Assessing the prevalence and youth-directed marketing power of outdoor food and beverage advertisements around schools in six cities across Canada.

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Recent policy initiatives in Canada propose to restrict the commercial advertising of foods containing sugars, sodium, or saturated fat to youth on digital and broadcast media. While there is abundant research on youth's exposure to food and beverage advertising on digital and broadcast media, there is limited research exploring youth's exposure to outdoor food and beverage advertisements (e.g., freestanding billboards, restaurant exteriors, bus shelters). To address this research gap and inform policy decisions, Manuscript 1 of this thesis describes the prevalence, content, and youth-directed marketing power of outdoor food and beverage advertisements near schools. Manuscript 2 of this thesis explores the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, neighbourhood deprivation, and ethnocultural composition near schools to understand how the built environment and neighbourhood characteristics influence outdoor advertising environments. For this research, data on outdoor advertisements and food outlets within 1000 m of elementary and secondary schools in six cities across Canada (Vancouver, BC; Calgary, AB; Winnipeg, MB; Ottawa, ON; Quebec City, QC; and Halifax, NS) was analyzed, along with Statistics Canada data on deprivation and ethnocultural composition (from the Canadian Index of Multiple Deprivation). Descriptive statistics, chi-square tests, and negative binomial regression models were used to analyze the data. Most (64.5%) outdoor F&B advertisements near schools promote "unhealthy" food and beverage products. The most common marketing techniques used to target youth were youth product/convenience (39.4%), sense of urgency/limited time offer/seasonal (18.4%), and price promotion/discount (13.1%). School areas with high food outlet counts contained 7.429 times more advertisements than those with low counts (CI: 4.805 – 11.486, $p < 0.05$). The mean count of outdoor advertisements on food outlet exteriors ($M = 23.22$, $SD = 35.52$) was 10.6 times higher than the mean count of freestanding outdoor advertisements ($M = 2.18$, $SD = 3.94$), revealing that most outdoor F&B advertisements around schools are located on food outlets. Measures for deprivation and ethnocultural composition were not found to have notable patterns of significance with outdoor advertisement, except for residential instability. School areas with a high degree of residential instability contained 1.707 times more advertisements than the school areas with a low degree of residential instability (CI:1.029 - 2.832, $p < 0.05$). These findings suggest outdoor F&B advertisements near schools primarily promote unhealthy food choices and advertisement prevalence is influenced by features of the built environment, such as food outlet density. Future research should explore the impact of planning and public health policy interventions to reduce outdoor food and beverage advertising to youth. Opportunities for these professions (as well as other relevant disciplines) to collaborate to create healthier food environments for youth should also be identified.

Acknowledgements

First, I would like to thank my supervisor, Dr. Leia Minaker, for allowing me to analyze her comprehensive outdoor food and beverage advertising datasets for my thesis. Her guidance, support, and willingness to meet and answer all my questions were vital to finishing my thesis. I greatly appreciate all her help. I would also like to thank Dr. Rob Feick, my thesis committee member, for providing insight and expertise on the GIS and spatial analysis aspects of my thesis. Furthermore, thank you to Dr. Jennifer Dean for taking the time to be the reader on my thesis defence committee.

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1 Chapter 1
Introduction

1.1 Problem Context & Relevance to Planning[1]

Rates of overweight and obesity among youth are rising in Canada. Based on Canadian health survey data, roughly one in three children lived with overweight/obesity in 2017/2018, while only about one in four children lived with overweight/obese in 1978/79 (Lytvyak et al., 2022; Rao et al., 2016). High childhood obesity rates are concerning as obesity during childhood is associated with increased risks of social problems, obesity in adulthood, and the development of non-communicable diseases (e.g., cardiovascular disease, diabetes) earlier in life (Bjertnaes, 2020; Sahoo et al., 2015; Shentow-Bewsh & Zuberi, 2018). Childhood obesity thus impacts the quality of life of many Canadians and increases costs and strains on the Canadian healthcare system (Anis et al., 2010; Shentow-Bewsh & Zuberi, 2018).

Unhealthy food and beverage (F&B) advertising is a risk factor for obesity and associated non-communicable diseases due to its influence on food preferences, purchases, and eating behaviours (Smith et al., 2019; Tatlow-Golden & Garde, 2020). Due to the vulnerability of youth to marketing messages, Health Canada has proposed restrictions on the commercial "advertising of certain foods containing sugars, sodium, or saturated fat" to youth on broadcast and digital media platforms (Health Canada, 2022; Health Canada, 2024). As advertising is restricted on broadcast and digital media platforms, food companies are expected to shift towards outdoor advertising (e.g., freestanding posters, billboards, exterior restaurant ads) to target youth (Finlay et al., 2022). Research is needed to understand and describe outdoor F&B advertisement prevalence and marketing power near schools as a baseline before these advertising restrictions come into effect to inform future monitoring and evaluation research and policy decisions. Outdoor F&B advertisement prevalence refers to the number of outdoor F&B advertisements in an area, while outdoor F&B marketing power refers to the number of outdoor F&B advertisements in an area that use youth-directed marketing techniques. These variables are commonly used as a proxy for actual advertisement exposure, which is harder to measure (see **Section 2.2.3-Literature Review Synthesis** for more information on how these terms are defined and assessed).

Internationally and within Canada, few studies have examined the prevalence and power of youth-directed outdoor unhealthy F&B advertisements. A scoping review of 53 studies on outdoor F&B advertising identified considerable heterogeneity in research methods and definitions used between studies, making comparability of results challenging (Finlay et al., 2022). Moreover, only one primary,

[1] This problem context is adapted from an assignment that was submitted for PLAN 710.

quantitative Canadian study was identified in this scoping review; this study assessed advertisement prevalence in 400 m buffer areas around 25 schools in Vancouver (Velazquez et al., 2019). Although this Vancouver study provides some insight into outdoor F&B advertising environments in Canada, it does not capture how advertising may vary in cities across Canada with unique geographic contexts. Research with consistent methods for describing outdoor F&B advertisement prevalence near schools is needed in cities across Canada to understand how outdoor F&B advertising environments vary between cities/provinces to help inform federal, provincial, and local policy decisions on advertisement restrictions.

Studies from countries other than Canada, such as the USA, found racialized and low-socioeconomic status (SES)/high-deprivation neighbourhoods have higher counts of outdoor F&B advertisements near schools than predominantly white, high-SES/low-deprivation neighbourhoods. Since studies found a higher prevalence of fast-food retailers in low SES and racialized neighbourhoods, it is unclear whether these disproportionate outdoor F&B advertisement exposures are due to targeted freestanding advertisements or the higher prevalence of food outlets with exterior advertisements (Brien et al., 2022; Cohen, 2022; D'Angelo et al., 2016; Hillier et al., 2009; Isgor et al., 2016; Vandevijvere et al., 2016; Velazquez et al., 2019). Research on food environments in Canada suggests that Canadian food environments are unique from those in the USA (Minaker et al., 2016). In USA studies on food environments, food deserts (areas with limited access to food outlets with nutritious foods) were found to be more prevalent in neighbourhoods with higher deprivation compared to neighbourhoods with lower deprivation. Conversely, in Canadian studies on food environments, neighbourhoods with higher deprivation had equivalent or better access to healthy food than neighbourhoods with lower deprivation. Instead of food deserts, Canadian neighbourhoods with high deprivation have evidence of food swamps (areas with high densities of food outlets with minimally nutritious foods) (Minaker et al., 2016). Due to the unique context of Canadian food environments, Canadian research that explores the associations between advertisement count, food outlet count, and neighbourhood deprivation is needed.

Understanding the association between outdoor F&B advertisement prevalence and food outlet density is critical for informing policies to create healthier food environments. For instance, this research can help determine whether a policy that restricts freestanding outdoor unhealthy F&B advertisements near schools or a policy that restricts unhealthy food outlet land-uses near schools (or both) would be the most effective at reducing exposure to unhealthy F&B advertising. This issue is relevant to planning as it highlights the importance of food-outlet zoning and land-use regulations for creating healthy communities (Cohen et al., 2022; Hillier et al., 2009). As shown in **Figure 1.1**, official plan objectives, zoning

incentives, and zoning requirements can all play a role in increasing the number of healthy food outlets and decreasing the number of unhealthy food outlets in a city.

Figure 1.1: Types of food policies under the jurisdiction of various municipal agencies (Cohen, 2022).

The Canadian Institute of Planners (CIP) (2018) created a policy on "Healthy Communities Planning" that urges planners to plan for healthy and equitable communities in the built, natural, and rural environment and encourages planners' involvement in food systems planning. Similarly, the Ontario Professional Planners Institute (OPPI) (2011) released a call to action encouraging planners to plan for food systems as part of healthy community planning initiatives. Although food systems planning is not as prominent in planning practice as other systems, such as housing, transportation, economic development, and the environment, planners can play a vital role in creating healthier and more equitable communities through food systems planning (Pothukuchi & Kaufman, 2000). Pothukuchi & Kaufman (2000) argue that food systems planning is as essential as other areas of planning:

> Air, water, food, and shelter are among the essentials of life… Planners have been involved in efforts to improve the quality of air and water through pollution control programs, and more comprehensively in shelter planning. But the fourth essential, food, has been virtually ignored by planners. Food is unique among human needs in its basic connections, among others, to land; in the centrality of its wholesomeness and nutrition to health; and in the social, economic, ecological, and political implications of the locations of its sources. To be truly concerned about improving human settlements, planners need to incorporate food issues into their working models.

Despite the importance of food systems planning, this area of planning is given limited attention in practice (Pothukuchi & Kaufman, 2000). A survey of 435 planning professionals in Canada found that unclear departmental or jurisdictional responsibilities for food systems planning make it challenging for planners to achieve this objective (Kwantlen Polytechnic University, 2021). Furthermore, planners perceive their role in food systems planning as limited due to the perception that it is primarily driven by the private sector (Pothukuchi & Kaufman, 2000). This thesis research can support these calls for planners' involvement in the food system by contributing evidence that supports the use of planning policies and tools to create healthier food environments. Furthermore, this research identifies distinct roles planners can play in food systems planning, clarifying some of the confusion surrounding the jurisdictional responsibilities of planners in food planning. Finally, this thesis identifies opportunities for planners and public health professionals to collaborate on healthy food systems planning initiatives where jurisdictional collaboration can produce more effective results than working in silos.

1.2 Study Purpose & Objectives

Due to these research gaps, this thesis will address the following research objectives, which will be assessed through specific research questions outlined in **Chapter 2 – Manuscript 1** and **Chapter 3 – Manuscript 2:**

1. To describe the prevalence, content, and youth-directed marketing power of outdoor F&B advertisements within 1000 m of schools in urban and rural areas.
2. To determine which types of outdoor F&B advertisements (e.g., freestanding advertisements, exterior food outlet advertisements, healthy F&B advertisements, unhealthy F&B advertisements) are most prevalent within 1000 m of schools differ by city, food outlet density, degree of urbanization, and neighbourhood deprivation and ethnocultural composition.
3. To understand the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation and ethnocultural composition within 1000 m of schools in six cities across Canada.

1.3 Study Area Context

1.3.1 Selected Cities

Six cities across Canada were chosen for data collection to assess different geographic contexts. These cities, shown in **Figure 1.2**, include Vancouver, BC; Calgary, AB; Winnipeg, MB; Ottawa, ON; Quebec City, QC; and Halifax, NS. **Table 1.1** summarizes key population and dwelling characteristics for each of these six cities. For each city, data on outdoor advertising was collected within a 1000 m street-network buffer area of 143 selected schools (23-24 schools selected per city). Both elementary and secondary schools were assessed. As a result, "youth" in this study refers to children and adolescents aged 4 – 18 years old.

These six cities were selected as they have large populations relative to other cities in their provinces. Vancouver, Calgary, Winnipeg, and Halifax are all the largest cities by population in their provinces, while Ottawa and Quebec City are the second largest cities by population in their provinces (Statistics Canada, 2022c). Additionally, Winnipeg, Halifax, and Quebec City are the capital cities of their provinces, while Ottawa is the capital city of Canada. Although these selected cities have large populations relative to other cities in their provinces, they have notably different population densities. The population densities of the selected cities ranged from 364.9 people per km^2 (Ottawa) to 5,749.9 people per km^2 (Vancouver), with most of the selected cities having population densities between 1000 – 2000 people per km^2 (Calgary, Winnipeg, Quebec City, Halifax) (Statistics Canada, 2022a). Furthermore, the percentage of private occupied dwellings by type differed between these cities. The percentage of dwellings that were apartments ranged from 24% (Calgary) to 62% (Vancouver), while the percentage of dwellings that were single- or semi-detached housing ranged from 16% (Vancouver) to 61% (Calgary and Winnipeg) (Statistics Canada, 2022a). Since this research focuses on youth's advertisement exposure, **Table 1.1** also summarizes the percentage of each city's population of youth. The six cities had similar percentages of youth making up their population, with youth from ages 0 – 14 making up a range of 11% to 18% of the population (Statistics Canada, 2022a). This thesis explores differences in outdoor F&B advertisement counts between these six cities, and highlights areas for future research to explore how these contextual and demographic differences might impact outdoor F&B advertisement prevalence.

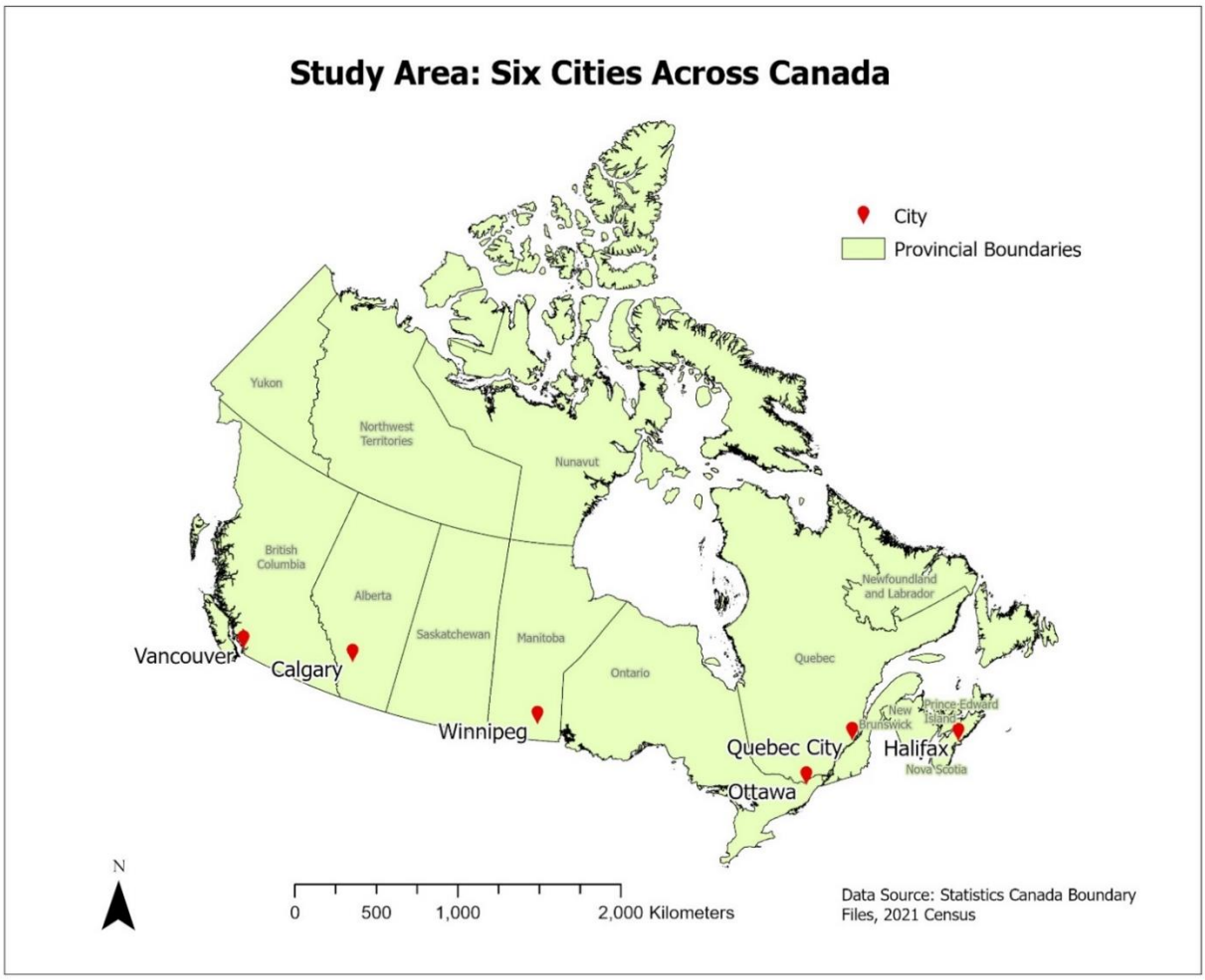

Figure 1.2: Locations of cities across Canada where data was collected. These cities include Vancouver, BC; Calgary, AB; Winnipeg, MB; Ottawa, ON; Quebec City, QC; Halifax, NS (Statistics Canada, 2023b).

Table 1.1: Key population and dwelling characteristics for the selected six cities (Statistics Canada 2022a).

Location		**Population Characteristics**			**Private Occupied Dwelling Characteristics**	
Province	**City[1]**	**Population count**	**Population density per km²**	**Youth 0-14 years n (%)**	**Single- and Semi-detached house n (%)[2]**	**Apartment n (%)[3]**
BC	**Vancouver** (CSD)	662,248	5,749.9	70,570 (11%)	49,550 (16%)	189,935 (62%)
AB	**Calgary** (CSD)	1,306,784	1,592.4	235,855 (18%)	307,710 (61%)	122,570 (24%)
MB	**Winnipeg** (CSD)	749,607	1,623.3	124,345 (17%)	184,780 (61%)	97,485 (32%)

Location		Population Characteristics			Private Occupied Dwelling Characteristics	
ON	**Ottawa** (CSD)	1,017,449	364.9	166,920 (16%)	191,435 (47%)	119,920 (29%)
QC	**Quebec City** (CSD)	549,459	1,214.8	81,030 (15%)	94,905 (36%)	144,295 (54%)
NS	**Halifax** (PC)	348,634	1,463.1	50,190 (14%)	70,205 (45%)	68,400 (44%)

[1] For all cities, except Halifax, the Census Subdivision (CSD) boundaries were used. For Halifax, the Population Centre (PC) boundaries were used as this more accurately reflected the data collection site, compared to the Halifax CSD boundary which covered the Halifax Regional Municipality boundary, rather than the city boundary.

[2] This variable collapses the following 2021 Statistics Canada Census variables: (1) Single-detached house; (2) semi-detached house.

[3] This variable collapses the following 2021 Statistics Canada Census variables: (1) Apartment in a building that has fewer than five storeys; (2) Apartment in a building that has five or more storeys.

1.3.2 Degree of Urbanization

Of the 23-24 schools selected in each city, up to five schools were selected from 'rural' areas (smaller municipalities within 1-2 hours of driving distance from the six urban cities) (Minaker, 2022a). On average, these smaller municipalities had lower population counts, lower population densities, lower percentages of dwellings that were apartments, and higher percentages of dwellings that were single- and semi-detached houses than the six urban cities. **Table 1.2** summarizes key population and dwelling characteristics for each of these selected smaller municipalities. In this thesis, the term 'degree of urbanization' refers to the urban and rural areas assessed. The term 'urban areas' refers to the six urban cities, while 'rural areas' refers to the selected nearby smaller municipalities. The degree of urbanization of schools was assessed in this thesis to see if outdoor F&B advertisement counts and food outlet counts (number of food stores and restaurants) differed between urban and rural areas. More information on the methods for selecting schools in urban and rural areas can be found in **Section 2.3.1.3 - School Sample Selection**.

Table 1.2 Key population and dwelling characteristics for the selected smaller municipalities (Statistics Canada, 2022a)

Location		Population Characteristics			Private Occupied Dwelling Characteristics	
Province	**Smaller Municipalities**	**Population count**	**Population density per km²**	**Youth 0-14 years n (%)**	**Single- and Semi-detached house n (%)**	**Apartment n (%)**
BC	**Delta**	108,455	603.7	16,425 (15%)	22,250 (58%)	6,175 (16%)
	Langley	28,963	2,845.2	4,420 (15%)	2,990 (24%)	7,655 (61%)

Location		Population Characteristics			Private Occupied Dwelling Characteristics	
AB	**Chestermere**	22,163	675.0	5,035 (23%)	5,910 (88%)	200 (3%)
MB	**St. Clements**	11,586	16.3	1,770 (15%)	3,925 (85%)	165 (4%)
	Selkirk	10,504	429.3	1,650 (16%)	2,850 (65%)	1,215 (28%)
	Hanover	17,216	23.6	5,010 (29%)	4,600 (89%)	225 (4%)
ON	**North Grenville**	17,964	51.0	2,935 (16%)	6,105 (87%)	425 (6%)
QC	**Cap-Sante**	3,594	66.0	690 (19%)	1,375 (91%)	65 (4%)
	Saint-Gabriel-de-Valcartier	3,223	7.5	700 (22%)	970 (91%)	20 (2%)
	Shannon	6,432	101.2	1,635 (25%)	1,830 (78%)	155 (7%)
	Donnacona	7,436	368.2	1,270 (17%)	2,175 (66%)	640 (19%)
NS	**Kings, Subdivision A.**	22,355	18.1	3,680 (16%)	8,440 (89%)	340 (4%)
	Bridgewater	8,790	644.9	1,040 (12%)	2,260 (53%)	1,275 (30%)

1.3.3 Deprived & Racialized Neighbourhoods

Studies from other countries, such as the USA, identified that high-deprivation and racialized neighbourhoods had disproportionately higher outdoor F&B advertisement counts in comparison to majority white, low-deprivation neighbourhoods (Brien et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Ruggles et al., 2023; Ruggles et al. 2024; Trapp et al., 2022; Wells et al., 2023). In this thesis, deprived and racialized neighborhoods are defined using the Canadian Index of Multiple Deprivation (CIMD) to assess whether similar trends are evident in Canadian cities (Statistics Canada, 2023a). More information on the CIMD and its role in this thesis' school selection strategy, methods, and data analysis can be found in **Sections 2.3 - Methods** and **3.3.2.2 - CIMD Dimension Classification.**

1.4 The Food Environment

Many different definitions and frameworks are used in literature to describe the food environment. For instance, Glanz et al. (2005) conceptualize the food environment, shown in **Figure 1.3**, to include four elements: (1) The Community Nutrition Environment; (2) The Organizational Nutrition Environment; (3) The Consumer Nutrition Environment; and (4) The Information Environment. Downs et al. (2020) build upon existing definitions of the food environment to incorporate it within the socio-

ecological model, as shown in **Figure 1.4**. This definition of the food environment includes (1) availability, (2) affordability, (3) promotion, (4) sustainability, (5) quality, and (6) convenience of foods and beverages. Despite the differences in these models, both indicate that food and beverage (F&B) advertising and promotion are key components of the food environment that have the potential to influence individual food choices.

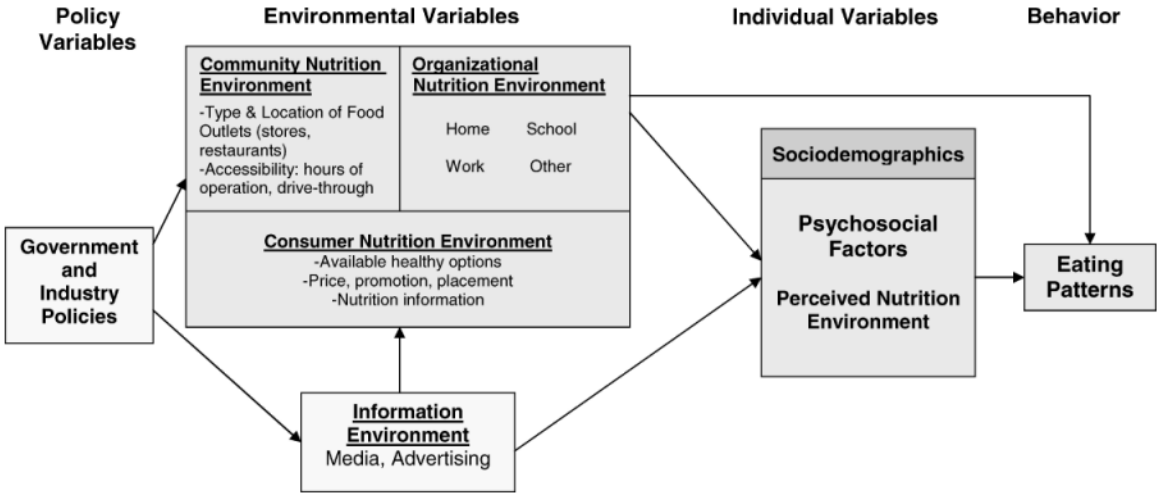

Figure 1.3: Glanz et al.'s (2005) model of the food environment.

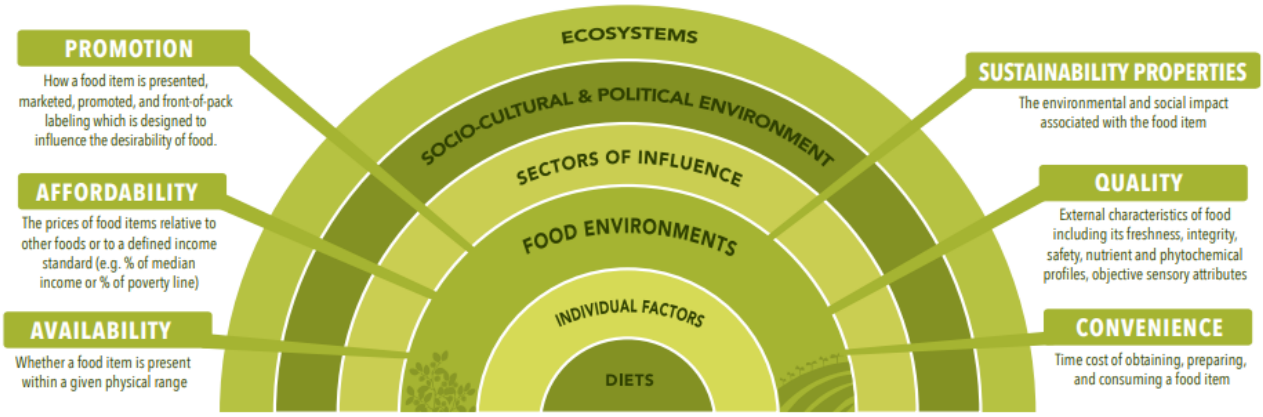

Figure 1.4: Downs et al.'s (2020) model of the food environment.

Although both models convey the role of food advertising in influencing individual food choices, the model from Glanz et al. (2005) aligns more closely with the research questions assessed in this thesis. As a result, Glanz et al.'s (2005) model is used throughout this thesis to frame the research in the context of the food environment. The datasets used in this research capture elements of the Information Environment and Consumer Nutrition Environment from Glanz et al.'s (2005) model. **Table 1.3** describes the three main datasets analyzed in this thesis and their connection to the food environment. Additional information on these datasets can be found in **Sections 2.3 - Methods and 3.3- Methods.**

Table 1.3: Thesis datasets and their connection to the Glanz et al. (2005) Food Environment Model

Dataset Name	Description	Data Collection Tools	Area of Glanz et al. (2005)'s Food Environment
Dataset 1: Outdoor Advertisements	Data on every food- or beverage-related outdoor advertisement located within the 1000 m study area of selected schools, excluding advertisements on store/restaurant exteriors.	• INFORMAS-OA[1] Survey	The Information Environment
Dataset 2: Exterior Store & Restaurant Advertisements	Data on every food- or beverage-related advertisement on the exterior of stores and restaurants located within the 1000 m study area of selected schools.	• CMAT-R[2] • CMAT-S[3] • CMAT-PCT[4]	The Information Environment
Dataset 3: Food Stores and Restaurants	Data on every food store and restaurant identified within the 1000 m study area of selected schools.	• INFORMAS-OA Survey	The Consumer Nutrition Environment

[1] INFORMAS-OA is the abbreviation for the International Network for Food and Obesity / Non-communicable Diseases Research, Monitoring and Action Support – Outdoor Advertisements.

[2] CMAT-R is the abbreviation for the Canadian Marketing Assessment Tool for Restaurants.

[3] CMAT-S is the abbreviation for the Canadian Marketing Assessment Tool for Stores.

[4] CMAT- PCT is the abbreviation for the Canadian Marketing Assessment Tool - Photo Coding Tool.

1.5 Thesis Structure

This thesis is organized into four chapters, including this introduction chapter. Chapter 2 contains Manuscript 1 of this thesis, which quantitatively assesses the content and promotional techniques of outdoor F&B advertisements within 1000 m of schools by city and by degree of urbanization. Chapter 3 contains Manuscript 2 of this thesis, which quantitatively assesses the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition within 1000 m of schools in six cities across Canada. Both Chapters 2 and 3 are structured using the following sections: (1) literature review, (2) methods, (3) results, (4) discussion, and (5) conclusion. Chapter 4 is the conclusion of this thesis and summarizes the key findings, identifies key areas for future research, and highlights the significance of this research to planning research and practice.

2 Chapter 2
Manuscript 1

2.1 Introduction

Rates of overweight and obesity among youth are rising in Canada. Based on Canadian health survey data, roughly one in three children lived with overweight/obesity in 2017/2018, while only about one in four children lived with overweight/obese in 1978/79 (Lytvyak et al., 2022; Rao et al., 2016). High childhood obesity rates are concerning as obesity during childhood is associated with an increased risk of social problems, obesity in adulthood, and the development of non-communicable diseases (e.g. cardiovascular disease, diabetes) earlier in life (Bjertnaes, 2020; Sahoo et al., 2015; Shentow-Bewsh & Zuberi, 2018). Childhood obesity thus impacts the quality of life of many Canadians and increases costs and strains on the Canadian healthcare system (Anis et al., 2010; Shentow-Bewsh & Zuberi, 2018).

Individual-level weight management interventions (e.g., dietary restrictions) are ineffective at managing weight on a population level as they do not address the socioeconomic and environmental factors that contribute to an individual's food choices and risk of developing obesity (Shentow-Bewsh & Zuberi, 2018). The type of food environment an individual is exposed to has been hypothesized to influence food choices and intake at the population level. Glanz et al. (2005) conceptualize the food environment, shown in **Figure 2.1**, to include four elements: (1) The Community Nutrition Environment; (2) The Organizational Nutrition Environment; (3) The Consumer Nutrition Environment; and (4) The Information Environment. While this model shows how environmental variables at a population level can influence eating patterns, there have been inconsistent findings in the literature on the associations between food environment exposure and food choices (Downs et al., 2020; Siddiqui et al., 2024).

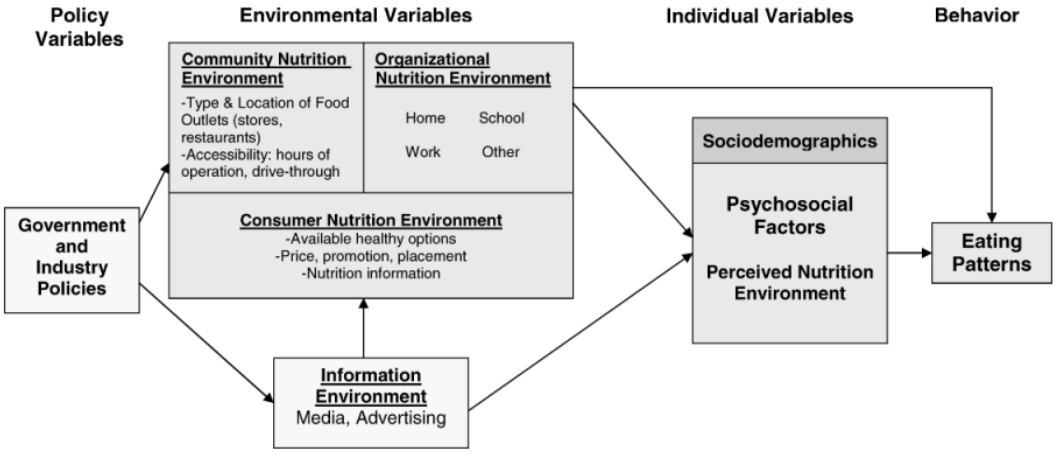

Figure 2.1: Glanz et al.'s (2005) model of the food environment.

F&B advertising makes up part of the food environment, known as the Information Environment (Glanz et al., 2005). Unhealthy F&B advertising on television is positively associated with increased consumption of unhealthy foods and BMI in youth; however, literature exploring the association between outdoor advertising media (e.g., freestanding posters, billboards) and youth food choices is limited (Finlay et al., 2022, Shentow-Bewsh & Zuberi, 2018; Siddiqui et al., 2024; Smith et al., 2019). Since youth spend a lot of time in and around schools, research that explores outdoor F&B advertising environments near schools is needed to understand youth's exposure to these advertisements. Furthermore, the rapid urbanization of cities is also transforming the food environment (Seto & Ramankutty, 2016). As cities densify and have more tall, mixed-use buildings, youth will potentially be exposed to more food retailers and outdoor advertisements on their journey from school to home. Research that investigates whether outdoor F&B advertising differs between urban and rural areas, as well as cities with different densities, is needed to understand how urbanization and densification impact the food information environment (Seto & Ramankutty, 2016). To address these research needs, this manuscript explores outdoor F&B advertising environments in six cities and surrounding regions in Canada, including Vancouver, BC; Calgary, AB; Winnipeg, MB; Quebec City, QC; Ottawa, ON; and Halifax, NS. This manuscript will also explore differences in advertising by city/region and urban vs. rural locales.

First, this manuscript synthesizes the findings of a literature review on outdoor F&B advertising environment research to assess key definitions, methods, and results, and generate specific research questions for this manuscript. Next, the methods sections explain the methods used to answer these research questions. Finally, the results and key findings are presented, followed by a discussion that examines the significance of this research to planning practice, theory, and research.

2.2 Literature Review[2]

2.2.1 Introduction

The purpose of this literature review is to gain an understanding of the current literature on outdoor F&B advertising near schools, identify gaps in the literature, and inform the research questions and methods for a study on outdoor F&B advertising environment near schools in cities across Canada. The research questions that informed this literature review were:

1. What research methodologies and methods are used in the literature to explore youth exposure to outdoor F&B advertisements?

[2] This literature review is adapted from an assignment that was submitted for PLAN 710.

2. What are the areas of heterogeneity and homogeneity in literature that explore youth exposure to outdoor F&B advertisements?
3. What are the key findings of literature that explore youth exposure to outdoor F&B advertisements?

Three main themes emerged when conducting this literature review, including (i) outdoor F&B advertisement prevalence; (ii) outdoor F&B marketing power; (iii) associations between food retailer environments, neighbourhood demographics, and outdoor F&B advertisement prevalence. This unstructured, narrative literature review identifies areas of consensus and inconsistency in the literature throughout these different themes and identifies areas for further research that will be explored in this thesis.

2.2.2 Methods

For this unstructured, narrative literature review, a search in the database, Scopus, was conducted. The search terms that were used include: ((outdoor*) AND (school OR youth OR child* OR adolescent*) (marketing OR advert*) AND (food OR beverage* OR drink*)). The search terms were applied to abstracts, titles, and keywords. This search returned 87 studies.

2.2.2.1 Study Selection & Eligibility Criteria

The titles and abstracts of the 87 studies were then screened for eligibility. Primary/secondary quantitative studies assessing outdoor food and beverage advertising environments near youth-serving institutions (e.g., schools, community centres) were considered for inclusion. Studies that assessed data collection tools and methods for quantitative studies on outdoor food and beverage advertising were also considered for inclusion. Finally, reviews were considered for inclusion. Qualitative studies and policy analysis studies were ineligible for inclusion since this thesis is taking a quantitative approach.

Two reviews were identified while screening the studies for eligibility. These reviews included a scoping review on quantitative outdoor F&B studies by Finlay et al. (2022), and a systematic review by Backholer et al. (2020) that synthesizes the evidence on children's exposure to F&B advertisements on various media. Finlay et al. (2022) conducted their literature search between January to February 2021, and selected 53 studies, which included non-peer reviewed sources (e.g., letters to editors, grey literature, conference abstracts). The review from Backholer et al. (2020) included 25 studies on F&B advertising to children from 2007 to 2019 (including grey literature), with only eight studies focusing on outdoor advertising media. Since comprehensive and recent reviews on outdoor F&B advertising to children already exist, the findings from these reviews were incorporated in this literature review. To avoid double-counting during this literature review's synthesis, studies that were assessed by Finlay et al.

(2022) and Backholer et al., (2020) were not included in this literature review, except for three noteworthy studies that required further assessment to adequately answer this literature review's questions (Isgor et al., 2016; Herrera & Pasch, 2017; Velazquez et al., 2019). This literature review updates the findings from these existing reviews by including additional studies that were not available / not identified when these reviews selected their sources.

After screening the studies, 18 peer-reviewed articles were determined to be eligible. An additional 3 peer-reviewed articles were identified through a snowballing strategy that explored the cited-by and reference lists of the previously identified literature. In total, 21 peer-reviewed articles were identified for this literature review.

2.2.2.2 Characteristics of the Selected Studies

The 21 selected studies were published between 2009 and 2024. 16 of the 21 studies conducted primary or secondary data analyses on outdoor F&B advertising/retail environments near schools. These 16 studies assessed data collected in the United States (n = 6), Australia (n = 3), New Zealand (n = 3), Ghana (n = 1), Spain (n = 1), Mongolia (n = 1), The Philippines (n=1), and Canada (n = 1). Another two of the 21 studies assessed outdoor F&B advertising data collection tools and methods. These studies both came from Canada. The remaining two studies were reviews (one scoping and one systematic) that included studies from a range of countries.

Of the 16 studies that conducted data analyses on outdoor F&B advertising/retail environments near schools, all 16 studies used descriptive statistics to analyze the data (e.g. percentage, density, mean counts) (Amevinya et al., 2022; Brien et al., 2022; D'Angelo et al., 2016; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kelly et al., 2015; Kneller et al., 2024; Martin-Pavo et al., 2022; Ruggles et al., 2023, Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Vandevijvere et al., 2016; Velazquez et al., 2019; Wells et al., 2023). Nine of the 16 studies used tests of independence between groups to test for statistical significance (e.g. Mann-Whitney U test, Chi-square test) (Amevinya et al., 2022; Brien et al., 2022; Kelly et al., 2015; Martin-Pavo et al., 2022; Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2022; Trapp et al., 2021; Wells et al., 2023). Six of the 16 studies used regression analyses (e.g. linear regression, multi-variate regression), in addition to descriptive statistics, to determine associations between variables and account for potential confounding variables (e.g. food-retailer prevalence) (D'Angelo et al., 2016; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kneller et al., 2024; Velazquez et al., 2019).

2.2.3 Literature Review Synthesis

This unstructured literature review uses a narrative synthesis to answer its research questions.

2.2.4 Results: Key Findings

Three main themes emerged when exploring the research questions in this unstructured, narrative literature review. The first theme that emerged in outdoor F&B advertising research was determining outdoor F&B advertising prevalence near schools. The second theme that emerged was determining outdoor F&B marketing power near schools. The third theme that emerged was the exploration of why some neighbourhoods had a higher prevalence of advertisements near schools than others. The results are organized in subsections for each emerging theme, and the research questions are explored for each theme.

2.2.4.1 Outdoor F&B Advertisement Prevalence Near Schools

16 of the 21 identified studies conducted primary/secondary data analyses on the prevalence of outdoor unhealthy F&B advertisements or F&B stores near schools. Of these 16 studies, 14 studies assessed the prevalence of outdoor F&B advertisements near schools (Amevinya et al., 2022; Brien et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kelly et al., 2015; Kneller et al., 2024; Martin-Pavo et al., 2022; Ruggles et al., 2023, Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Velazquez et al., 2019; Wells et al., 2023), while two studies explored the prevalence of food and/or tobacco stores and restaurants near schools (D'Angelo et al., 2016; Vandevijvere et al., 2016). Furthermore, the two identified reviews provide a synthesis of outdoor advertisement prevalence methodologies and results in their identified studies (Backholer et al., 2020; Finlay et al., 2022). Finally, one of the identified studies assesses different tools in estimating youth exposure to outdoor advertisements (Wray et al., 2023).

2.2.4.1.1 Study Design and Datasets: Measuring Outdoor Advertisement Prevalence and Exposure

The 16 identified quantitative studies on the prevalence of outdoor F&B advertising / food stores near schools all used cross-sectional methodologies and followed similar processes for collecting and cleaning data on outdoor advertisement prevalence. In most cases, buffer study areas around schools were determined through mapping software (e.g. ArcGIS), then one to two researchers collected data on outdoor advertisements visible along the streets/sidewalks within the study area. For the studies that used food store data, existing datasets of food stores and their addresses were used (D'Angelo et al., 2016; Isgor et al., 2016; Vandevijvere et al., 2016). Data was recorded and then coded based on guides the researchers were trained to use (Amevinya et al., 2022; Brien et al., 2022; D'Angelo et al., 2016; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kelly et al., 2015; Kneller et al., 2024; Martin-Pavo et al., 2022; Ruggles et al., 2023, Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Vandevijvere et al., 2016; Velazquez et al., 2019; Wells et al., 2023). Only one of these 16 identified studies measured

exposure instead of prevalence (Trapp et al., 2021). This study determined 72 simulated school routes of various transportation methods (i.e. train routes, bus routes, and walking routes). Researchers traveled these routes, took photos of all outdoor advertisements on the route, and then coded their findings (Trapp et al., 2021). Although Trapp et al.'s (2021) study more accurately measures the exposure to outdoor advertisements that a child may encounter on their journey home from school, it is more time-consuming as it covers a larger area than the studies using buffer areas around schools as a study area. Furthermore, a study from Wray et al. (2023) aimed to compare the performance of three different methods – smartphone global positioning system (GPS), road-network buffers, and radial buffers – in estimating exposure to outdoor F&B advertisements. The study found that buffer models performed better in estimating exposure and purchases from food outlets, while the GPS models performed better for estimating exposure and purchases from quick service outlets (e.g., fast food, coffee shop) (Wray et al., 2023). Since these findings do not suggest one method is generally better at measuring exposure than the other, further research is needed to determine which method (buffer or GPS model) is more accurate at measuring advertisement exposure.

2.2.4.1.2 Defining Outdoor F&B Advertisements

In the 14 quantitative studies that assessed the prevalence of outdoor F&B advertisements near schools, the definition of outdoor advertisements was inconsistently defined. Most studies included freestanding outdoor advertisements (e.g., billboard, bus shelter) and exterior food store/restaurant advertisements in their definition of outdoor advertisements (n = 9) (Herrera & Pasch, 2017; Hillier et al., 2009; Kelly et al., 2015; Martin-Pavo et al., 2022, Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Velazquez et al., 2019); however, other studies exclusively included at exterior food store/restaurant advertisements, and did not include freestanding outdoor advertisements (Isgor et al., 2016). Brien et al. (2022) and Kneller et al. (2024) exclusively looked at advertisements on convenience store exteriors. Furthermore, the definition of outdoor advertising was described with varying levels of detail on exclusion and inclusion criteria, making it challenging to compare definitions. For instance, some studies explicitly excluded non-permanent signs (e.g., advertisements on buses driving by) (Hillier et al., 2009; Trapp et al., 2022), while other studies included advertisements on buses that passed by during data collection (Trapp et al., 2021). The remaining studies did not explicitly mention whether advertisements on buses were included or excluded. The scoping review from Finlay et al. (2022) identified similar inconsistencies in defining outdoor food advertisements, suggesting that more specificity is needed for findings to be comparable between studies.

2.2.4.1.3 Defining Study Areas Near Schools

The size of the study area around schools varied from 250 meters to 6 kilometers with some studies using radial buffers (Euclidian distance) (n = 8) (Brien et al., 2022; Hillier et al., 2009; Kelly et al., 2015; Martin-Pavo et al., 2022; Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2022; Wells et al., 2023), while other studies used road-network buffers (Manhattan distance) (n = 3) (Amevinya et al., 2022; Kneller et al., 2024; Velazquez et al., 2019). Although most studies in this literature review used radial buffers, road-network buffers provide more accuracy in estimating walking times as they measure the distance of road/pedestrian network paths. The most common buffer area size used was 500 meters (n = 8) (Amevinya et al; Brien et al., 2022; Isgor et al., 2016; Kelly et al., 2015; Kneller et al., 2024; Martin-Pavo et al., 2022; Trapp et al., 2022; Wells et al., 2023). The scoping review from Finlay et al. (2022) also observed a wide range of study area sizes around schools. They found that the buffer areas around schools ranged from 100 meters to 2 kilometers and also identified 500 meters as the most common buffer size (Finlay et al. 2024).

2.2.4.1.4 School Type

The type of school used as the study area varied between studies. Two of the identified studies looked exclusively at secondary schools (Herrera & Pasch, 2017; Trapp et al., 2021), and three of the identified studies looked exclusively at elementary schools (Brien et al., 2022; Kelly et al., 2015; Martin-Pavo et al., 2022). The other 11 studies looked at both primary and secondary schools (Amevinya et al., 2022; D'Angelo et al., 2016; Hillier et al., 2009; Isgor et al.; Kneller et al., 2024; 2016; Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2022; Vandevijvere et al., 2016; Velazquez et al., 2019; Wells et al., 2023). When analyzing and reporting results, only six of the studies looked at differences in data between primary and secondary schools (Amevinya et al., 2022; D'Angelo et al., 2016; Ruggles et al., 2024; Trapp et al., 2022; Velazquez et al., 2019; Wells et al., 2023). One of these studies found no significant difference by school type (Ruggles et al., 2024). Another study found that elementary schools had more outdoor F&B advertisements on average than secondary schools (Trapp et al., 2022). Two studies found higher outdoor advertisement counts near secondary schools than elementary schools (Amevinya et al., 2022; Velazquez et al., 2019), another study found higher counts of fast-food outlets near secondary schools than elementary schools (D'Angelo et al., 2016), while another study found higher prevalence of outdoor alcohol advertisements near secondary schools (Wells et al., 2023). When these studies explored differences in advertisement counts by other variables (e.g., socioeconomic status) data for primary and secondary schools were grouped together. Based on these studies, secondary schools typically have more outdoor advertisements, food stores and restaurants than elementary schools; however, this finding is not consistent across all the literature.

2.2.4.1.5 Classifying Foods in Advertisements

The guidelines used to classify foods in advertisements as 'healthy' or 'unhealthy' varied between the identified studies. Many studies used food guidelines from their country or province to classify foods. For instance, Velazquez et al. (2019) used British Columbia's School Food Guidelines criteria. Multiple studies used the International Network for Food and Obesity/non-communicable diseases Research Monitoring and Action Support (INFORMAS) outdoor advertising protocol (n = 4) (Amevinya et al., 2022; Trapp et al., 2022; Trapp et al., 2021; Wells et al., 2023). INFORMAS is "a global network of public-interest organisations and researchers that aims to monitor, benchmark and support public and private sector actions to increase healthy food environments and reduce obesity and NCDs and their related inequalities" (INFORMAS, n.d.). Due to this variability in definitions, it is challenging to compare the results between studies. Since the most common classification protocol used was the INFORMAS outdoor advertising protocol, future research on outdoor F&B advertising prevalence should use this protocol to create homogeneity in data collection and coding methods and improve the comparability of results between studies (Finlay et al., 2022; Mackay et al., 2017). If the INFORMAS outdoor advertising protocol cannot be used, future research should use federal or provincial food classification guidelines so that research is relevant to federal/provincial policies and can be used to inform policy decisions.

2.2.4.1.6 Key Findings

In terms of major findings, all 16 studies that analyzed outdoor F&B advertisements found most advertisements contained images of unhealthy F&B products. The comparability of more detailed results is challenging due to inconsistency in methods. A scoping review by Finlay et al. (2022) identified 19 additional studies that explored the prevalence of outdoor unhealthy F&B advertisements near schools. This review also found that most (63%) outdoor F&B advertisements near schools contained unhealthy F&B products, with the most advertised products being fast food and sugar sweetened beverages (SSBs) (Finlay et al., 2022). This scoping review also acknowledges that comparability of results is limited due to the inconsistency in methods.

Furthermore, only one primary, quantitative Canadian study (Vancouver, BC) was identified in this literature review and Finlay et al. (2022)'s scoping review, indicating that more research on outdoor F&B advertising environments is needed in Canada is needed. Research with consistent methods for describing outdoor F&B advertisement prevalence near schools is needed in cities across Canada to understand how outdoor F&B advertising environments vary between provinces to help inform federal policy decisions on advertisement restrictions.

2.2.4.2 Outdoor F&B Marketing Power Near Schools

2.2.4.2.1 Study Design & Datasets: Measuring Outdoor F&B Marketing Power

Five of the 16 quantitative studies that assessed outdoor F&B advertisement prevalence near schools, also assessed the youth-directed marketing power of these outdoor advertisements. In these five studies, researchers coded the collected outdoor F&B advertisement data based on the youth-directed marketing techniques evident in the advertisements. The percentage of outdoor F&B advertisements using youth-directed marketing techniques was then determined (Amevinya et al., 2022; Brien et al., 2022; Herrera & Pasch, 2017; Velazquez et al., 2019; Wells et al., 2023).

2.2.4.2.2 Defining Youth-directed Marketing Power

There was also inconsistency in how youth-directed marketing techniques were defined and coded in these studies. One study defined youth-directed marketing power solely based on whether promotional offers were included in the advertisement (Herrera & Pasch, 2017). The other studies determined youth-directed marketing power based the presence of promotional offers and promotional techniques (e.g. animated characters, youth-appealing colours and images); however, the definition of promotional offer and promotional techniques still varied between the studies (Amevinya et al., 2022; Brien et al., 2022; Velazquez et al., 2019; Wells et al., 2023). Wells et al. (2023) used a teen-informed coding tool developed by Bowman et al. (2019) to determine the teen-directed marketing power of outdoor F&B advertisements. Bowman et al. (2019) conducted an environmental audit of outdoor F&B advertisements and consulted with teenagers to identify teen-directed marketing techniques and develop a coding tool to measure the teen-directed marketing power of F&B advertisements. The top ten advertisement features identified as teen-directed marketing techniques, in order of importance, were determined to be (Bowman et al., 2019):

1. Price
2. Image of F&B
3. Taste Description
4. Price Promotion / Discount
5. Slogan / Description
6. Logo / Brand name
7. Geographic location / directions
8. Contest / Game
9. Loyalty program
10. Celebrity or Cross-promotion with sports / TV / movie

Finlay et al. (2022) only identified nine additional studies that assessed the marketing techniques of advertisements. The most frequent marketing techniques across these studies included “premium offers, promotional characters, health claims, taste appeals, and emotional appeals.” Finlay et al. (2022) argues that research on youth-directed marketing in outdoor advertisements is limited due to the lack of

definitions and classifications to code for youth-directed marketing techniques. Moreover, Finlay et al. (2022) recommends future studies use food marketing guidelines developed by the World Health Organization (WHO) or INFORMAS to improve the comparability of studies.

2.2.4.2.3 Key Findings

Inconsistencies in the definitions and classifications of youth-directed marketing power made the comparability of results challenging. Finlay et al. (2022) found the percentage of advertisements coded as youth-directed ranged from <1% to 10.4% in their identified studies. Future research should use the INFORMAS or WHO marketing guidelines to make the comparison of results easier (Finlay et al., 2022).

2.2.4.3 Outdoor F&B Advertising Environments, Food Retail Environments, and Neighbourhood Demographics

2.2.4.3.1 Testing for Differences Between Groups

11 of the identified studies explored of why some neighbourhoods had a higher prevalence of advertisements near schools than others (Amevinya et al., 2022; Brien et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Kneller et al., 2024; Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2022; Vandevijvere et al., 2016; Velazquez et al., 2019; Wells et al., 2023). Food retail environments (e.g., food outlet density) and neighbourhood socioeconomic status (SES) were commonly identified variables that might impact the prevalence of outdoor F&B advertisements in a study area. Two of the studies that measured outdoor F&B advertisement prevalence near schools, found outdoor advertisements to be most prevalent on food outlet exteriors rather than freestanding ad locations (Amevinya et al., 2022; Hillier et al., 2009). Moreover, seven studies explored how outdoor advertisement prevalence near schools varied by neighbourhood ethnicity and/or SES and found the prevalence to be highest in racialized and/or low SES neighbourhoods (Brien et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Ruggles et al., 2023; Ruggles et al. 2024; Trapp et al., 2022; Wells et al., 2023). Five studies (from England, New Zealand, and the United States) identified in a systematic review on children's advertising exposure found that neighbourhoods with lower SES had higher exposures to outdoor unhealthy F&B advertisements (Backholer et al., 2020). Two Australian studies identified in this systematic review found no significant differences in advertising exposure by neighbourhood SES groups (Backholer et al., 2020). Finlay et al.'s (2022) scoping review identified 25 additional studies that assessed how advertisement exposure differences by SES. Most of these studies found that high deprivation neighbourhoods had higher outdoor F&B advertisement exposures; however, some studies found no significant differences by SES group (Finlay et al., 2022). Since different countries seem to have different findings in whether advertisement exposure changes by SES, research in Canada is needed to understand how advertisement

exposure varies by race/ethnicity and SES. While measuring differences in outdoor F&B advertisement prevalence between groups can provide insights on potential inequities, it does not account for how the built environment (e.g., number of food outlets) may be influencing the number of outdoor advertisements. This distinction is important for understanding if the number of unhealthy food outlets neighbourhoods is influencing the number of unhealthy outdoor F&B advertisements in racialized / low-SES.

2.2.4.3.2 Testing for Associations Between Variables

Only three studies identified in this literature review explored associations between outdoor F&B advertising environments, food retail environments, and neighbourhood socioeconomic status and/or racial/ethnic composition (Isgor et al., 2016; Velazquez et al., 2019). These association studies are important as they can determine the built environment's role in creating differences in advertisement exposure based on neighbourhood socioeconomic status and racial/ethnic composition. Isgor et al. (2016) performed multivariable regression analyses to examine the associations between store-front F&B advertising prevalence and neighbourhood socioeconomic status and racial/ethnic composition; this analysis was performed separately for each store type. The degree of urbanization[3] was controlled for in this study. The results found that stores in low-income neighbourhoods had a higher prevalence of F&B advertisements than their mid- and high- income counterparts (Isgor et al., 2016). When controlling for income, no associations between the racial/ethnic composition of neighbourhoods and advertisement prevalence were found (Isgor et al., 2016). A limitation of this study is that it did not focus specifically on school zones or youth-targeted advertising and only included store-front outdoor advertisements in the study. As a result, these findings do not determine the associations between these variables for all outdoor F&B advertisements in youth-targeted areas (Isgor et al., 2016). Kneller et al. (2024) conducted a similar study to Isgor et al. (2016) and found that the percentage of unhealthy F&B advertisements increased with higher deprivation; however, this study only assessed advertisements on convenience stores and bus stops near schools, not all types of outdoor advertisements. Moreover, Velazquez et al. (2019) performed a negative binomial regression analysis to examine the associations between neighbourhood socio-economic deprivation score, school type, and store counts by store type with the number and types of advertisements. Neighbourhood commercial density was controlled for in this study. This study found that outdoor F&B advertisement prevalence near schools was associated with the number and type of food stores; and the increase of one convenience store in a school zone was associated with a 38% increase in outdoor F&B advertisements. Conversely, socioeconomic deprivation score was not found to

[3] Degree of urbanization is defined by Isgor et al. (2016) as "constructed based on the urban-centric locale code definitions obtained from the National Center for Education Statistics to represent the following areas: urban (small, midsize, and large cities), suburban (small, midsize, and large suburbs plus distant and fringe towns), and rural (distant, fringe, and remote rural areas plus remote towns)."

be associated with outdoor F&B advertisement prevalence. Due to the limited studies available assessing the association between outdoor F&B advertising environments, food retailer environments, and neighbourhood demographics, further studies are needed to understand these associations in cities across Canada.

2.2.5 Knowledge Gaps and Future Research Opportunities

The most notable knowledge gap identified in the research was the lack of Canadian research on outdoor F&B advertising environments. Although a comprehensive study on outdoor F&B advertising environments in Vancouver exists, the findings of this study are not transferable to many cities in Canada due to Vancouver's unique context of being a highly populated and highly dense city. To better inform imminent federal policies on F&B advertising in Canada, research on outdoor F&B advertising environments in a variety of Canadian contexts (major cities, mid-size cities, rural areas) is needed. To address this knowledge gap in the literature, the main research objective of Manuscript 1 is to describe outdoor F&B advertising environments near primary and secondary schools across Canada. This research objective will be assessed through the following research questions:

1. What types of food and beverage products are featured in outdoor advertisements within 1000 m of schools in six cities and smaller municipalities in Canada? Are there statistically significant differences between cities, as well as urban and rural areas?
2. What types of promotional techniques are used in outdoor advertisements within 1000 m of schools in six cities and smaller municipalities in Canada? Are there statistically significant differences between cities, as well as urban and rural areas?

This literature review also revealed that studies in other countries identified children in neighbourhoods with a high prevalence of food insecurity – primarily low socioeconomic status and racialized neighbourhoods – are exposed disproportionately to unhealthy F&B advertisements. Conversely, the one Canadian study on outdoor F&B advertising environments near schools in Vancouver did not find socioeconomic deprivation score was not to be associated with outdoor F&B advertisement prevalence. Since this is the only Canadian study to exist on outdoor F&B advertising environments, more research in Canadian contexts is needed to determine if associations between neighbourhood socioeconomic status, racial composition, and outdoor F&B advertising are evident in Canadian cities. Furthermore, studies have found a higher prevalence of fast-food retailers in low socioeconomic status and racialized neighbourhoods; however, it is unclear whether these disproportionate advertisement exposures are due to targeted advertising or the higher prevalence of fast-food retailers with outdoor advertisements (Brien et al., 2022; D'Angelo et al., 2016; Hillier et al., 2009;

Isgor et al., 2016; Vandevijvere et al., 2016; Velazquez et al., 2019). Thus, research is needed to determine associations between outdoor F&B advertising environments, food outlet counts, and neighbourhood deprivation and ethnocultural competition near schools across Canada. To address these knowledge gaps, Manuscript 2 will explore the following research questions:

1. How do mean outdoor F&B advertisement counts within 1000 m of schools differ by city, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition
2. What is the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition within 1000 m of schools in six cities across Canada?

Finally, since there was notable heterogeneity in the existing literature on outdoor F&B advertising environments, the research methods used in this thesis will attempt to use similar research methods to the literature where homogeneity exists to allow easier comparability of results. Since this study will use the same data collection and analysis methods for the six cities being studied, reliable and accurate comparisons between cities across Canada within the study can be made.

2.3 Methods

This manuscript uses data from two primary datasets from Dr. Leia Minaker, which includes data on outdoor F&B advertisements within 1000 m of selected geocoded elementary and secondary schools in six major cities across Canada. Throughout this manuscript, these datasets will be referred to as Dataset 1: Outdoor Advertisements and Dataset 2: Exterior Store & Restaurant Advertisements. Information on these datasets is summarized in **Table 2.1.** This manuscript also uses secondary data from the Statistics Canada 2021 Census of Population (Statistics Canada, 2022a), the Canadian Index of Multiple Deprivation (CIMD) (Statistics Canada, 2023a), and DMTI Spatial's CanMap streetfiles (DMTI Spatial CanMap Streetfiles, 2023). Data sources are described in detail below.

Table 2.1: Overview of the primary datasets used in this manuscript.

Dataset Name	Description	Data Collection Tools
Dataset 1: Outdoor Advertisements	Data on every food- or beverage- related outdoor advertisement located within the 1000 m study area of selected schools, excluding advertisements on store/restaurant exteriors.	• INFORMAS-OA Survey

Dataset 2: Exterior Store & Restaurant Advertisements	Data on every food- or beverage- related advertisement on the exterior of stores and restaurants located within the 1000 m study area of selected schools.	• CMAT-R • CMAT-S • CMAT-PCT

Some of the methods described in the following sections were performed or supervised by Dr. Leia Minaker as she created the datasets. These methods were included in the thesis as they informed how I could code and analyze the data to answer the research questions. The following sections contain ongoing footnotes to clarify who performed which tasks.

2.3.1 Data Collection

2.3.1.1 Study Setting

Data on outdoor F&B advertisement prevalence and marketing power within 1000 m of elementary and secondary schools was collected in the following six urban Canadian cities of Vancouver, BC; Calgary, AB; Winnipeg, MB; Ottawa, ON; Quebec City, QC; and Halifax, NS. This data was also collected for smaller municipalities within 1-2 hours driving distance of each of the six cities to represent rural areas (see **Table 1.2** for the list of smaller municipalities) (Minaker, 2022a).[4]

2.3.1.2 School Sampling Frame

All public schools within each of the six cities and surrounding smaller municipalities were identified using publicly available school directories. School names and full addresses (i.e., number, street name, city, postal code) were recorded in a Microsoft Excel Comma-separated values (CSV) file for each city.[5] Each city's CSV file was uploaded to ArcGIS Pro and school addresses were geocoded as point features using the Geocode Addresses tool.[6]

2.3.1.3 School Sample Selection[7]

Literature from the USA on outdoor F&B advertising suggests low-income and racialized neighbourhoods have higher amounts of unhealthy F&B advertisements compared to majority white, high-income neighbourhoods (Finlay et al., 2022). To assess whether similar trends are evident in Canadian cities, schools were selected from both high- and low-income neighbourhoods, as well as majority racialized and majority white neighbourhoods. The Canadian Index of Multiple Deprivation (CIMD) was used in this selection process to identify the degree of deprivation of school neighbourhoods

[4] This setting was determined by Dr. Minaker when creating the datasets.

[5] This method was determined by Dr. Minaker.

[6] This method was performed by Amanda Morielli.

[7] The school selection strategy was determined and conducted by Dr. Minaker when creating the datasets.

(Statistics Canada, 2023a). The CIMD provides an understanding of inequalities by using a geographically based index that assesses deprivation and marginalization using the four dimensions shown in **Table 2.2**.

Table 2.2: The CIMD dimensions and descriptions (Statistics Canada, 2023a)

CIMD Dimension	Census indicators the dimension is derived from
1) Residential Instability	• Proportion of dwellings that are apartment buildings • Proportion of persons living alone • Proportion of dwellings that are owned * • Proportion of movers within the past 5 years • Proportion of the population that is married / common-law * • Median 2021 household income *
2) Ethno-cultural composition	• Proportion of the population that is foreign born • Proportion of the population self-identified as visible minority • Proportion of the population with no knowledge of either official language (linguistic isolation) • Average number of persons per room • Proportion of the population which are recent immigrants
3) Economic Dependency	• Proportion of population participating in the labour force (aged 15 and older) * • Proportion of the population who are aged 65 and older • Ratio of employment to population * • Dependency ratio (population aged 0 – 14 and population aged 65 and older divided by population aged 15 – 64) • Proportion of population receiving government transfer payments
4) Situational Vulnerability	• Proportion of the population identified as indigenous • Proportion of homes needing major repairs • Proportion of the population aged 25 – 64 without a high-school diploma • Proportion of single parent families • Median dollar value of dwelling

*This indicator was reverse-coded.

CIMD scores are available at the Dissemination Area (DA) level. DAs are the smallest area that Statistics Canada's Census of Population data is disseminated by, with the average population ranging from 400 to 700 persons (Statistics Canada, 2021). Thus, DA-level CIMD scores were linked to all the identified public schools in the school sampling frame to identify the demographics of the neighbourhood around each school. The Spatial Join tool was used in ArcGIS Pro to link each school point feature to a Statistics Canada dissemination area (DA) boundary file. Next, the Add Join tool was used in ArcGIS Pro to link the DA-level Canadian Index of Multiple Deprivation (CIMD) scores to the DA boundary file which was previously joined to the school point feature class. This join identified the CIMD score for the DA in which the school was located.

The analytical guidelines for using the CIMD suggests that a composite index can be created from the four dimensions if associations between individual dimensions and the outcome of interest are in the same direction (Statistics Canada, 2023a). When the associations between dimensions are moving in the same direction, the mean of the dimensions' scores can be taken to create a composite index. Since data for the outcome of interest was not available at the time of school selection, correlations between the CIMD dimensions themselves within the current school sampling frame were examined in IBM SPSS Statistics using Pearson's correlations, as shown in **Table 2.3** (Minaker, 2022a).

Table 2.3: Correlation matrix between the four CMID dimensions within the sampling frame of all schools in and around the six cities (Minaker, 2022a).

	Residential instability	**Economic dependency**	**Ethno-cultural composition**	**Situational vulnerability**
Residential instability	-	0.194***	0.078*	0.304***
Economic dependency	-	-	-0.012	0.253***
Ethno-cultural composition	-	-	-	0.269***

*Correlation is significant at p<0.05
**Correlation is significant at p<0.01
***Correlation is significant at p<0.001

Since the CIMD dimensions of situational vulnerability and economic dependency were significantly positively correlated with each other, these dimensions were combined to form a composite index that reflects the economic status of a neighbourhood (Minaker, 2022a). Ethno-cultural composition was not included in this composite index, despite its significant correlation since this dimension was looked at independently in school selection so that associations between outdoor advertising and deprivation could be examined separately for low-income and racialized neighbourhoods. The CIMD dimension of residential instability was not considered in school selection, as current literature does not suggest correlations between this variable and the outcome of interest (Minaker, 2022a). The scores for the CIMD dimensions of interest were then converted into quintiles using the Rank Cases in Ntiles tool in IBM SPSS Statistics. Quintiles 1 and 2 were considered low deprivation, quintile 3 was considered moderate deprivation, and quintiles 4 and 5 were considered high deprivation (Minaker, 2022a). The CIMD dimensions of interest were then used to create the following four stratum for school selection:

1. **Low** ethno-cultural composition deprivation, **low** economic dependency, and situational vulnerability deprivation.
2. **Low** ethno-cultural composition deprivation, **high** economic dependency, and situational vulnerability deprivation.

3. **High** ethno-cultural composition deprivation, **low** economic dependency, and situational vulnerability deprivation.
4. **High** ethno-cultural composition deprivation, **high** economic dependency, and situational vulnerability deprivation.

The goal of the selection strategy was to have an equal number of elementary and secondary schools in each stratum. **Table 2.4** depicts the school selection strategy, with the ideal sample size of schools in each stratum per city. Ideally, within each stratum, for each city/region, 3 elementary schools and 3 secondary schools would be selected via random sampling. For each city, up to 4 additional schools were selected from nearby smaller municipalities (Minaker, 2022a).

Table 2.4: Selection strategy categories for each city using CIMD dimensions that were associated with food and beverage marketing to youths (n = 12 elementary schools; n = 12 high schools) (Minaker, 2022a).

		Ethno-cultural composition	
		Low deprivation (quintile 1, 2)	**High deprivation (quintile 4, 5)**
Mean of economic dependency + situational vulnerability scores	**Low deprivation (quintile 1, 2)**	n = 3 elementary schools; n = 3 secondary schools	n = 3 elementary schools; n = 3 secondary schools
	High deprivation (quintile 4, 5)	n = 3 elementary schools; n = 3 secondary schools	n = 3 elementary schools; n = 3 secondary schools

For each city, a stratified random sample from all the identified public schools was selected to meet the sample size for each cell. For some cities, there were inadequate sample sizes for each cell. In these cases, schools were selected to maximize equal distribution of schools for all cells, as much as possible. For instance, in Vancouver, schools from quintile 3 were included in the low deprivation category, despite normally being excluded in the selection criteria. Moreover, in Halifax, there were only six secondary schools so the desired sample size of 12 secondary schools could not be achieved. As a result, more elementary schools were selected (n = 18) to ensure 24 schools were still assessed in total. One selected school in Quebec City was removed when surveyors reached the location and realized it was a youth hospital rather than a school. As a result, only 23 schools were assessed in Quebec City. The sample size of selected schools (N = 143) for all cities and nearby smaller municipalities for each of the four categories of deprivation and marginalization based on the CIMD index is shown in **Table 2.5** (Minaker, 2022a).

Table 2.5: Sample size of selected schools for all cities and nearby smaller municipalities for each classification of deprivation and marginalization (adapted from Minaker, 2022a).

Elementary and Middle Schools		**Ethno-cultural composition**	
		Low deprivation (quintile 1, 2)	**High deprivation (quintile 4, 5)**
Mean of economic dependency + situational vulnerability scores	**Low deprivation (quintile 1, 2)**	n = 24	n = 22
	High deprivation (quintile 4, 5)	n = 17	n = 23
Secondary Schools		**Ethno-cultural composition**	
		Low deprivation (quintile 1, 2)	**High deprivation (quintile 4, 5)**
Mean of economic dependency + situational vulnerability scores	**Low deprivation (quintile 1, 2)**	n = 15	n = 16
	High deprivation (quintile 4, 5)	n = 9	n = 17

2.3.1.4 Study Area

A 1000 m street-network buffer area around each school in the sample was considered the study area. The area around schools was selected as the study area as they are youth-serving institutions where students typically consume at least one meal per day. The age of youths attending these schools ranged from 4 – 18 years old (Minaker, 2022a).

ArcGIS Pro was used to create 1000 m street-network buffers around each school. First, a road network dataset was created for each city using DMTI Spatial's CanMap streetfiles, which were accessed through the University of Waterloo Geospatial Centre's license agreement (DMTI Spatial CanMap Streetfiles, 2023). The DMTI CanMap streetfiles were last updated October 2023 and contain detailed road and highway networks for all of Canada (DMTI Spatial CanMap Streetfiles, 2023). The ArcGIS Pro Create Network Dataset tool was used to create the road network using the road and trail shapefiles from the DMTI CanMap streetfiles. Elevation fields were included in the elevation model to more accurately determine the distance. In the Network Dataset Properties, the Service-Area Index was turned on, elevation fields were identified, and the walking travel mode was added. Then, the Build Network tool was used to build the road network. The created road network was then set as the network data source. Next, the Network Analysis Service Area tool was used to create the 1000 m street-network buffers around each school. The school point features were used as the facility locations, the distance 1000 m away from facilities was selected, and high-precision analysis with overlap was run. **Figure 2.2** provides an example of the school points and road network buffers in Calgary.[8]

[8] Data surveyors used google maps to determine the 1000 m distance around schools. The 1000 m street-network buffer in ArcGIS Pro was created by Amanda Morielli for data analysis purposes.

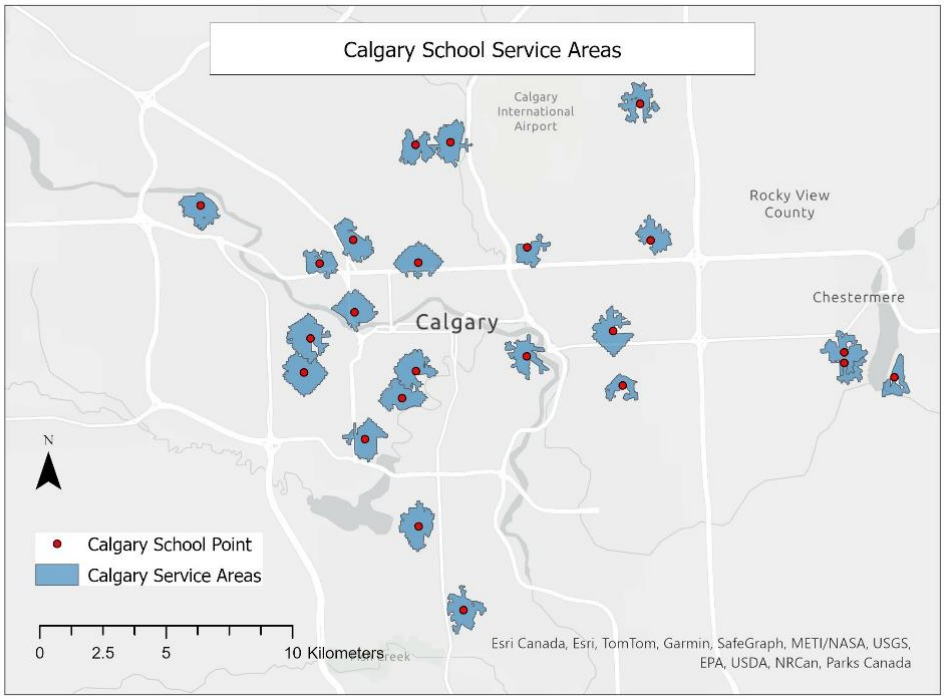

Figure 2.2: 1000 m street-network buffers created in ArcGIS Pro around Calgary school points

2.3.1.5 Dataset 1: Outdoor Advertisement Surveying[9]

The data collection and assessment methods used to create Dataset 1: Outdoor Advertisements were adapted from the International Network for Food and Obesity/NCDs Research, Monitoring and Action Support (INFORMAS) protocol for monitoring outdoor F&B advertisements near youth-serving institutions (e.g., schools) (Mackay et al., 2017). The INFORMAS Outdoor Advertising (INFORMAS-OA) protocol was developed based on studies conducted in Australia and New Zealand and is a globally recognized protocol (Mackay et al., 2017). Using this protocol to assess Canadian outdoor advertising environments near schools will produce results that can be compared to other countries due to the homogeneity in methods.

Six data collectors (one per city/region) visited all the streets identified in the 1000 m street-network buffer area for each school between May and September 2022. These data collectors were trained, upper-year undergraduate students that attended university in the city they were surveying. Prior to collecting data, data collectors underwent training on how to complete the survey and were provided with a detailed user guide. This training helped reduce inter-rater variability by ensuring all data collectors recorded information the same way (Minaker, 2023).

[9] Data collection was coordinated and supervised by Dr. Minaker.

While walking through the streets, the data collectors photographed every food- or beverage-related outdoor advertisement they encountered within the 1000 m study area. Eligible outdoor advertisements included advertisement on any outdoor medium (e.g., billboard, free-standing sign, poster) and any outdoor setting (e.g. bus shelter, street, vending machine) that were visible from the road/sidewalk. Ineligible advertisements included non-food or non-beverage advertisements, and symbols/words used for store identification (e.g., McDonald's arches outside a McDonald's store) (Minaker, 2023).

The data collectors recorded information about each advertisement in the INFORMAS-OA survey, which had been adapted by the research team and uploaded in the Qualtrics Offline Survey app. For each outdoor advertisement, data collectors recorded a unique Outdoor Advertisement ID, unique School ID, and City ID. The survey coded the food and beverage products in the advertisement using a select-all-that-apply list of product types (e.g., sugar-sweetened beverage, dairy products, fresh fruit/vegetables, frozen treats, water). The survey also coded promotional features present in the advertisement using a select-all-that-apply list of promotional characters/offers (e.g., cartoon character, celebrity, price discount, limited time offer) (Minaker, 2023).

2.3.1.6 Dataset 2: Exterior Store and Restaurant Advertisement Surveying[10]

The data collection and assessment methods used to create Dataset 2: Exterior Store and Restaurant Advertisements used three separate tools: the Canadian Marketing Assessment Tool for Restaurants (CMAT-R), the Canadian Marketing Assessment Tool for Stores (CMAT-S) and the Canadian Marketing Assessment Tool -Photo Coding Tool (CMAT-PCT). These tools were developed based on expert and government consultations, as well as the findings of a scoping review on restaurant marketing to children (Minaker et al., 2024). The inter-rater reliability of these tools was assessed using Cohen's Kappa and percent agreement for dichotomous variables. These tests revealed that these tools have strong inter-rater reliability (Minaker et al., 2024).

Google maps was used to identify food stores and restaurants within the 1000 m street-network buffer area of schools. If a school had more than 50 food stores within its buffer, 30 food stores were randomly selected to make data collection more feasible. Similarly, if there were more than 50 restaurants within a school's buffer, 30 restaurants were randomly selected for inclusion (Minaker, 2023).

Six data collectors (one per city) visited all the food stores and restaurants identified in the 1000 m street-network buffer area for each school between May and September 2022 and recorded information

[10] Data collection was coordinated and supervised by Dr. Minaker.

in logbooks about advertisements on the exterior (e.g., window) of restaurants and food stores (Minaker, 2023).

Excel logbooks were created based on the CMAT-R, CMAT-S and CMAT-PCT tools. Key variables included in the logbook included retailer and restaurant name, retailer and restaurant ID that was linked to the nearest school, and full addresses. In the logbooks, data collectors also had to indicate the food and beverage products in the advertisement (e.g., sugar-sweetened beverage, dairy products, fresh fruit/vegetables, frozen treats, water), as well as promotional features present in the advertisement (e.g., cartoon character, celebrity, price discount, limited time offer). Data collectors completed a hard copy of these logbooks while surveying the identified food stores and restaurants within the school buffers. At the end of the day, these hard copy findings were input by data collectors into the electronic Excel logbook (Minaker, 2023).

2.3.2 Data Coding

The data recorded in the Qualtrics Offline Survey app for Dataset 1 was imported into Microsoft Excel and organized. Once the data was sorted into columns by variable, it was imported into IBM SPSS Statistics and further coded. In IBM SPSS Statistics, all the select-all-that-apply survey questions were recoded into yes/no responses using the Recode into Different Variables tool. If an item in a select-all-that-apply list was selected by the data collector to describe an advertisement, it was recoded as 1 (yes) and was recoded as 0 (no) if not selected. Since data collection for Dataset 2 was recorded directly into Microsoft Excel, this data was then directly imported into IBM SPSS Statistics for further coding.

2.3.2.1 Food Classification[11]

The list of advertisement food and beverage products included in the survey was adapted from the INFORMAS-OA protocol (Mackay et al., 2017). **Table 2.6** shows descriptions and examples of the food and beverage product types included in the adapted INFORMAS-OA survey and user guide.

Table 2.6: Description and examples of the F&B product types included in the adapted INFORMAS-OA Survey.

Type of Food / Beverage in Outdoor Advertisements	Examples
Chocolate / candy	KitKat, Sour Patch Kids
Sugar-free gum / mint	-
Cookies / granola bar / donut	Oreos, Clif energy bars, Timbits

[11] The food types included in the survey were determined by Dr. Minaker. The collapsed categories of "core" and "non-core" foods were determined by Amanda Morielli.

Type of Food / Beverage in Outdoor Advertisements	Examples
Salty snack	Potato chips, crackers, rice cakes
Frozen treat	Popsicles, ice-cream, frozen yogurt
Breakfast cereal	Any cereal, not just youth-appealing
Fruit / vegetable	Apples, bananas, cucumber
Dairy product	Milk, yogurt, cheese
Meat / seafood / alternatives	-
Grains / bread / bakery product	-
Fast-food / restaurant product	McDonald's Big Mac, Starbucks Frappucino
Read-to-eat meal	Frozen or packaged, not from restaurants
Sugar-sweetened beverage	Pop, juice, bubble tea, iced coffee, slushies, energy drinks, sports drinks
Artificially sweetened beverage	Diet pop, diet sports drinks, diet energy drinks
Water	Includes sparkling and flavoured waters
Other unsweetened beverage	Coffee, tea with no added sweeteners
Alcohol	Beer, wine, spirits, coolers, cocktails

The INFORMAS Outdoor Advertising Protocol recommends further classifying these food and beverage products using a standardised approach that "distinguishes energy-dense, nutrient poor foods (non-core foods) and nutritious foods" (core foods) (Mackay et al., 2017). INFORMAS recommends creating these 'core food' and 'non-core food' classifications based on existing relevant local food classification policies to provide consistency with legislation. Since this dataset includes data from across Canada, information from *Canada's Dietary Guidelines: Resources for Health Professionals and Policy Makers* was used to determine how these food and beverage products should be collapsed into 'core food' and 'non-core food' variables (Health Canada, 2019; Mackay et al., 2017).

Guideline 1 from *Canada's Dietary Guidelines* was used to define 'core foods,' as this guideline discusses healthy patterns of eating that are associated with positive health outcomes. Guideline 1 states the following three points (Health Canada, 2019):

1. "Vegetables, fruit, whole grains, and protein foods should be consumed regularly. Among protein foods, consume plant-based more often."
2. "Foods that contain mostly unsaturated fat should replace foods that contain mostly saturated fat."
3. "Water should be the beverage of choice."

Guideline 2 from *Canada's Dietary Guidelines* was used to define 'non-core foods,' as this guideline discusses food and beverages that undermine healthy eating. Guideline 2 states (Health Canada 2019):

> "Processed or prepared foods and beverages that contribute to excess sodium, free sugars, or saturated fat undermine healthy eating and should not be consumed regularly."

Based on these guidelines, the food and beverage product variables were collapsed into 'core F&B' and 'non-core F&B' categories, as shown in **Table 2.7.** Some food and beverage types were not collapsed into the 'core F&B' or 'non-core F&B' classifications as they did not clearly fit into either category. For instance, artificially sweetened beverages were not included in either category, as they do not fit the core F&B recommendation of having water as the beverage of choice, nor do they fit the non-core food description of being high in excess sodium, free sugars, or saturated fat. Alcohol was not included in either the 'core' or 'non-core' classifications as these products are not readily available for purchase by minors. These classifications of core and non-core F&Bs also align with the INFORMAS protocol for outdoor advertisements in most cases (Mackay et al., 2017)

Table 2.7: Collapsed food and beverage product types included in the core food and non-core food classifications.

Food / Beverage Classification	Collapsed Variables
Core food / beverage	1. Fruit / vegetable 2. Dairy product 3. Meat / seafood / alternatives 4. Grains / bread / bakery product 5. Water
Non-core food / beverage	1. Chocolate / candy 2. Salty snack 3. Cookies / granola bar / donut 4. Frozen treat 5. Fast food / restaurant product 6. Read-to-eat meal 7. Sugar-sweetened beverage
Alcohol	1. Alcohol
Other	1. Breakfast cereal 2. Artificially sweetened beverage 3. Other unsweetened beverage

2.3.2.2 Promotional Characters & Techniques[12]

The list of youth-directed marking techniques included in the adapted INFORMAS-OA survey was adapted from the INFORMAS outdoor advertisement protocol (Mackay et al., 2017). These youth-directed marketing techniques are also similar to the techniques considered by Health Canada in their proposed restriction on the commercial advertising of non-core foods to children (Health Canada, 2024). A full list of descriptions and examples of youth-directed marketing indicators included in the INFORMAS-OA Survey can be found in **Appendix A** (Minaker, 2022b).

Due to limited data on each of the marketing techniques included in the INFORMAS-OA survey, as well as overlap between variables, some of the variables were collapsed into broader categories for the data analysis. **Table 2.8** shows the new collapsed variable categories that were used in the data analysis.

Moreover, the surveys used in Dataset 1: Outdoor Advertisements and Dataset 2: Exterior Store & Restaurant Advertisements asked slightly different questions and variables. Similar variables between the two datasets were collapsed when the datasets were merged. **Figure 2.7** also shows which variables between the two datasets were combined.

Table 2.8: Youth-directed marketing techniques and their respective collapsed variables

Youth-Directed Marketing Technique	Collapsed Variables
Brand / company character	**Dataset 1: Outdoor Advertisements:** 1. Brand/company character **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. Brand character
Generic cartoon character	**Dataset 1: Outdoor Advertisements:** 1. Generic cartoon character **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. Cartoon
Licensed character / cross-promotion with movie or TV / celebrity / athlete	**Dataset 1: Outdoor Advertisements:** 1. Licensed character (e.g., Winnie-the-Pooh, Hello Kitty) 2. Cross-promotion with movie/TV 3. Famous sportsperson / athlete 4. Celebrity / social media influencer **Dataset 2: Exterior Store & Restaurant Advertisements:** 5. Licensed character 6. Celebrity
Images of kids / teens	**Dataset 1: Outdoor Advertisements:** 1. Images of kids and teens

[12] The promotional characters and techniques used in Dataset 1 and Dataset 2 were determined by Dr. Minaker. Amanda Morielli was responsible for cleaning, organizing, and collapsing/combining/recoding variables to merge the datasets.

Youth-Directed Marketing Technique	Collapsed Variables
	Dataset 2: Exterior Store & Restaurant Advertisements: 2. Child / teen actor
Price promotion / discount	**Dataset 1: Outdoor Advertisements:** 1. Price discount 2. Price Promotion **Dataset 2: Exterior Store & Restaurant Advertisements:** 3. Price Promotion
Contest / game / toy / gift / collectible	**Dataset 1: Outdoor Advertisements:** 1. Contest / game (e.g., McDonald's Monopoly) 2. Toy / gift / collectible (e.g., Happy Meal toy) **Dataset 2: Exterior Store & Restaurant Advertisements:** 3. Incentive (i.e. Does the ad promote any type of giveaway or contest or is a toy included that might appeal to children or teens?)
Corporate social responsibility	**Dataset 1: Outdoor Advertisements:** 1. Corporate social responsibility (E.g. Tim Horton's Orange Shirt Day Fundraiser) **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. Corporate social responsibility (E.g. Tim Horton's Orange Shirt Day Fundraiser)
Youth product / convenience	**Dataset 1: Outdoor Advertisements:** 1. For kids / teens (e.g., for school lunches) **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. For kids / teens (e.g. for school lunches) 3. Convenience
Loyalty program	**Dataset 1: Outdoor Advertisements:** 1. Loyalty program / points / app **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. Awards
Sense of urgency / seasonal offer / limited time offer	**Dataset 1: Outdoor Advertisements:** 1. Seasonal / limited time feature **Dataset 2: Exterior Store & Restaurant Advertisements:** 2. Sense of urgency

2.3.3 Data Analysis[13]

IBM SPSS Statistics software was used to generate descriptive statistics (counts and percentages) about the contents of the outdoor F&B advertisements found within the 1000 m street-network buffers of the selected schools. The Descriptive Statistics Crosstabs tool in IBM SPSS Statistics was used to cross-tabulate the counts and percentages for outdoor advertisement food / beverage types and marketing

[13] The data analysis was performed by Amanda Morielli.

technique type by each city. The Descriptive Statistics Crosstabs tool was used again to cross-tabulate the counts and percentages for outdoor advertisement food / beverage types and marketing technique type by urban (cities) and rural (nearby smaller municipalities) areas. Chi-square tests of independence were also performed through the Descriptive Statistics Crosstabs tool to determine with the distribution of advertisements differed between cities and urban/rural areas.

2.4 Results

The results of the data analysis are organized into two subsections: (1) outdoor F&B advertisement prevalence near schools; and (2) outdoor F&B youth-directed marketing power. For each subsection, descriptive statistics are assessed for the total dataset, by city, and by rural and urban areas.

2.4.1 Outdoor F&B Advertisement Prevalence Near Schools

2.4.1.1 Prevalence by City

Table 2.9 shows descriptive statistics (frequency and percent) for the type of F&B products in outdoor F&B advertisements found within 1000 m of schools in six cities across Canada. Chi-square tests were also used to test whether the frequency of advertisements and their content differed between the cities. A total of 2585 outdoor F&B advertisements were identified in the study area of 1000 m street-network buffers around 143 schools in six cities across Canada. Vancouver had the highest advertisement count (n = 831), while Halifax had the lowest advertisement count (n = 190).

Table 2.9: Descriptive statistics and chi-square test of independence for outdoor F&B advertisements and their F&B content within 1000 m of 143 schools by six cities across Canada.

	All Cities **n (%)** n = 2585	**Vancouver** **n (%)** n = 831	**Calgary** **n (%)** n = 305	**Winnipeg** **n (%)** n = 458	**Ottawa** **n (%)** n = 237	**Quebec City** **n (%)** n = 564	**Halifax** **n (%)** n = 190	**Pearson's Chi-square test of independence Asymp. Sig.**
Advertisements that contain a non-core F&B product	1667 (64.5)	551 (66.3)	205 (67.2)	337 (73.6)	198 (83.5)	277 (49.1)	99 (52.1)	<0.001*
Advertisements that contain a core F&B product	243 (9.4)	65 (7.8)	62 (20.3)	40 (8.7)	11 (4.6)	55 (9.8)	10 (5.3)	<0.001*

	All Cities n (%) n = 2585	Vancouver n (%) n = 831	Calgary n (%) n = 305	Winnipeg n (%) n = 458	Ottawa n (%) n = 237	Quebec City n (%) n = 564	Halifax n (%) n = 190	Pearson's Chi-square test of independence Asymp. Sig.
Type of Food in Outdoor Advertisements								
Chocolate / candy	60 (2.3)	16 (1.9)	10 (3.3)	3 (0.7)	6 (2.5)	18 (3.2)	7 (3.7)	0.053[a*]
Salty snack	68 (2.6)	18 (2.2)	11 (3.6)	13 (2.8)	7 (3.0)	16 (2.8)	3 (1.6)	0.712
Cookie / granola bar / donut	46 (1.8)	22 (2.6)	0 (0.0)	10 (2.2)	1 (0.4)	9 (1.6)	4 (2.1)	0.031[b*]
Sugar-free gum / mint	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	N/A
Frozen treat	272 (10.5)	85 (10.2)	38 (12.5)	79 (17.2)	11 (4.6)	46 (8.2)	13 (6.8)	<0.001*
Breakfast cereal	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	N/A
Fruit / vegetable	78 (3.0)	15 (1.8)	14 (4.6)	13 (2.8)	4 (1.7)	30 (5.3)	2 (1.1)	<0.001*
Dairy product	26 (1.0)	6 (0.7)	6 (2.0)	10 (2.2)	0 (0.0)	3 (0.5)	1 (0.5)	0.016[d]
Meat / seafood / alternatives	60 (2.3)	9 (1.1)	26 (8.5)	6 (1.3)	1 (0.4)	14 (2.5)	4 (2.1)	<0.001[a*]
Grains / bread / bakery product	77 (3.0)	27 (3.2)	16 (5.2)	17 (3.7)	1 (0.4)	13 (2.3)	3 (1.6)	0.015*
Fast-food / restaurant product	968 (37.4)	311 (37.4)	130 (42.6)	187 (40.8)	145 (61.2)	139 (24.6)	56 (29.5)	<0.001*
Ready-to-eat meal	74 (2.9)	32 (3.9)	5 (1.6)	18 (3.9)	0 (0.0)	19 (3.4)	0 (0.0)	0.002*
Type of Beverages in Outdoor Advertisements								
Water	31 (1.2)	11 (1.3)	8 (2.6)	1 (0.2)	5 (2.1)	4 (0.7)	2 (1.1)	0.036[c]
Sugar-sweetened beverages	515 (19.9)	148 (17.8)	73 (23.9)	114 (24.9)	38 (16.0)	99 (17.6)	43 (22.6)	0.004*
Artificially sweetened beverage	60 (2.3)	19 (2.3)	17 (5.6)	14 (3.1)	2 (0.8)	6 (1.1)	2 (1.1)	<0.001[a*]
Other unsweetened beverage	142 (5.5)	41 (4.9)	22 (7.2)	34 (7.4)	6 (2.5)	28 (5.0)	11 (5.8)	0.079
Alcohol	268 (10.4)	76 (9.1)	10 (3.3)	14 (3.1)	10 (4.2)	145 (25.7)	13 (6.8)	<0.001*

* The p-value is less than $\alpha = 5\%$, therefore the null hypothesis is rejected.

[a] 1 cell (8.3%) has expected counts less than 5.

[b] 2 cells (16.7%) have an expected count less than 5.

[c] 3 cells (25%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

[d] 4 cells (33.3%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

For all advertisements (n = 2585), the most frequently identified food products were fast-food / restaurants (37.4%, n = 968), sugar sweetened beverages (19.9%, n = 515), frozen treats (10.5%, n = 272), alcohol (10.4%, n = 268), and other unsweetened beverages (5.5%, n = 142), as shown in **Figure 2.3**. All other coded food products were found in less than 5% of the total advertisements.

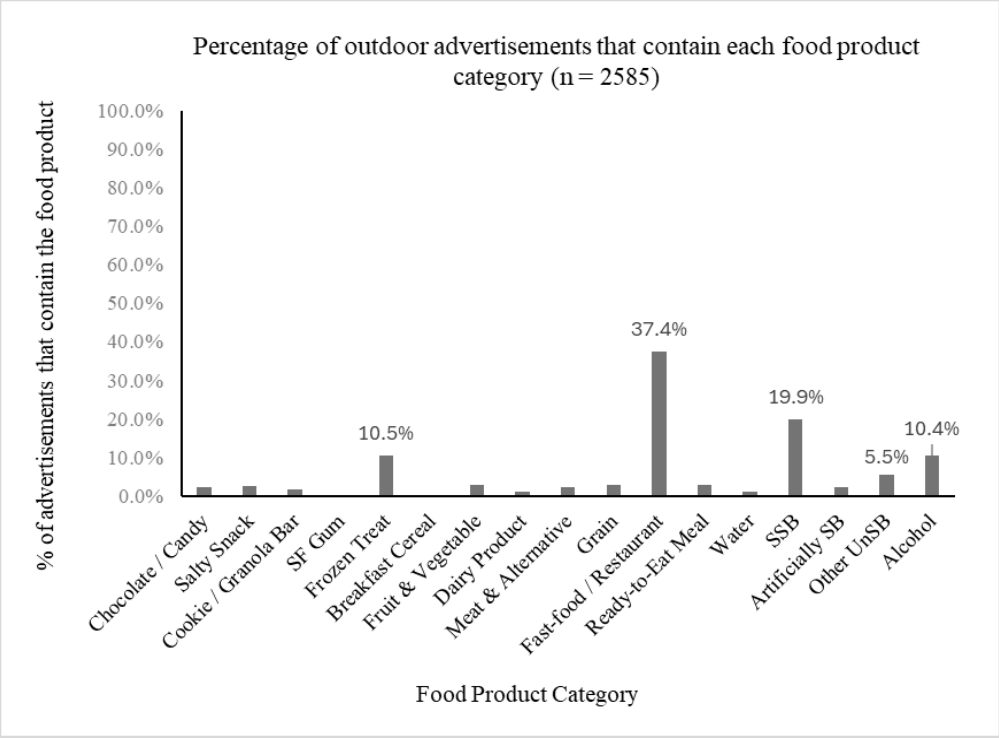

Figure 2.3: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools in six cities by food product categories. SSB = Sugar Sweetened Beverage; Artificially SB = Artificially Sweetened Beverage; Other UnSB = Other Unsweetened Beverage.

The distributions of non-core & core F&B products in advertisements differed significantly between cities, as shown in **Figure 2.4** and **Figure 2.5**. For all advertisements (n = 2585), 64.5% (n = 1667) contained a non-core F&B product, while only 9.4% (n = 243) contained a core F&B product. Ottawa (n = 237) had the highest percentage of advertisements containing a non-core F&B product (83.5%, n = 198), while Quebec City (n = 564) and Halifax (n = 190) had the lowest percentages of advertisements containing a non-core F&B product (49.1%, n = 277 and 52.1%, n = 99 respectively). Calgary (n = 305) had the highest percentage of advertisements containing a core F&B product (20.3%, n = 62), while all other cities had core F&Bs in less than 10% of advertisements.

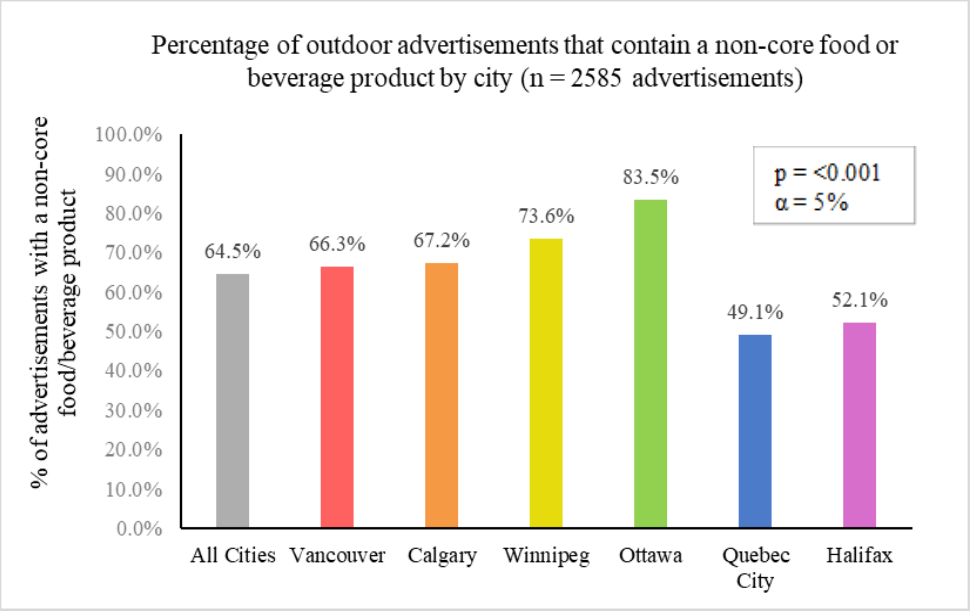

Figure 2.4: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain a non-core F&B product by city, with a Pearson's chi-square test of independence to test whether the distribution of advertisements with non-core F&Bs differs between the six cities. The p-value for the chi-square test is less than α, therefore the distribution of non-core F&B products in advertisements is significantly different between cities.

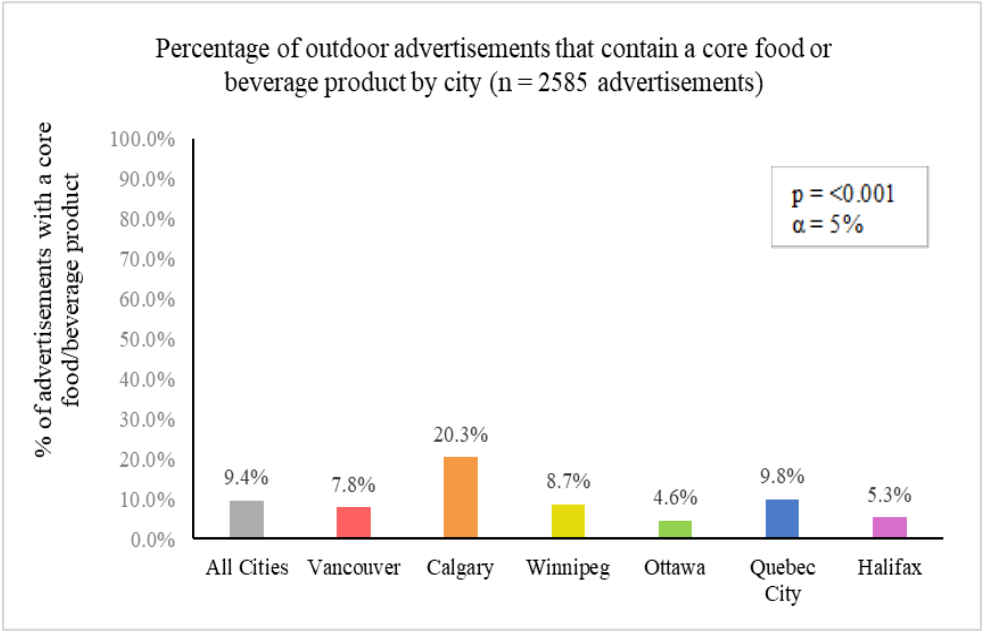

Figure 2.5: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain a core F&B product by city, with a Pearson's chi-square test of independence to test whether the distribution of advertisements with core F&Bs differs between the six cities. The p-value for the chi-square test is less than α, therefore the distribution of core F&B products in advertisements is significantly different between cities.

The distributions of some individual food products also differed significantly between cities. These food products include chocolate / candy, cookie / granola bar, frozen treats, fruits & vegetables, meat & alternatives, grains, fast-food / restaurants, ready-to-eat meals, sugar sweetened beverages, artificially sweetened beverages, alcohol. Although these food product distributions differed in a statistically significant way, many of these food products did not have notable value differences between cities. Alcohol is an exception as it differed significantly and had notable value differences between cities, as shown in **Figure 2.6**. For all advertisements (n = 2585), 10.4% (n = 268) contained an alcohol product. Quebec City (n = 564) had the highest percentage of advertisements containing an alcohol product (25.7%, n = 145). In all other cities, less than 10% of their advertisements contained an alcohol product. Advertisements that promote a fast-food store / restaurant also differed significantly and had notable value differences between cities, as shown in **Figure 2.7**. For all advertisements (n = 2585), 37.4% (n = 968) promoted a fast-food store / restaurant. Ottawa (n = 237) had the highest percentage of advertisements promoting a fast-food store / restaurant (61.2%, n = 145), while Quebec City (n = 564) and Halifax (n = 190) had the lowest percentages (24.6%, n = 139 and 29.5%, n = 56). The food products that did not differ significantly between cities include salty snacks, water, and other unsweetened beverages.

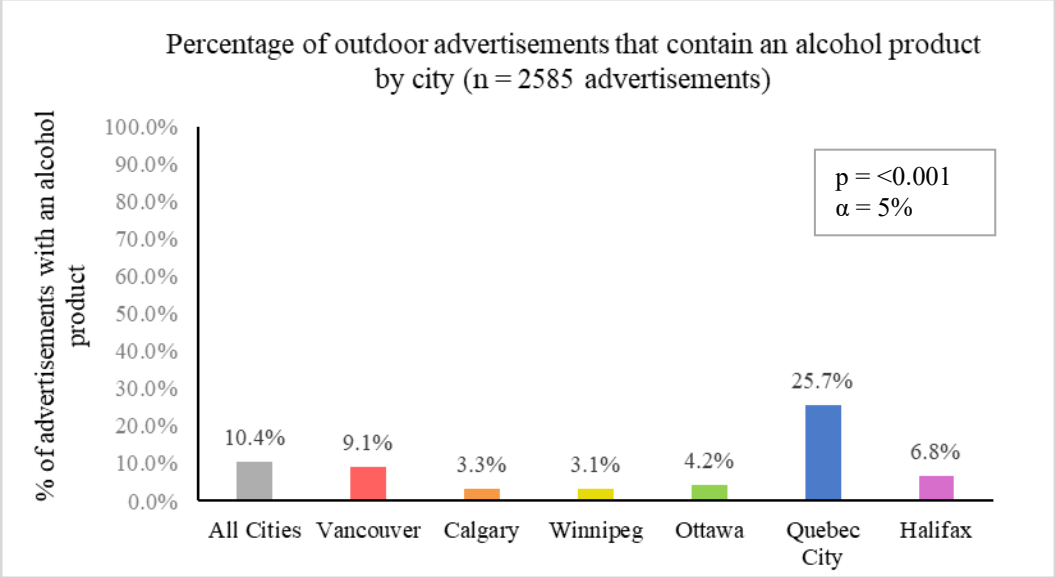

Figure 2.6: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain an alcohol product by city, with a chi-square test of independence to test whether the distribution of advertisements with alcohol products differs between the six cities. The p-value for the chi-square test is less than α, therefore the distribution of alcohol products in advertisements is significantly different between cities.

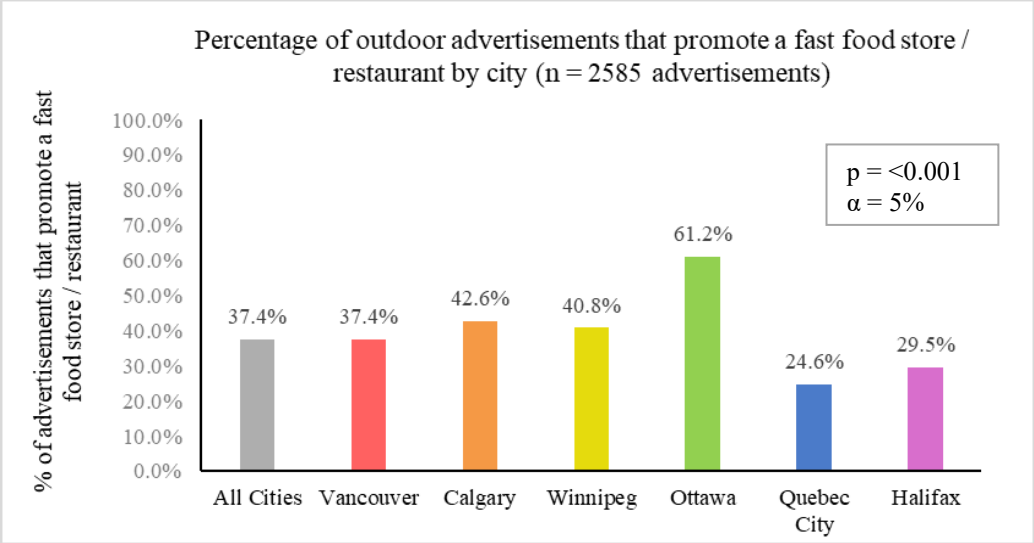

Figure 2.7: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that promote a fast-food store / restaurant by city, with a chi-square test of independence to test whether the distribution of advertisements differs between the six cities. The p-value for the chi-square test is less than α, therefore the distribution of fast-food store / restaurant promotions in advertisements is significantly different between cities.

2.4.1.2 Prevalence in Urban and Rural Areas

Table 2.10 shows descriptive statistics (frequency and percent) for the type of F&B products in outdoor F&B advertisements found within 1000 m of 143 schools in rural and urban areas of six cities in Canada. Chi-square tests were also used to test whether the frequency of advertisements and their content differed between rural and urban areas.

Table 2.10: Descriptive statistics and chi-square test of independence for outdoor advertisements and their F&B content within 1000 m of 143 schools by rural and urban areas across Canada.

	Urban **n (%)** n =2376	**Rural** **n (%)** n = 204	**Chi-square test of independence Asymp. Sig.**
Advertisements that contain a non-core food or beverage product	1517 (63.8)	145 (71.1)	0.038*
Advertisements that contain a core food or beverage product	228 (9.6)	15 (7.4)	0.293
Type of Food in Outdoor Advertisements			
Chocolate / candy	50 (2.1)	10 (4.9)	0.011[a]
Salty snack	64 (2.7)	4 (2.0)	0.531
Cookie / granola bar / donut	41 (1.7)	5 (2.5)	0.452[a]
Sugar-free gum / mint	0 (0.0)	0 (0.0)	N/A
Frozen treat	251 (10.6)	21 (10.3)	0.904

Breakfast cereal	0 (0.0)	0 (0.0)	N/A
Fruit / vegetable	75 (3.2)	3 (1.5)	N/A
Dairy product	26 (1.1)	0 (0.0)	0.133
Meat / seafood / alternatives	58 (2.4)	2 (1.0)	0.184[a]
Grains / bread / bakery product	67 (2.8)	10 (4.9)	0.094
Fast-food / restaurant product	874 (36.8)	90 (44.1)	0.038*
Ready-to-eat meal	74 (3.1)	0 (0.0)	0.011*
Type of Beverages in Outdoor Advertisements			
Water	29 (1.2)	2 (1.0)	0.763[a]
Sugar-sweetened beverage	465 (19.6)	49 (24)	0.127
Artificially sweetened beverage	58 (2.4)	2 (1.)	0.184[a]
Other unsweetened beverage	131 (5.5)	11 (5.4)	0.942
Alcohol	253 (10.6)	15 (7.4)	0.139

* The p-value is less than α = 5%, therefore the null hypothesis is rejected.

[a] 1 cell (25%) has expected counts less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

The distributions of non-core F&B products in advertisements differed significantly between urban and rural areas. Rural areas had a higher percentage of advertisements that contain a non-core F&B product compared to urban areas (71.1% and 63.8% respectively), as shown in **Figure 2.8**. The distributions of core F&B products in advertisements did not differ significantly between urban and rural areas, as shown in **Figure 2.9**. Only two of the individually assessed food product categories in advertisements differed significantly between urban and rural areas. These categories are fast-food store / restaurant and ready-to-eat meal. Although these food product distributions differed in a statistically significant way, they did not have notable value differences between urban and rural areas.

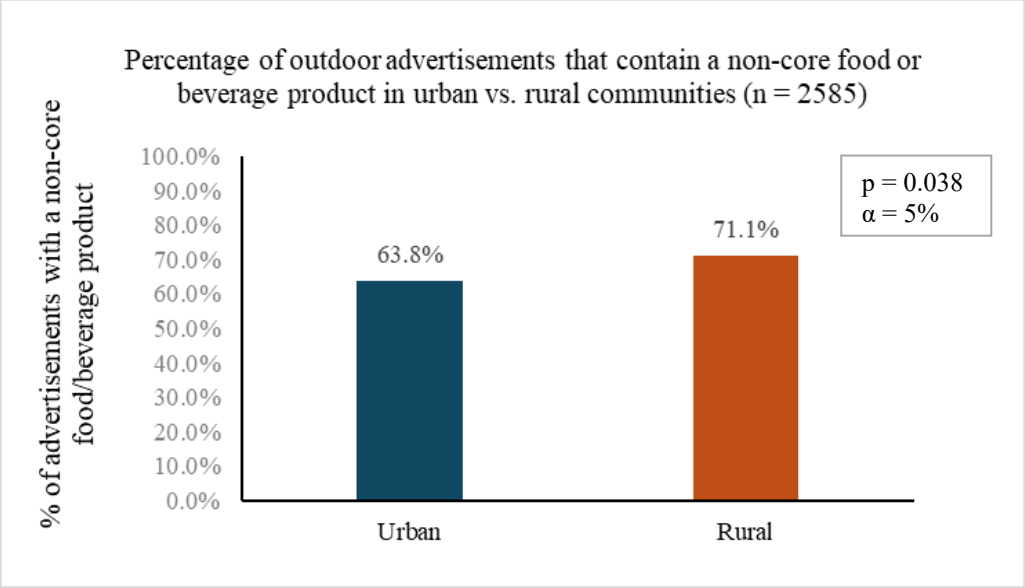

Figure 2.8: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain a non-core F&B product by rural and urban areas, with a chi-square test of independence to test whether the distribution of advertisements with non-core foods differed between the rural and urban areas. The p-value for the chi-square test is less than α, therefore the distribution of non-core F&Bs in advertisements is significantly different between rural and urban areas.

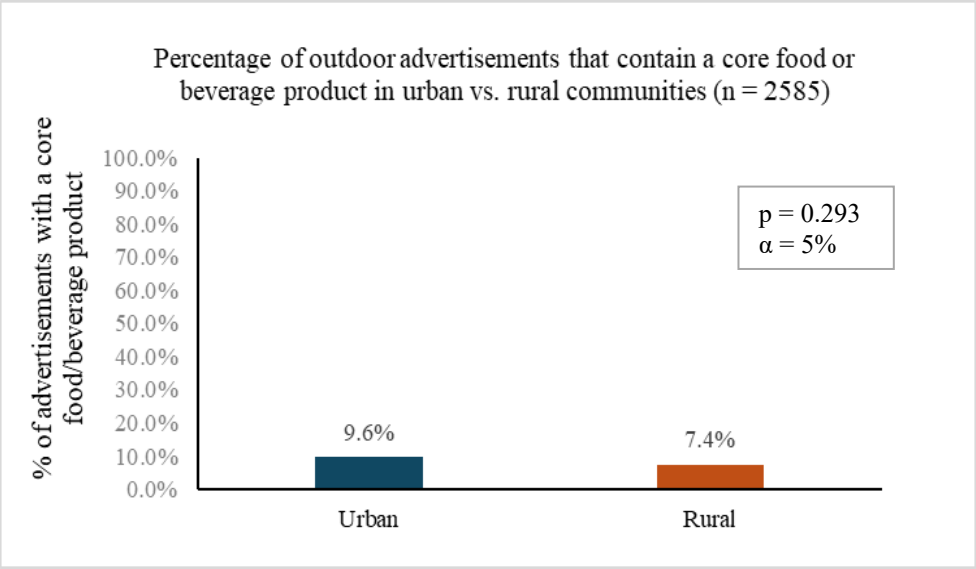

Figure 2.9: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain a core F&B product by rural and urban areas, with a chi-square test of independence to test whether the distribution of advertisements with core foods differed between the rural and urban areas. The p-value for the chi-square test is greater than α, therefore the distribution of non-core F&Bs in advertisements is not significantly different between rural and urban areas.

2.4.2 Outdoor F&B Advertisement Youth-directed Marketing Power

2.4.2.1 Marketing Power by City

Table 2.11 shows descriptive statistics (frequency and percent) for the type of youth-directed marketing techniques used in outdoor F&B advertisements found within 1000 m of 143 schools by six cities across Canada.

Table 2.11: Descriptive statistics and chi-square test of independence for the type of youth-directed marketing techniques used in outdoor F&B advertisements within 1000 m of 143 schools by six cities across Canada.

	All Cities n (%) n = 2585	Vancouver n (%) n = 831	Calgary n (%) n = 304	Winnipeg n (%) n = 458	Ottawa n (%) n = 237	Quebec City n (%) n = 558	Halifax n (%) n = 190	Pearson Chi-square test of independence Asymp. Sig.
Promotional Character(s)								
Brand / company character	139 (5.4)	29 (3.5)	7 (2.3)	14 (3.1)	7 (3.0)	60 (10.8)	22 (11.6)	<0.001*
Generic cartoon character	114 (4.4)	32 (3.9)	9 (3.0)	33 (7.2)	0 (0.0)	29 (5.2)	11 (5.8)	<0.001*
Licensed character / cross-promotion with movie or TV / celebrity / athlete	56 (2.2)	22 (2.6)	4 (1.3)	8 (1.7%)	2 (0.8)	16 (2.8)	4 (2.1)	0.358[a]
Images of kids/teens	15 (0.6)	8 (1.0)	2 (0.7)	1 (0.2)	2 (0.8)	2 (0.4)	0 (0.0)	0.408[c]
Promotional Offer(s)								
Price promotion / discount	338 (13.1)	133 (16.0)	43 (14.1)	43 (9.4)	27 (11.4)	65 (11.6)	27 (14.4)	0.016*
Contest / game / toy / collectible	187 (7.2)	44 (5.3)	34 (11.2)	36 (7.9)	14 (5.9)	44 (7.9)	15 (7.9)	0.022*
Corporate social responsibility	40 (1.5)	17 (2.0)	3 (1.0)	8 (1.7)	4 (1.7)	6 (1.1)	2 (1.1)	0.661[b]
Youth product / convenience	1018 (39.4)	242 (29.1)	164 (54.1)	218 (47.6)	53 (22.4)	275 (49.2)	66 (35.1)	<0.001*
Loyalty program	149 (5.8)	34 (4.1)	34 (11.2)	27 (5.9)	11 (4.6)	31 (5.5)	12 (6.3)	<0.001*
Sense of urgency / seasonal offer / limited time offer	475 (18.4)	105 (12.7)	78 (25.7)	107 (23.4)	37 (15.6)	112 (20)	36 (18.9)	<0.001*

* The p-value is less than $\alpha = 5\%$, therefore the null hypothesis is rejected.

[a] 1 cell (8.3%) has expected counts less than 5.

[b] 3 cells (25%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

[c] 6 cells (50%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

For all advertisements (n = 2585), the most frequently identified youth-directed marketing techniques were youth product / convenience (39.4%, n = 1018), sense of urgency / seasonal / limited time (18.4%, n = 475), price promotion / discount (13.1%, n = 338), as shown in

Figure 2.10. All other youth-directed marketing techniques were found in less than 10% of the total advertisements. Promotional offers were a more prevalent marketing technique than promotional characters.

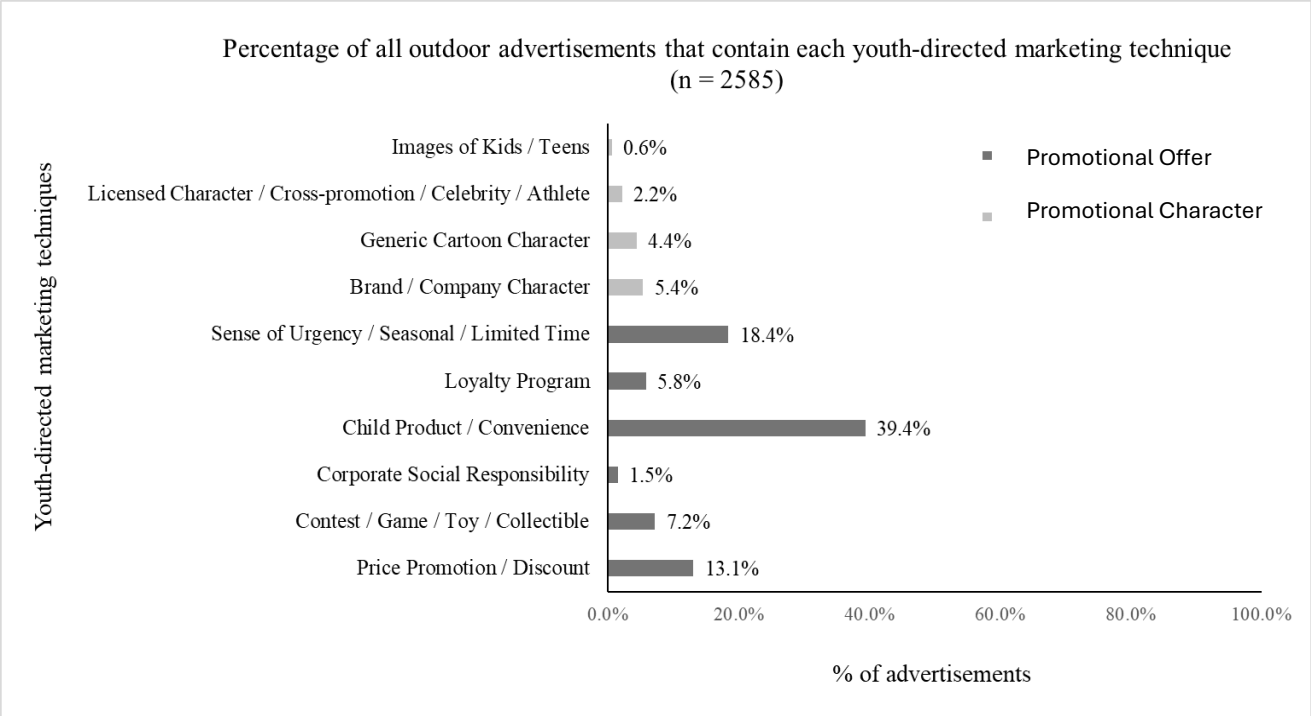

Figure 2.10: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools in six cities that contain each youth-directed promotional technique.

The distributions of some youth-directed marketing techniques differed significantly between cities. These techniques include brand / company character, generic cartoon character, price promotion / discount, contest / game / toy / collectible, youth product / convenience, loyalty program, sense of urgency / seasonal offer / limited time offer. Although these marketing technique distributions differed in a statistically significant way, many of these techniques did not have notable value differences between cities. The youth product / convenience marketing technique is an exception as it differed significantly and had notable value differences between cities, as shown in **Figure 2.11**. Calgary (n = 304) had the highest percentage of advertisements containing a youth product / convenience promotion (54.1%, n = 164). Ottawa (n = 237) had the lowest percentage of advertisements containing a youth product / convenience promotion (22.4%, n = 53).

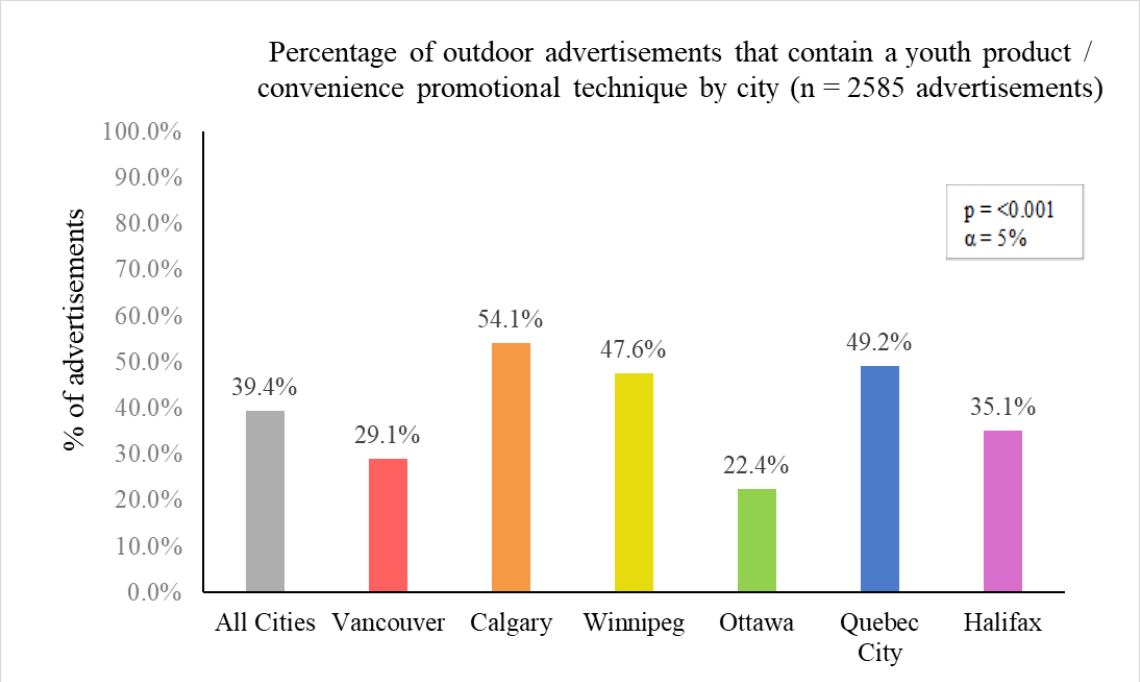

Figure 2.11: Graph showing the percentage of outdoor F&B advertisements within 1000 m of 143 schools that contain a youth product / convenience promotional technique by city, with a chi-square test of independence to test whether the distribution of advertisements differs between the six cities. The p-value for the chi-square test is less than α, therefore the distribution of these advertisements is significantly different between cities.

2.4.2.2 Marketing Power in Urban and Rural Areas

Table 2.12 shows descriptive statistics (frequency and percent) for the type of youth-directed marketing techniques used in outdoor F&B advertisements found within 1000 m of 143 schools by rural and urban areas across Canada. Chi-square tests were used to test whether the frequency of advertisements and their marketing content differed between rural and urban areas. Overall, the outdoor F&B advertisements in urban and rural areas contained similar percentages of each youth-directed marketing technique. The most used marketing technique, youth product / convenience, was found to be about 8.2% more prevalent in outdoor F&B advertisements in rural areas (47.1%) than in urban areas (38.9%). All other marketing techniques were found to be similarly prevalent in the outdoor F&B advertisements of urban and rural areas. For all marketing techniques, there was insufficient rural data to run a chi-square test of independence to assess whether the marketing techniques urban and rural areas differed in a statistically significant way.

Table 2.12: Descriptive statistics and chi-square test of independence for outdoor F&B advertisements and their youth-directed marketing techniques within 1000 m of 143 schools by rural and urban areas across Canada.

	Urban n (%) n = 2369	Rural n (%) n = 204	Chi-square test of independence Asymp. Sig.
Promotional Character(s)			
Brand / company character	134 (5.7)	5 (2.5)	0.131[a]
Generic cartoon character	112 (4.7)	2 (1.0)	0.039[a]
Licensed character / cross-promotion with movie or TV / celebrity / athlete	53 (2.2)	3 (1.5)	0.732[b]
Images of kids / teens	11 (0.5)	4 (2.0)	0.026[b]
Promotional Offer(s)			
Price promotion / discount	309 (13.0)	29 (14.3)	0.604[a]
Contest / game / toy / collectible	176 (7.4)	11 (5.4)	0.460[a]
Corporate social responsibility	36 (1.5)	4 (2.0)	0.853[b]
Youth product / convenience	921 (38.9)	96 (47.1)	0.049[a]
Loyalty program	139 (5.9)	10 (4.9)	0.730[a]
Sense of urgency / seasonal offer / limited time offer	430 (18.2)	45 (22.1)	0.220[a]

[a] 2 cell (33.3%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

[b] 3 cells (50%) have an expected count less than 5. This violates the chi-square test assumption that at least 80% of the cells must have an expected count greater than 5.

2.5 Discussion

2.5.1 Key Findings

The findings of this study provide insight into the content and type of outdoor F&B advertising environments in six large cities and nearby rural areas across Canada. The following three key findings were synthesized from this study's results and are discussed in this section in further detail: (1) outdoor F&B advertising environments are "unhealthy"; (2) the proportion of outdoor F&B advertisement types varies by city; and (3) youth-directed marketing techniques were used in outdoor F&B advertisements near schools.

2.5.1.1 Outdoor F&B Advertising Environments are "Unhealthy"

Findings from this study indicate that most outdoor F&B advertisements near schools promote "unhealthy" F&B products. Of the assessed advertisements, 64.5% (n = 1667) contained a non-core F&B product, while only 9.4% (n = 243) contained a core F&B product. These findings are consistent with the findings of the 14 primary, quantitative studies identified in the literature review as they also found that the majority of outdoor F&B advertisements promoted non-core food products (Amevinya et al., 2022; Brien et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kelly et al., 2015;

Kneller et al., 2024; Martin-Pavo et al., 2022; Ruggles et al., 2023, Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Velazquez et al., 2019; Wells et al., 2023). Similarly, 19 additional studies identified in a scoping review by Finlay et al. (2022) found that most outdoor F&B advertisements promoted non-core food products. Research that explores the association between outdoor F&B advertisement exposure and food choices is limited due to the challenges of monitoring outdoor advertisement exposure (Finlay et al., 2022); however, studies on other advertising media found that F&B advertisements influence food choices (Folkvord & Hermans, 2020). Due to the ability of advertisements to influence food choices, these unhealthy outdoor F&B advertising environments near schools in cities across Canada can be a risk factor for overweight and obesity in youth (Smith et al., 2019; Tatlow-Golden & Garde, 2020).

When looking at individual product categories, the most advertised F&B products in outdoor advertisements near schools were fast-food/restaurant products (e.g., Big Mac from McDonald's), SSBs, frozen treats, and alcohol. Studies on other advertising media (e.g., social media, television) similarly found the most common food-related categories advertised to youth include fast-food/restaurant products, SSBs, sweets, and energy drinks (Amson et al., 2021; Busse, 2018; Tsochantaridou et al., 2023). As a result, if proposed restrictions on advertising unhealthy F&B products to youth on broadcast and digital media platforms in Canada are implemented, youth will still have exposure to outdoor F&B advertisements containing these non-core foods around their schools (Health Canada, 2022; Health Canada, 2024). Furthermore, these remaining outdoor F&B advertisements can have strong influences on food behaviors if they are near food outlets that sell the advertised products. Bowman et al., (2019) consulted with youth to identify which outdoor F&B advertising techniques were most influential and found that location/directions were among the top 10 most influential advertising techniques to youth. If outdoor F&B advertisements are near food outlets that sell the advertised products, it will be more convenient for youth to act on the influences of the advertisements and purchase the advertised foods. This study did not evaluate whether outdoor F&B advertisements promoted products sold at nearby stores that could be accessed by youth during school lunch breaks and on their journeys home from school. As a result, the ability of youth to act on the influence of the advertisements and purchase the advertised products is unknown. Future research should identify whether outdoor F&B advertisements promote products that are available at nearby stores to determine how convenient it is for youth to purchase products from outdoor F&B advertisements.

2.5.1.2 The Proportion of Outdoor F&B Advertisement Types Varies by City

The results of this study show that there are statistically significant differences in the proportions of outdoor F&B advertisement types by city. For instance, Ottawa had the highest percentage of

advertisements containing a non-core F&B product (83.5%, n = 198), while Quebec City and Halifax had the lowest percentages (49.1%, n = 277, and 52.1%, n = 99, respectively). Moreover, Quebec City (n = 564) had the highest percentage of advertisements containing an alcohol product at 25.7% (n = 145), while less than 10% of the advertisements in all the other cities contained an alcohol product. Furthermore, rural areas had higher proportions of advertisements containing non-core foods than urban areas (71.1% and 63.8% respectively). As a result, it is evident that not all outdoor F&B advertising environments in cities across Canada are the same. If this research is used to inform policy and decision-making for cities that were not studied, the results from the city in the study that most closely matches the city's context should be used. Future research should also conduct case studies and policy analyses of outdoor F&B advertising environments to further understand why some cities have higher percentages of advertisements that contain core food products compared to other cities, and why some cities have higher percentages of non-core food products compared to other cities. For instance, the province of Quebec is the sole jurisdiction in Canada with legislation that prohibits advertising to children, which may be why there are lower percentages of non-core food advertisements near schools (Anggadol, 2024; Canadian Marketing Association, n.d.).

2.5.1.3 Youth-Directed Marketing Techniques were used in Outdoor F&B Advertisements near Schools

The content analysis of marketing techniques found that youth-directed marketing techniques were identified in outdoor F&B advertisements near schools. Promotional offers were a more prevalent marketing technique than promotional characters. Since marketing techniques are inconsistently defined in the literature, it is unclear whether these findings are consistent with the findings of other studies. Based on the scoping review by Finlay et al. (2022), some studies identified the use of promotional characters in a high proportion of advertisements, which is not consistent with the findings from this study.

Moreover, the most common marketing techniques identified in outdoor advertisements in this study were youth product/convenience (39.4%), sense of urgency/limited time offer/seasonal (18.4%), and price promotion/discount (13.1%). Bowman et al.'s (2019) study assessing the strength of teen-directed marketing techniques found that price promotion/discounts were a key strategy to target teens. Since teenagers have more purchasing power than children, it is possible that advertisers were trying to target teenagers rather than children in the six cities this manuscript assessed. Since data for elementary schools and secondary schools were not assessed separately, it is unclear how marketing techniques differ between these different age groups. Future research should explore the differences in marketing techniques by school type (primary and secondary schools).

2.6 Conclusion

2.6.1 Relevance for Planning Research & Practice

This research has relevance to healthy cities research as it fills gaps in the literature on describing the content and prevalence of outdoor F&B advertisements in cities with different geographical contexts across Canada, which was identified to be very limited in the literature review. More specifically, this research has relevance to the Government of Canada's framework for preventing childhood obesity, *Curbing Childhood Obesity: A Federal, Provincial and Territorial Framework for Action to Promote Healthy Weights,* as it pertains to their third strategy of measuring and reporting on progress to reduce childhood overweight and obesity in Canada, including monitoring factors influencing weight (Health Canada, 2023; Public Health Agency of Canada, 2012). The count and descriptive data on outdoor F&B advertisements in cities across Canada in this manuscript provide a cross-sectional assessment of outdoor F&B advertising environments in 2022. Similar studies should be performed in the future to understand how outdoor F&B advertising environments in Canada are changing over time. These data and findings can be compared with other monitored variables associated with overweight and obesity in youth (e.g., food consumption, obesity rate) that were collected at approximately the same time in Canada to understand potential associations between associations between advertisement prevalence and obesity prevalence. These findings can then be used to inform policies on outdoor F&B advertisement restrictions in Canada.

Since the ability to restrict advertisements is not within the scope of planning practice but rather public health, the findings of this manuscript do not directly translate to actions that planners can take to create healthier outdoor F&B advertising environments near schools (Cohen, 2022). Indirectly, this research is relevant to planning practice as it provides an understanding of the content of advertising environments near schools. Since outdoor F&B advertisements are likely promoting products available at nearby stores, the type of stores near schools likely impacts the content of advertisements. If this is the case, urban planners can indirectly play a role in creating healthier outdoor F&B advertising environments by establishing zoning bylaws that prevent "unhealthy" food outlets and incentivize "healthy" food outlets (Cohen, 2022). Manuscript 2 explores the potential association between food outlet counts and outdoor F&B advertisement prevalence by type to better understand the role of urban planners in creating healthier F&B advertising environments near schools. Nevertheless, the findings of this manuscript show that outdoor F&B advertisements near schools primarily promote non-core food products. To create healthier food environments near schools, interdisciplinary collaborations between urban planners and public health professionals will likely be needed.

2.6.2 Study Limitations

This study has several limitations that impact its accuracy and reliability. One limitation was that advertisement counts could not accurately be compared between the six cities due to limitations with data collection. For instance, data was collected for 24 schools in each city, except Quebec City, where only 23 schools were assessed. As a result, Quebec City has less schools contributing to its total advertisement count. Moreover, some schools had overlapping buffer areas. In cases where school buffers overlapped, the advertisements were only attributed to one school. As a result, cities with many overlapping school buffers, such as Vancouver, had fewer advertisements in their total advertisement count than they would have if the buffers did not overlap. Furthermore, if a school had more than 50 food stores within its buffer, 30 food stores were randomly selected to make data collection more feasible. Similarly, if there were more than 50 restaurants within a school's buffer, 30 restaurants were randomly selected for inclusion (Minaker, 2023). As a result, the total number of advertisements was lower than the actual count for areas with over 50 food stores/restaurants, as exterior advertisements on food stores and restaurants were only assessed for 30 food stores/restaurants. Due to these limitations, this section focused on comparing the percentages advertisement types in each city rather than a comparison of advertisement counts. Future studies should aim to have more consistent data sampling and collection in each study area to ensure advertisement prevalence can be compared more accurately.

Another limitation of this study is that the rural communities assessed had notable ranges in population count and density. This occurred because small communities within a 1–2-hour drive of the six cities assessed were selected to represent rural communities. This was done for feasibility of data collection, as data surveyors lived within the six main cities. The limitation of this was that for some cities, such as Vancouver, the surrounding cities still had high population densities. As a result, although the selected small communities are less dense and have lower populations compared to the main cities, some of these small communities are mid-sized cities rather than rural communities. Future studies should use more distinct definitions of rurality, or use quantitative measures such as population density, to determine the degree of urbanization of communities.

Furthermore, the classification of core and non-core F&Bs in advertisements had some limitations. Some of the F&B items classified as core could technically contain non-core products. For example, the grains/bread/bakery product category under core F&Bs could contain non-core F&B items, such as cupcakes. Similarly, some of the F&B items classified as non-core could technically contain core products. For example, one of the non-core F&B categories is fast-food/restaurant products. Although fast-food stores typically promote non-core F&Bs, this category would also include advertisements that promote core F&Bs, such as salads. To mitigate this, the INFORMAS protocol recommends classifying

food in advertisements as “core” or “non-core” during the coding process, rather than retroactively based on the food classification categories (Mackay et al., 2017). Nevertheless, the food classifications in this study are adapted from the INFORMAS food classifications and should be accurate in most cases, even though core and non-core foods were determined retroactively from these food classifications of the advertisements rather than the advertisements themselves. Future studies should consider classifying core and non-core food classifications during the initial advertisement coding for even more accurate findings.

Finally, although the study area of 1 km around schools is within the range identified in the literature, most studies used 500 m study area around schools. Initially, this thesis was going to look at 250 m, 500 m, and 1 km buffer to see how outdoor F&B advertisement environments changed at further distances from schools; however, there was an error with recording the location of freestanding outdoor F&B advertisements, so this could not be performed. Future research should explore outdoor F&B advertisement counts at multiple distances to see how advertisement environments change at various distances from schools.

3 Chapter 3
Manuscript 2

3.1 Introduction

As discussed in Manuscript 1, rates of overweight and obesity among youth are rising in Canada. Population-level interventions are more effective at reducing the risk of developing obesity than individual-level weight management interventions as they address the socioeconomic and environmental factors that contribute to an individual's food choices (Downs et al., 2020; Siddiqui et al., 2024). The food environment is "a modifiable component of the built environment" that has been hypothesized to influence food choices and intake at a population level; however, findings in the literature are inconsistent on the association between food environment exposure and food choices (Downs et al., 2020; Siddiqui et al., 2024; Stevenson et al., 2022).

In the literature, multiple definitions and frameworks exist to describe the food environment. Glanz et al.'s (2005) model of the food environment, as shown in **Figure 3.1,** focuses on four environmental variables: (1) The Community Nutrition Environment; (2) The Organizational Nutrition Environment; (3) The Consumer Nutrition Environment; and (4) The Information Environment.

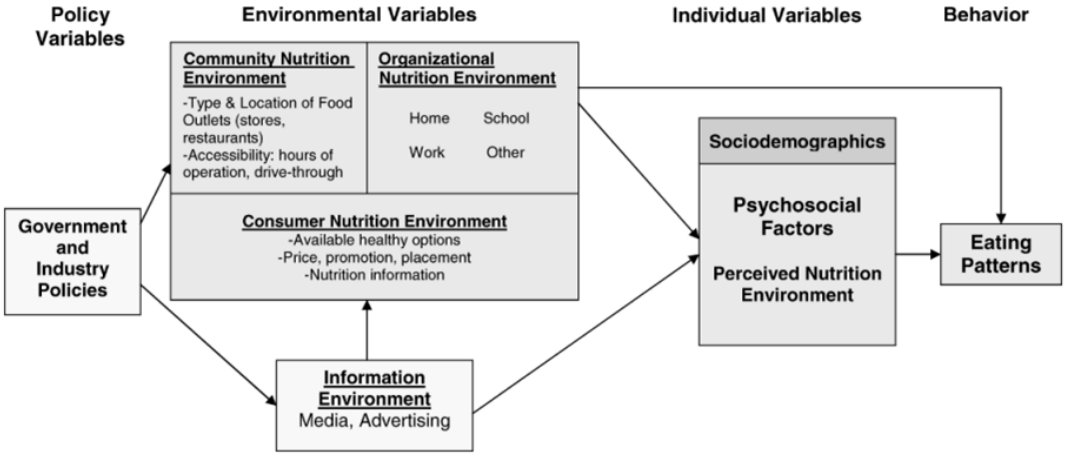

Figure 3.1: Glanz et al.'s (2005) model of the food environment.

The research conducted in Manuscript 1 focused solely on the Information Environment in Glanz et al.'s (2005) model by examining the content of outdoor F&B advertisements within 1000 m of schools. Although this research provides insight into the types of F&B advertisements to which youth are potentially exposed during lunch breaks and their journeys to and from school, it does not consider how the prevalence and type of food outlets (i.e., food stores and restaurants) near schools may impact the

prevalence and type of advertisements that youth are potentially exposed to. The geographic location and access to types of food outlets is a key component of the Community Nutrition Environment, identified in Glanz et al.'s (2005) model of the food environment, that influences food choices and eating patterns. Since most of the studies in Manuscript 1's literature review included freestanding outdoor advertisements (e.g., billboards and bus stops) and advertisements on food outlet exteriors, it is evident that the Information Environment and Community Nutrition Environment are connected in promoting F&B products in outdoor environments (Herrera & Pasch, 2017; Hillier et al., 2009; Kelly et al., 2015; Martin-Pavo et al., 2022, Ruggles et al., 2023; Ruggles et al., 2024; Trapp et al., 2021; Trapp et al., 2022; Velazquez et al., 2019). As a result, further research that evaluates and tests for associations between the Information Environment and Community Nutrition Environment is needed to determine which component of the food environment should be targeted by policy interventions to restrict unhealthy F&B advertising to youth. If most outdoor advertisements are located on food outlets, and areas with high food outlet densities have higher proportions of freestanding outdoor advertisements, then policy interventions that target the Community Nutrition Environment will likely be more effective at reducing outdoor unhealthy F&B advertising to youth.

Furthermore, the literature review in Manuscript 1 identified studies from countries other than Canada, such as the USA, that found racialized and low-SES/high-deprivation neighbourhoods have higher counts of outdoor F&B advertisements near schools than predominantly white, high-SES/low-deprivation neighbourhoods. (Backholer et al., 2020; Brien et al., 2022; Finlay et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009; Isgor et al., 2016; Kneller et al., 2024; Ruggles et al., 2023; Ruggles et al. 2024; Trapp et al., 2022; Wells et al., 2023). Since studies have found a higher prevalence of fast-food outlets in low socioeconomic status and racialized neighbourhoods, it is unclear whether these disproportionate outdoor F&B advertisement exposures are due to targeted freestanding advertisements or the higher prevalence of fast-food retailers with outdoor advertisements (Brien et al., 2022; D'Angelo et al., 2016; Hillier et al., 2009; Isgor et al., 2016; Vandevijvere et al., 2016; Velazquez et al., 2019). Research on food environments in Canada suggests that Canadian food environments are unique from those in the USA. (Minaker et al., 2016). In USA studies on food environments, food deserts (areas with limited access to food outlets with nutritious foods) were found to be more prevalent in neighbourhoods with higher deprivation compared to neighbourhoods with lower deprivation. Conversely, in Canadian studies on food environments neighbourhoods with higher deprivation had equivalent or better access to healthy food than neighbourhoods with lower deprivation. Instead, Canadian neighbourhoods with high deprivation have evidence of food swamps (areas with high densities of food outlets with minimally nutritious foods) (Minaker et al., 2016). Due to the unique context of Canadian food environments,

Canadian research that explores the associations between advertisement count, food outlet count, and neighbourhood deprivation is needed.

Due to the limited Canadian research on the associations between outdoor F&B advertising environments, food environments, and neighbourhood characteristics, this Manuscript will explore the following research questions:

1. How do mean outdoor F&B advertisement counts within 1000 m of schools differ by city, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition?
2. What is the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition within 1000 m of schools in six cities across Canada?

First, this manuscript synthesizes the findings of a literature review to guide the research methods used in this manuscript. Next, the methods sections explain the methods used to answer the research question. Finally, the results and key findings are presented, followed by a discussion that examines the significance of this research to planning practice and research.

3.2 Literature Review[14]

3.2.1 Introduction

The literature review in Manuscript 1 identified notable gaps in the literature on outdoor F&B advertising environments near schools and informed the research questions this Manuscript's study on outdoor F&B advertising environment near schools in cities across Canada. This literature review builds upon the literature review in Manuscript 1 to further understand:

1. Research methods used in the literature to determine the association between the prevalence of outdoor unhealthy F&B advertisements near schools and neighbourhood deprivation/ethnocultural composition; and
2. The key applications, debates, and challenges of these spatial analysis research methods?

The findings of this literature review were used to inform the data analysis in Manuscript 2.

[14] This literature review is adapted from an assignment that was submitted for the SMART Healthy Cities Training Platform Methods Café Course.

3.2.2 Methods

A literature search was conducted on the Scopus database to identify peer-reviewed articles that use socio-spatial analysis research methods to determine the association between the prevalence of outdoor unhealthy product advertisements near schools and neighbourhood demographics. The search terms that were used include: ((outdoor*) AND (marketing OR advert*) AND (prevalence OR exposure OR frequency OR amount OR number) AND (food OR beverage* OR drink)) AND (socio* OR social)). The search terms were applied to the article title, abstract, and keywords of documents in the database. This search returned 39 articles.

3.2.2.1 Study Selection & Eligibility Criteria

The titles and abstracts of the 39 articles were then screened for eligibility, and 8 peer-reviewed articles were determined to be relevant. Primary/secondary quantitative studies that examined associations between advertisement prevalence and neighbourhood demographics were included. Many of the studies from the literature search were not considered relevant as they solely described advertisement prevalence and did not explore associations between advertisement prevalence and neighbourhood demographics.

An additional peer-reviewed study identified in the Manuscript 1 literature review was included due to its relevance in addressing the objectives of this literature review. Furthermore, two independently identified methods papers that assess spatial-analysis research methods were included in this literature review to determine the strengths and limitations of the socio-spatial analysis techniques used in outdoor advertising research.

In total, 11 peer-reviewed articles were included in this literature review. Five of these articles were previously included in Manuscript 1's literature review; however, they were further assessed in this literature review to answer the additional research questions.

Characteristics of the Selected Studies

The 11 selected articles were published between 2016 and 2023. Nine of the articles were quantitative studies that examined the association between outdoor F&B advertisement prevalence and neighbourhood demographics. Two of the articles assessed the strengths and weaknesses of various socio-spatial epidemiology techniques. The selected articles came from the United States (n = 6), Australia (n = 3), Canada (n = 1), and Sweden (n = 1).

3.2.3 Literature Review Synthesis

This unstructured literature review uses a narrative synthesis to answer its research questions.

3.2.4 Results: Key Findings

The selected peer-reviewed articles were then synthesized to identify themes in research methods used to explore associations between the prevalence of outdoor F&B advertisements and neighbourhood demographics near schools. Two key areas that will be explored in this literature review include: (i) geographic boundaries and demographics assessed; and (ii) statistical tests and key findings. This literature review will identify areas of consensus and differences between the research methods in the literature and explore the strengths and limitations of different socio-spatial analysis methods.

3.2.4.1 Determining Geographic Boundaries & Neighbourhood Demographics

All nine of the identified primary/secondary studies assessed how outdoor F&B advertisement prevalence near schools changed with the area's demographics. Eight of the studies determined the study area's demographics using administratively delineated geographic boundaries (Fagerberg et al., 2019; Fraser et al., 2022; Isgor et al., 2016; Sainsbury et al., 2017; Trapp et al., 2022; Velazquez et al., 2019; Wells et al., 2023; Zahid et al., 2022), except for one study which used the demographics of student's parents (Ruggles et al., 2023). Since the selected articles came from countries other than Canada, the geographic boundaries and census variables and indices do not align exactly with the Statistics Canada census boundaries and variables; however, most of them approximately match one or two of the Statistics Canada variables and geographies and can thus be used to inform the methods in this manuscript.

The most common geographic boundaries used in these studies to determine neighbourhood demographics were aggregated postal code areas or dissemination areas. Three studies used aggregated postal code areas (or their respective country's equivalent) as geographic boundaries (Fraser et al., 2022; Sainsbury et al., 2017; Wells et al., 2023); while three other studies used dissemination areas (or their respective country's equivalent) as geographic boundaries (Isgor et al., 2016; Velazquez et al., 2019; Zahid et al., 2022). Both aggregated postal code areas and dissemination areas are relatively small geographies which allows for a more accurate representation of the neighbourhood demographics in the buffer areas around selected schools.

The most common demographic variable assessed across the selected studies was socioeconomic status (SES). Seven of the selected studies determined neighbourhood socioeconomic status using the index for SES created from their country's census or an index for neighbourhood deprivation created by their provincial or local government (Fagerberg et al., 2019; Fraser et al., 2022; Isgor et al., 2016; Sainsbury et al., 2017; Trapp et al., 2022; Velazquez et al., 2019; Wells et al., 2023). Two of the selected studies used household income instead of socioeconomic status to describe the area's demographics (Ruggles et al., 2023; Zahid et al., 2022). Zahid et al. (2022) used American Community Survey estimates

for household income, collected by the United States.Census Bureau. Ruggles et al. (2023) determined household income using data from the Texas Education Agency on the percentage of students at schools that qualify for free or reduced-price lunch (FRPL). To qualify for FRPL, household incomes must fall at or below 130% or 185% of Federal Poverty Line. Schools where >60% of students qualified for FRPL were considered low-income (Ruggles et al., 2023). Since the SES indices used in the other studies factor in income, solely using income to describe a neighbourhood is a less rigorous approach. Using a SES index provides a more comprehensive indication of how vulnerable a neighbourhood is as it considers how various factors in addition to income can make neighbourhoods vulnerable (e.g., racial composition, residential instability, etc.).

One concern raised in the literature was the challenges of using administratively delineated boundaries and distance estimation in socio-spatial analysis research (Kirby et al., 2017). Many socio-spatial studies use administratively delineated boundaries (e.g., municipal boundary, dissemination area) as study areas since these boundaries are readily available, but administratively delineated boundaries do not adequately represent how people navigate and use space – a phenomenon known as the Uncertain Geographic Context Problem (UGCoP) (Chen & Kwan, 2015; Kirby et al., 2017). For instance, when food access researchers aim to determine available food outlets in a neighbourhood, they often use administratively delineated boundaries of neighbourhoods (e.g., dissemination area). Since these boundaries are arbitrary sizes, the amount of food outlets in an area may be misrepresented as being lower or higher than the reality of how space is used. To minimize the UGCoP, researchers should create boundaries for their studies that reflect how target study subjects use space, such as creating buffer areas that reflect local walking behaviours to food outlets (Chen & Kwan, 2015).

3.2.4.2 Statistical Tests and Key Findings

Only three of the selected studies used statistical tests to determine the association between neighbourhood demographics and outdoor unhealthy F&B prevalence (Isgor et al., 2016; Velazquez et al., 2019; Zahid et al., 2022). These statistical tests included multivariable regression analyses, logistic regression with standard errors, and negative binomial regression analyses. The other six studies used statistical tests of difference to determine if the prevalence of outdoor unhealthy F&B advertisement was statistically different between neighbourhoods (Fagerberg et al., 2019; Fraser et al., 2022; Ruggles et al., 2023; Sainsbury et al., 2017; Trapp et al., 2022; Wells et al., 2023). These statistical tests included chi-squared tests, Mann Whitney U tests, and Kruskal-Wallis tests. Velazquez et al. (2019) and Isgor et al. (2016) had the most rigorous statistical methods, using statistical tests to determine differences between groups as well as associations between variables, with and without controls for food outlet density.

For all studies, the type of statistical test used was determined by the type of data being analyzed. First, tests for normality were performed on the data to determine whether parametric or non-parametric statistical tests should be used. For instance, Ruggles et al. (2023) used a Shapiro-Wilk test of normality to determine the data's distribution. Then, once the data's distribution was known, the study researchers selected statistical tests that are appropriate for the sample size. In the case of Ruggles et al. (2023), a relatively small sample size was used so a bootstrap statistical test (e.g., bootstrapped Wilcoxon rank-sum tests) was needed to simulate a larger sample size. Although the statistical tests used by other studies can be looked to as potential methods, the capacity to use these tests will be heavily dependent on the type, distribution, and amount of data available for analysis.

Despite these differences in statistical tests, most of the selected studies had similar findings. All the studies that used a test of difference, found that lower SES areas had significantly more advertisements than higher SES areas (Fagerberg et al., 2019; Fraser et al., 2022; Ruggles et al., 2023; Sainsbury et al., 2017; Trapp et al., 2022; Wells et al., 2023; Velazquez et al., 2019). One of the studies that used regression analyses did not find associations between outdoor unhealthy F&B advertisement prevalence and socioeconomic status (Velazquez et al., 2019). Other studies that used regression analyses found associations between advertisement prevalence and income (Isgor et al., 2016; Zahid et al., 2022).

3.2.5 Application to Research Methods

The findings of this literature review are valuable in informing this manuscript's research methods. For instance, most studies in this literature review used socioeconomic status data linked to aggregated postal code or dissemination area boundaries to determine neighbourhood deprivation. This manuscript can similarly use Statistics Canada census data on deprivation linked to dissemination area boundaries to determine neighbourhood deprivation. One limitation of this, identified by Chen & Kwan (2015) and Kirby et al. (2017), is that administratively delineated boundaries (e.g., dissemination areas) are susceptible to the uncertain geographic context problem, thus impacting the accuracy of the findings in this manuscript. To mitigate inaccuracies caused by the uncertain geographic context problem, the tabulate intersection tool in ArcGIS Pro can be used to calculate more accurate neighbourhood deprivation scores based on the percentage of the dissemination areas overlapping with the 1000 m road-network buffer around schools.

Furthermore, this literature review also revealed that a limited number of studies assessed associations between neighbourhood demographics, food outlet density, and outdoor F&B advertisement prevalence, and further research is needed on this topic. The rigorous regression models used by Velazquez et al. (2019) and Isgor et al. (2016) provide a good precedent for the type of data analysis that can be performed in Manuscript 2.

3.3 Methods

This manuscript uses data from three primary datasets from Dr. Leia Minaker, which includes data on restaurants, stores, and outdoor food and beverage (F&B) advertisements within 1000 m of selected geocoded elementary and secondary schools in six major cities across Canada. Throughout this manuscript, these datasets will be referred to as Dataset 1: Outdoor Advertisements, Dataset 2: Exterior Store & Restaurant Advertisements, and Dataset 3: Food Stores and Restaurants. Information on these datasets is summarized in **Table 3.1.** This manuscript also uses secondary data from the Statistics Canada 2021 Census of Population (Statistics Canada, 2022a), the Canadian Index of Multiple Deprivation (CIMD) (Statistics Canada, 2023a), and DMTI Spatial's CanMap streetfiles (DMTI Spatial CanMap Streetfiles, 2023).

Table 3.1: Overview of the primary datasets used in this manuscript.

Dataset Name	Description	Data Collection Tools
Dataset 1: Outdoor Advertisements	Data on every food- or beverage- related outdoor advertisement located within the 1000 m study area of selected schools, excluding advertisements on store/restaurant exteriors.	• INFORMAS-OA Survey
Dataset 2: Exterior Store & Restaurant Advertisements	Data on every food- or beverage- related advertisement on the exterior of stores and restaurants located within the 1000 m study area of selected schools.	• CMAT-R • CMAT-S • CMAT-PCT
Dataset 3: Food Stores and Restaurants	Data on every food store and restaurant identified within the 1000 m study area of selected schools.	• INFORMAS-OA Survey

Some of the methods described in the following sections were performed or supervised by Dr. Leia Minaker as she created the datasets. These methods were included in the thesis as they informed how I could code and analyze the data to answer the research questions. The following sections contain ongoing footnotes to clarify who performed which method.

3.3.1 Data Collection

The data collection methods discussed in **Section 2.3 - Methods** applies to this manuscript as well. Refer to **Section 2.3 - Methods** for information on data collection, including the study setting, the school sampling frame, the school selection strategy, the study area, the outdoor advertisement surveying process, and the exterior store/restaurant advertisement surveying process. Additional data collection methods undertaken for this Manuscript are discussed below.

3.3.1.1 Dataset 3: Food Stores and Restaurant Surveying[15]

The data collection and assessment methods used to create Dataset 3: Food Stores and Restaurant Surveying used an adaptation of the INFORMAS-OA Survey. Google Maps was used to identify all food stores and restaurants within the 1000 m street-network buffer area of schools. All stores and restaurants identified within the 1000 m street-network buffer of schools were recorded in Dataset 3: Stores and Restaurants (Minaker, 2023).

Six data collectors (one per city) visited all the food stores and restaurants identified in the 1000 m street-network buffer area for each school between May and September 2022 and recorded information in Excel logbooks (Minaker, 2023). Key variables included in the logbook for Dataset 3 included store and restaurant name, store and restaurant type, store and restaurant ID that was linked to the nearest school, and full addresses. If data collectors noticed stores and restaurants identified in their logbooks were permanently closed or no longer there, they updated their lists accordingly. Similarly, if data collectors identified stores and restaurants in-person that were not identified in their logbooks, the information for these stores and restaurants was added to their logbooks (Minaker, 2023). Data collectors completed a hard copy of these logbooks while surveying the identified food stores and restaurants within the school buffers. At the end of the day, these hard copy findings were input by data collectors into the electronic Excel logbook (Minaker, 2023). The addresses of stores and restaurants in Dataset 3 were then geocoded as point features in ArcGIS Pro using the Geocode Addresses tool.

3.3.1.2 Updating Datasets 2 & 3 to Include Duplicate Advertisements, Stores, and Restaurants[16]

In some cases, as shown in **Figure 3.2**, the 1000 m street-network buffer areas around schools overlapped and as a result they contained some of the same stores, restaurants, and advertisements. There were approximately 30 instances of overlapping buffers. When buffer areas overlapped, data collectors only linked each identified store and restaurant to the nearest school, which resulted in some schools having a lower store and restaurant count than reality. After store and restaurant data was geocoded into ArcGIS Pro, the Select tool was used to identify the stores and restaurants in overlapping buffer areas and link them to all the schools they were within 1000 m of. Datasets 2 and 3 were then updated to include duplicates of stores, restaurants, and external advertisements due to overlapping buffer areas.

[15] Data collection and surveying to create the datasets was supervised by Dr. Minaker.

[16] Updating Datasets 2 and 3 was performed by Amanda Morielli.

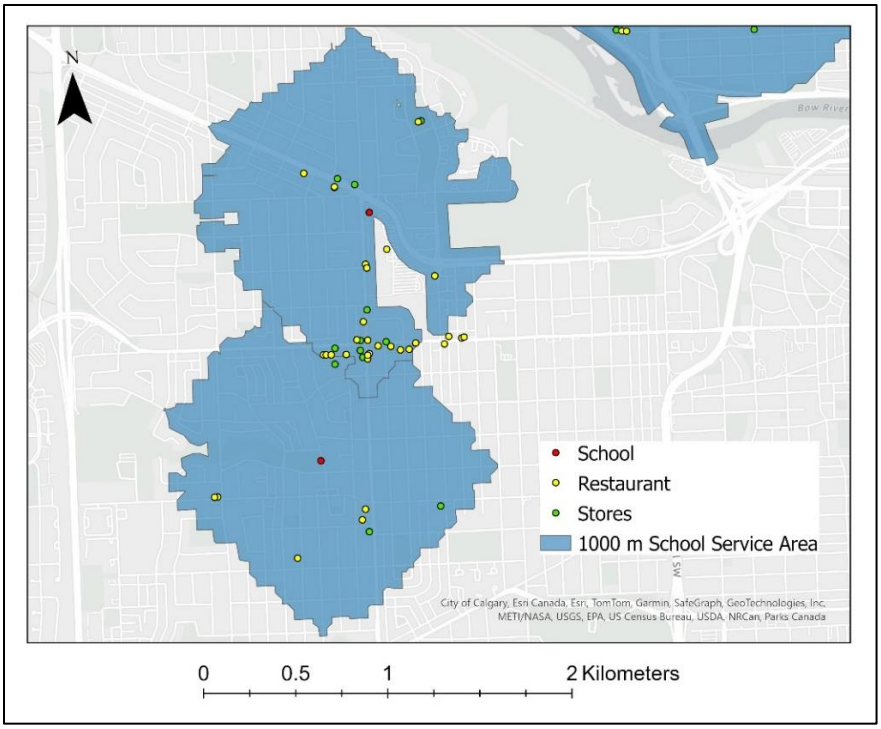

Figure 3.2: Map showing the overlapping 1000 m buffer areas around the schools.

3.3.1.3 Updating Dataset 2 to Include Estimated Total Advertisement Counts for Schools with Over 50 Stores or Restaurants[17]

When recording advertisement data for Dataset 2: Exterior Store and Restaurant Advertisements, if a school had more than 50 food stores within its buffer, 30 food stores were randomly selected to make advertisement data collection more feasible. Similarly, if there were more than 50 restaurants within a school's buffer, 30 restaurants were randomly selected. As a result, only a sample of exterior food store and restaurant advertisements were collected for areas with over 50 food stores or restaurants, and a total advertisement count for the area was not obtained. To estimate the total count of exterior store and restaurant advertisements within the buffer areas of schools with more than 50 stores and restaurants, the mean number of advertisements found on the randomly selected stores and restaurants was multiplied by the total number of restaurants and stores in the school buffer area (Minaker, 2023).

3.3.2 Data Coding

Section 2.3 - Methods discusses how Datasets 1 and 2 coded the foods in advertisements. These data coding methods apply to this Manuscript as well. Additional data coding methods undertaken for this Manuscript are discussed in the following sections.

[17] Updating Dataset 2 was performed by Amanda Morielli.

3.3.2.1 Food Store and Restaurant Classification

Stores and Restaurants were classified by data collectors using the store and restaurant types shown in **Table 3.2**. These store and restaurant classifications were also adapted from the INFORMAS-OA survey. These classifications did not end up being used in the data analysis.

Table 3.2: Food Store and Restaurant Types[18]

Food Store Type	Restaurant Type
1. Grocery Store 2. Convenience Store 3. Pharmacy 4. Ethnic Grocery Store 5. Dollar Store 6. Specialty Store 7. Bulk Store 8. Fruit & Vegetable (FV) Market	9. Fast Food Restaurant 10. Sit Down Restaurant 11. Café / Bubble Tea / Juice / Other Beverage 12. Frozen Dessert / Pastry / Baked Goods

The count of food stores and restaurants within 1000 m of each school was then transformed into tertiles using the Rank Cases in Ntiles tool in IBM SPSS Statistics, as shown in **Table 3.3**. The tertile classifications for food outlets were then used in the data analysis, described further in **Section 3.3.3 - Data Analysis.**

Table 3.3: Food outlet count tertiles

Tertile	Density	Food Outlet Count Range for Each Tertile
1	Low	0 - 8
2	Medium	9 - 25
3	High	> 25

3.3.2.2 CIMD Dimension Classification[19]

In the school selection strategy, the deprivations scores for each CIMD dimension (residential instability, ethnocultural composition, composite dimension of economic dependence & situational vulnerability) for the DA that each school was in was used to determine the neighbourhood deprivation. Once the 1000 m street-network buffer areas were created around each school, the study area included multiple DAs, each with different CIMD dimension deprivation scores, as shown in **Figure 3.3**.

[18] The food store and restaurant coding determined by Dr. Minaker and Amanda Morielli. Food outlet count tertiles were created by Amanda Morielli.

[19] CIMD Dimension Classification was performed by Amanda Morielli.

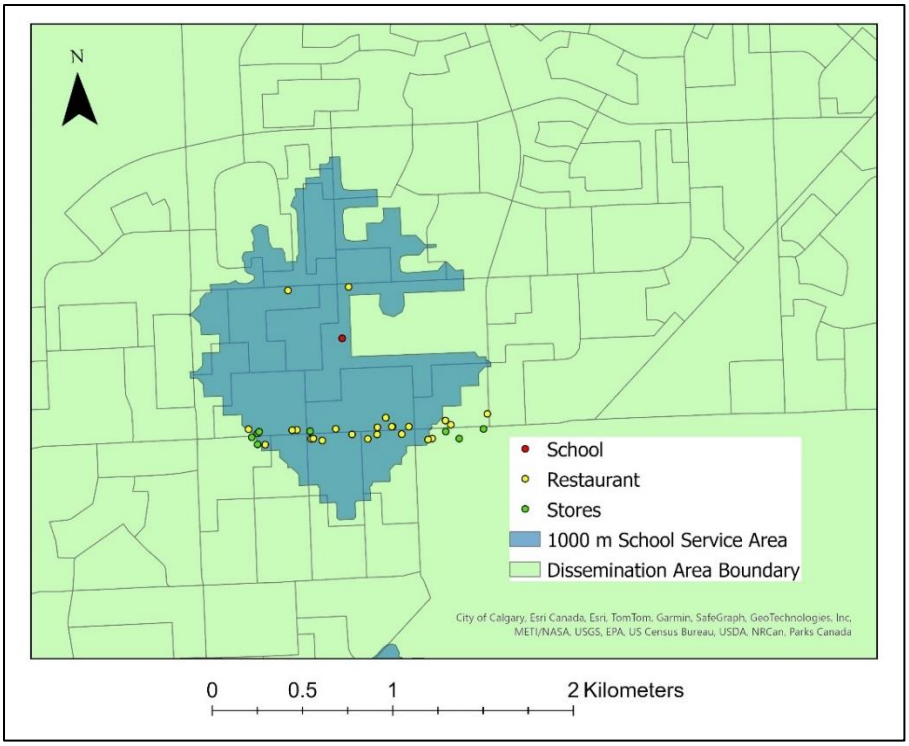

Figure 3.3: Map showing multiple dissemination area boundaries within the 1000 m buffer around schools.

To calculate the weighted CIMD dimension deprivation scores for the 1000 m street-network buffer areas around each school, the Tabulate Intersect tool in ArcGIS Pro was used. The input zone feature was the 1000 m street-network buffer areas, and the input class feature was the Statistics Canada dissemination area (DA) boundary file (which had previously been joined to the DA-level CIMD scores for each CIMD dimension). The output table from this analysis included the CIMD dimension deprivation scores for each DA that intersected the 1000 m street-network buffer areas, as well as a PERCENTAGE field, which calculates the percentage of each DA boundary that intersects the 1000 m street-network buffer areas. The PERCENTAGE field was used to calculate the weighted average of the deprivation scores for each CIMD dimension (See **Table 3.4**).

Table 3.4: Tabulate intersection output table

School_ID	DAUID	RES_INST_S	EC_DEP_S	ETH_CUL_S	SIT_VUL_S	AREA	PERCENTAGE
1	48060189	0.8646325	-0.2685998	-0.7055784	0.2060403	7904.641	0.577202784
1	48060190	0.3095791	-0.3751188	-1.0572905	0.1181695	2045.344	0.149352584
1	48060191	0.1970285	0.0153085	-0.0251989	-0.0330201	14989.35	1.094533506
1	48060192	0.7294546	-0.3508726	-0.2282214	0.5288362	28621.77	2.089982874
1	48060193	1.0774666	0.6553817	0.6263205	0.4702261	131935.4	9.634020396
1	48060194	0.9458711	0.4341908	-1.0283174	0.4855685	101234.2	7.392198594
1	48060195	2.734361	0.3165199	0.595513	0.8767447	117359.6	8.569685924
1	48060196	1.5501531	-0.1787683	-0.0018854	1.02454	121084.8	8.84170178
1	48060197	1.2018272	-0.0320429	-0.0768614	0.4598193	162977.5	11.90074146
1	48060198	-0.0823437	-0.7871409	-0.9460888	-0.7101104	193646.9	14.14023936
1	48060199	-0.4453847	-0.5932982	-1.3792802	-0.4422776	161799.1	11.81469356
1	48060200	0.3443433	-0.6506271	-0.4113854	0.1608921	135893.5	9.923047882
1	48060201	0.476897	-0.7538413	-0.6578474	0.040915	11670.6	0.852196233
1	48060306	-0.841466	-0.4890595	1.1729041	-1.1808503	50025.73	3.652916023
1	48060830	-0.0741797	-0.5036909	-0.5402047	0.1897183	43369.93	3.166904749
1	48060831	0.3891363	0.4713954	-1.1316137	0.0738782	82652.13	6.035320293
1	48062165	1.0204171	-0.4580452	-0.1773432	-0.5611669	2263.225	0.165262421
		0.677045257	-0.16504444	-0.37067014	0.143748879		100.0000004

The weighted deprivation scores for each CIMD dimension for each school were then transformed into a tertiles using the Rank Cases in Ntiles tool in IBM SPSS Statistics (where Tertile 1 = low deprivation, Tertile 2 = moderate deprivation, and Tertile 3 = high deprivation). The tertiles for each CIMD dimension were then used in the data analysis, described further in **Section 3.3.3 - Data Analysis.**

3.3.3 Data Analysis[20]

The Descriptive Statistics Crosstabs tool in IBM SPSS Statistics software was used to cross-tabulate count data from Datasets 1,2, and 3 for the number of restaurants, stores, and outdoor F&B advertisements found within the 1000 m street-network buffers of the selected schools by School ID. The count data generated from this tool was organized in Microsoft Excel by School ID. Additional variables regarding neighbourhood demographics (i.e. CIMD tertile, City) were also organized in Microsoft Excel by School ID. This data was then further analyzed using the Descriptives tool in IBM SPSS Statistics to create the descriptive tables of mean counts and standard deviations of advertisement type (**Table 3.5**) within 1000 m of a school. Means were calculated for all cases, as well as by predictor variable groups (i.e. CIMD tertile). To calculate the mean for predictor variable groups, the Split File tool in IBM SPSS Statistics was used, and the option to compare groups based on a given variable was selected. Predictor variable groups were compared independently to calculate the means shown in **Table 3.5**.

Negative binomial regression analyses were also performed in IBM SPSS Statistics to examine associations between city, neighbourhood deprivation, degree of urbanization, and outlet count. A

[20] The data analysis was performed by Amanda Morielli.

negative binomial regression model was selected as this model supports count data that is over dispersed and not zero-inflated. Separate models were fit for each outcome variable in **Table 3.6** (all advertisements, core advertisements, non-core advertisements). These models evaluate the main effects of the predictor variables which include city, degree of urbanization, degree of residential instability, degree of economic dependence and situational vulnerability, ethnocultural composition, and number of food outlets. Additional models that controlled for the number of outlets were also fit for each outcome variable. Each column in **Table 3.6** represents a different model that was performed. These models were run using the Generalized Linear Model tool in IBM SPSS Statistics and selecting a custom negative binomial regression model with log link that estimates parameter values with 95% confidence intervals.[21] More information on fitting and selecting an appropriate model can be found in **Appendix B**. Furthermore, collinearity diagnostics were run in SPSS to test correlations between predictor variables in the regression model. The results of this test showed that there were not high correlations between any of the predictor variables used in the model, indicating that there is no collinearity in the model (see **Appendix C**).

3.4 Results

A total of 2585 outdoor F&B advertisements were identified in the study area of 1000 m street-network buffers around 143 schools in six cities across Canada. After duplicates were added to account for overlapping buffers, and estimates were calculated for missing store/restaurant data, a total of 3632 outdoor F&B advertisements were analyzed.

The results of the data analysis are organized into two subsections: (1) results of the mean and standard deviation descriptive analysis; and (2) results of the negative binomial regression analysis to test for associations between variables.

3.4.1 Mean Count of Advertisements within 1000 m of Schools by City, Degree of Urbanization, Neighborhood Deprivation, and Food Outlet Count

Table 3.5 shows the mean (M) count and standard deviation (SD) of advertisements within 1000 m of schools by city, degree of urbanization, neighborhood deprivation, and food outlet count. Based on the data for all schools, there was a mean of 25.40 (SD = 38.41) outdoor F&B advertisements within 1000 m of schools. Moreover, outdoor advertisements that contained non-core F&B products had a higher

[21] Velazquez et al., 2019 performed similar negative binomial regression analyses in Vancouver and was the inspiration for these models. This analysis adds to this existing research by exploring differences between cities, degree of urbanization, ethnocultural composition and additional deprivation measures.

mean count within 1000 m of schools (M = 16.07, SD = 23.37) than outdoor advertisements that contained core F&B products (M = 9.32, SD = 16.57). Furthermore, the mean count of outdoor advertisements on restaurant/store exteriors within 1000 m of schools (M = 23.22, SD = 35.52) was 10.6 times higher than the mean count of freestanding outdoor advertisements within 1000 m of schools (M = 2.18, SD = 3.94). The bar graphs in **Figure 3.4** show the mean and SD findings for advertisement type within 1000 m of all schools. The standard deviation error bars in **Figure 3.4** are large and overlapping, indicating wide variability in the data between schools.

Table 3.5: Mean (M) count and standard deviation (SD) of advertisements within 1000 m of schools (n = 143) by city, degree of urbanization, neighbourhood deprivation, and food outlet count.

	All Ads within 1000 m of a school M (SD)	Core F&B Ads within 1000 m of a school M (SD)	Non-Core F&B Ads within 1000 m of a school M (SD)	Freestanding Outdoor Ads within 1000 m of a school M (SD)	Restaurant / Store Exterior Ads within 1000 m of a school M (SD)
All Cases	25.40 (38.41)	9.32 (16.57)	16.07 (23.37)	2.18 (3.94)	23.22 (35.52)
City					
Vancouver	70.96 (68.75)	26.12 (30.26)	44.79 (40.41)	5.88 (5.44)	65.08 (64.79)
Calgary	13.33 (13.19)	4.42 (4.92)	8.92 (9.23)	1.50 (2.78)	11.83 (11.16)
Winnipeg	22.88 (19.80)	6.50 (6.42)	16.38 (15.43)	1.33 (2.84)	21.54 (18.50)
Ottawa	10.21 (12.03)	1.62 (2.12)	8.58 (10.48)	0.29 (0.81)	9.92 (11.47)
Quebec City	23.65 (21.65)	12.09 (12.52)	11.57 (10.95)	2.57 (2.94)	21.09 (19.27)
Halifax	11.29 (21.10)	5.29 (12.01)	6 .00 (9.65)	1.54 (4.69)	9.75 (17.06)
Degree of Urbanization					
Urban	27.78 (40.50)	10.33 (17.57)	17.44 (24.53)	2.44 (4.17)	25.34 (37.43)
Rural	10.75 (15.21)	3.10 (4.55)	7.65 (11.49)	0.60 (1.23)	10.15 (14.91)
Degree of Residential Instability					
Low	5.91 (8.75)	1.79 (3.28)	4.13 (6.12)	0.28 (1.08)	5.64 (8.56)
Medium	21.00 (20.04)	5.77 (6.07)	15.23 (16.00)	1.63 (2.27)	19.38 (19.12)
High	48.88 (54.94)	20.25 (24.30)	28.60 (32.46)	4.60 (5.55)	44.27 (50.96)
Degree of Economic Dependence + Situational Vulnerability					
Low	13.87 (25.30)	4.57 (8.46)	9.32 (17.77)	1.21 (2.66)	12.66 (23.58)
Medium	36.06 (54.67)	15.29 (24.55)	20.75 (31.30)	3.29 (5.35)	32.77 (50.54)
High	26.02 (24.33)	8.00 (9.78)	18.00 (17.02)	2.02 (3.03)	24.00 (22.53)
Ethnocultural Composition					
Low	36.15 (58.74)	13.77 (24.82)	22.36 (34.84)	3.02 (4.98)	33.13 (54.72)
Medium	19.23 (21.62)	6.92 (11.31)	12.31 (13.32)	1.71 (3.76)	17.52 (19.01)
High	21.04 (20.94)	7.37 (8.31)	13.67 (15.01)	1.83 (2.73)	19.21 (19.29)
Number of Food Outlets					
Low (0-8)	3.75 (4.75)	0.98 (2.24)	2.77 (3.26)	0.09 (0.29)	3.66 (4.73)

Medium (9 -25)	14.12 (12.67)	4.96 (5.42)	9.16 (9.86)	1.24 (1.77)	12.88 (12.00)
High (>25)	57.23 (51.52)	21.60 (23.53)	35.60 (30.50)	5.10 (5.46)	52.12 (48.07)

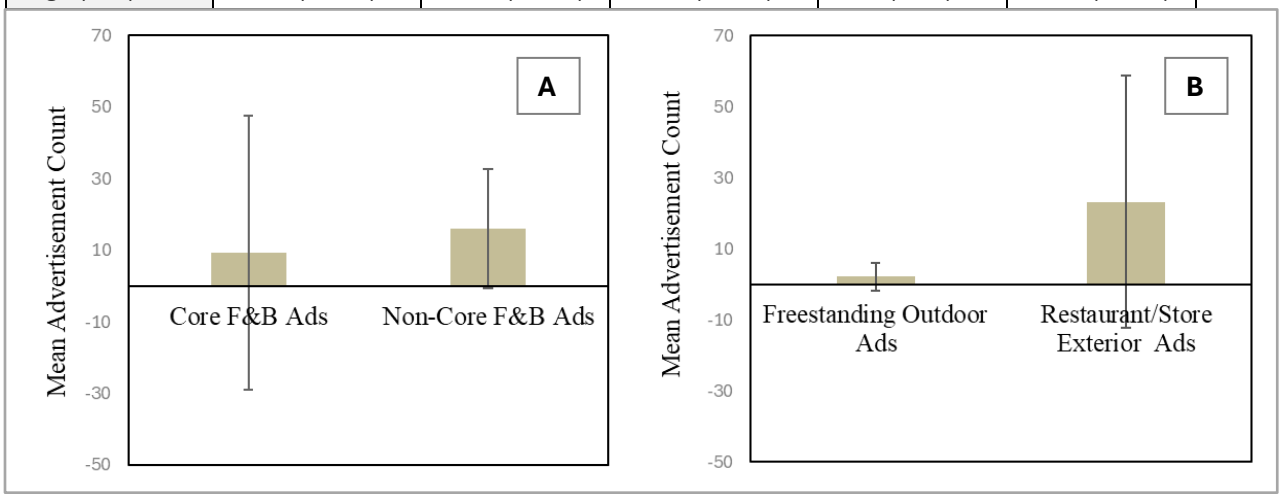

Figure 3.4: Bar graphs depicting the mean (M) count of outdoor advertisements by type within 1000 m of 143 schools across Canada with ±SD error bars. (A) depicts the mean advertisement counts with ±SD error bars for advertisements that contain core F&B products (M = 9.32 ±16.57) and advertisements that contain non-core F&B products (M = 16.07 ± 23.37). **(B)** depicts the mean advertisement counts for freestanding outdoor advertisements (M = 2.18 ± 3.94) and restaurant/store exterior advertisements with ±SD error bars (M = 23.22 ± 35.52).

The mean advertisement counts within 1000 m of schools by city shows that Vancouver had a notably higher mean advertisement count compared to all the other cities, as shown in **Figure 3.5A**. Vancouver's mean advertisement count within 1000 m of schools was 70.96 (SD = 68.75), while the mean advertisement counts for the other cities ranged from 10.21 (SD = 12.03) advertisements in Ottawa to 23.65 (SD = 21.65) advertisements in Quebec City. The standard deviation error bars in **Figure 3.5A** are large and overlapping, indicating wide variability in the data between cities. Moreover, all cities, except Quebec City, had higher mean counts of advertisements containing non-core F&B products compared to core F&B products. In Vancouver, Calgary, and Winnipeg, the mean count of advertisements containing non-core F&B products was approximately double the mean count of advertisements containing core F&B products. In Ottawa, the mean count of advertisements containing non-core F&B products was 5.29 times higher than the mean counts for advertisements containing core F&B products. In Halifax the mean count of advertisements containing non-core F&B products was only 1.13 times higher than the mean count of advertisements containing core F&B products. Quebec City was the only city in which the mean number of advertisements containing non-core F&B products was slightly lower than the mean number of advertisements containing core F&B products (non-core M = 11.57, SD = 10.95; core M = 12.09, SD = 12.52).

The mean advertisement counts within 1000 m of schools by degree of urbanization shows that urban areas (M = 27.78, SD = 40.50) had higher mean advertisement counts compared to rural areas (M =

10.75, SD = 15.21), as shown in **Figure 3.5B**. The standard deviation error bars in **Figure 3.5B** are large and overlapping, indicating wide variability in the data between urban and rural areas. In both urban and rural areas, the mean counts of advertisements containing non-core F&B products is higher than the mean counts of advertisements containing core F&B products.

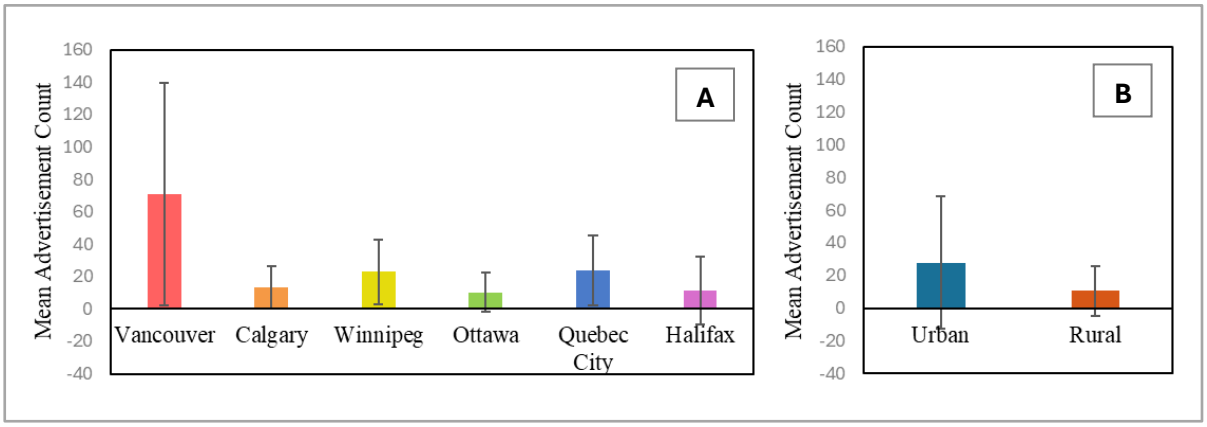

Figure 3.5: Bar graphs depicting the mean (M) count of outdoor advertisements by city and degree of urbanization (A) Bar graph depicting the mean (M) advertisement counts with ±SD error bars for six cities, including Vancouver (M = 70.96 ± 68.75), Calgary (M = 13.33 ±13.19), Winnipeg (M = 22.88 ± 19.80), Ottawa (10.21 ± 12.03), Quebec City (23.65 ±21.65), and Halifax (11.29 ± 21.10). **(B)** Bar graph depicting the mean advertisement counts with ±SD error bars for urban (M = 27.78 ± 40.50) and rural areas (M = 10.75 ± 15.21).

Figure 3.6 contains four bar graphs that depict the mean (M) advertisement count with ±SD error bars for four different variables describing neighbourhood characteristics. **Figure 3.6A** shows that areas with high degrees of residential instability had the highest mean count of outdoor advertisements (M = 48.88, SD = 54.94) compared to medium and low degrees. **Figure 3.6B** shows that areas with medium degrees of economic dependence and situational vulnerability had the highest mean count of outdoor advertisements (M = 36.06, SD = 54.94) compared to high and low degrees. **Figure 3.6C** shows that areas with low ethnocultural compositions had the highest mean count of outdoor advertisements (M = 36.15, SD = 58.74) compared to medium and high compositions. **Figure 3.6D** shows that areas with high counts of food outlets had the highest mean count of advertisements (M = 57.23, SD = 51.52) compared to areas with low and medium counts of food outlets. The standard deviation error bars for all bar graphs in **Figure 3.6** are large and overlapping, indicating wide variability in the data.

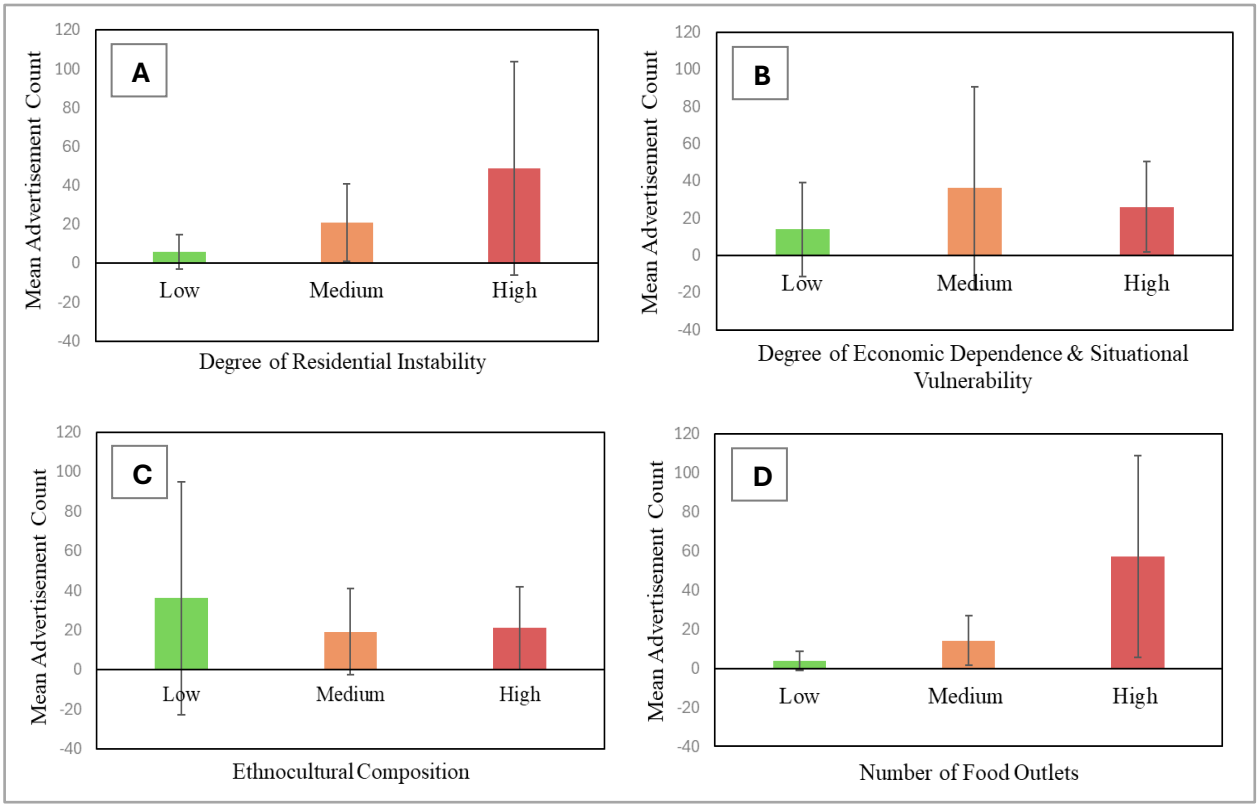

Figure 3.6: Bar graphs depicting the mean (M) advertisement count with ±SD error bars for different variables describing neighbourhood characteristics. (A) depicts the mean advertisement counts for areas with low (M = 5.91 ± 8.75), medium (M = 21.00 ± 20.04), and high (M = 48.88 ± 54.94) degrees of residential instability. **(B)** depicts the mean advertisement counts for areas with low (M = 13.87 ± 25.30), medium (M = 36.06 ± 54.94), and high (M = 26.02 ± 24.33) degrees of economic dependence & situational vulnerability. **(C)** depicts the mean advertisement counts for areas with low (M = 36.15 ± 58.74), medium (M = 19.23 ± 21.62), and high (M = 21.04 ± 20.94) ethnocultural compositions. **(D)** depicts the mean advertisement counts for areas with low (M = 3.75 ± 4.75), medium (M = 14.12 ± 12.67), and high (M = 57.23 ± 51.52) numbers of food outlets.

3.4.2 Associations between Advertisement Count within 1000 m of Schools and City, Degree of Urbanization, Neighbourhood Deprivation, and Food Outlet Count

Table 3.6 shows the results of the six negative binomial regressions models that were run to evaluate the main effects of predictor variables – including city, degree of urbanization, degree of residential instability, degree of economic dependence and situational vulnerability, ethnocultural composition, and food outlet count – on outdoor advertisement count.

Table 3.6: Results from negative binomial regressions modeling the count of outdoor advertisements within 1000 m of schools (n = 143). These models evaluate the main effects of the predictor variables – which include city, degree of urbanization, degree of residential instability, degree of economic dependence and situational vulnerability, ethnocultural composition – on outdoor advertisement count. Models (2), (4), and (6) also include food outlet count as a predictor variable to control for food outlet count.

Predictors	**(1) Total Ads** **IRR [CI]** [a]	**(2) Total Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]	**(3) Core F&B Ads** **IRR [CI]** [a]	**(4) Core F&B Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]	**(5) Non-Core F&B Ads** **IRR [CI]** [a]	**(6) Non-Core F&B Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]
City						
Vancouver [b]	1	1	1	1	1	1
Calgary	**0.354 [0.191, 0.657]**	**0.391 [0.241, 0.633]**	**0.403 [0.209, 0.778]**	**0.377 [0.227, 0.625]**	**0.321 [0.176, 0.588]**	**0.362 [0.223, 0.589]**
Winnipeg	**0.466 [0.241, 0.901]**	**0.566 [0.344, 0.932]**	**0.348 [0.178, 0.679]**	**0.393 [0.237, 0.654]**	**0.512 [0.267, 0.981]**	0.647 [0.390, 1.074]
Ottawa	**0.352 [0.176, 0.703]**	**0.346 [0.199, 0.603]**	**0.160 [0.074, 0.343]**	**0.151 [0.081, 0.283]**	**0.429 [0.217, 0.851]**	**0.419 [0.240, 0.733]**
Quebec City	**0.448 [0.231, 0.869]**	0.631 [0.374, 1.064]	0.560 [0.280, 1.118]	0.882 [0.510, 1.524]	**0.363 [0.188, 0.699]**	**0.469 [0.276, 0.797]**
Halifax	**0.136 [0.072, 0.256]**	**0.242 [0.145, 0.405]**	**0.153 [0.117, 0.429]**	**0.259 [0.153, 0.438]**	**0.130 [0.069, 0.246]**	**0.231 [0.135, 0.395]**
Degree of Urbanization						
Urban [b]	1	1	1	1	1	1
Rural	0.684 [0.395, 1.183]	0.772 [0.494, 1.205]	0.549 [0.293, 1.027]	0.620 [0.360, 1.065]	0.747 [0.431, 1.295]	0.840 [0.534, 1.321]
Degree of Residential Instability						
Low [b]	1	1	1	1	1	1
Medium	**2.890 [1.794, 4.656]**	1.423 [0.931, 2.175]	**2.159 [1.267, 3.678]**	1.089 [0.679, 1.746]	**3.125 [1.926, 5.070]**	**1.560 [1.005, 2.421]**
High	**5.393 [3.193, 9.109]**	**1.707 [1.029, 2.832]**	**5.706 [3.200, 10.174]**	1.491 [0.848, 2.624]	**4.857 [2.886, 8.174]**	1.661 [0.994, 2.773]
Degree of Economic Dependence + Situational Vulnerability						
Low [b]	1	1	1	1	1	1
Medium	1.640 [0.965, 2.786]	**1.586 [1.053, 2.387]**	**2.028 [1.158, 3.552]**	**2.093 [1.355, 3.232]**	1.410 [0.829, 2.396]	1.332 [0.872, 2.034]

Predictors	**(1) Total Ads** **IRR [CI]** [a]	**(2) Total Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]	**(3) Core F&B Ads** **IRR [CI]** [a]	**(4) Core F&B Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]	**(5) Non-Core F&B Ads** **IRR [CI]** [a]	**(6) Non-Core F&B Ads** (Controlling for Food Outlet Count) **IRR [CI]** [a]
High	1.231 [0.718, 2.111]	1.371 [0.895, 2.101]	1.187 [0.665, 2.119]	1.446 [0.900, 2.322]	1.198 [0.698, 2.056]	1.238 [0.801, 1.915]
Ethnocultural Composition						
Low [b]	1	1	1	1	1	1
Medium	1.125 [0.686, 1.845]	0.906 [0.610, 1.346]	1.220 [0.708, 2.103]	0.919 [0.597, 1.415]	1.036 [0.632, 1.697]	0.904 [0.603, 1.355]
High	1.013 [0.625, 1.642]	0.939 [0.637, 1.384]	1.259 [0.741, 2.138]	1.166 [0.765, 1.779]	0.937 [0.577, 1.521]	0.891 [0.598, 1.326]
Number of Food Outlets						
Low (0-8) [b]	-	1	-	1	-	1
Medium (9-25)	-	**2.992 [2.054, 4.359]**	-	**3.969 [2.482, 6.347]**	-	**2.495 [1.687, 3.688]**
High (>25)	-	**7.429 [4.805, 11.486]**	-	**10.673 [6.333, 17.985]**	-	**6.351 [4.062, 9.930]**

[a] The values shown are the exponential of the B-coefficient and Confidence Intervals (CI). The Incidence Rate Ratio (IRR) is the exponentiation of the B-coefficient.

[b] The B coefficient was set to zero because this parameter is redundant.

Bolded values indicate a significance of p < or = 0.05, 95% CI used.

Compared to Vancouver, almost all the cities in all the negative binomial regression models had significantly fewer advertisements. When looking at the regression model for all advertisements that controls for food outlet counts (Model 2), the cities that have significantly fewer advertisements in comparison to Vancouver ranges from Halifax, with only 24.2% the advertisement count in Vancouver (CI: 0.145 - 0.405), to Winnipeg, with 56.6% of the advertisement count in Vancouver (CI: 0.344 - 0.932). When food outlet count was controlled in the model of all advertisements, Quebec City no longer had significantly fewer advertisements than Vancouver.

Before controlling for food outlet counts, school areas with medium and high degrees of residential instability were significantly associated with higher advertisement counts, for all types of advertisements, compared to school areas with low degrees of residential instability. After controlling food outlet counts, fewer significant associations were observed between residential instability and increases in advertisements counts. In the controlled model for all advertisements, only school areas with

a high degree of residential instability contained significantly more advertisements than the school areas with a low degree of residential instability (IRR = 1.707, CI:1.029 - 2.832). Moreover, in the controlled model for advertisements that contain a non-core F&B product, only school areas with a medium degree of residential instability contained significantly more advertisements than the school areas with a low degree of residential instability (IRR = 1.560, CI: 1.005 - 2.421).

After controlling for food outlet counts, school areas with medium degrees of economic dependence and situational vulnerability were significantly associated with increases in advertisement counts compared to school areas with low degrees of this deprivation for all types of advertisements (IRR = 1.586, CI: 1.053, 2.387) and advertisements containing a core F&B product (IRR = 2.093, CI: 1.355 - 3.232). School areas with high degrees of economic dependence and situational vulnerability were not significantly associated with increases in advertisement counts compared to school areas with low degrees of this deprivation.

The negative binomial regression models that included food outlet count tertiles (low, medium, and high) found that the number of food outlets is significantly associated with the counts of all advertisements, as well as the counts of advertisements containing core and non-core F&B products. For all advertisements, school areas with medium food outlet counts contained 2.992 times more advertisements than school areas with low food outlet counts (CI: 2.054 – 4.359), while school areas with high food outlet counts contained 7.429 times more advertisements than school areas with a low food outlet counts (CI: 4.805 – 11.486). For advertisements containing a core F&B product, school areas with medium food outlet counts contained 3.969 times more advertisements than school areas with low food outlet counts (CI: 2.482 - 6.347), while school areas with high food outlet counts contained 10.673 times more advertisements than school areas with low food outlet counts (CI: 6.333 - 17.985). Similarly, for advertisements containing a non-core F&B product, school areas with medium food outlet counts contained 2.495 times more advertisements than school areas with low food outlet counts (CI: 1.687 - 3.688), while school areas with high food outlet counts contained 6.351 times more advertisements than school areas with low food outlet counts (CI: 4.062 - 9.930).

No statistically significant associations were found between the degree of ethnocultural composition and advertisement count, nor the degree of urbanization and advertisement count, even after controlling for food outlet counts within the 1000 m road-network buffers around schools.

3.5 Discussion

3.5.1 Key Findings

The findings of this study provide insight into the associations between outdoor F&B advertising environments, food environments, and neighbourhood characteristics (i.e., neighbourhood deprivation, ethnocultural composition) in six large cities across Canada, and nearby rural areas. The following four key findings were synthesized from this study's results and are discussed in this section in further detail: (1) outdoor F&B advertisement prevalence is significantly associated with food outlet density; (2) outdoor F&B advertisement prevalence is significantly different between cities; (3) outdoor F&B advertisement prevalence is not significantly different between urban and rural areas; (4) outdoor F&B advertisement prevalence is significantly associated with only some of the CIMD dimensions.

3.5.1.1 Outdoor F&B Advertisement Prevalence is Significantly Associated with Food Outlet Density

Outdoor F&B advertisement prevalence is significantly associated with food outlet density. Total outdoor F&B advertisement counts, outdoor core F&B advertisement counts, and non-core F&B advertisement counts within 1000 m of schools significantly increased as the number of food outlets increased. This is not surprising given that most of the identified outdoor advertisements were located on food outlet exteriors. On average, ~25 outdoor F&B advertisements were identified within 1000 m of schools, where ~23 of these advertisements were located on food outlet exteriors, and only ~2 of these advertisements were freestanding. It is also true that areas with high food outlet counts also had higher mean counts of freestanding outdoor F&B advertisements (M = 5.10, SD = 5.46) compared to areas with low and medium counts of food outlets (M = 0.09, SD = 0.29; and M = 1.24, SD = 1.77, respectively).

Since most outdoor F&B advertisements are located on food outlet exteriors, the types of F&B products promoted within 1000 m of schools will depend on the types of food outlets near schools and the types of products offered by these food outlets. Therefore, to create healthier food environments near schools, policy interventions could focus on (1) restricting food outlets from advertising non-core foods near schools, (2) incentivizing food outlets to advertise core foods near schools, (3) restricting "unhealthy" food outlets from operating near schools, and/or (4) incentivizing "healthy" food outlets to operate near schools. Since models of the food environment show that food choices are influenced by the type and location of food outlets and advertisements, policies that target both food outlets and outdoor F&B advertisements will be most effective at creating healthier food environments near schools that foster healthier food choices (Downs et al., 2020; Finlay et al., 2022; Glanz et al., 2005; Perry et al., 2024; Smith et al., 2019).

3.5.1.2 Outdoor F&B Advertisement Prevalence is Significantly Different Between Cities

The findings from this study also show that advertisement prevalence is significantly different between cities. Vancouver had notably higher mean advertisement counts within 1000 m of schools compared to other assessed cities. Moreover, compared to Vancouver, almost all other cities in all the negative binomial regression models (both before and after controlling for food outlet counts) had significantly fewer advertisements. One potential reason for these differences between cities is differences in the built environment and population density. Vancouver is the city with the highest population density in all of Canada (5,749.9 people per km^2), with most of the population (62%) living in apartment/condo buildings (see **Table 1.1**) (Statistics Canada, 2022a; Statistics Canada, 2022b). Denser cities typically have more infrastructure for freestanding advertisements (e.g. bus stops, billboards), and advertisements will be seen by more people in densely populated areas. As a result, density is likely a contributing factor to the differences between cities shown in this study. Future research should explore associations between population density and outdoor F&B advertisement prevalence to further investigate this potential connection.

Another notable difference between cities was that Quebec City had higher mean counts of advertisements containing core F&B products compared to non-core F&B products. Moreover, despite Vancouver having notably higher advertisement counts than Quebec City, Quebec City did not have significantly lower counts of core F&B advertisements than Vancouver in the negative binomial regression models (both before and after controlling for food outlet counts). These findings suggest that Quebec City has healthier F&B advertising environments than other cities. One potential reason for this finding is that the province of Quebec is the sole jurisdiction in Canada with legislation that prohibits advertising to children (Anggadol, 2024; Canadian Marketing Association, n.d.). In 1980, Sections 248 and 249 of Quebec's *Consumer Protection Act (CPA)* prohibited the commercial advertising of all goods and services – including outdoor F&B advertising – that target children under the age of 13 years old (Anggadol, 2024; Office de la Protection du Consommateur, 2012). The Act has three criteria to determine whether advertisements are targeting children, including (1) if the good/service is intended for children or appeals to children, (2) if the advertisement is designed to appeal to children, and (3) if the advertisement is present in a location that children are frequently exposed to (Office de la Protection du Consommateur, 2012). Since non-core food products (e.g., candy and fast-food meal toys) are appealing to children, advertisements for non-core F&B products can potentially be prohibited if the other child-targeting criteria are satisfied. None of the other provinces/cities assessed have legislation prohibiting advertising to children. Thus, this Act may explain why Quebec has more core F&B advertisements than non-core F&B advertisements near schools.

Overall, these significant differences between cities indicate that outdoor F&B advertisements across Canada vary. As a result, data from cities with different political, legislative, and geographic contexts is needed to understand outdoor F&B advertising environments across Canada and better inform federal and provincial policy decisions on advertising to youth. Future research should further explore why these differences in outdoor F&B advertisement counts between cities exist (i.e. conducting qualitative interviews with city planners and policymakers).

3.5.1.3 Outdoor F&B Advertisement Prevalence is Not Significantly Different Between Urban and Rural Areas

While urban areas seemed to have higher mean counts of outdoor F&B advertisements than rural areas, these results were not statistically significant in the negative binomial regression models. None of the identified literature explored differences in outdoor F&B advertisement prevalence between rural and urban areas, so this finding cannot be compared to existing literature. One potential reason for this finding is that not all the small municipalities selected to represent rural areas had low population densities. For example, Langley, BC, was selected to represent small municipalities near Vancouver; however, its population density is higher than that of Calgary, Winnipeg, Ottawa, Quebec City, and Halifax (See **Table 1.1** and **Table 1.2**). Future studies should use density to determine the degree of urbanization in cities to more accurately assess if there are outdoor F&B advertising differences between rural and urban areas.

3.5.1.4 Outdoor F&B Advertisement Prevalence is Significantly Associated with Only Some of the CIMD Dimensions.

The following CIMD dimensions, shown in **Table 3.7** were used in the analysis to assess associations between different dimensions of deprivation and outdoor F&B advertisement counts around schools. A more comprehensive list of the census indicator variable data used to compose each dimension is found in **Table 2.2**. Since each CIMD dimension is composed of very multi-faceted data, this section explores how various aspects of each dimension relate to the results. Since the CIMD dimensions are more multi-faceted than most deprivation variables used in the literature (e.g., income), this section also explores why this study's results may differ from the findings of the literature.

Table 3.7: Overview of CIMD dimensions used in this study (Statistics Canada, 2023a).

CIMD Dimension	Statistics Canada (2023) Definition
1) Residential Instability	"Speaks to the tendency of neighbourhood inhabitants to fluctuate over time, taking into consideration both housing and familial characteristics"
2) Ethno-cultural Composition	"Refers to the community make-up of immigrant populations"
3) Composite Index of Economic Dependency and Situational Vulnerability	**Economic dependency** "relates to reliance on the workforce, or a dependence on sources of income other than employment income" **Situational vulnerability** "speaks to variations in socio-demographic conditions in the areas of housing and education, while taking into account other demographic characteristics"

3.5.1.4.1 Outdoor F&B Advertisement Prevalence is Significantly Associated with the Degree of Residential Instability in Neighbourhoods

Before controlling for food outlet counts, school areas with medium and high degrees of residential instability had significantly higher outdoor F&B advertisement counts, for all types of advertisements (total ads, core F&B ads, and non-core F&B ads), compared to school areas with low degrees of residential instability. Since the CIMD dimension of residential instability includes the variable "proportion of dwellings that are apartment buildings," and apartment buildings are typically adjacent to retail spaces or are mixed-use buildings that include retail spaces, it is likely the higher proximity to food outlets and higher degrees of residential instability that resulted in this significant association.

After controlling for food outlet counts, only school areas with a high degree of residential instability contained significantly more outdoor F&B advertisements than the school areas with a low degree of residential instability (IRR = 1.707, CI:1.029 - 2.832). Residential instability is a measure of housing instability, household instability, and high residential mobility. Residential instability primarily impacts low-income households, and as a result, neighborhoods with high degrees of residential instability also have low household incomes (Cotton & Schwartz-Barcott, 2016). Furthermore, the CIMD dimension of Residential instability includes the reverse-coding of the census indicator "median 2021 household income." Since no identified studies in the literature looked at the association between residential instability and outdoor F&B advertisement prevalence, these findings were compared to literature that explored the association between income/socioeconomic status/deprivation and outdoor F&B advertisement prevalence. Findings from the literature are mixed on whether neighbourhood income/socioeconomic status/deprivation is associated with outdoor F&B advertisement prevalence. Most studies found that higher levels of neighbourhood deprivation are associated with increases in outdoor

F&B advertisement prevalence, or that neighbourhoods with high deprivation have higher counts of outdoor F&B advertisements than their low-deprivation counterparts (Backholer et al., 2020; Brien et al., 2022; Finlay et al., 2022; Hillier et al., 2009; Isgor et al., 2016; Kneller et al., 2024; Ruggles et al., 2023; Ruggles et al. 2024; Trapp et al., 2022; Wells et al., 2023); however, some studies, including the sole identified quantitative study from Canada, found no significant associations/differences in outdoor F&B advertisement counts between neighbourhood socioeconomic status groups (Backholer et al., 2020; Finlay et al., 2022; Velazquez et al., 2019). The findings from this study are consistent with most of the literature on deprivation and outdoor F&B advertisement counts; however, it differs from the findings of the only quantitative Canadian study on this topic (Velazquez et al., 2019). Future research in Canada should continue to explore the associations between neighbourhood deprivation/socioeconomic status/income to better understand the associations that exist.

3.5.1.4.2 Outdoor F&B Advertisement Prevalence was Not Significantly Associated with Neighbourhood Ethnocultural Composition

The findings from the negative binomial regression show that outdoor F&B advertisement prevalence was not significantly associated with neighbourhood ethnocultural composition. This lack of association suggests that neighbourhoods with high ethnocultural compositions are not targeted disproportionately by outdoor F&B advertisements. These findings differ from USA literature that found majority racialized neighbourhoods have a higher prevalence of outdoor F&B advertisements compared to majority white neighbourhoods (Finlay et al., 2022; Herrera & Pasch, 2017; Hillier et al., 2009). The CIMD dimension of ethnocultural composition includes the proportion of the population who identify as a visible minority, as well as the proportion of the population that is foreign-born, are recent immigrants, and/or have no knowledge of either of Canada's official languages (English and French). As a result, the variable of ethnocultural composition includes recent immigrants and foreign-born individuals who are not visible minorities. To more accurately draw comparisons with literature from the USA, future Canadian studies should explore the association between the proportion of the population identifying as a visible minority (racialized person) and outdoor F&B advertisement prevalence. However, it is also possible that the Canadian and USA contexts are quite different, and that racialized neighbourhoods in Canada do not have higher outdoor F&B advertising counts than other neighbourhoods. Research suggests that Canadian cities do not have the same racial segregation and poverty concentration patterns as the USA (Walks & Bourne, 2006). Canadian cities have a high proportion of visible minorities with low incomes living in apartment housing, and due to limited economic mobility opportunities for these groups, they can become spatially clustered in undesirable neighbourhoods. Conversely, wealthier visible minorities, have more economic mobility, and are less likely to cluster in undesirable neighbourhoods;

however, they may choose to cluster in more desirable ethnic enclave neighbourhoods (Walks & Bourne, 2006). As a result, future research should explore the differences in outdoor F&B advertisement exposure between neighbourhoods with a high proportion of racialized persons with low incomes and neighbourhoods with a high proportion of racialized persons with high incomes. Future research should also continue to explore the associations between outdoor F&B advertising environments and immigrants as there is limited Canadian research on immigrant experiences with the food environment (Minaker et al., 2016).

3.5.1.4.3 Outdoor F&B Advertisement Prevalence Did Not Have Significant Association Patterns with the Composite CIMD dimension of Economic Dependence and Situational Vulnerability.

Although statistical significance was found in some of the negative binomial regression models for associations between outdoor F&B advertisement counts and moderate levels of economic dependence and situational vulnerability, no consistent gradient/pattern in the findings was observed. Since none of the existing literature explored or identified associations between economic dependency, situational vulnerability, and outdoor F&B advertisement prevalence, it is likely that these variables are not associated with each other. Future research should explore the associations between these variables using economic dependence and situational vulnerability as individual dimensions rather than a composite index (as was used in this thesis) to see if one of these dimensions is associated with outdoor F&B advertisement prevalence.

3.5.2 Relevance for Planning Research & Practice

This research is relevant to planning research as it assesses the relationship between outdoor F&B advertisement counts, food outlet counts, and neighbourhood characteristics to inform planners about the state of food environments in cities in Canada. There is limited existing literature that conducts primary quantitative studies on the associations between these variables, especially in Canada, where only one study from Vancouver exists on this topic (Velazquez et al., 2019). The current study found Vancouver had notably higher outdoor F&B advertisement counts compared to other cities across Canada. Although Velazquez et al.'s (2019) study provides important insights to planners in Vancouver, it is less insightful to planners in other cities across Canada as they have drastically different contexts. This manuscript fills this research gap by synthesizing data on outdoor F&B advertising environments near schools in six cities across Canada. If planners are using this research to inform policy, the results from the city that most closely matches the city's context should be used.

Furthermore, the findings of this research are relevant to planning practice as it identifies an area of the food environment that planners can modify through zoning regulations to create healthier cities for

youth. As this study shows, school areas with higher food outlet counts have higher outdoor F&B advertisement counts, and most of these advertisements are located on the exteriors of food outlets themselves. As a result, zoning bylaws that incentivize "healthy" food outlets to operate near schools or restrict "unhealthy" food outlets from operating near schools can help reduce youth exposure to "unhealthy" food outlets and "unhealthy" advertisements and can encourage healthier food choices in youth. These findings are especially important for the future of planning, as Canadian cities are becoming denser to accommodate population growth pressures with limited land areas to develop. As cities densify, high-density mixed-use residential apartment/condo buildings with lower-level retail spaces are becoming more common, which can consequently increase exposure to "unhealthy" food outlets and outdoor "unhealthy" F&B advertisements. Due to limited areas to develop schools in densifying cities, Toronto is building Canada's first elementary school in a condo (Government of Ontario, 2022). This trend of building schools in high-density mixed-use residential buildings will likely continue in cities across Canada as the population grows. Based on the findings of this study, these schools will be at risk of having high exposure to outdoor F&B advertisements and food outlets. The research from this manuscript can be used by planners to inform zoning policies that create healthier food environments around schools, especially as cities densify and exposures to outdoor F&B advertisements increase. More specific details on potential zoning policies that planners can implement are discussed in **Chapter 4 - Conclusion**.

3.5.3 Study Limitations

This study had several limitations that impacted its accuracy and reliability. One limitation is that advertisement counts had to be estimated around some schools. If a school had more than 50 food stores/restaurants within its buffer, 30 food stores/restaurants were randomly selected to make data collection of outdoor F&B advertisements more feasible. As a result, the outdoor F&B advertisement counts on the food store/restaurant exteriors that were not sampled had to be estimated to obtain a total advertisement count for the area. Since these estimates are based on data from randomly selected food stores/restaurants, they are likely representative of the actual content; however, estimation is not as accurate as collecting data from every store/restaurant within the school buffer areas.

Another limitation is that for some schools, data collectors included food outlets slightly beyond the 1000 m buffer area around schools if they knew that students frequented these locations during lunch and after school. This data collection method is advantageous as it more accurately reflects students' exposures based on how they navigate space and spend their time compared to the arbitrary 1km buffer; however, this method was not fully consistently used by every data collector for every school, which impacts the reliability of the data. Future research should consider using buffer areas that are informed by

how students navigate space to more accurately assess their exposures to outdoor F&B advertisements and food outlets.

Furthermore, this study is limited in its analysis of food outlets near schools. Although the type of food outlets was collected, it was not included in this analysis, so the association between food outlet type and outdoor F&B advertisement counts is unknown. An analysis of food outlet type was not included due to challenges with classifying food outlets as "healthy" or "unhealthy." Since many food outlets have a variety of healthy and unhealthy options, it is challenging to classify food outlets into these categories. Future research should develop tools to accurately classify food stores in a time-effective manner, so more insight on food outlets can be incorporated into research on outdoor F&B advertising environments.

Another limitation is that this study did not look at the differences in advertisement counts between primary and secondary schools in each city. These differences were not looked at as there would not have been enough data in each cell to perform a chi-square test. Since teenagers have more purchasing power than children, it would have been interesting to see if secondary schools were targeted by advertisements more than elementary schools. It would have been particularly interesting to see if advertisement counts differed between primary and secondary schools in Quebec City since Quebec has an advertising ban on children under 13 years old (Office de la Protection du Consommateur, 2012). Future research should explore the differences in marketing techniques by school type (primary and secondary schools).

4 Chapter 4
Conclusion

4.1 Summary of Findings

The purpose of this thesis is to describe outdoor F&B advertising environments near schools in cities across Canada and understand the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition. The findings of this thesis contribute to empirical research gaps on outdoor F&B advertising environments in Canadian cities. Furthermore, this thesis contributes to planning practice by identifying opportunities for planners to use planning policies / tools and collaborate with public health professionals to create healthier food environments for youth.

Manuscript 1 describes the F&B content, youth-directed marketing power, and prevalence of outdoor F&B advertisements within 1000 m of schools, and explores differences between six cities across Canada, as well as urban and rural areas. Three key findings emerged from this research. The first key finding is that most (64.5%) outdoor F&B advertisements near schools promote "unhealthy" F&B products. The second key finding is that the content of outdoor F&B advertisements varies by city and degree of urbanization. Therefore, it is necessary to monitor outdoor F&B advertising environments in cities with a variety of geographical contexts across Canada to better inform policy decisions. The third key finding is that youth-directed marketing techniques were identified in outdoor F&B advertisements around schools, with the most popular techniques being youth product/convenience (39.4%), sense of urgency/limited time offer/seasonal (18.4%), and price promotion/discount (13.1%).

Manuscript 2 explores the association between outdoor F&B advertisement prevalence, food outlet density, degree of urbanization, and neighbourhood deprivation/ethnocultural composition within 1000 m of schools in six cities across Canada. Five key findings emerged from this research. The first key finding is that outdoor F&B advertisement prevalence is significantly associated with food outlet density. As a result, policies to create healthier food environments should target both food outlets and outdoor F&B advertisements. The second key finding is that outdoor F&B advertisement prevalence near schools is significantly different between cities, with Vancouver having a notably higher prevalence of outdoor F&B advertisements near schools. These differences seem to be the result of contextual differences such as differing population densities and advertising policies; however, further research is needed to determine why these differences exist. The third key finding is that outdoor F&B advertisement prevalence is not significantly different between urban and rural areas; however, this finding is limited due to the inclusion of mid-sized and/or high-density communities in the rural category. The fourth key

finding is that high outdoor F&B advertisement prevalence around schools is significantly associated with high degrees of residential instability, which are typically low-income areas. As a result, policies to create healthier F&B advertising environments near schools should focus on areas with high degrees of residential instability. Finally, the fifth key finding is that outdoor F&B advertisement prevalence was not significantly associated with neighbourhood ethnocultural composition, which differs from findings in literature from the USA.

4.2 Contributions to Research

Due to the rising rates of obesity and overweight amongst youth in Canada, the Government of Canada is seeking research that reports on progress to reduce childhood overweight and obesity in Canada, including monitoring factors influencing weight (e.g., F&B advertisements) (Health Canada, 2023; Public Health Agency of Canada, 2012). Furthermore, Health Canada has proposed restrictions on the commercial advertising of unhealthy foods to children on broadcast and digital media platforms (Health Canada, 2022; Health Canada, 2024). As advertising is restricted on broadcast and digital media platforms, food companies are expected to shift towards outdoor advertising to target youth (Finlay et al., 2022). Research is needed imminently to understand and describe outdoor F&B advertisement prevalence and youth-directed marketing power near schools in cities across Canada as a baseline before these advertising restrictions come into effect. This thesis fills this research gap by assessing the prevalence and marketing power of outdoor F&B advertisements in six cities across Canada. Many of the definitions used in this thesis align with Health Canada's proposed policy restriction on marketing non-core foods to children on digital and broadcast media and can be used to inform the possibility of extending this policy's scope to include outdoor media (Health Canada, 2024).

Based on the literature reviews in this thesis, as well as a scoping review by Finlay et al. (2022), only one primary, quantitative Canadian study has monitored outdoor F&B advertisement prevalence around schools and evaluated the association between outdoor F&B advertisement prevalence, food outlet density, and neighbourhood deprivation (Velazquez et al., 2019). This existing study collected data in Vancouver and consequently provides important insights to planners, policy makers and public health professionals in Vancouver and similarly dense and intensifying cities (Velazquez et al., 2019). This study is less insightful to professionals in other Canadian cities since Vancouver is the city with the highest population density in all of Canada (5,749.9 people per km^2). Due to Vancouver's uniquely dense built environment, the transferability of this existing outdoor advertising research to other Canadian cities is limited. This thesis fills this empirical research gap by analyzing data on outdoor F&B advertising environments near schools in six cities and nearby smaller municipalities across Canada, providing less dense cities with findings that can be transferred with higher reliability. Since data is synthesized for each

of the six cities, local planners, policy makers and public health professionals from cities across Canada can look at the results from the city (or rural area) that most closely matches their city's context to inform policy decisions.

4.3 Contributions to Planning Practice

This thesis research supports calls from CIP, OPPI, and food systems researchers for planners' involvement in food system planning by contributing to evidence that supports the use of planning policies and tools to create healthier food environments (CIP, 2018; OPPI, 2011; Pothukuchi & Kaufman, 2000). The most notable findings from this thesis research for planners are (1) outdoor F&B advertisement prevalence near schools is strongly associated with food outlet prevalence near schools and (2) most outdoor F&B advertisements are located on food outlet exteriors. As a result, the types of F&B products promoted within 1000 m of schools will depend on the types of food outlets near schools and the types of products these food outlets want to promote. Therefore, to create healthier F&B advertising environments near schools, policy interventions could focus on (1) restricting food outlets from advertising unhealthy foods near schools, (2) incentivizing food outlets to advertise healthy foods near schools, (3) restricting unhealthy food outlets from operating near schools, and/or (4) incentivizing healthy food outlets to operate near schools. Policy intervention options (1) and (2) fall primarily under the jurisdiction of public health professionals, while policy intervention options (3) and (4) fall within the jurisdiction of urban planning.

In 2017, the Food Environment Policy Index (Food-EPI) tool, developed by INFORMAS, was used to examine the current state of food environment policy in Canada and identify key areas for improvement (Vanderlee et al., 2017; Vanderlee et al., 2019). This study compared Canada's progress in implementing policy and infrastructure support to create healthier food environments to international best practices. In the following seven food policy areas, provinces and territories across Canada were rated as having limited or non-existent policies[22] (Vanderlee et al., 2017; Vanderlee et al., 2019):

1. Restricting the promotion of unhealthy foods to children via broadcast media.
2. Restricting the promotion of unhealthy foods to children via non-broadcast media.
3. Restricting the promotion of unhealthy food to children in child areas.
4. Planning policies to restrict unhealthy food outlets.

[22] Quebec was the only province/territory in Canada that was rated as having strong food policies related to restring the promotion of unhealthy foods to children via broadcast media, non-broadcast media, and in child areas due to Quebec's *Consumer Protection Act* (Office de la Protection du Consommateur, 2012).

5. Planning policies to promote healthy food outlets.
6. Healthy and unhealthy food availability in stores.
7. Healthy and unhealthy food availability in restaurants.

The findings of the Food-EPI Canada report demonstrate that the four policy intervention options identified in this thesis are not currently being implemented in Canada or are only being implemented to a limited extent (Vanderlee et al., 2017; Vanderlee et al., 2019). Planners across Canada should begin to implement planning policies that restrict unhealthy food outlets around schools and encourage healthy food outlets around schools to create healthier food environments for youth. Planners can look to best practices from other countries to identify ways these policies can be implemented in Canada. For example, South Korea has utilized zoning restrictions to create "Green Food Zones" within 200 m around schools that ban the sale of fast food and soda (Drewnowski et al., 2020; Vanderlee et al., 2017; Vanderlee et al., 2019). Moreover, several cities in the USA have implemented planning policies that encourage healthy food outlets, particularly in underserved areas (Vanderlee et al., 2017; Vanderlee et al., 2019). For example, Birmingham, Alabama has approved a "healthy food overlay district" zoning bylaw that would apply to census tracts with limited healthy food access (Prickett, 2019). This bylaw prevents small box discount stores (e.g., dollar stores) from being built within one mile of existing small box discount stores (Prickett, 2019; Healthy Food Policy Project, n.d.). This bylaw also encourages grocery stores to be built by relaxing some of the zoning requirements on grocery stores, such as reducing parking requirements and allowing larger floor areas (Healthy Food Policy Project, n.d.). Finally, this bylaw allows mobile grocers and community gardens to sell in residential neighbourhoods (Prickett, 2019; Healthy Food Policy Project, n.d.). Furthermore, Canada has some existing examples of using zoning bylaws to create healthier environments. From 2002 to 2016, 27 municipalities across Canada were identified as adopting municipal zoning bylaws that either partially or fully ban fast-food drive-through services (Nykiforuk et al., 2018). Although this bylaw does not ban food outlet types, it bans certain services that food outlets can provide.

While these examples showcase how zoning can be used to reduce unhealthy food access and promote healthy food access, it is not clear how effective these bylaws are. Since there is limited research that evaluates the outcomes of these zoning bylaws, Soon et al. (2023) performed a simulation study of a restrictive junk food ban in the Region of Waterloo. This study found that the zoning bylaws were ineffective at reducing unhealthy food access in areas with existing unhealthy food stores (e.g., convenience stores and fast-food outlets). Since existing unhealthy food outlets would still be allowed to operate as legal non-conforming uses if a zoning bylaw to restrict unhealthy food outlets was passed, changes to the food environment would only be observed if existing food outlets stopped operating,

which could take decades (Soon et al., 2023). For these zoning bylaws to be effective, they would need to be implemented before unhealthy food outlets open, such as in new developments or rural areas without many existing food outlets (Soon et al., 2023). As suburban neighbourhoods in many Canadian cities begin to intensify to accommodate housing shortages with mixed-use residential infill developments, there is an opportunity for municipalities to implement zoning bylaws that foster healthier food environments near schools before they become inundated with unhealthy food outlets. Since this thesis found that youth are exposed to a higher prevalence of outdoor F&B advertisements near schools in areas with more food outlets, this research can be used by planners as evidence to support zoning bylaws that restrict unhealthy food outlets near schools. However, due to the limited research on the implications of such bylaws, municipalities should identify and mitigate any potential unintended consequences before implementation. For instance, if affordable, healthy alternatives to unhealthy food outlets cannot be provided, such a bylaw could create food access barriers for people who rely on financially accessible food options (Soon et al., 2023). Furthermore, studies have shown that food outlets in suburban mixed-use developments have challenges remaining economically viable (Grant & Perrott, 2011). To ensure that policies restricting unhealthy F&B outlets or advertisements do not detrimentally impact the economic viability of healthy food outlets, collaborations with business improvement areas and economic development professionals are needed to identify ways to mitigate the unintended financial consequences of these policies on healthy food outlets.

Since restrictive zoning bylaws would be unsuccessful in neighbourhoods with existing unhealthy food outlets, food policies that restrict the promotion of unhealthy F&B products near schools could be implemented in these areas to encourage healthier eating behaviours in youth. As this thesis identifies, most outdoor F&B advertisements around schools promote unhealthy F&B products, which can influence youth to make unhealthy food choices. Therefore, restricting unhealthy F&B advertisements near schools could create healthier food environments, even if the food outlets in the area do not change. Since food policies that restrict the promotion of unhealthy foods to children would fall under the jurisdiction of public health professionals, such policies could not be implemented by planners. Planners and public health professionals should work together to create complementary policies that create healthier food environments around schools in both newly developed and well-established neighbourhoods. In Canada, municipal planners are not required to consult with public health professionals on community plans, zoning bylaws, and development applications (Gregg & Chen, 2017). Fostering collaboration between these departments and creating opportunities for public health professionals to comment throughout the planning process can lead to the identification and implementation of more healthier food environment policies.

4.4 Recommendations for Future Research

This thesis has played a significant role in filling empirical research gaps on outdoor F&B advertising environments around schools across Canada and has identified opportunities for planners to become involved with creating healthier food environments around schools. Although this research has valuable findings for planning research and practice, there were some limitations with the study design that should be improved in future research to create more accurate and reliable findings. These areas for improvement include the following:

- If feasible, collect outdoor F&B advertisement data on every food outlet around schools rather than only a sample.
- Ensure data surveyors are consistently using the same distances around schools to collect data.
- Assess the differences in outdoor F&B advertisements between primary and secondary schools.
- Avoid selecting schools with overlapping buffer areas to avoid duplicates of data points.
- Create a more rigorous system of classifying F&B advertisements and food outlets into 'healthy' and 'unhealthy' categories.
- Assess outdoor F&B advertisement prevalence in neighborhoods with high proportions of visible minorities and immigrants as separate categories, rather than as a combined category.
- Study outdoor F&B advertising environments in more rural and remote communities to better understand the rural experience and inform policy.
- Explore the differences in outdoor F&B advertising environments by neighborhood density to better understand the advertising differences in higher and lower-density areas of a city.

Since this thesis' purpose was to describe outdoor F&B advertising environments and understand associations between the built environment (e.g., number of food outlets) and outdoor F&B prevalence, this study did not assess the impacts of outdoor F&B advertising environments on eating behaviors; future research should aim to determine these impacts. Furthermore, if policies that prohibit unhealthy outdoor F&B advertisements or outlets near schools are implemented, research will be needed to determine how effective these policies are at changing youth eating behaviours. Research identifying any negative unintended consequences of these policies (e.g., lack of affordable food options) will also be necessary to ensure these policies are not creating additional barriers to healthy eating.

Finally, this thesis research identifies preliminary opportunities for public health professionals and planners to collaborate. Future research should explore more specific and detailed opportunities for these professions to collaborate to create healthier food environments. Other multidisciplinary collaborations that would foster the creation of more nutritious food environments should also be explored. For instance, planners and public health professionals may also want to consult with economic

development professionals to ensure restrictive policies do not negatively impact the financial viability of healthy food outlets.

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Appendix A

Descriptions and examples of marketing indicators for Outdoor Advertisement Settings (adapted from Minaker, 2022b)

OUTDOOR ADVERTISEMENT SETTINGS		
Indicator	**Description**	**Examples**
Brand / company character	Presence of company- or brand-owned characters or spokespersons that may appeal to youth. *Note: these characters are often given a name and are used across marketing platforms.*	- Tony the Tiger - Ronald McDonald - Wendy's Wendy - A&W Burger Family - Kraft Bears - Pillsbury Doughboy - Starbucks Mermaid
Generic cartoon character	Presence of generic cartoon characters, children, animals, etc. that **<u>are not</u>** branded or licensed characters, celebrities, or cross-promotions to youth-directed media.	- Cartoon pictures of fictional sports players - Cartoon drawings of animals - Cartoon kids or families
Licensed character / cross-promotion with movie or TV / celebrity / athlete	Presence of licensed characters from TV shows, movies, books, etc., that may appeal to youth. Presence of actors, athletes, musicians, influencers, or other public figures that may appeal to youth.	- Dora the Explorer - Paw Patrol characters - Batman - Spiderman - Characters from Riverdale - Marvel superheroes - Star Wars characters - YouTubers and social media influencers - Blue Jays + Pizza Pizza ad - Olympians + Coca Cola ad

OUTDOOR ADVERTISEMENT SETTINGS		
Indicator	**Description**	**Examples**
Images of kids / teens	Presence of kids and teens in advertisements that show the product is appealing to youth.	
Price promotion / discount	There is a sale, deal, discount, or special offer present, or the F&B is featured on the dollar or value menu. Exclusive specials on certain days of the weekday are also included.	- Two for one - 50% off - Buy one get one free
Contest / game / toy / gift / collectible	Youth-directed coupons, contests, toys, prizes, or giveaways are promoted with the purchase of the F&B *Note: contests or giveaways must be for youth-directed prizes (unlike, for e.g., a Patio Furniture set)*	- Enter to win tickets to a youth-directed movie - Coupon for free Goldfish crackers - Toys included with purchase - Stickers included with youth's meal
Corporate social responsibility	F&B marketing makes appeals to other product benefits, for example: value, sustainability, philanthropy, etc.	- "Proud supporter of / proceeds go to X organization" - B Certified Corporations - Sustainably sourced ingredients - Partnerships with social/environmental organizations (e.g., Burger King and World Wildlife Fund, Tim Horton's Orange Shirt Day)
Youth product / convenience	Specific promotion of the product or service being convenient for snacking, packing in lunches, eating after sports practice, etc., including third-party delivery services.	- Third-party delivery services (e.g., Uber Eats, Skip the Dishes, local third-party services) - "Perfect for on-the-go snacking." - "Great for packing in lunches"

OUTDOOR ADVERTISEMENT SETTINGS		
Indicator	**Description**	**Examples**
	Note: this does not include single serve packaging (e.g., juice boxes or crackers and cheese packs) without specific promotion of their convenience.	- "Contains 6 easy pre-wrapped servings"
Loyalty program	F/B marketing promotes a youth-directed restaurant/brand website, brand social media pages or opportunities to "join," "become a member", redeem points, and collect rewards or to connect or share with others in a manner that is evidently youth-directed	- Restaurant rewards apps - "Find more cool recipes on our social media channels" - "Tag your friends and use X hashtag" - Invitations to share photos with their social media followers - Websites with a 13+ age limit - Scannable codes or numbers to text to receive updates or promotions
Sense of urgency / seasonal offer / limited time offer	Any description of the product or flavour being "new", limited time, or seasonal offer. *Note: This does not include daily specials at restaurants or daily features only available on certain days of the week.*	- "New look, same great taste" / Improved recipe - Starbucks's pumpkin spiced latte only available in the fall - New menu item - "Spicy McNuggets are here" - McDonalds

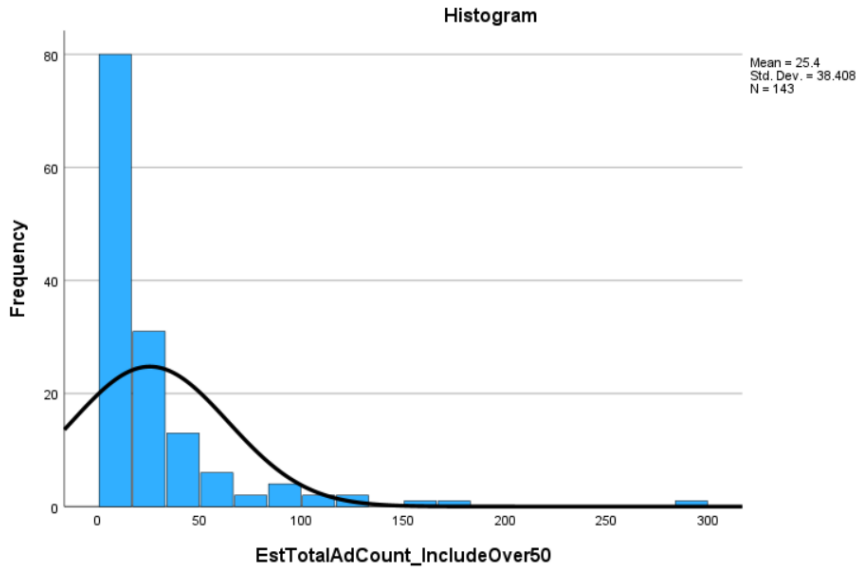
Appendix B

Selecting and Fitting a Negative Binomial Regression Model in IBM SPSS Statistics

Selecting a Negative Binomial Regression Model

Since the outcome variable being modelled is count data, the regression model needs to be a type that supports count data. To determine which regression model would be the best fit, the outcome variable was tested for zero-inflation and overdispersion.

Based on the histogram below, the data does not appear to be notably zero-inflated.



Based on the table below, the outcome variable data has overdispersion because the variance of the data is much greater than the mean.

Statistics

EstTotalAdCount_IncludeOver50

N	Valid	143
	Missing	0
Mean		25.40
Variance		1475.157

Since the predictor variable data has overdispersion and is not too zero-inflated, a negative binomial regression model was selected.

Fitting the Negative Binomial Regression Model

A custom negative binomial regression with the log link value estimated based on the data was selected in SPSS.

This model was selected as the Omnibus test results showed this model was a better fit compared to the intercept only model, as shown below.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
152.309	14	<.001

Dependent Variable: EstTotalAdCount_IncludeOver50
Model: (Intercept), City_ID, SPC, Percentile Group of RES_INST_S, Percentile Group of EC_SIT_S, Percentile Group of ETH_CUL_S, Percentile Group of OutletCountAll_IncludeOver50

a. Compares the fitted model against the intercept-only model.

The Goodness of Fit test results showed this custom model was a better fit compared to the default negative binomial regression test in SPSS with log link with value pre-set to 1. In the custom model, the AIC and BIC values are lower than the default model, and the Pearson Chi-Square value is closer to 1 than the default model, indicating a better fit (See images below).

Default Model with Log-link set to 1

Goodness of Fit[a]

	Value	df	Value/df
Deviance	1282.807	128	10.022
Scaled Deviance	1282.807	128	
Pearson Chi-Square	1368.906	128	10.695
Scaled Pearson Chi-Square	1368.906	128	
Log Likelihood[b]	-918.033		
Akaike's Information Criterion (AIC)	1866.066		
Finite Sample Corrected AIC (AICC)	1869.845		
Bayesian Information Criterion (BIC)	1910.508		
Consistent AIC (CAIC)	1925.508		

Dependent Variable: EstTotalAdCount_IncludeOver50
Model: (Intercept), City_ID, SPC, Percentile Group of RES_INST_S, Percentile Group of EC_SIT_S, Percentile Group of ETH_CUL_S, Percentile Group of OutletCountAll_IncludeOver50

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

Custom Model with Estimated Log-link

Goodness of Fit[a]

	Value	df	Value/df
Deviance	123.317	128	.963
Scaled Deviance	123.317	128	
Pearson Chi-Square	93.986	128	.734
Scaled Pearson Chi-Square	93.986	128	
Log Likelihood[b]	-518.533		
Akaike's Information Criterion (AIC)	1067.065		
Finite Sample Corrected AIC (AICC)	1070.845		
Bayesian Information Criterion (BIC)	1111.508		
Consistent AIC (CAIC)	1126.508		

Dependent Variable: EstTotalAdCount_IncludeOver50
Model: (Intercept), City_ID, SPC, Percentile Group of RES_INST_S, Percentile Group of EC_SIT_S, Percentile Group of ETH_CUL_S, Percentile Group of OutletCountAll_IncludeOver50

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

Appendix C

Collinearity Diagnostics in IBM SPSS Statistics

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	10.853	12.580		.863	.390		
	SPC	-1.635	7.350	-.015	-.222	.824	.896	1.116
	City_ID	-7.256	1.549	-.324	-4.683	<.001	.831	1.204
	Percentile Group of EC_SIT_S	-6.363	3.344	-.136	-1.903	.059	.784	1.275
	Percentile Group of RES_INST_S	13.839	3.923	.295	3.528	<.001	.570	1.755
	Percentile Group of ETH_CUL_S	-5.058	3.016	-.108	-1.677	.096	.964	1.038
	Percentile Group of OutletCountAll_IncludeOver 50	17.377	3.836	.364	4.530	<.001	.616	1.623

a. Dependent Variable: EstTotalAdCount_IncludeOver50

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	SPC	City_ID	Percentile Group of EC_SIT_S	Percentile Group of RES_INST_S	Percentile Group of ETH_CUL_S	Percentile Group of OutletCountAll _IncludeOver5 0
1	1	5.533	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.889	2.494	.00	.83	.00	.00	.00	.00	.00
	3	.250	4.706	.00	.02	.39	.07	.02	.03	.04
	4	.143	6.224	.00	.03	.12	.07	.09	.52	.06
	5	.101	7.408	.00	.01	.10	.55	.00	.23	.22
	6	.055	10.005	.07	.03	.01	.04	.85	.13	.36
	7	.028	13.940	.93	.08	.37	.27	.03	.08	.33