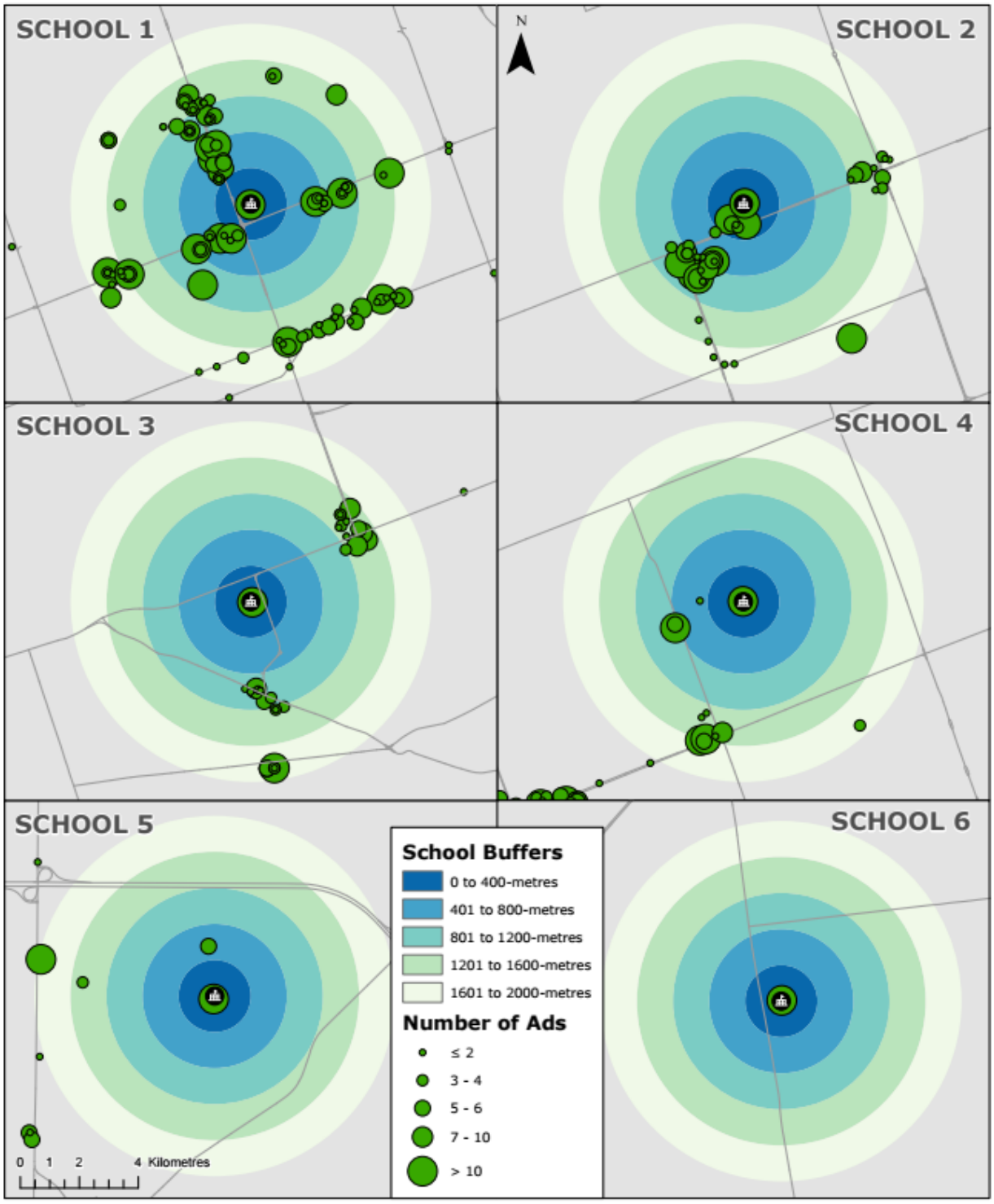

Figure 4.6 Advertising Exposure in proximity to secondary schools (n=6)

Total Advertising Power

Figure 4.7 illustrates total advertising power in proximity to schools. The larger the circle, the more advertising power is concentrated at these locations. For instance, a very large circle may be indicative of a vendor that has 1) either a lot of advertisements of smaller power, or 2) a few advertisements of larger power. The results show that advertising power is generally higher in close proximity to schools, and as distance decreases, the sum of power scores decreases. In some instances, advertising power is lower within 400m than it is within 800m, which is reasonable due to the extent of secondary school properties, as was mentioned previously. It is evident that the most saturated schools have a greater number of large circles in closer proximity than further away. Many smaller circles are located on the periphery of the buffer rings, closer to 2000m. These results suggest that there are either 1) more advertisements situated closer to these schools, or that 2) advertising power is greater in closest proximity to schools.

Table 4.7 shows how the sum of power scores and total advertising power changes within individual buffer rings surrounding the sample of secondary schools. The sum of power scores were highest within one of the first two buffers (0-400m and 401-800m), apart from the two semi-isolated schools (3 and 4). For these two schools, the sum of power scores were highest at 1200-1600m, which were also the buffers that had the highest number of advertisements. Total advertising power was highest within one of the first two buffers for all schools. The number of advertisements may not be highest within 0-400m or 0-800m, but the total advertising power *is* the highest within these distances across all schools, which is suggestive that there are more powerful ads located within closer distances to these teen-centred institutions.

When total advertising power is broken down by type with cafeterias as their own category (see Table 4.8), the findings show that the cafeterias in the most isolated school environments (schools 5 & 6) have the highest total advertising power compared to the semi-isolated and saturated schools. This may suggest that more geographically isolated schools compensate for not having many vendors located nearby by either including a greater number of advertisements in their cafeterias, or having more powerful

advertisements. The most saturated of the schools (school 1) had the highest billboard exposure, with the total advertising power the greatest at the 2000m buffer. Results also show that fast food advertisements commonly had higher total advertising power.

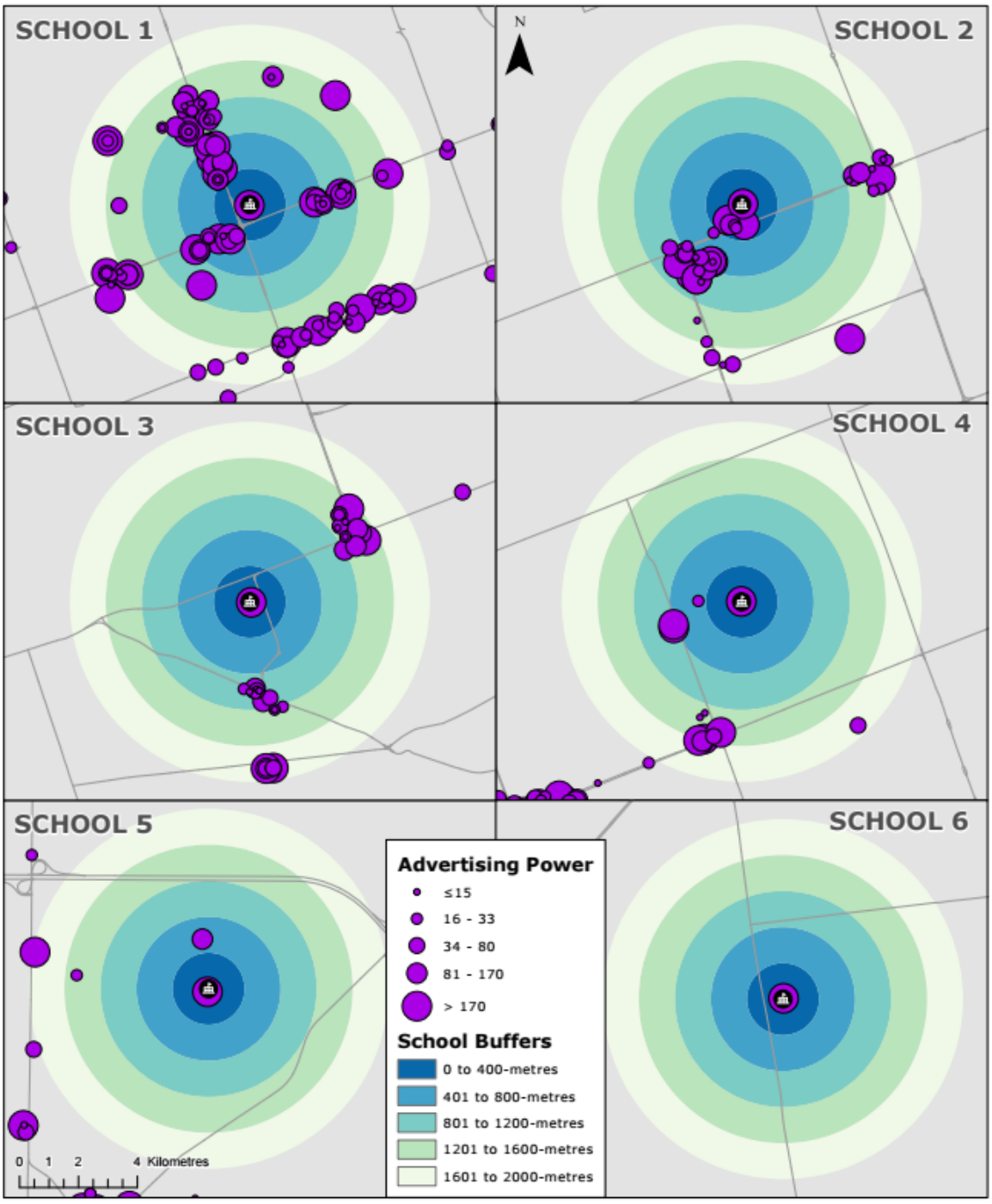

Figure 4.7 Total advertising power in proximity to secondary schools (n=6)

Table 4.7 Sum of power scores and total advertising power in proximity to secondary schools (n=6)

Buffer	Ad Count	Advertising Exposure	Sum of Power Scores	Total Advertising Power
School 1				
0-400m	14	27.852	280.454	557.946
401-800m	182	120.692	4790.011	3176.475
801-1200m	96	38.197	2065.051	821.658
1201-1600m	132	37.515	3039.038	863.711
1601-2000m	124	27.410	2962.742	654.910
School 2				
0-400m	83	165.123	1989.955	3958.889
401-800m	68	45.094	1484.529	984.459
801-1200m	78	31.035	1865.330	742.191
1201-1600m	29	8.242	567.409	161.261
1601-2000m	25	5.526	463.426	102.440
School 3				
0-400m	15	29.842	292.011	580.938
401-800m	0	0.000	0.000	0.000
801-1200m	29	11.539	549.983	218.831
1201-1600m	64	18.189	1239.620	352.306
1601-2000m	40	8.842	1070.171	236.560
School 4				
0-400m	15	29.842	290.682	578.293
401-800m	6	3.979	219.142	145.323
801-1200m	16	6.366	390.483	155.368
1201-1600m	27	7.674	789.642	224.420
1601-2000m	25	5.526	525.114	116.076
School 5				
0-400m	18	35.810	401.608	798.973
401-800m	5	3.316	84.875	56.284
801-1200m	0	0.000	0.000	0.000
1201-1600m	4	1.137	28.614	8.132
1601-2000m	11	2.432	246.898	54.576
School 6				
0-400m	14	27.852	325.682	647.923
401-800m	0	0	0.000	0.000
801-1200m	0	0	0.000	0.000
1201-1600m	0	0	0.000	0.000
1601-2000m	0	0	0.000	0.000

Table 4.8 Total advertising power by signage type

	Signage Type					
	Fast Food	Full-Service	Convenience	Grocery	School Cafeteria	Billboard
School 1						
0-400m	0.00	0.00	0.00	125.33	432.61	0.00
401-800m	2357.48	172.42	630.65	0.00	-	16.58
801-1200m	453.99	17.90	309.56	15.12	-	24.67
1201-1600m	371.74	152.62	307.79	4.26	-	27.287
1601-2000m	337.54	96.82	183.47	1.55	-	35.59
School 2						
0-400m	3280.58	35.81	0.00	53.71	588.78	0.00
401-800m	912.49	29.84	4.64	37.80	-	0.00
801-1200m	689.54	46.95	5.57	0.00	-	0.00
1201-1600m	41.21	54.28	65.65	0.00	-	0.00
1601-2000m	12.60	1.77	78.91	9.28	-	0.00
School 3						
0-400m	0.00	0.00	0.00	0.00	580.94	0.00
401-800m	0.00	0.00	0.00	0.00	-	0.00
801-1200m	78.78	65.65	0.00	74.40	-	0.00
1201-1600m	148.07	9.09	179.90	3.98	-	11.37
1601-2000m	45.76	41.78	148.99	0.00	-	0.00
School 4						
0-400m	0.00	0.00	0.00	0.00	578.29	0.00
401-800m	18.57	0.00	126.66	0.00	-	0.00
801-1200m	155.18	0.00	0.00	0.00	-	0.00
1201-1600m	131.30	0.00	81.85	1.99	-	9.38
1601-2000m	106.10	9.95	0.00	0.00	-	0.00
School 5						
0-400m	0.00	0.00	0.00	0.00	798.97	0.00
401-800m	56.37	0.00	0.00	0.00	-	0.00
801-1200m	0.00	0.00	0.00	0.00	-	0.00
1201-1600m	8.24	0.00	0.00	0.00	-	0.00
1601-2000m	54.60	0.00	0.00	0.00	-	0.00
School 6						
0-400m	0.00	0.00	0.00	0.00	647.92	0.00
401-800m	0.00	0.00	0.00	0.00	-	0.00
801-1200m	0.00	0.00	0.00	0.00	-	0.00
1201-1600m	0.00	0.00	0.00	0.00	-	0.00
1601-2000m	0.00	0.00	0.00	0.00	-	0.00

4.4 Discussion

This study first aimed to examine how the broader food environment (i.e., community and information environment) differs across all school neighbourhoods in the study area. The results addressing this first objective revealed that vendor exposure and advertising exposure are significantly correlated with several socio-economic variables, predominantly median household income and lone parent families. Findings from our regression analysis suggest that average median household income was negatively correlated with vendor exposure and advertising exposure surrounding schools. This evidence validates past studies that have found low-income school neighbourhoods to be associated with more advertising exposure (Cassady et al., 2015; Isgor et al., 2016). These findings showed a lack of association involving visible minorities and recent immigrants, which was similar to results found by other researchers (Dubreck et al., 2019; Isgor et al., 2016).

The findings from this study also suggest that lone parent households are linked to neighbourhoods with higher vendor exposure and advertising exposure, making this subpopulation especially vulnerable to food marketing. This is consistent with previous work that has demonstrated the relationship between socioeconomic disadvantage, including measures of lone parenthood, in proximity to health deterring food environments, such as fast food clustering (Dubreck et al., 2018), and food deserts (Larsen & Gilliland, 2008).

After the broader food environment was explored surrounding all schools, the second objective of this study was to explore the vendor and advertising environment surrounding a sample of secondary schools, and apply the tool developed in Chapter 3 to understand how the information environment for teens differs across secondary school neighbourhoods. Although studies have measured in-school food commercialism (Johnston, Delva, & O'Malley, 2007; Velazquez et al., 2015b), this study was unique in that it measured the advertising environment surrounding and inside secondary schools. The advertising exposure and total advertising power results showed that school cafeterias tend to promote a plethora of food and beverage items to secondary school students, which has also been demonstrated by other researchers (Johnston et al., 2007;

Potvin Kent et al., 2019; Velazquez et al., 2015b). The application of this teen-informed coding tool offers novel insight involving the food items promoted in secondary schools by revealing that these advertisements are quite powerful from a teen perspective, and thus, teen-directed.

4.4.1 Policy and Practice

The findings from this study support the recent call from health-related organizations to shed light on the state of food and beverage marketing to young people, with a focus on measuring and monitoring the exposure to, and power of, food marketing techniques and advertisements (Hooper, 2018; Prowse, 2018; UNICEF, 2018; WHO, 2012, 2019). International organizations, including the World Health Organization (WHO, 2012, 2019) and the United Nations (UNICEF, 2018) have issued calls to action to better understand the extent and effects of food and beverage marketing in different countries, and gain evidence as to how advertising exposure impacts young people. The WHO (2012) encouraged researchers worldwide to collect baseline data to understand this public health issue so that it can be mitigated through policy measures; more recently, the WHO has continued to advocate for the generation of more evidence around food marketing (WHO, 2019). The results from this information environment study can inform health policy research and contributes to a more fulsome representation of the state of food and beverage advertising in the context of a Canadian city. This evidence can be compared across countries and contexts, as was encouraged by the WHO (2012).

On a national policy level, Health Canada (Hooper, 2018, Prowse, 2017) has not only stressed the importance of monitoring the impacts of food-related advertising on children under 13, but teens as well, despite not including this vulnerable age group in current policy protection measures (Hooper, 2018). The findings from this study can inform the Child Health Protection Act (i.e., Bill S-228), given that the House of Commons ordered a five-year review on the consequences of only protecting those under the age of 13, as opposed to 17, from food marketing (Hooper, 2018; Parliament of Canada, 2019). This research can advise Canadian food environment policy by illuminating the extent of teens' exposure to food marketing within the community food environment, as well as the power of these advertisements, all from a teen perspective. This research was necessary

to demonstrate how food marketing in Canada uniquely influences teens, so that we can further advocate for their protection.

On a school policy level, these findings support previous school food environment (i.e., organizational environment) research that advocates for more rigid policies that restrict food and beverage marketing in Canadian secondary schools (Potvin Kent et al., 2019; Velazquez et al., 2017). According to Potvin Kent et al. (2019), although provincial regulations have been introduced in several provinces (Ministry of Education of British Columbia, 2013; Ministry of Education of Ontario, 2010; Nova Scotia Department of Education & Department of Health Promotion, 2006), they lack thorough restrictions of food advertising. This is concerning, given that findings from several in-school advertising studies revealed that there were an abundance of advertisements promoting unhealthy food and beverage options (Potvin Kent et al., 2019; Velazquez et al., 2015b). Based on the results from this research, it is recommended that secondary school boards pay careful consideration to the types of foods they advertise to their students. Given that school cafeterias tend to be quite powerful advertising environments, these teen-centred institutions need to ensure they are promoting healthier food and beverage options in ways that appeal to the teenage population. Therefore, these results related to vendor exposure, advertising exposure, and total advertising power support the advancement of food environment policy that restricts the marketing of unhealthy food and beverages to Canadian teens, both within and surrounding secondary schools.

4.4.2 Strengths and Limitations, and Future Research

Notable limitations of this study include its cross-sectional design, which does not consider the ever-changing nature of the information environment. Food and beverage advertisements are not fixed, with billboard content and vendor signage frequently changing; this study only captures a snapshot of the information environment within the food environment at one point in time. Although the measure of vendor exposure was comprehensive for all schools in the study area, the advertising exposure that was calculated for all schools included billboards only and did not consider any other forms of advertising. Additionally, the results generated from measuring the advertising exposure and total advertising power surrounding the small sample of schools (n=6) may not be

generalizable to other secondary school food environments; this warrants caution when interpreting findings and drawing comparisons to other research contexts.

Another potential limitation of this study is that the power scores do not consider the nutritional content of the ads. We coded the advertisements based on a new teen-informed coding tool (generated in Chapter 3) which was developed through consultations with teens to understand the features of advertisements that are teen-directed, and that often persuade teens to visit food vendors. Most teens consulted indicated that they do not value health appeal or nutritional value when eating out (Chapter 3). There are several studies and reports that have already shed light on the poor-quality foods, both available to, and promoted to, adolescents (Heart & Stroke, 2017; Liu et al., 2019; Velazquez et al., 2015a; Velazquez et al., 2019). Thus, a potential strength of this study is that it took a unique approach to food environment research by considering teens' perspectives to measure the power of food advertisements surrounding schools, and coded the content based on their views; this was important to better understand the impact of the food environment on teens' food purchasing perceptions.

A second strength of this study is that it comprehensively measured multiple environmental variables that make up the food environment, including the community, organizational, and information environment. Vendor types that were included in the study went beyond traditional fast food restaurant classifications, which often underestimated junk food exposure by not taking into consideration "healthy" food vendors, such as grocery stores (Dubreck et al., 2018; Sharkey et al., 2011). Many researchers have stressed that grocery stores should also be measured as a source of unhealthy food, given that nutrient poor foods high in sugar, salt, and fat, are also available (Caspi et al., 2012; Dubreck et al., 2018) and purchased there by young people (Macdiarmid et al., 2015).

This study moves beyond what so many studies have done by not only measuring the community (i.e., vendors) and information food environment (i.e. billboards) surrounding all schools in the study area, but also investigating the information food environment (i.e., vendor signage) and organizational food environment (i.e., school cafeteria signage) surrounding and within a sample of six secondary schools. While many studies have

looked at the information and organizational food environment in isolation (Herrera & Pasch, 2017; Hillier et al., 2009; Kelly et al., 2008; Potvin Kent et al., 2019; Terry-McElrath et al., 2014; Velazquez et al., 2015a; Velazquez et al., 2019; Velazquez et al., 2015b), this is the first known study that incorporates both information and organization food environments in a single study.

Additional research is needed to assess the exposure to, and power of, advertisements surrounding teen-centred institutions, and explore how this power changes across diverse neighbourhoods. Considering the results showed the most isolated schools having the highest total advertising power, studies need to explore more isolated settings, such as secondary school cafeterias in rural neighbourhoods. This evidence is needed to further inform food marketing policy that restricts the advertising of nutrient-poor foods to teens. The achievement of this policy goal could lead to the creation of healthier food environments within Canadian communities, and improved dietary health.

This consideration of exposure and power should be considered in future food environment studies, especially those that focus on the information environment, to understand the state of marketing across various contexts, and to evaluate how these variables change in proximity to secondary schools. Vendor exposure, advertising exposure, and total advertising power should be explored in other teen-focused settings to compare these features of the information environment in other community spaces that teens frequent. In addition, future research should explore whether teens' perceptions of influence align with actual purchase behaviours. Advertising exposure should be compared to the number and type of vendor visits to assess whether advertised vendors and food items correlate with teens' purchasing behaviours. Teen food purchasing research should also consider the power of viewed advertisements to determine whether visits correlate with advertisement power. This research reiterates the importance of incorporating qualitatively-driven methods into geographic health research to more accurately capture the relationship between food environment exposure and dietary outcomes (Caspi et al., 2012; Engler-Stringer et al., 2014a; Knigge & Cope, 2006; Riggsbee et al., 2019; Williams et al., 2014).

4.5 Conclusions

This comprehensive study revealed not only broad community level factors of the food environment and the information environment (i.e., billboards) for all schools in the study area, but also focused on measuring the information environment (i.e., billboards and vendor signage) both in and surrounding secondary schools in various neighbourhood contexts. The application of a novel teen-informed coding tool that was developed in Chapter 3 supports the creation of food environment policy that restricts the marketing of energy-dense, nutrient-poor foods and beverages to high-school aged adolescents. Measures of vendor exposure, advertising exposure, and total advertising power were shown to increase in proximity to secondary schools. The findings from this study led support for advocating for behavioural interventions and policy that reduces this type of exposure. The use of variables such as vendor exposure, advertising exposure, and total advertising power can be measured across other settings to compare the impact of food environments on teens and other vulnerable populations. Policymakers, including Health Canada, should especially consider limiting outdoor food and beverage advertising surrounding and within schools, and further consider this type of spatial exposure when aiming to improve dietary behaviours.

4.6 References

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Chapter 5

5 Synthesis

The purpose of this chapter is to summarize and discuss the research presented in this thesis. This thesis attempted to answer two research questions and address a series of related objectives shown below:

1. What features of food and beverage advertisements are perceived to be most effective at drawing teenagers inside food vendors?

   Objective (1a): To identify the elements of food advertisements that teens perceive to be important in persuading them to visit a food vendor or make a food purchase.

   Objective (1b): To create a teen-informed coding tool to measure the power (i.e., content, design, and execution) of food and beverage advertisements from a teen perspective.
2. How does the community food environment and information environment differ across schools in the city of London, Ontario, Canada and the neighbouring town of Strathroy?

   Objective (2a): To examine how exposure to vendors and billboards around all schools varies by socio-economic status and school level.

   Objective (2b): To examine how exposure to vendors, vendor signage, and billboards, varies across a sample of secondary schools.

   Objective (2c): To examine how the power of advertisements in and around secondary schools varies across contrasting school environments.

This chapter is comprised of six sections: Section 5.1 summarizes the key findings of the two studies described in Chapters 3 and 4. Section 5.2 discusses the research and methodological contributions to the food environment literature. Section 5.3 describes the limitations of this research. Section 5.4 provides an overview of the potential policy implications. Section 5.5 outlines recommendations for future research. Finally, Section 5.6 offers an overall conclusion. Due to the integrated article format of this thesis, there will be some instances of repetition throughout this chapter.

5.1 Summary of Studies

This thesis investigated food environments for teens in the Canadian context in two separate, but complementary studies. A sequential mixed methods design was used to conduct this research, with the first study combining qualitative and quantitative methods, followed by a second quantitative study which applied the teen-informed coding tool that was derived from the first study.

Study 1 (Chapter 3) assessed how food and beverage advertising influences teens' perceived food purchasing perceptions related to advertising. Photographs of local food and beverage advertisements were taken within the study area and then a sample were brought to a local youth advisory council for content analysis. A variety of advertisement types were included in the analysis, including vendor signage (i.e., secondary school cafeterias, full-service restaurants, fast food restaurants, convenience stores, and grocery stores), billboards, and transit shelters. This group of teens collaborated with the author to create a teen-informed coding tool to measure the power of advertisements within the larger food environment. Study 1 identified ten key teen-directed coding criteria that teens considered to be important features of advertisements that draw themselves and their peers into food vendors. A survey was then administered to a larger group of teens to generate weights to determine the relative importance of each ad feature. This study found that the presence of price and image(s) of food and beverages were especially important features to include on advertisements. The results also revealed that certain criteria that researchers currently consider to be teen-directed are not actually perceived to be important from a teen perspective (i.e., the healthfulness of food items, social media).

Findings from Study 1 revealed that not just the content, but also the appearance of advertisements (e.g., size, placement, and colour), can play a significant role in the appeal of food and beverage advertisements. The teens identified size as the most important appearance-related feature, and the survey results showed that the least attention-grabbing features of advertisements were mainly due to their small size. Consequently, this tool was designed to consider not only the *presence or absence* of the coding criteria and their relative importance, but weights were also assigned according to the *size* of

these features. Based on these findings, a quantitative teen-informed coding tool was generated to measure the power of food and beverage advertisements within the information environment component of the food environment, where each advertisement is coded and assigned a final power score out of 100. An interrater reliability (IRR) analysis was calculated to determine the validity of the tool.

Study 2 (Chapter 4) involved a food information environment audit that captured photos of outdoor food and beverage signage at food vendors and on billboards. This study first examined the broader community food environment (i.e., location and type of food vendors) and information environment (i.e., billboards) surrounding all elementary and secondary schools within the study area to provide contextual information on vendor exposure and advertising exposure. Spearman's Correlation Coefficient analysis was used to examine the association between socio-economic status measures and these exposure variables. ANOVA tests were used to compare exposure differences in relation to level of urbanicity (i.e., urban, suburban, rural), and then a Mann-Whitney U Test was conducted to analyze exposure differences between elementary and secondary schools. The second phase of this study involved a more in-depth exploration of vendor exposure and advertising exposure (i.e., billboards and vendor signage) at different distances within 2000m of six secondary schools. The teen-informed coding tool produced in Chapter 3 was applied to the advertisements that were collected in the food information environment audits to measure the total advertising power within the corresponding territory surrounding each of the six secondary schools. Once power scores were generated for each advertisement, the data was mapped in ArcGIS to assess how advertising exposure (i.e. density and proximity) and total advertising power (i.e. creative marketing content and design of the advertisement) differs across a range of secondary school food environments.

The findings from the larger sample including all schools (n=119) demonstrated a significant positive association between vendor and advertising exposure and lone parent families, which indicates that as exposure increases, so does the percentage of families that are headed by lone parents. Additionally, median household income was significantly negatively correlated with vendor exposure and advertising exposure, which

suggests that as median household income decreases, vendor exposure and advertising exposure increases. In summary, neighbourhoods with higher proportions of these two vulnerable groups, lone parent families and lower income families, are more heavily exposed to food vendors and food advertising; this was expected, as previous studies have shown this pattern between socioeconomic disadvantage and health deterring environments (Dubreck et al., 2018; Larsen & Gilliland, 2008). Although some studies have revealed similar findings (Dubreck et al., 2019; Isgor et al., 2016), it was unexpected that visible minorities and recent immigrants were not correlated with higher vendor and advertising exposure. However, this may be due to the healthy immigrant effect, which suggests that healthier people are increasingly immigrating to Canada (Statistics Canada, 2015), or immigrants may simply be choosing healthier neighbourhoods to settle in. Additionally, there were no significant differences found between school levels, which could have been the result of both elementary and secondary schools being located in similar neighoubourhoods in the study area. Results from the second phase of the study, which explored total advertising power surrounding a sample of secondary schools, revealed that vendor exposure, advertising exposure, and total advertising power were highest in close proximity to secondary schools (0-400m), however in some instances, the scores were lower within 0-400m than within 0-800m; as mentioned previously, this was likely due to the expansiveness of secondary school properties. The advertising exposure and total advertising power results from this study demonstrated that school cafeterias tend to promote an abundance of food and beverage items to students, with the most isolated schools having the highest total advertising power in their school cafeterias compared to the others.

5.2 Research Contributions

The findings from these two studies align with the food environment literature concerning the community food environment surrounding schools, showing that vendor exposure tends to be highest near schools (Austin et al., 2005; Day & Pearce, 2011; Sadler et al., 2016; Zenk & Powell, 2008). Most importantly, due to the understudied nature of the information environment within geographic and public health literature,

especially surrounding secondary schools and from a teen perspective, the findings from this thesis fill several additional research gaps.

Study 1 highlighted the importance of conducting qualitative consultations with the population of interest (i.e., teens) before assessing the information environment to understand which advertisement features resonate with them. It also reveals the importance of creating the coding criteria based on these consultations, since most researchers use predefined criteria (Elliot, 2012; Kelly et al., 2008; Kelly et al., 2010; Potvin Kent et al., 2012; Velazquez et al., 2019). Additionally, this research demonstrated the necessity of considering the relative importance of coding criteria, since past research typically only codes for the presence or absence of criteria (Elliot, 2012; Potvin Kent et al., 2012; Potvin Kent et al., 2014). Despite the literature which shows the large influence that toys and giveaways have on younger children's food preferences, the results from this study showed that gamification (e.g., toys, contests, games) was not as influential from a teen perspective. Also consistent with the literature (Hutchings, 1994; Potvin Kent et al., 2014; Prowse, 2017; WHO, 2012, 2019), the teens consulted in Study 1 expressed that the appearance or design of advertisements largely contributes to the level of appeal when it comes to desiring certain food or beverages.

The results from Study 1 significantly contribute to food environment, geography, and public health literature by filling methodological and practical gaps within these areas of research. Study 1 addresses the shortage of research that examines the food-related information environment (Velazquez et al., 2019). The focus of this study was to qualitatively explore how food and beverage advertising influences teens' purchasing perceptions and then develop a tool to quantify the power of food and beverage advertisements within the broader food environment. The outcomes from this research fill a gap in food environment methodology, which currently lacks the development and deployment of measurement tools that consider teen perspectives (Velazquez et al., 2017). The incorporation of teens' food purchasing perceptions within the tool contributes to the literature, as most studies 1) incorporate both children and teens in the same study population as opposed to measuring these age groups separately (Elliot, 2016; Engler-Stringer et al., 2014; Williams et al., 2014); and 2) do not address how advertising

specifically affects teenagers' purchasing perceptions (Bibeau et al., 2012; Elliot, 2016; Velazquez et al., 2019; Velazquez et al., 2017; Williams et al., 2014). The development of the teen-directed advertising criteria is important, since policymakers have not yet established these criteria, or distinguished between teen-directed and child-directed marketing techniques (Health Canada, 2017).

Study 2 first illustrated vendor exposure and advertising exposure surrounding all schools in the study area, and then specifically investigated the information environment surrounding six secondary schools to capture its effects from a teen perspective. While food environment research has grown in recent years (Minaker et al., 2016), previous literature indicates that this field remains understudied and lacks comprehensive understanding from a geographer's standpoint (McKendrick, 2004). Given that teen-centred settings are typically not considered in food environment studies to the same extent as child-related institutions (Engler-Stringer et al., 2014; Minaker et al., 2016), this study contributes to the school food environment literature by applying the teen-informed coding tool that was developed (Study 1) to measure the power of advertisements found within the information environment surrounding secondary schools. Ultimately, the results from Study 2 revealed that vendor exposure, advertising exposure, and total advertising power increases as proximity to secondary schools increases. This combination of power and exposure produces a more accurate view of what researchers consider to be the *impact* of the information environment in this locale (Prowse, 2017).

The results from Study 2 validate previous studies that have suggested a significant inverse relationship between income and advertising exposure (Cassady et al., 2015; Isgor et al., 2016), where exposure tends to be highest in lower-income neighbourhoods. Additionally, the lack of correlation between advertising exposure and visible minority and recent immigrant populations is consistent with findings found by Isgor and colleagues (2016). The results from this study support the growing literature base that shows the pervasiveness of food and beverage marketing in secondary schools (Johnston, Delva, & O'Malley, 2007; Potvin Kent et al., 2019; Velazquez et al., 2015). A novel finding that was found in this study was that the two most isolated secondary schools had the highest total advertising power in their school cafeterias compared to the more

saturated vendor environments, which may suggest that students attending isolated schools are more subject to powerful teen-directed advertising techniques.

Using a sequential mixed methods approach, both Study 1 and Study 2 contextualize the food environment within the Canadian context from an *information environment* perspective, and contains critical results pertaining to the exposure and power of outdoor food and beverage advertisements within the study area. These studies collectively add to the scarce body of literature that focuses on teens' exposure to outdoor food and beverage advertisements (Velazquez et al., 2019), as well as the power of these advertisements (Prowse, 2017; WHO, 2019). This thesis addresses this gap in the literature, which suggests that the state of food marketing to teens in Canada is currently incomplete and underestimated due to a lack of research (Prowse, 2017).

This thesis provides a more comprehensive view of the information environment through the combination of teen perspectives (Study 1) with spatial mapping (Study 2). The findings from these studies collectively highlight the importance of both qualitatively examining the population of interest's perspectives (i.e. in this case, teenagers'), in combination with quantitative GIS-related techniques to more accurately and comprehensively uncover the impacts of the information environment on Canadian teens. This research collectively contributes to the knowledge gap that exists within geographic food environment and public health research, as limited research exists which combine young people's perspectives with store audit measures (Caspi et al., 2012) and GIS related technologies (Knigge & Cope, 2006; Riggsbee et al., 2019).

This mixed methods thesis supports the use of Glanz et al.'s (2005) food environment model (discussed in Chapter 1) as a conceptual framework to guide the measurement of the food environment in diverse geographic settings. Its consideration of various environmental elements (i.e., consumer, community, organizational, and information) allow for a more comprehensive representation of the exposure and power of food environments. This research also supports the consideration of behavioural economics in food environment research, as this theory supports the idea that young people are greatly influenced by the way options are presented within their food environments (Roberto &

Kawachi, 2016). This thesis used this guiding framework to qualitatively examine how features of food and beverage advertisements influence teens' food purchasing perceptions. It is evident that this consideration is necessary to achieve a more accurate understanding of how food advertising shapes food choices within secondary school-aged adolescents' food environments. Additionally, the results from these studies further reinforce the idea that food environments, especially information environments (e.g., food and beverage advertising and signage), are critical determinants of health and should be considered when conducting future food environment studies.

5.3 Limitations

Despite the research contributions of this thesis, several limitations should be noted before making appropriate recommendations. Firstly, the food information environment audits that were collected and used in both studies were cross-sectional in nature, and thus, do not account for the ever-changing retail food environment in the study area. It is recognized that food retailers within the study area regularly close down, move locations, or new vendors open up, and that advertisements (e.g. billboards, transit shelters, vendor signage) are constantly changing throughout the year. As a result, these audits provided a snapshot of the information environment at the point of data collection, which occurred between May and October 2018.

A limitation of this research concerns the weights assigned to the size of the coding criteria within the teen-informed coding tool developed in Study 1. These weights (i.e. small features were multiplied by 0.25 and medium/large features were multiplied by 1.0) were somewhat arbitrary, but were ultimately decided on by the youth advisory council. This weighting decision is justified and somewhat consistent with previous literature, which sheds light on the notion that teens typically navigate their retail food environments using various transportation methods and from a distance (Cowburn et al., 2016; Wilson et al., 2018), as opposed to standing in close proximity to advertisements. The findings from Study 1 complement this literature, given that the teens expressed that they rarely notice the smaller features of advertisements. The insignificance of small advertisement features is reflected in previous works that either exclude small advertisements from their design altogether (Kelly et al., 2008; Velazquez et al., 2019), or

code them according to size (Yancey et al., 2009). It is also important to note that this qualitative participatory method involving a sample of teens (n=44) does not allow us to claim representativeness of Canadian teens in general, as we did not collect demographic data beyond age.

A final limitation of Study 1 is that this newly developed tool does not take into consideration the size of the entire advertisement (i.e., actual size of the billboard, transit shelter, or vendor sign) when generating power scores. Instead, this tool focused on measuring the content and size of features within each advertisement. Lastly, this tool does not account for the nutritional quality of the food and beverages that were advertised, given that there is already evidence that most food-related items advertised to young people are of low nutritional value (Harris et al., 2009; Heart & Stroke, 2017; Liu et al., 2019; Sadeghirad et al., 2016; Velazquez et al., 2015a; Velazquez et al., 2019).

In Study 2, a limitation concerns the sample size of secondary schools that were included in the food information environment audit, and lack of consideration of rural schools. Although there is a small sample of secondary schools (n=6) that were comprehensively audited, the diversity involving the level of retail food environment accessibility ranged widely across these schools. This wide range allowed for the visualization of how exposure changes in different areas surrounding a diversity of secondary schools. Although Study 2 is useful in determining the power of advertisements from a teen perspective, a limitation is that it did not examine the relationship between food advertising and teen-purchasing behaviours, or how it relates to dietary outcomes. Advertising exposure and total advertising power were not assessed in relation to vendor visits, and this study did not capture the food items that local teens were purchasing. Thus, Study 2 does not shed light on whether the viewing of advertisements correlates with actual food purchases, as that was outside the intended scope of the study.

5.4 Implications for Policy and Practice

The findings from this thesis have the potential to inform and develop policies and interventions with the goal of improving food environments and creating healthy communities. In Canada, federal policies have changed in recent years, with a focus on

restricting food and beverage marketing to children (Health Canada, 2019; Hooper, 2018). Conversely, the outputs from these two studies advocate for the additional protection of *teenagers* from the vulnerabilities of food and beverage marketing.

The results from this thesis mainly relate to federal Bill-S228 (i.e., The Child Health Protection Act), which was recently amended to prohibit food and beverage marketing to children under the age of 13 years, as opposed to under 17 years (Hooper, 2018; Vergeer et al., 2018). Currently, there are growing concerns that this age amendment will leave teenagers vulnerable to food and beverage marketing within their food environments (Health Canada, 2019; Yan et al., 2018). Furthermore, although there has been a research and policy focus on *child-directed advertising* techniques, which have been identified by Health Canada (2017) and other global organizations (WHO, 2012), there are currently no teen-directed marketing guidelines established. These changes have resulted in a demand for research and evidence-informed guidance to illuminate the extent and power of food and beverage marketing to teens in Canada; this is needed to develop effective and appropriate food environment policy that promote healthy dietary behaviours and outcomes (WHO, 2019; Prowse, 2017).

This research conducted with local teens was necessary to uncover teen-directed marketing techniques and learn how this population perceives food and beverage marketing to draw them inside food vendors. This thesis ultimately demonstrated the state of marketing to Canadian teens, and revealed how the exposure to, and power of, advertisements differs across school neighbourhoods within the study area. The findings suggest health policymakers should consider focusing on the development of additional interventions and food environment policies that restrict the formation of food swamps surrounding secondary schools and enable teens to make healthier food choices within their food environments.

Given that teens are highly exposed to advertising and food availability within secondary school settings, this research suggests that school boards and school cafeteria managers need to think carefully about advertising to teens to ensure they are promoting a healthy selection of foods that are nutrient-dense, as opposed to promoting energy-dense nutrient-

poor options which is commonly seen by researchers (Potvin Kent et al., 2019; Velazquez et al., 2015). On a local policy level, provincial school policies should be put in place that mandate schools to advertise only healthier food options within schools. This policy intervention is necessary to ensure that teens are protected from unhealthy food and beverage marketing. Institutions, such as schools, can work towards promoting healthier food items to teens by using the teen-directed marketing techniques produced in Study 1 to create effective advertisements that draw teens towards purchasing a healthier selection of foods. Ultimately, this coding tool can be used in practice and applied in geographic health and food environment research to better represent the extent of food and beverage marketing to Canadian teens. The evidence generated from these studies may support the need for food environment policy changes to be implemented to improve food environments and the associated dietary health of Canada's young people.

5.5 Future Research

Despite the contributions that this thesis makes to food environment research, there is still a need for research on the exposures and effects of outdoor food and beverage marketing in the Canadian context.

Firstly, the procedures conducted in Study 1 produced a tool that could be used in practice by researchers that plan to focus on assessing the information environment in teen-centred settings. Future food environment research may employ the use of this teen-informed coding tool when conducting food information environment audits, or when coding and interpreting their data. The use of this tool will enable researchers to quantify the power of food-related advertisements in diverse neighbourhoods and geographic locations. Additionally, this methodology will be especially useful for health geographers, considering that this coding tool can be used in combination with GIS-technologies and spatial mapping to uncover what Prowse (2017) considers to be the *impact* of food and beverage marketing, which is a function of both exposure and power of advertisements. From a health geography perspective, measuring exposure is especially relevant, as it relates to the density and proximity of advertisements within a geographic locale.

There is also a need for additional information environment research surrounding teen-centred settings. Considering the sample of secondary schools used in this thesis is small (n=6), more outdoor food and beverage advertising research is needed surrounding both secondary schools, and other settings that young people frequent (e.g., parks, malls, recreational centres). Future information environment studies surrounding schools should consider both the areas surrounding these settings, as well as the school cafeterias within, to comprehensively assess what foods are offered and advertised to secondary school-aged students. Furthermore, there is a need for research that investigates the information environment within a variety of neighbourhood types, especially rural Canadian neighbourhoods, as they are typically understudied (Minaker et al., 2016).

Supplementary health geography and health promotion research should build on this thesis by exploring whether teens' food purchasing perceptions align with their purchasing behaviours. For example, do teens who go to school in areas with greater total advertising exposure make more junk food purchases during the school day? Do they have poorer diet quality than teens who are less exposed? In addition, contact with food advertisements could be measured (e.g. using GPS) and compared to the number and type of food vendor visits, to determine if there is a direct relationship or time lag between exposure and purchase. Teen food purchasing research should consider the power of the advertisements that were viewed to assess whether vendor visits correlate with the power of the advertisements.

5.6 Conclusion

The purpose of this thesis was to develop a teen-informed coding tool that quantifies the food-related information environment from a teen perspective, and then apply this tool to measure the extent and power of food and beverage advertising in London and Strathroy in Ontario, Canada. Through the investigation of several components of Glanz et al.'s (2005) food environment model (i.e., community, organizational, consumer), the information environment was explored both surrounding and within a sample of secondary schools. This mixed methods research allows for a more complete understanding of the impact that food and beverage marketing has on Canadian teens, as a function of power and exposure. These findings can be used to encourage

policymakers, planners, and health professionals to consider teen-directed marketing techniques when creating food environment policy, and advocate for the protection of teens from food and beverage marketing that has shown to be pervasive both within and surrounding secondary schools. The results from these two studies also support the need for behavioural interventions (e.g., the SmartAPPetite smartphone nutrition app intervention) that encourage teens to make healthier choices within their food environments, which are typically overwhelmed with the advertising of unhealthy food options. This thesis further reinforces the idea that food environments, especially the information environment, are critical determinants of health and should be considered when conducting future food environment studies and when creating policy. This attention is key to create healthier communities for young Canadians that encourage healthy dietary behaviours.

5.7 References

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