Neighbourhood Fast Food Access and Fast Food Consumption in Canada

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Abstract

Food environments with high fast food access may increase risk for poor diet. As much as 62% of the Canadian diet consists of highly processed convenience foods, including food consumed at so-called 'fast food' outlets (Ogilvie & Eggleton, 2016). These types of limited service restaurants offer convenience foods, which are typically both calorically dense and high in fat, salt, and sugar. This thesis contributes a new measure of fast food access for Canadian neighbourhoods and examines whether neighbourhood fast food access is associated with increased fast food consumption. Fast food retail outlets were extracted from the Statistics Canada Business Register and mapped in a geographic information system (ArcGIS) by their geocoded location. Absolute and relative fast food access measures were created using 1000m and 3000m network buffers in the neighbourhoods of respondents of the 2015 Canadian Community Health Survey-Nutrition (*N* = 10,182). Fast food consumption was measured using a question from the survey's 24-hour dietary recall. 12.7% of adult Canadians reported eating in a fast food restaurant the previous day, with this number varying by province and city. Despite significant variation in Canadian adults' reporting of fast food consumption across provinces and cities, there was no conclusive influence of the neighbourhood food environment (at either 1000m or 3000m) on fast food consumption. Factors associated with fast food consumption in multivariate analyses were young age (18-24), being male, single, and in the workforce. Results speak to the scale at which fast food consumption cultures may be created. Neighbourhood access may matter less than the surrounding urban environment as a whole in determining fast food consumption.

Keywords: Retail Food Environment; Health; Geographic Food Access; Fast Food

Résumé

Les environnements alimentaires ayant une densité élevée de restauration rapide augmentent le risque de mauvaises habitudes alimentaires. Des études suggèrent qu'au moins 62% des nourritures que les canadiens consomment quotidiennement sont de la restauration rapide (Ogilvie & Eggleton, 2016). Des régressions logistiques binomiales furent utilisées afin d'examiner le lien entre l'accessibilité géographique de la restauration rapide dans le quartier et la consomption de restauration rapide par niveau d'éducation dans un échantillon représentatif de la population canadienne. Les commerces de restauration rapide furent extraits du Registre des Commerces du Statistiques Canada et cartographiés dans un système d'information géographique (ArcGIS) par leurs locations géocodées. Les mesures absolues et relatives de l'accessibilité de la restauration rapide furent créées en utilisant des zones tampons de 1000m et à 3000m dans les quartiers des sondés de l'enquête sur la santé dans les collectivités canadiennes-nutrition (2015). La consomption de restauration rapide fut mesurée d'après une question du sondage sur le rappel alimentaire des dernières 24 heures. 12.7% des adultes canadiens ont déclaré avoir mangé dans un commerce de restauration rapide durant le dernier jour, avec variation par province et par région métropolitaine de recensement. Malgré la variation significative dans la consomption de restauration rapide parmi les provinces et les villes, aucune influence de l'environnement alimentaire du quartier (à 1000m ou à 3000m) sur la consomption de restauration rapide n'a été notée. Les variables explicatives associées à la consomption de restauration rapide furent le groupe d'âge (18-24), le sexe (les hommes), le statut marital (célibataire), et le statut de travail (employé). Les résultats indiquent l'ampleur à laquelle les cultures de restauration rapide sont créées. Il est possible que l'accessibilité géographique aux aliments dans le quartier soit moins importante que

l'environnement urbain environnant dans son ensemble à déterminer la consomption de restauration rapide.

Les mots-clés : l'environnement alimentaire; la santé; l'accessibilité géographique aux aliments; la restauration rapide

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CHAPTER ONE: INTRODUCTION

1.1 Theoretical Background

This study is firmly rooted in the field of health geography. Health geography is a sub-discipline of human geography, which looks at the interaction between human health and the environment (Luginaah, 2009). Health geography examines the role of place, space, and scale in determining both physical and mental health outcomes (Dummer, 2008). Health geography differs from epidemiology in that it focuses on the social contexts for health within a framework of spatial organization rather than using the traditional biomedical model (Dummer, 2008). Health geography research has implications for public health and supports evidence-based policy development (Luginaah, 2009). This study draws on previous research on the built environment and health, neighbourhood food environments, and the social determinants of health.

Built environment and health

The relationship between the built environment and health has received much attention in recent years within the field of health geography. The built environment refers to the "places and spaces created or modified by people including buildings, parks, and transportation systems" (Roof & Oleru, 2008: 24). The structure of the built environment varies greatly depending on the setting. Urban built environments are much denser than rural environments and may, in turn, influence health differently. For example, an urban dweller might be at risk from poor air quality whereas an individual in the country might have cleaner air but worse access to health resources. Factors of the built environment can affect cardiometabolic health outcomes through active living potential (i.e., walkability of an area) and through healthy food access (Collins Perdue et al., 2003). Public health research in this area is useful because features of the built environment are modifiable. Making improvements in the structure of the built environment creates potential for major impacts

on health at the population level (Jackson, 2003). Small changes to neighbourhood environments, such as putting in a new sidewalk or opening a grocery store, have the potential to improve health outcomes for neighbourhood residents.

Neighbourhood food environment. One focus of built environment research on population health is the retail food environment. Past research classified food environments into three categories: home food environments, work/school food environments, and neighbourhood food environments. All three types of food environment can impact eating behaviour and are not necessarily exclusive. The neighbourhood retail food environment refers to the food available for purchase and consumption in the area where one lives and works (Lytle & Sokol, 2017). Past research suggests that neighbourhood food environments play a role in determining dietary behaviour both in terms of eating out and in the home (Huang et al., 2015). One feature of measuring the retail food environment is geographic food access.

Geographic food access. Geographic food access refers to the geographic availability of different types of food stores and restaurants (Glanz et al., 2005). Food access can negatively impact dietary intake through both lack of access to healthy food and wide accessibility of unhealthy food options (Laxy et al., 2015; Shaw et al., 2006). Geographic information systems (GIS) are increasingly used to investigate availability, proximity, and density of other types of resources that can influence health including food retail (Fleischhacker et al., 2010; Huang et al., 2015). GIS allows researchers to examine information related to types of food outlets over large geographic areas and to explore hypotheses related to food access, population-level consumption patterns, and health outcomes. Past research has used GIS to measure neighbourhood food access in a variety of ways, including distance from an individual's home to nearest food outlet, number and types of food outlets available, and density of outlets within a defined area (Lytle & Sokol,

2017). Polsky et al. (2016) suggest that fast food access studies should also use a relative access measure, which demonstrates the proportion of fast food restaurants out of total restaurants available. The use of two measures allows researchers to assess the influence of density of fast food outlets within an area as well as the influence of the proportion of restaurants that are fast food within an area.

Fast food industry and access. The food industry is a major player in the Canadian economy and has a fundamental role in shaping Canadian diet through determining which foods Canadians are able to access. In 2018, annual sales of food services and drinking places in Canada totaled $72.1 billion (Statistics Canada, 2019a). Fast food restaurants represent 44.4% of total revenue in the food industry. Fast food restaurants reported an increase in revenue of $1.6 billion (+5.1%) in 2018, totaling $32 billion (Statistics Canada, 2019a). These types of limited service restaurants offer convenience foods, which are typically both calorically dense and high in fat, salt, and sugar. Research suggests that as much as 62% of the Canadian diet consists of these highly processed convenience foods (Ogilvie & Eggleton, 2016). The prevalence and easy access of fast food can have a negative impact of Canadians' eating habits and health.

Commercialization and the retail food environment. The transition to post-Fordism and neoliberal policies in the 1970s and 1980s had numerous ramifications in North American society. Public health is one area that was profoundly affected by these changes. A substantial body of literature suggests that liberal market-based economies are a "root cause of the obesity pandemic" (Egger et al, 2012; Elmes, 2016; Goryakin et al., 2014; Lang and Raynor, 2007). Research in this area indicates that the development of a post-industrial consumerist society is associated with lifestyle changes that promote obesity (Lang and Rayner, 2007). For example, Egger et al. (2012) suggest that modern, market-based economies drive economic growth through increased

consumption, which can lead to over-consumption of resources. Another study by Offer et al. (2010) found that, among affluent countries, market liberal welfare regimes have the highest prevalence of obesity and highest rates of obesity growth. Offer and colleagues suggest that the drive for economic growth and the commercialization of the food industry puts an emphasis on consumption over health.

Another theory suggests that the move from social democratic policies toward market friendly policies has created environments more conducive to obesity (Elmes, 2016). In a special Lancet series on obesity in 2015, Roberto et al. state, "today's food environments exploit people's biological, psychological, social, and economic vulnerabilities." Individuals are stuck in an environment that encourages them to over-consume food energy beyond their daily energy needs, and most foods available are designed to be addictive rather than healthy (Offer et al., 2010). The industrial food system has increased the availability of highly processed convenience foods in the market. Elmes (2016) suggests that unequal access to nutritious food in North America is partially due to the emergence of an industrial food system that is designed to produce short-term profits for food corporations at the expense of the long-term benefits of consumers, food workers, and ecosystems. More attention is needed on how the current food environment can be reshaped in order to prioritize consumer health and reduce diet-related health risks at the population level.

Social determinants of health

This thesis also draws on the literature of social determinants of health. The social determinants of health refer to the economic and social conditions that influence individual and group differences in health (Marmot, 2005). Within this framework, there exist both primary and secondary determinants of health. Primary determinants include socioeconomic and demographic factors, such as education, employment status, household income, age, and sex. Secondary

determinants include biological and psychosocial intermediaries between the social environment and health, such as stressors, control, self-esteem, social support, and social involvement (Kosteniuk & Dickinson, 2003). The social determinants of health have implications for health inequalities. Past research shows that health is tied to social status, such that each step up the socioeconomic ladder is associated with an increment in better health (Bor, 2017). Health inequalities by social status are also present for cardiometabolic health outcomes. For example, there is a higher prevalence of obesity and diet-related chronic diseases, such as hypertension and type 2 diabetes, among individuals with low socioeconomic status (McLaren, 2007).

Diet and socioeconomic status. Differences in diet may contribute to health inequalities between social groups. Past studies show that people with low socioeconomic status tend to consume fast food more frequently (Laxy et al., 2015; Turrell & Giskes, 2008). However, evidence is limited on what role fast food access may play in determining the relationship between low socioeconomic status and fast food consumption. Further research is needed to investigate how neighbourhood and individual factors interact to influence dietary intake and how this may be influenced by socioeconomic status.

1.2 Research Objectives

The main objective of this master's thesis is to examine the relationship between neighbourhood fast food access and fast food consumption in a representative Canadian population-based sample. This thesis also investigates the role of socioeconomic status in determining the relationship between fast food access and fast food consumption. The overarching hypothesis guiding this research is that retail food environments marked by greater access to fast food outlets will be associated with higher fast food consumption in the Canadian population. This

study, therefore, asks two questions 1) Is neighbourhood fast food access associated with fast food consumption? 2) Is this relationship stronger in individuals with low socioeconomic status?

To explore my research questions, I conducted a population-based cross-sectional study using 2015 Canadian Community Health Survey-Nutrition (CCHS-Nutrition) data linked to fast food density measures developed from the Statistics Canada Business Register at the census dissemination area level of survey respondents. This thesis examines two measures of neighbourhood fast food access: absolute density of fast food outlets (number of fast food outlets/meters^2) and a relative density measure called 'restaurant mix' (proportion of fast food restaurants out of total restaurants). Both measures are tested at two scales: within a 1000m network buffer and within a 3000m network buffer from the population-weighted centroid of the dissemination area of each respondent to the 2015 CCHS-Nutrition.

To my knowledge, this is the first study to examine neighbourhood fast food access and fast food consumption in a large nationally representative sample. Most studies to date have been smaller in scale and more local in scope, possibly obscuring the true range in scale of food environments and dietary behaviour in the Canadian population. Second, this thesis includes several new methodological insights, including 1) a 'gold standard' dataset that has not previously been used to measure fast food access; 2) both a relative and an absolute measure of fast food density; and, 3) an examination of the interplay between fast food access, fast food consumption, and socioeconomic status, which may have implications for diet-related health inequalities across the social gradient.

1.3 Summary and outline

This thesis draws on literature in health geography, population health, and the social determinants of health in order to inform the research on the link between the retail food

environment and eating behaviour. This thesis examines the relationship between neighbourhood fast food access and fast consumption in a large population sample with a wide geographic reach and investigates the role of socioeconomic status in this relationship. In the next chapter, I will review literature relevant to my research questions. Chapter three outlines the methodology of this thesis, including its study design, data sources, and methods. Chapter four contains the results of this thesis. Chapter five discusses results and identifies the substantive, methodological, and policy contributions of this thesis.

CHAPTER TWO: LITERATURE REVIEW

In this chapter, I review literature relevant to my thesis and outline the background and significance of my research questions. I examine the relationship between the food environment and health and explore past research on geographic fast food access and fast food consumption. In the first section, I describe the ecological approach to diet and public health; in the second section, I examine past research on the neighbourhood food environment and eating patterns; in the third section, I explore the interplay between fast food access, fast food consumption, and investigate how both neighbourhood food environments and socioeconomic status may play into individuals' food choices. In this chapter, I explain the need for better methods and measures in this area of research. I explore the complexities of accurately capturing neighbourhood fast food access and how this relates to the large picture of determinants of eating behaviour.

2.1 Diet and Public Health

Obesity and obesity-related illnesses poses an urgent public health challenge. In 2010, overweight and obesity were estimated to cause 3.4 million deaths, 39% of years life lost, and 3.8% of DALYs worlwide (Lim et al., 2010). Since 1980, the number of obese adults within Canada has doubled, while the number of obese children has tripled. In 2017, the Public Health Agency of Canada reported that 64% of Canadian adults and 30% of Canadian children are overweight or obese (PHAC, 2017). The annual cost in health care spending, and in lost productivity due to obesity, is estimated to be between $4.6 billion and $7.1 billion (CIHI, 2011). In 2016, the prevalence of type 2 diabetes among obese Canadians was 13.2% compared with 6.6% among overweight Canadians and 3.6% among those classified as having a normal weight (Statistics Canada, 2016).

Poor dietary intake is a risk factor for obesity, hypertension, type 2 diabetes, and other negative cardiometabolic health outcomes. A recent study in the *Journal of the American Medical Association* found that 45% of adult deaths due to cardiometabolic diseases were associated with 10 dietary factors: under consumption of fruits, vegetables, nuts/seeds, whole grains, unprocessed red meats and over consumption of processed meats, sugar-sweetened beverages, polyunsaturated fats, seafood omega-3 fats, and sodium. The highest proportions of cardiometabolic deaths were related to excess sodium intake, insufficient intake of nuts/seeds, high intake of processed meats, and low intake of seafood omega-3 fats (Micha et al., 2017). These results suggest that the consumption of highly processed convenience foods that are high in sodium contribute to higher risk of cardiometabolic disease. In order to reduce diet-related health risk, researchers aim to create interventions that improve diet quality. Much of past research in this area has focused on treating high-risk individuals, but this approach may not be sufficient to create widespread, long-term change in eating behaviour.

Ecological Public Health Approach to Eating Behaviour Change

This thesis is informed by an ecological approach to interventions for improving eating behaviour. Eating behaviour is a modifiable risk factor for chronic diseases and obesity (Wardle, 2007). Much of past research on improving eating behaviour has focused on individual-level behavioural modification for high-risk individuals (Story, Robinson-O'Brien, & Glanz, 2008; Spahn et al., 2010). The high risk, individual focus largely ascribes responsibility for obesity to the individual with the condition (Wang & Brownell, 2005). For example, one patient-centered counseling model emphasizes educating patients about healthy food choices and uses a 4step nutrition counseling process, which includes intensive behavioural counseling and follow-ups (Rosal et al., 2001). The framework behind these interventions postulates that, with enough

knowledge about healthy eating, individuals will choose nutritious diets in order to prevent future illness (CIHI, 2011). However, many health researchers have questioned whether the individual-level approach is too narrow to create large-scale change in eating patterns. In order to create more durable change, it may be necessary to also consider interventions that stretch beyond the individual-level.

A wealth of past research indicates that individual-level interventions have limited effectiveness in long-term change in eating behaviours (Lang & Rayner, 2007; Wang & Brownell, 2005; Swinburn et al., 2011). One limitation of the high risk, individual model of dietary change is that this approach views individuals as rational actors (Corrigan et al., 2015). The principle of rational actors, adopted from economic theory, suggests that, if someone wants to improve their health, then they will make rational health decisions in order to adopt healthier practices (Corrigan et al., 2015). However, the 'rational patient' approach discounts psychological challenges of long-term behaviour change. Research shows that most health decisions are implicit rather than carefully thought out (Spahn et al., 2010). Health decisions are also shaped by other factors including emotion, stressors, and restraints on time and resources (Jabs & Devine, 2006; Laitinen et al., 2002). Thus, the rational patient approach is insufficient because interventions that try to change health behaviours without considering context are less likely to result in long-term change (Spahn et al., 2010).

Another reason individual-level diet interventions may not create long term improvement in eating behaviour is the lack of perceivable positive change experienced by patients. Research suggests that individuals tend to prioritize pleasure in the present moment over potential benefits in the future (Paquet, 2010). For example, one study found that individuals are more likely to

engage in beneficial health behaviours if they are tied with some form of immediate reward (Rothman & Salovey, 1997).

The theory of temporal self-regulation helps explain why it is difficult to create long-term change in health behaviours through individual education. Temporal self-regulation theory states that behaviours that are maladaptive in the long-run are often driven by a strongly favourable balance of immediate costs and benefits (Hall & Fong, 2007). In making a decision, it is cognitively easier for people to weigh a short-term benefit over a long-term cost. This concept applies to eating behaviour in that it is much easier for someone to feel pleasure through indulging in highly palatable, energy dense but nutrient-poor fast food than through choosing a healthier option that may not be as immediately satisfying but will offer a greater benefit over time. Thus, the effectiveness of many medical model interventions is limited because these interventions are "behaviourally inappropriate" (Rose, 1985). In other words, the effectiveness of health interventions will be limited if they work against people's natural inclinations.

Another problem with individual-level interventions is that they tend to only target individuals who are high at risk. Thus, not only does the medical model have limited effectiveness in long-term change, it also fails to improve the eating patterns of much of the population. Rose (1985: 431) states that "a large number of people at a small risk may give rise to more cases of disease than the small number at a high risk." In order to better combat chronic disease associated with poor diet, it is critical to consider both an individual-level approach and a population health based approach to changing eating behaviour.

Population health approach. Population-level approaches may be helpful in reducing high population rates of obesity (Hawe et al., 2012; Rose, 2001). Population health research focuses on producing knowledge about interventions that have the potential to impact health at the population

level. Population health research is also important for reducing health inequalities across socioeconomic groups (Hawe et al., 2012). Although obesity is a major public health issue, there has been much greater focus on treatment for obesity rather than on prevention (Wang & Brownell, 2005). In focusing on treatment, the medical high-risk approach is palliative and temporary by assisting vulnerable individuals without addressing the root of the problem (Rose, 1985). Research suggests that *prevention* of obesity and chronic disease is easier and more cost-efficient than *treatment* of these conditions (Lang & Rayner, 2007). In order to move beyond a focus on individual-level change, researchers must focus their attention on possible preventive methods that will affect the entire population. Developing policy interventions that change underlying environmental conditions of risk is one public health approach with potential for prevention (Hawe & Potvin, 2009). In order to create effective interventions, it is crucial to consider the environmental context within which individuals' eating behaviours take place.

In recent years, many health researchers have shifted towards a more ecological approach to eating behaviour change, which emphasizes both social and environmental factors of eating behaviour (Egger & Swinburn, 1997; Hruby & Hu, 2015). This approach places dietary habits in an ecological context, which looks at the interaction of biological, behavioural, and environmental factors on individuals' eating behaviours (Egger & Swinburn, 1997). Past research suggests that the obesogenic environment is the driving force behind increasing prevalence of obesity in populations (Arcaya et al., 2016; Lang & Rayner, 2007). Rapid technological change and de-industrialization has led to an environment with less opportunity for physical activity and an abundance of highly processed calorie-dense foods (Egger et al., 2012). This shift in environment has led to a surge of research looking at the relationship between the built environment and health

(Jackson, 2003). One topic in this research is the study of neighbourhood food environments and the ways in which food access may determine eating patterns.

2.2 Neighbourhood Food Environments and Fast Food Access

Unfavourable food environments hinder the effects of treatment and limit the potential scope of preventive programs such as mass educations (Egger & Swinburn, 1997). Past research shows that food environments with high availability of fast food are linked to higher prevalence of obesity and hypertension (OECD, 2017; Wang & Brownell, 2005). The neighbourhood retail food environment refers to the food available for purchase and consumption in the area where one lives and works (Lytle & Sokol, 2017).

The retail food environment comprises many different components that shape individuals' eating behaviour. Glanz et al. (2005) propose a model of community nutrition environments that maps both environmental and individual variables that determine eating behaviour (Figure 1). Elements of the community nutrition environment include food availability, food affordability, food quality, and geographic food access (Glanz et al., 2005). Food availability and quality refer to the types of food that are available for purchase in a community, and food affordability refers to how much these foods cost. Geographic food access refers to the spatial availability of different types of food stores and restaurants. Past research suggests geographic food access is a defining feature of unfavourable food environments, both through lack of access to healthy food and through wide accessibility of unhealthy food options (Laxy et al., 2015; Shaw et al., 2006).

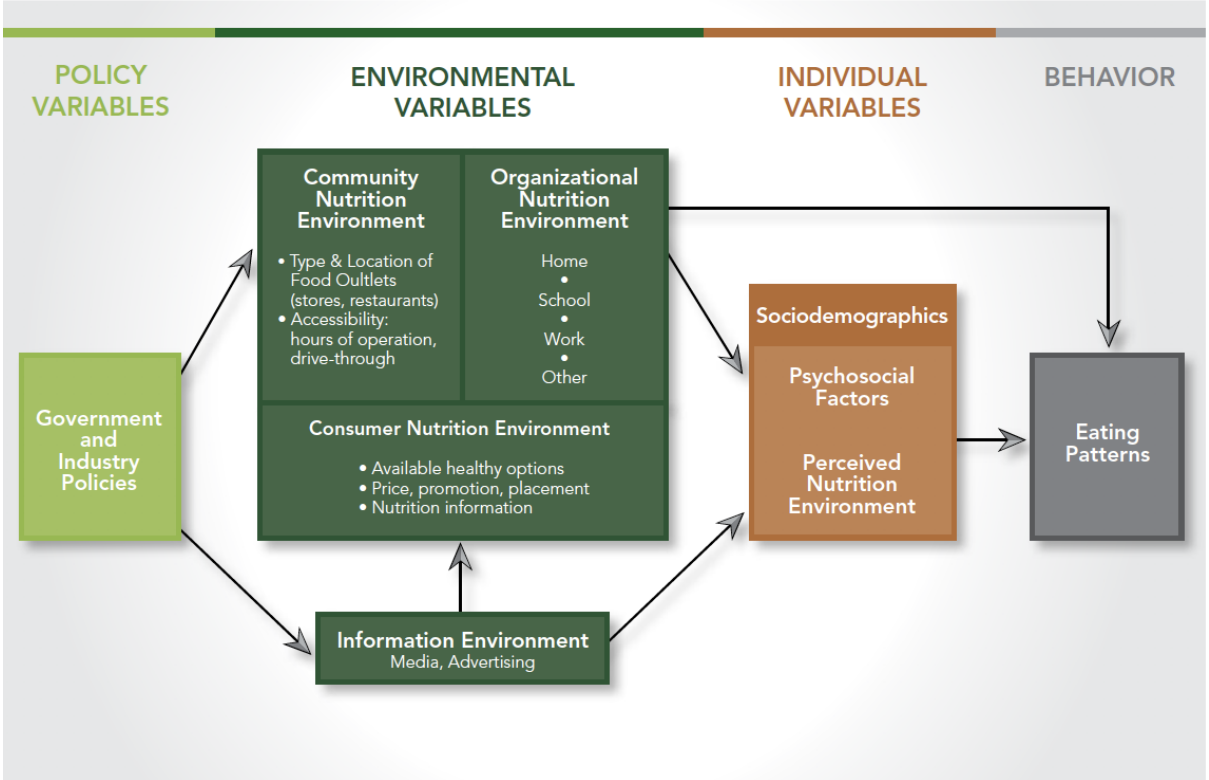

Figure 1
The multi-level determinants of eating patterns (Glanz et al., 2005)

Unfavourable food environments. The food environment sets up the range of possible food options available to the consumer, such that unfavourable food environments may negatively impact individuals' diet quality. The environmental approach to obesity postulates that obesity is a normal physiological response to an inappropriate environment (Lang and Rayner, 2007). The last fifty years has seen an increase in the availability of inexpensive nutritionally poor food (Swinburn et al., 2011). The current food environment promotes heavy consumption of cheap convenience foods, which are typically calorically dense and nutritionally poor (Ogilvie & Eggleton, 2016).

Geographic food access plays a large role in shaping the favourability of neighbourhood food environments (Glanz et al., 2005; Huang et al., 2015). Past research has outlined two types of unfavourable food environments: food deserts and food swamps. Individuals may live in food

deserts, which are areas devoid of healthy food options, or in food swamps, which are areas with a high-density of high-calorie processed food relative to healthier options (Shaw, 2006; Hager et al., 2016). Beyond these categories, researchers are also working to develop more nuanced approaches to classifying unfavourable food environments. For example, a 2016 study by Widener et al. suggests that the food desert concept is too simplistic. Food deserts suggest the absence of healthy food, but they do not describe the overall makeup of food choices available. Widener et al. recommend moving away from this term in order to allow for more variation in how food access is measured. Another recent study found that the presence of a food swamp is a stronger predictor of obesity rates than the absence of full-service grocery stores (Cooksey-Stowers et al., 2017). These results suggest that high access to unhealthy food may have more of an impact on obesity than lack of healthy options alone. High density of fast food outlets is one characteristic of unfavourable neighbourhood retail food environments.

Fast Food Access. Fast food consumption is associated with increased risk of obesity and obesity-related illness (Yan et al., 2015). A systematic review of fast food consumption and obesity risk found that sufficient evidence of weight gain exists for public health recommendations to limit fast food consumption (Rosenheck, 2008). Neighbourhood fast food access may be a determinant of overall fast food consumption (Fleischhacker et al., 2010). However, it remains unclear what role access plays in the link between fast food consumption and obesity. Neighbourhood fast food access can be difficult to measure accurately, and past studies show mixed results on whether or not higher fast food access increases fast food consumption (Cobb et al., 2015).

Some research suggests that individuals living in areas with high access to fast food may consume more fast food (Bernsdorf et al., 2017; Burgoine et al., 2016; Longacre et al., 2012). For example, a recent study conducted in Denmark (N = 48,305) examined the association between

GIS-located fast food outlets and self-reported fast food intake among adults (Bernsdorf et al., 2017). Bernsdorf and colleagues found that weekly fast food consumption was positively associated with fast food outlet density ($p < 0.0001$) and negatively associated with distance to the nearest fast food outlet ($p < 0.0001$). Another study in New Hampshire and Vermont found that families ($N = 1547$ households) who lived in towns with five or more fast-food outlets were about 30% more likely to eat fast food compared to those in towns without fast-food outlets (Longacre et al., 2012). These results suggest that geographic fast food access may be a factor in determining fast food consumption.

However, there have been conflicting results that question the association between fast food access and fast food consumption (Oexle et al., 2015; Richardson, 2011). For example, one study within an eight-county area in South Carolina found that neither perceived availability of fast food nor actual physical presence of fast food was significantly associated with weekly consumption of fast food (Oexle et al., 2015). Another study found no association between fast food availability and weekly frequency of fast food consumption in a sample of U.S. young adults enrolled in the National Longitudinal Study of Adolescent Health ($N = 13,150$; Richardson et al., 2011). This study was on a much larger scale than the study conducted by Oexle et al. but it may have been limited by looking at only chain fast food restaurants and by using a weekly frequency consumption measure, which has been to shown to have lower accuracy than 24-hour recall (Kirkpatrick et al., 2014). Further study is needed to examine fast food access and consumption on a national level with a geographically diverse sample using a high quality measure of eating behaviour.

Canadian context. There have been two studies that examined the relationship between the food environment and eating behaviour within Canada (Clary et al., 2017; He et al., 2012). He and

colleagues (2012) found that close proximity to convenience stores in adolescents' neighbourhoods was associated with lower scores on healthy eating. There are two studies to date that have examined fast food access on a national level (Hollands et al., 2013; Hollands et al., 2014). Both studies examined the association between restaurant density and body-mass index (BMI) using respondent data from the 2007-08 CCHS and food outlet data from the 2008 *Canadian Restaurant Directory*. The 2014 study found that fast food density per 10,000 population was positively associated with BMI across Canada. While these results are instructive, Hollands and colleagues did not examine a possible mechanism linking features of the food environment with BMI—fast food consumption. There is limited research on fast food consumption in the Canadian context. No study to date has used GIS to examine fast food access and fast food consumption on a pan-Canadian scale.

Measuring Fast Food Access. Past health studies on neighbourhood fast food access have used a variety of methods for measuring fast food access, which may contribute to inconsistency in results. There is no consensus among researchers on the best way to measure fast food access, though most studies use some form of GIS-derived density measure. Bernsdorf et al. (2013) measured fast food access both as proximity (distance to nearest fast food outlet) and density (number of fast food outlets within a 1000m network buffer around respondent's home). Hollands et al. (2013; 2014) used a density measure by population; they measured fast food access as number of fast food outlets per 10,000 individuals. Longacre et al. (2012) was one of the few studies not to use GIS to measure access. Researchers in this study created an inventory of in-town fast food outlets through Google Earth and Yahoo! Yellow Pages and then drove all in-town street networks to verify location of outlets. This latter approach is appealing from a validity standpoint but

fundamentally impractical for large-scale studies. Overall, the variety of measures used across the different studies makes it difficult to compare results.

Among the studies that found no association, there was also a range of access measures used. Oexle et al. (2015) included both a perceived neighbourhood fast food access measure as well as a GIS-based measure. The GIS-based measure looked at the number of fast food restaurants within a 1-mile buffer around the respondent's home. However, the authors note that a majority of respondents (84.6%) had no fast food outlet present in their neighbourhood so the variable was treated as dichotomous (0 vs. ≥1 fast food outlet present). The large number of respondents with no fast food outlets may account for the study's null results. Richardson et al. (2011) defined fast food access as the number of chain fast food outlets per 100 kilometer of roadway within a 3000m network buffer. They suggest that a 3000m buffer is the most appropriate distance for examining associations between neighbourhood fast food outlets and individual-level behaviour. However, it is worth noting that they base this decision on two previous studies they conducted that looked at physical activity (Boone-Heinonen, 2010; Boone-Heinonen et al., 2011). It remains unclear whether the buffer size for food access and physical activity should be the same.

One challenge across studies in measuring access is how to account for differences in individual behaviours in urban versus rural settings. The Oexle et al. (2015) study highlights the difficulty of trying to capture access in a largely rural area using a standard buffer size. If a majority of respondents have no fast food outlets within the area defined as their neighbourhood, it is difficult to accurately measure the effects of fast food access. Several studies used a 1000m buffer because past research shows that 73% of trips on foot are less than 1000m with an average trip length of 800m between home and shopping (Bernsdorf et al., 2013). However, this 1000m buffer size may be less useful for areas where people primarily use cars to access shopping and are willing to travel

much greater distances. Some studies have tried to account for different neighbourhood environment types by splitting analyses into urban, semi-urban (or suburban), and rural subsections (Bernsdorf et al., 2013; Richardson et al., 2011) or by Census Metropolitan Area/non-Census Metropolitan Area (Hollands et al., 2013). The issue of the appropriate buffer size to use in studies of the food environment has not been resolved, and the approach taken in this thesis is to examine two buffer sizes.

Another consideration in measuring fast food access within network buffers is whether to use an absolute or relative density measure. An absolute density measure is the number of fast food outlets within a defined area (i.e., a 1000m network buffer) whereas a relative density measure is the proportion of fast food outlets compared to all restaurants within that area. Polsky et al. (2016) suggest that relative density measures may be more meaningful than absolute density measures. They conducted a study of adults living in four cities in southern Ontario (N = 10,199) and found an association between weight status (obesity and BMI) and the relative density of fast food restaurants relative to all restaurants within a 10-minute walk of residential areas but no association with number of fast food outlets alone. It makes sense that the relative share of outlets serving fast food would affect consumption because individuals with a greater number of healthy options available may be less likely to choose fast food, but surprisingly few past studies have included a relative access measure. There is need for further research that incorporates a relative fast food measure into questions of fast food access and food choices.

There is also inconsistency between fast food outlet measures in the literature. Fleischhacker et al. (2011) conducted a systematic review of fast food access studies and found that nearly half of studies included (n = 16) used their own set of features to define fast food. Within Canada, there is also no standardized dataset used to measure fast food access. Past studies on fast food outlets

have relied on commercial proprietary datasets (i.e., 2013 EPOI distributed by DMTI spatial) with no agreement between researchers on how to classify outlets (Lytle & Sokol, 2017). For example, Hollands et al. (2013, 2014) use limited service establishments as a proxy for fast food even though this category also includes other types of outlets, such as cafés and juice bars. There are also concerns about the accuracy of commercial proprietary datasets for research, with high frequency of outlet misclassification, inaccurate geocoding, and outlet duplicates (Lebel et al., 2017). There is need for standardization on how fast food outlets are measured in Canada as well as for a 'gold standard' database for food environment research on Canadian fast food access. This thesis represents the first step toward standardized measurement of the Canadian retail food environment through the use of a new national food outlet dataset with high accuracy.

2.3 Food Environments, Eating Behaviour, and Socioeconomic Status

Individuals with low socioeconomic status may be more susceptible to unfavourable food environments. Health inequities between socioeconomic groups continue to be a problem in Canadian society (Marmot, 2005; Braveman & Gruskin, 2004). Link and Phelan (1995) suggest that socioeconomic status is a fundamental cause of health inequalities. A fundamental cause has four defining features: 1) it influences multiple disease outcomes 2) it affects health outcomes through multiple risk factors 3) it involves access to resources that affect health 4) inequalities are reproduced over time (Phelan et al., 2010). For example, life expectancy and health-adjusted life expectancy are consistently lower among individuals with lower educational attainment and with greater material and social deprivation (PHAC, 2018). The social gradient in health shows that inequalities in population health status relate to inequalities in social status, such that each step up the socioeconomic ladder is associated with an increment in better health (Kosteniuk & Dickinson,

2003). This gradient is evident for chronic diseases, such as obesity and type 2 diabetes, with higher prevalence among those with low socioeconomic status (McLaren, 2007).

Within Canada, both education level and income level are determinants of risk for obesity (CIHI, 2011). One study suggests that educational attainment is a strong determinant of obesity among adults, and household income level is associated with obesity rates in children (Raine, 2004). The mechanisms through which low socioeconomic status contributes to obesity are complex, and both environmental factors and individual level behaviour patterns play a role. Individuals with low educational attainment may be less familiar with principles of healthy eating habits and food choices, which leaves them more vulnerable to unfavourable food environments (Neumark-Sztainer et al., 2003). More research is needed that examines the interaction of the food environment and socioeconomic status on dietary outcomes.

Fast food and neighbourhood deprivation. The increased risk for obesity among groups with low social status in Canada may be due to differences in neighbourhood structure. Previous studies show that deprivation is linked to less favourable food environments (MacIntyre et al., 2002; Pearce et al., 2007; Laxy et al., 2015). In a recent systematic review of fast food access studies, 76% of studies ($n = 21$) examining fast food access and socioeconomic factors found that fast food restaurants were more prevalent in low-income areas compared to middle-to-high income areas (Fleischhacker et al., 2010). For example, a study in Wisconsin linked data from a population-based survey and a commercially available business database and found that neighbourhood-level economic hardship was associated with higher density of convenience stores and fast food restaurants (Laxy et al., 2015). Low-income areas may also have less access to healthy foods, sometimes without full-service grocery stores (Wang & Brownell, 2005).

However, research suggests that the mechanisms behind the social gradient in obesity are more complex than neighbourhood factors alone (Ogilvie & Eggleton, 2016). There are also a number of individual level factors that shape dietary intake. Socioeconomic status influences eating behaviour in a variety of ways, including where food is purchased, which foods are chosen, and the time spent on preparation of food (Jabs & Devine, 2006; Monsivais et al., 2014; Wang & Brownell, 2005). Past research suggests that people with low socioeconomic status make different food choices than those with middle-to-high socioeconomic status (Taylor et al., 2015). In particular, individuals with low socioeconomic status may be more likely to choose fast food over other available options.

Socioeconomic status and fast food. Past studies show that people with low socioeconomic status tend to consume fast food more frequently (Laxy et al., 2015; Turrell & Giskes, 2008), although a recent study in the United States suggests that higher income Americans are more likely to consume fast food on any given day (Fryar et al., 2018). To understand the relationship between socioeconomic status and fast food, it is important to consider both neighbourhood-level and individual-level factors. One neighbourhood explanation is that low-income areas may have a greater number of fast food outlets available. For example, one study in New Zealand found a strong association between neighbourhood deprivation and geographic access to fast food outlets (Pearce et al., 2007). However, other explanations exist beyond neighbourhood deprivation. The perception that fast food is an affordable option may help explain higher consumption of fast food among low-income individuals. Fast food is often marketed as a bargain, with substantial portion sizes and multi-serving family combos. For example, Wang and Brownell (2005) describe how people are encouraged to 'supersize' a meal at fast-food restaurants but no similar incentives exist for healthier options like produce or legumes. This type of marketing may lead individuals with

low socioeconomic status to choose fast food, regardless of access to healthier options, because fast food seems like a better value for their money.

There are two prominent individual-level hypotheses for why people with low socioeconomic status may be more likely to consume fast food. The first hypothesis involves time scarcity (Jabs & Devine, 2006; Monsivais et al., 2014). Preparation of healthy foods often requires more time and knowledge than eating out or obtaining less healthy but conveniently prepared foods (Wang & Brownell, 2005). Individuals with lower socioeconomic status may have less time and resources to devote to healthy eating, especially if they work full-time and have children (Taylor et al., 2005). For example, one study found a negative association between maternal employment and frequency of family meals, which is positively associated with diet quality (Neumark-Sztainer et al., 2003). Furthermore, healthy foods are often perishable, which may raise concerns about buying food that will go to waste if not cooked in time (Wang & Brownell, 2005). Thus, time scarcity is one possible explanation for why individuals with lower socioeconomic status may choose to consume fast food more frequently.

The second hypothesis is the psychosocial hypothesis, which suggests that chronic stress can lead to increased consumption of unhealthy food as a psychological coping mechanism (Dallman et al., 2003). Individuals with low socioeconomic status face a number of stressors in their daily lives, which can lead to multiple negative physical and mental health outcomes (Baum et al. 2006). Low self-rated mental health is more common among Canadians with low income and low levels of educational attainment (PHAC, 2018). Previous research suggests that people who suffer from chronic stress may consume more 'comfort foods,' which are defined as densely-caloric foods high in fat, salt, and sugar (Dallman et al., 2003; Greeno & Wing, 1994; Lazarus, 1993). For example, a longitudinal population-based study in Finland found that stress-driven eaters tended to eat

'sausages, hamburgers and pizza, and chocolate' more frequently than other people (Laitinen et al., 2002: 29). The study also found that both history of unemployment and a low level of educational attainment were significant predictors of stress-driven eaters. These results could help explain why individuals with low socioeconomic status are more likely to consume fast food. Overall, past research shows that both neighbourhood-level and individual-level factors contribute to the influence of socioeconomic status on fast food consumption. There is need for more research that examines the influence of socioeconomic status on the relationship between the food environment and eating behaviour.

Socioeconomic status, access, and diet. While substantial research exists on the food environment, fast food consumption, and socioeconomic status individually, surprisingly little research has examined the interplay between all three. Glanz et al. (2015) suggest that the effects of environmental factors on eating behaviour can be moderated or mediated by demographic factors. Socioeconomic status may moderate the relationship between fast food access and fast food consumption, such that the association is stronger among those with low socioeconomic status. Only one study, which took place in the United Kingdom, has directly tested this hypothesis. Burgoine and colleagues (2016) examined the interaction between exposure to fast food outlets and educational attainment on fast food consumption and obesity. These researchers stratified the sample by educational attainment and found that exposure to fast food outlets was associated with fast food consumption in all-socioeconomic groups, but this association was strongest in individuals with low educational attainment. There is need for further research both to substantiate these findings and to provide more information on the relationship between fast food access and socioeconomic status in the Canadian context.

2.4 Summary of the literature

In this chapter, I have examined past literature on the retail food environment and explored ways in which the current study will contribute to the field. Despite substantial supportive literature, there is a clear need for further study to better under the relationship between neighbourhood fast food access and fast food consumption. Public health researchers have moved toward an ecological approach to improving diet, which suggests that the retail food environment plays a role in determining eating behaviour. Fast food consumption is linked with obesity, but it remains a question to what extent fast food access influences fast food consumption. Past studies in this area have been limited by inconsistent methodology, including a variety of measures for fast food access and limited accuracy in food outlet data. There is also a need for research on these questions in a larger population sample. This thesis contains key methodological contributions to research on fast food access and consumption. This thesis also contributes scale and quality of data not previously used. Both the measure of neighbourhood fast food access and the measure of fast food consumption are high quality data.

CHAPTER THREE: METHODOLOGY

This chapter restates the research questions and provides detail on the study design, methodological approach, and measures used. This chapter describes the methods in four sections: (1) study design (2) data sources (3) measures (4) analytic plan and concludes with a summary of methodology. These methods were used to investigate the relationship between neighbourhood fast food access and fast food consumption across socioeconomic status levels in Canada.

3.1 Study design

This thesis is a quantitative Canadian population-based cross-sectional study that uses Statistics Canada Business Register data and 2015 CCHS-Nutrition data in order to examine the relationship between neighbourhood food access and fast food consumption. It also examines how individual educational attainment, as a proxy for socioeconomic status, may influence the relationship. The key exposure of interest is the neighbourhood retail fast food environment and the key outcome is fast food consumption, a behavioural outcome derived from the 2015 CCHS-Nutrition—a national dataset that provides excellent quality 24-hour dietary recall data. The exposure measure for fast food access was created in ArcGIS (ESRI) using Statistics Canada Business Register food outlet data.

3.2 Data sources

Business Register. The Business Register is a central repository of information on businesses and institutions operating in Canada maintained by Statistics Canada (Statistics Canada, 2018). The Business Register contains sensitive information but is available to McGill researchers in the Geosocial Determinants of Health research group through an agreement with Statistics Canada. This is the first study to use the Business Register to measure geographic food access in Canada. Much of past research on the retail food environment has used proprietary datasets. The Business

Register offers a higher quality record of current businesses than commercial proprietary datasets because response to the survey is mandatory for all businesses that pay taxes.

2015 Canadian Community Health-Nutrition Survey. The CCHS is a nationally representative cross-sectional survey that gathers health-related data at sub-provincial levels of geography (Government of Canada, 2017). The CCHS is a key resource for health surveillance and population health research in Canada. The survey began collecting data in 2001 and was repeated every two years until 2005 and from then on annually. Data from the survey is used by health researchers and by many government agencies to plan and implement policy and programs to improve the health of Canadians (Government of Canada, 2017).

The 2015 CCHS-Nutrition is a national survey that is collaboration between Statistics Canada and Health Canada. The survey provides a rich source of information on food consumption at the national and provincial levels using a 24-hour dietary recall (Government of Canada, 2018). The last CCHS-Nutrition was completed in 2004. The updated 2015 version of the CCHS-Nutrition allows researchers to examine how Canadian dietary intake has changed over the past ten years and also includes new measures such as household food insecurity (Government of Canada, 2018).

The CCHS-Nutrition master file was accessed through Statistic Canada's Research and Data Centre, which allows access to respondents' postal codes and unsuppressed data for demographic variables such as income and age. All analyses were conducted under project number 18-SSH-MCG-5624 at the McGill University site of the Canadian Research Data Centre Network, a secure laboratory that provides access to micro-data holdings of Statistics Canada, Canada's national statistical agency. Statistics Canada has in place a detailed protocol for respondent confidentiality that was followed in these analyses (Statistics Canada, 2010).

3.3 Measures

Exposure—neighbourhood fast food access. Fast food access was measured using a novel fast food outlet density measure derived from the Statistics Canada Business Register. For each CCHS-Nutrition respondent, a fast food exposure measure was calculated for the census dissemination area in which they reside. Fast food outlets were mapped in a geographic information system (ArcGIS) by their geocoded location. A neighbourhood fast food exposure measure was calculated for all census dissemination areas in Canada by creating 1000m and 3000m network buffers around the population-weighted centroid of each census dissemination area. This study used both a relative and absolute density measure for fast food outlets.

Absolute density of fast food outlets. The absolute density measure provides the density (number of fast food outlets/meters^2) of fast food restaurants within the buffers. The absolute density measure is the total number of fast food outlets within the 1000m or 3000m buffer divided by area.

Relative density of fast food outlets. The relative access measure provides the restaurant mix (density of fast food restaurants divided by fast food restaurants and sit-down restaurants x 100%). The relative measure involves the number of fast food outlets divided by the total number of outlets * 100 to provide a ratio.

Fast Food Outlet Classification. Fast food outlets were categorized from the Business Register by a mixture of NAICS code and name-based categorization. NAICS codes refer to the North American Industry Classification system (NAICS), which is an industry classification system developed by the statistical agencies of Canada, Mexico, and the United States. Economic units that have similar production processes are classified by the same NAICs code (Statistics Canada, 2019b). Fast food outlets were pulled from the Limited Service Establishment NAICS code. The Limited Service Establishment NAICS was split into three categories: fast food, cafés, and other

limited service. This process was done by name-based categorization. Outlets were classified as fast food if they were part of major fast food chains or limited service restaurants with a restaurant name that included foods defined as fast food (i.e., pizza, burger, fry/frie*, kebab, shawarrma). Keyword searches were run through all other categories of food outlets in order to re-categorize outlets that classified as fast food into the correct category. Keyword searches included names of major fast food chains (i.e., McDonalds) as well as common forms of fast food. All fast food outlets were then mapped in ArcGIS by their geocoded latitude and longitude coordinates.

Outcome—fast food consumption. Consumption of fast food was measured as a dichotomous variable using a self-report question from the 2015 CCHS-Nutrition. Respondents were asked where the food they ate in the day before the interview was prepared: home, fast food (which includes take-outs and pizzerias), and other locations (restaurants with sit-down service, schools, bars, home, work cafeterias, religious organizations). Respondents were classified as having consumed fast food the day before if they indicated they had eaten at a fast food restaurant for any meal or snack. Respondents were classified as having not consumed fast food the day before if they indicated no items of food consumed in a fast food restaurant.

Demographics. 2015 CCHS-Nutrition respondents reported their age, sex, and ethnicity. Other sociodemographic variables examined were immigration status, ethnicity, household income, household food security, marital status, single parent household, urbanicity, and province.

Socioeconomic status. Socioeconomic status was measured by individual educational attainment. Educational attainment had a much higher response rate than individual income in the 2015 CCHS-Nutrition. Educational attainment is an appropriate and useful measure for socioeconomic status, and it also allows the results of this study to be compared to a similar study

examining fast food access, consumption, and educational attainment conducted in Cambridgeshire county, UK (Burgoine et al., 2016).

Participants were asked "What type of educational institution [are you attending/did you attend]?" Responses were categorical (1 = *Elementary, junior high school or high school*; 2 = *Trade school, college CEGEP or other non-university institution*; 3 = *Bachelor's degree or more*). For this study, educational attainment was recoded into four categories (1 = *Less than high school diploma*; 2 = *High school diploma*; 3 = *Some advanced training*; 4 = *University degree or more*). This educational attainment categorization is consistent with similar studies looking at Canadian food environments (Hollands et al., 2013; Polsky et al., 2016). Educational attainment was also examined as a dichotomous variable (1 = *Less than bachelor's degree*; 2 = Bachelor's degree or more).

3.4 Analytic Plan

Statistical analyses were performed using SPSS and Stata statistical softwares. Descriptive statistics were produced in contingency tables for the socio-demographic variables, the food environment variables, and the outcome variable. Descriptive statistics were used to provide context for the fast food consumption patterns of Canadians and neighbourhood fast food access across Canada. Multivariate regression analyses were used to examine the association between neighbourhood fast food access and fast food consumption while taking account of other factors.

This thesis examined both absolute fast food density and a relative measure called restaurant mix (number of fast food outlets/total number of restaurants*100) within both 1000m network buffers and 3000m network buffers. All analyses were run using four density measures: 1) fast food density at 1000m 2) restaurant mix at 1000m 3) fast food density at 3000m, and 4) restaurant mix at 3000m.

Bivariate relationships were examined to identify potential demographic covariates. Covariates tested for included age, gender, ethnicity, income, immigration status, working status, single parent household, household food security, and urbanicity. Ethnicity, income, immigration status, single parent household, food security, and urbanicity were not related to fast food consumption in bivariate analyses and thus were not included in subsequent analyses. Age, sex, marital status, and working status were associated with fast food consumption at the .05 level ($ps<.04$ for all tests). These variables were included as covariates in adjusted regression models assessing the relationship between access and consumption.

Multivariate regression analyses were used to examine the associations between fast food access and fast food consumption, while taking account of other factors. Survey sampling weights provided by Statistics Canada were used in all regressions (Statistics Canada, 2014). Unadjusted models considered the associations between the four fast food access measures and fast food consumption and subsequent models adjusted for age, sex, working status, marital status, and educational attainment. Models of fast food consumption were also run within educational attainment subgroups (less than high school, high school, some advanced training, bachelor's degree or more), owing to the focus of the thesis on socioeconomic status.

3.5 Summary of methodology

This chapter outlined the study design, data sources, and measures used in this study. This thesis is a quantitative cross-sectional study with a large population-based Canadian sample. This study uses Statistics Canada Business Register data and 2015 CCHS-Nutrition data to investigate the relationship between neighbourhood fast food access and fast food consumption across educational levels in a representative sample of working age adults. The next chapter will outline the analytic plan used to examine this relationship and will explain results.

CHAPTER FOUR: RESULTS

This chapter presents the analytic results in five sections: (1) participant demographics (2) fast food access across Canada (3) fast food consumption across Canada (4) fast food consumption by access across Canada (5) multivariate analyses and concludes with a summary of results. Descriptive statistics were used to examine sample characteristics and to provide context on the exposure measure, neighbourhood fast food access, and the outcome measure, fast food consumption, in Canada. Multivariate regression analyses were used to examine the relationship between neighbourhood fast food access and fast food consumption.

4.1 Participant Demographics

Participants were 10,182 Canadians between the ages of 18-64 years old (M = 42, SD = 13; Table 1). 56% of respondents were female, and 80% of participants were white. 20.4% of respondents identified as immigrants. The median education level was high school educated, and the mean household income was $47,300 ($SD$ = 4150). 61.1% of respondents were classified as overweight or obese (M = 27.37, SD = 5.87). 76.1% of respondents reported having jobs, and 60.5% of respondents reported being married. 11.3% of respondents lived in a food insecure household, and 8.6% of respondents reported living in a single parent household. 197 respondents were missing data on fast food consumption and were excluded from analyses.

Table 1
Summary of demographics for 2015 CCHS-Nutrition respondents, aged 18-64

	N	% or *M*±*SD*
Total sample	10182	
Gender		
Female	5364	52.7
Male	4819	47.3
Age		42 ± 13
18-24 years	1113	10.9
25-44 years	5326	42.5
45-64 years	4743	46.6
Body-mass index		27.37 ± 5.87
Underweight	186	2.1
Normal weight	3277	36.8
Overweight	3031	34.0
Obese	2411	27.1
Ethnicity		
White	7703	80.0
Asian	1250	13.0
Black	262	2.7
Other	413	4.3
Education level		
Less than high school	929	9.2
High school	2843	28.1
Some advanced training	3613	35.7
Bachelor's degree or above	2734	27.0
Income quintile		47,300±4150
Low 1st	2036	
Mid low 2nd	2036	
Mid 3rd	2036	
Mid high 4th	2037	
High 5th	2037	
Immigration		
Immigrant	2076	20.4
Non-immigrant	8088	79.6
Working status		
Working	7745	76.1
Unemployed	2426	23.9
Marital status		
Married/cohabitating	6140	60.5
Single	4004	39.5
Single parent household		
Yes	835	8.6
No	8863	91.4
Household food security		
Food secure	8999	88.4
Food insecure	1154	11.3

4.2 Fast food consumption across Canada

The percentage of participants that consumed fast food in the last 24 hours varied by participant demographics (Table 2). Overall 12.7% of Canadians consumed fast food in the past 24 hours-so more than 1 in 10 Canadians report eating at a fast food restaurant in the past 24 hours. Among participants who reported consuming fast food in the last 24 hours, the mean number of fast food items consumed was 2.58 (*SD* = 1.64; range 1-13). Overweight and obese participants were more likely to have consumed fast food in the last 24 hours than normal weight participants ($p < .05$; Figure 2).

Table 2
Fast food consumption by demographics for 2015 CCHS-Nutrition respondents, aged 18-64

	N	Percent consumed fast food
Total sample	9985	12.7
Gender		
Female	5364	***10.7**
Male	4819	****14.9**
Age		
18-24 years	1113	****19.0**
25-44 years	5326	13.0
45-64 years	4743	11.0
Ethnicity		
White	7703	12.4
Asian	1250	13.0
Black	262	13.6
Other	413	12.1
Education level		
Less than high school	929	12.8
High school	2843	14.4
Some advanced training	3613	12.7
Bachelor's degree or above	2734	***10.9**
Income quintile		
Low 1st	1997	11.8
Mid low 2nd	1997	14.3
Mid 3rd	1997	12.4
Mid high 4th	1997	12.7
High 5th	1997	13.3
Immigration		
Immigrant	2076	11.7
Non-immigrant	8088	13.0
Working status		
Working	7745	13.2
Unemployed	2426	***10.9**
Marital status		
Married/cohabitating	6140	11.5
Single	4004	***14.5**
Single parent household		
Yes	835	12.6
No	8863	12.8
Household food security		
Food secure	8999	12.7
Food insecure	1154	12.8

Note. Bold values are significantly different than national average.

*$p < .05$ **$p < .001$

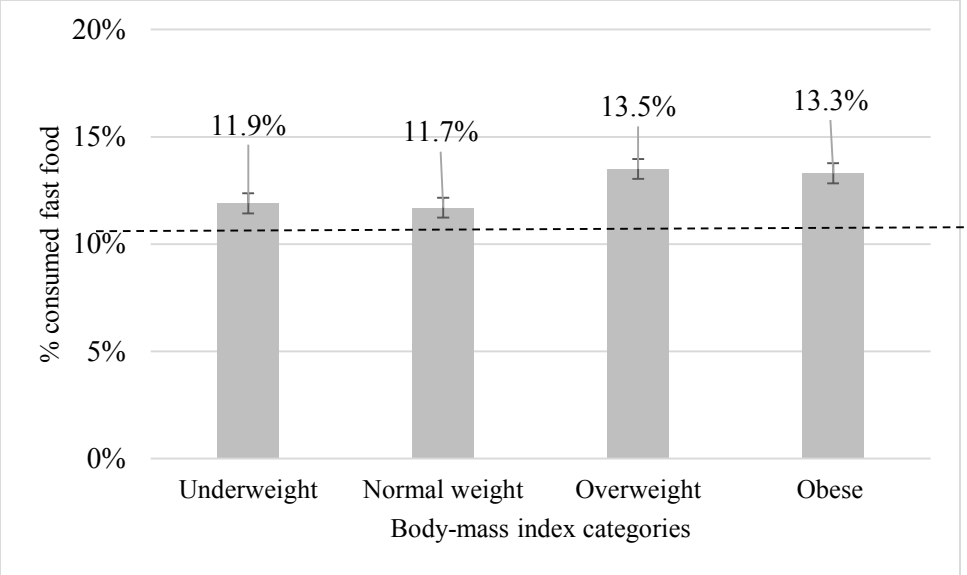

Figure 2. Fast food consumption by body-mass index category among 2015 CCHS-Nutrition respondents, aged 18-64.

Figure 3 summarizes significant differences in fast food consumption by participant demographics. Male participants (14.9%) were more likely to have consumed fast food than female participants (10.7%). Participants who reported working (13.2%) were also more likely to have consumed fast food than unemployed participants (10.9%). Single participants (14.5%) were more likely to have consumed fast food than married participants (11.5%). Participants aged 18-24 (19%) were more likely to have reported consuming fast food than participants aged 25-44 (13%) or participants aged 45-64 (11%). Socioeconomic status was also associated with fast food consumption. Individuals with a university education (10.9%) were less likely to have reported consuming fast food than individuals with lower educational attainment (Figure 4).

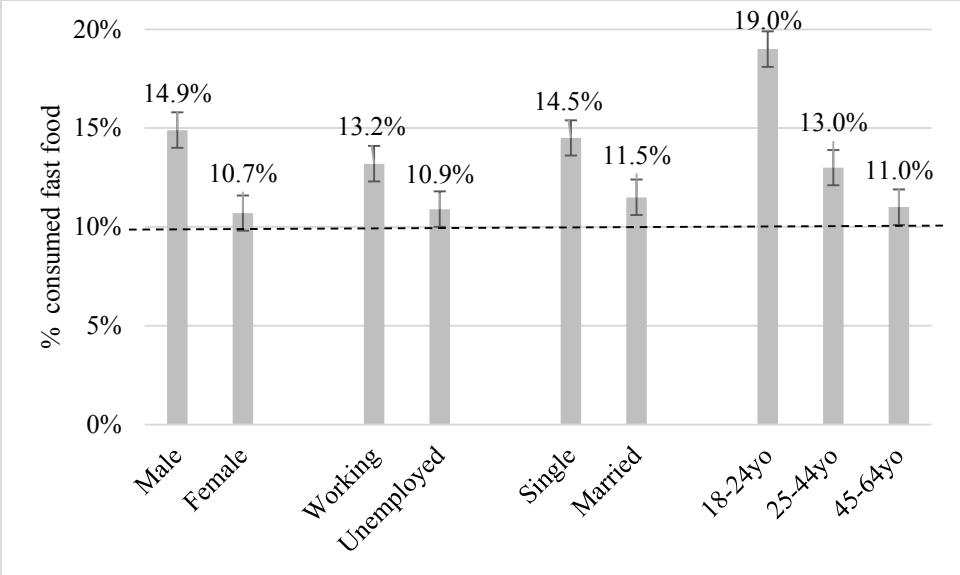

Figure 3. Significant differences in fast food consumption across demographics for 2015 CCHS-Nutrition respondents, aged 18-64.

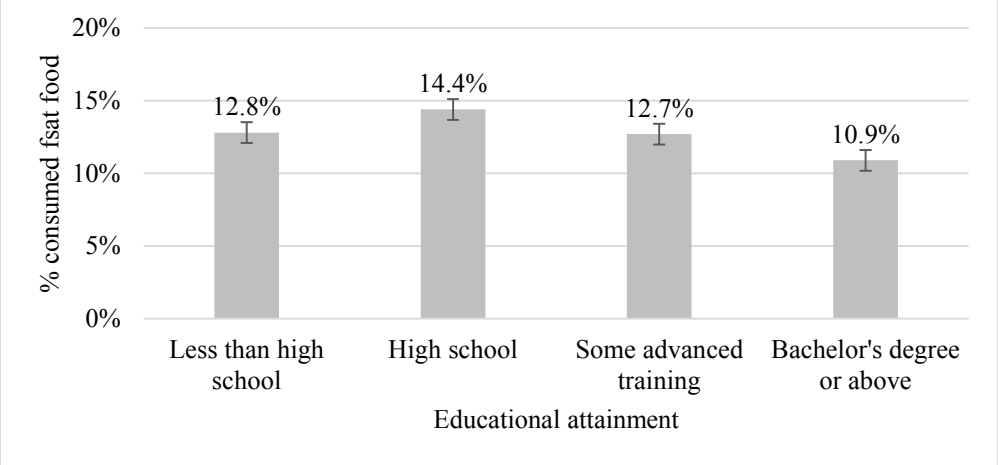

Figure 4. Fast food consumption by educational attainment for 2015 CCHS-Nutrition respondents, aged 18-64.

Fast food consumption rates also varied by geography (Table 3). Participants in Saskatchewan (10.6%) and Quebec (11.1%) were less likely to have consumed fast food in the last 24 hours than participants in other provinces, whereas Newfoundland and Labrador had a significantly higher frequency of fast food consumption (15.4%; Figure 5). Among the three largest Canadian cities,

Montreal had the lowest frequency of fast food consumption (10.9%) compared with Toronto (14.9%) and Vancouver (12.5%). Despite the majority of participants living in rural areas having little to no fast food access within 3000m, there was no difference between fast food consumption of rural participants (12.7%) and urban participants (12.7%).

Table 3
Fast food consumption by geography for 2015 CCHS-Nutrition respondents, aged 18-64

	N	% consumed fast food
Total sample	9985	12.7
Urbanicity		
Rural	2224	12.7
Urban	7958	12.7
Less than 30,000	1178	13.5
30,000-99,000	871	13.5
100,000-499,000	1994	11.9
500,000 or more	3915	12.7
Province		
Newfoundland and Labrador	607	****15.4**
Nova Scotia	733	13.6
Prince Edward Island	556	***14.4**
New Brunswick	619	12.1
Quebec	1636	***11.1**
Ontario	2230	13.8
Manitoba	661	12.4
Saskatchewan	699	****10.6**
Alberta	1161	12.9
British Columbia	1280	11.7
CMA		
Montreal	788	***10.9**
Toronto	1040	14.9
Vancouver	714	12.5

Note. Bold values are significantly different than national average.
**p* < .05 ***p* <.001

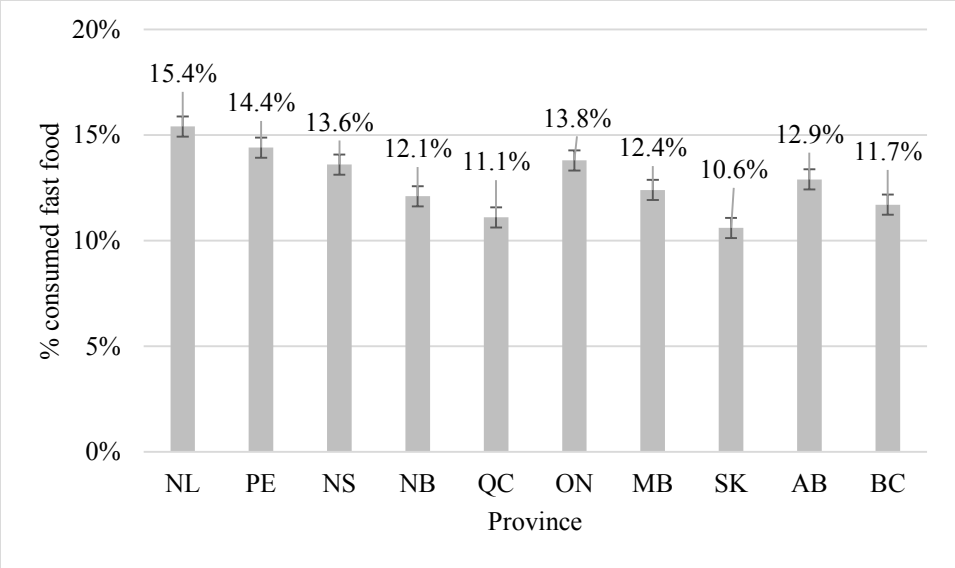

Figure 5. Average fast food consumption by province for 2015 CCHS-Nutrition respondents, aged 18-64.

4.2 Fast Food Access across Canada

The following section summarizes descriptive statistics on fast food access among survey respondents across Canada. 260 respondents had missing access data and were left out from analyses (N = 9,922). Analyses on average restaurant mix by province and census metropolitan area were restricted to non-zero access respondents (N = 4992 at 1000m and N = 7669 at 3000m). Correlations were run to assess whether fast food density (the absolute access measure) was associated with restaurant mix (the relative access measure) for both 1000m network buffers and 3000m network buffers. A moderate positive correlation was found between fast food density and restaurant mix at 1000m ($R(9922) = .40$, $p < .00001$), and a small positive correlation between fast food density and restaurant mix at 3000m was found ($R(9922) = .23$, $p < .00001$).

The percentage of participants with access to fast food varied across urban settings. In the total sample, 49.7% of participants had no access to fast food within a 1000m buffer (Table 4) and 22.7% of participants had no access to fast food within a 3000m buffer (Table 5).

Table 4
Access to fast food outlets within 1000m by urbanicity of 2015 CCHS-Nutrition respondent's home

	No access to fast food N(%)
Total Sample	4930(49.7%)
Urbanicity	
Rural	2083(96.5%)
Urban	2847(36.7%)

Table 5
Access to fast food outlets within 3000m by urbanicity of 2015 CCHS-Nutrition respondents' home

	No access to fast food N(%)
Total Sample	2253(22.7%)
Urbanicity	
Rural	1853(85.9%)
Urban	400(5.2%)

Participants living in rural areas were less likely to have access to fast food than participants in urban areas. 96.5% of participants living in rural areas had no access to fast food within a 1000m buffer and 85.9% of participants living in rural areas had no access to fast food within a 3000m buffer, whereas 36.7% of participants living in urban areas had no access to fast food within a 1000m buffer and 5.2% of participants living in urban areas had no access to fast food within a 3000m buffer.

Among participants living in urban areas, those in larger population urban environments had higher access to fast food (Figure 6). For example, 98.3% of participants in urban areas with

500,000 people had access to fast food within 3000m compared with 81.8% of participants in urban areas with less than 30,000 people.

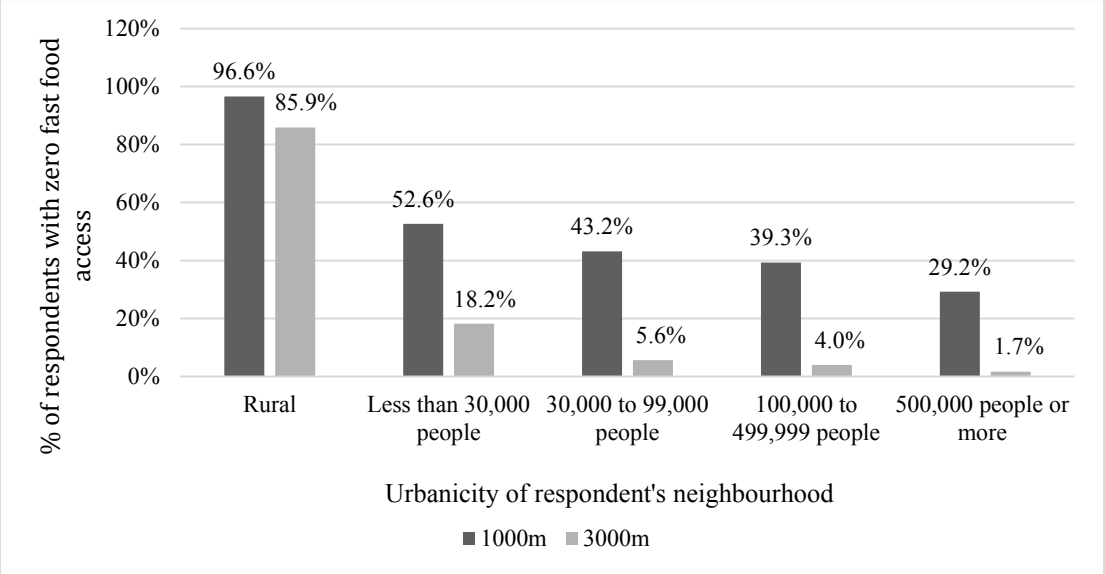

Figure 6. Percentage of 2015 CCHS-Nutrition respondents with zero fast food access by urbanicity.

There was also variation in restaurant mix (relative fast food access) across the sample. Restaurant mix (number of fast food outlets/total number of restaurants in an area *100) represents the proportion of restaurants available within 1000m and 3000m that are fast food restaurants. Restaurant mix values range from 0-100, with higher values representing a higher proportion of fast food outlets. The mean restaurant mix within 1000m was 40.31 (*SD* = 26.07) and the mean restaurant mix within 3000m was 34.22(*SD* = 15.79). There was variation in average restaurant mix by province (Figure 7; Table 6). Quebec *(mean* for 1000m = 29.87, *SD* = 21.88; *mean* for 3000m = 25.70, *SD* = 14.06) and British Columbia (*mean for* 1000m = 29.85, *SD* = 13.34; *mean for* 3000m = 25.29, *SD* = 13.34) had significantly lower restaurant mix than other provinces. Newfoundland and Labrador had the highest restaurant mix (*mean* for 1000m = 54.81, *SD* = 28.13; *mean* for 3000m = 52.31, *SD* = 19.23).

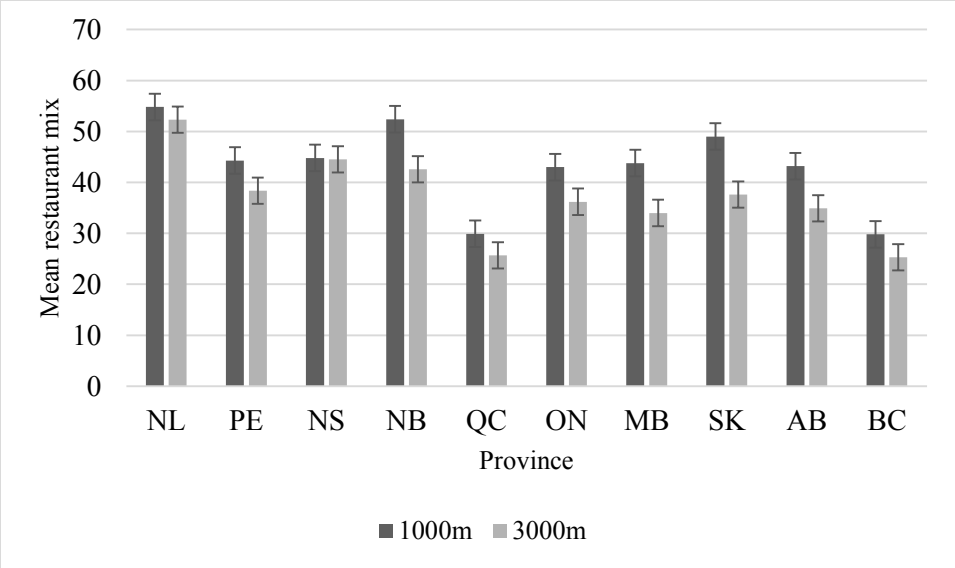

Figure 7. Average restaurant mix (proportion of restaurants that are 'fast food' restaurants) by province for 2015 CCHS-N respondents with non-zero access, aged 18-64.

Table 6
Average restaurant mix (proportion of fast food restaurants) within 1000m and within 3000m by province among 2015 CCHS-Nutrition respondents with non-zero access to fast food outlets

	Restaurant Mix 1000m *M*(*SD*)	**N**	**Restaurant Mix 3000m *M*(*SD*)**	**N**
Total Sample	40.31(26.07)	4992	34.22(15.79)	7669
Province				
Newfoundland and Labrador	****54.81(28.13)**	171	****52.31(19.23)**	323
Prince Edward Island	44.26(28.40)	198	38.37(18.69)	319
Nova Scotia	44.76(26.34)	296	***44.52(21.05)**	493
New Brunswick	****52.36(26.64)**	111	***42.57(12.86)**	289
Quebec	****29.87(21.88)**	843	****25.70(14.06)**	1294
Ontario	43.06(24.81)	1446	36.18(12.95)	1905
Manitoba	43.78(26.72)	335	33.99(12.41)	494
Saskatchewan	***49.04(28.68)**	328	37.60(12.56)	501
Alberta	43.18(25.34)	608	34.93(10.97)	975
British Columbia	****29.85(23.40)**	656	****25.29(13.34)**	1076

Note. Bold values are significantly different than national average.
**p* < .05 ***p* <.001

Restaurant mix also significantly differed by Canadian census metropolitan areas (census boundaries of large cities which include their suburbs; Figure 8; Table 7). Vancouver (*mean* for 1000m = 25.00, *SD* = 18.92; *mean* for 3000m = 21.74, *SD* = 9.63) and Montreal (*mean* for 1000m = 25.66, *SD* = 17.35; *mean* for 3000m = 21.45, *SD* = 8.79) had similarly low restaurant mix. Hamilton had the highest restaurant mix (*mean* for 1000m = 51.12, *SD* = 28.84; *mean* for 3000m = 41.03, *SD* = 14.63)—meaning that Hamilton had a higher proportion of its restaurants as fast food, compared to other cities in Canada.

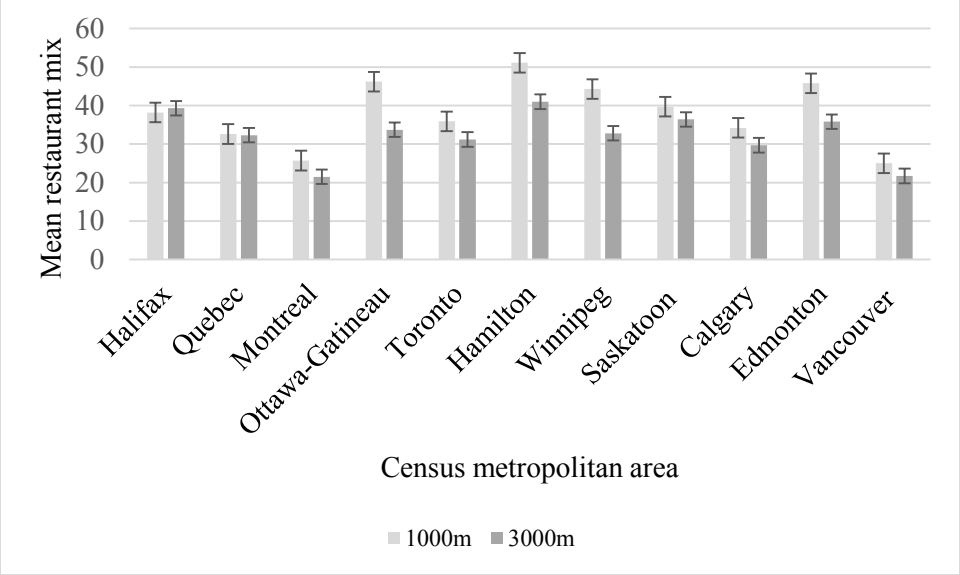

Figure 8. Average 'restaurant mix' (proportion of fast food restaurants out of all restaurants) within 1000m and 3000m among 2015 CCHS-Nutrition respondents with non-zero access by census metropolitan area.

Table 7
Average restaurant mix (proportion of fast food restaurants) within 1000m and 3000m by census metropolitan area among 2015 CCHS-Nutrition respondents with non-zero access to fast food outlets

	Restaurant Mix 1000m *M*(*SD*)	**N**	**Restaurant Mix 3000m *M*(*SD*)**	**N**
Total Sample	40.31(26.07)	4992	34.22 (15.79%)	3444
City				
Halifax	38.23(26.54)	191	39.31(20.15)	290
Quebec	32.56(26.26)	90	32.26(18.19)	178
Montreal	****25.66(17.35)**	580	****21.45(8.79)**	750
Ottawa-Gatineau	46.17(21.26)	113	33.67(15.00)	167
Toronto	35.85(21.22)	744	31.89(10.08)	973
Hamilton	****51.12(28.84)**	72	***41.03(14.63)**	76
Winnipeg	44.28(27.33)	278	32.76(12.77)	385
Saskatoon	39.68(25.14)	124	36.44(15.71)	188
Calgary	34.24(21.90)	229	***29.71(9.39)**	364
Edmonton	45.84(28.39)	197	35.81(10.11)	305
Vancouver	****25.00(18.92)**	462	****21.74(9.63)**	681

Note. Bold values are significantly different than national average.
*$p < .05$ **$p < .001$

4.4 Fast food consumption by access across Canada

The frequency of fast food consumption is fairly consistent across different levels of fast food access (Figure 9). There is a signal that there is slightly higher consumption with access within 1000m, but this difference is not conclusive and there is no difference in frequency of consumption within and beyond the 3000m buffers.

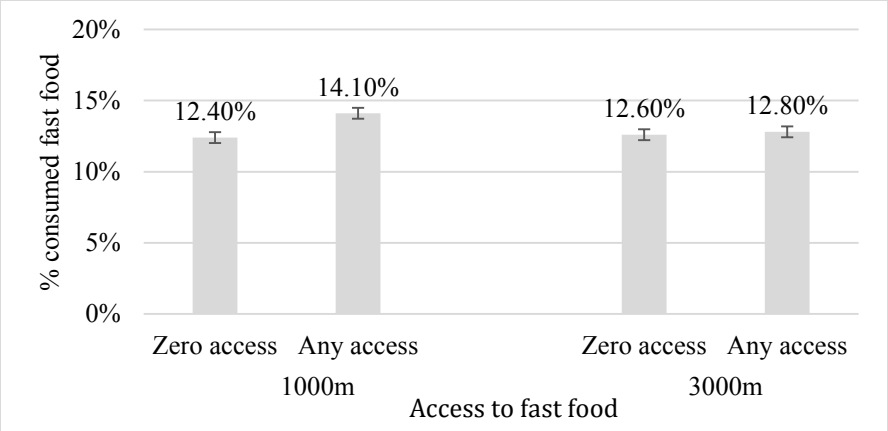

Figure 9. Fast food consumption by fast food access within 1000m and within 3000m among 2015 CCHS-Nutrition respondents.

To examine whether individual educational attainment had an influence on this relationship, fast food consumption rates were compared by level of fast food access and education (Table 8). For this comparison, education level was split by university-educated or not university-educated. Participants with at least a bachelor's degree and no fast food access within 3000m reported lower frequency of fast food consumption (9.9%) compared to other groups (p<.001).

Table 8
Percent of 2015 CCHS-Nutrition respondents that consumed fast food by fast food access and education

	Percent consumed fast food N(%)
Total sample	1231(12.7%)
Fast food access by education	
Less than bachelor's degree	
1000m any access	460(13.9%)
1000m no access	479(12.8%)
3000m any access	690(13.3%)
3000m no access	249(13.3%)
Bachelor's degree or more	
1000m any access	161(10.5%)
1000m no access	123(11.2%)
3000m any access	250(10.9%)
3000m no access	***34(9.9%)**

Note. Bold value is significantly lower.
**p* < .001

Within the subgroup with less than high school education, there was a difference ($p < .05$) in fast food consumption between participants with any fast food access within 1000m (15.7%) and participants with no fast food access within 1000m (10.1%; Table 12). There was also a difference in fast food consumption ($p < .05$) between participants with any fast food access within 3000m (14.1%) and participants with no fast food access within 3000m (9.6%) in the less than high school group.

Table 9
Percent of 2015 CCHS-Nutrition respondents with less than high school education that consumed fast food by access within 1000m and 3000m

	Percent consumed fast food N(%)
Total sample	1231(12.6%)
Fast food access by education	
Less than high school	
1000m any access	***60(15.7%)**
1000m no access	51(10.1%)
3000m any access	***81(14.1%)**
3000m no access	30(9.6%)

Note. Bold values are significantly higher.
*$p < .05$

Overall results show that the frequency of fast food consumption by fast food access may be dependent on participants' education level, such that the frequency of fast food consumption of participants with lower educational attainment is more influenced by fast food access than other groups.

4.5 Multivariate regression analyses

Multivariate analyses were used to examine the relationship between fast food access measures and fast food consumption. Table 10 summarizes the predicted odds of fast food consumption in the unadjusted models for all four fast food access measures (fast food density within 1000m, restaurant mix-proportion of fast food restaurants out of total restaurants-within 1000m, fast food density within 3000m, and restaurant mix within 3000m). No significant associations were found for any of the four access measures on fast food consumption in unadjusted models. Models were

also run with continuous fast food access measures and within age groups with no significant results.

Table 10
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, for unadjusted bivariate analyses with four fast food access measures (low/medium/high)

	Odds Ratio	95% CI for Odds Ratio	
		Lower	Upper
Fast food density within 1000m			
Low	.92	.642	1.319
Medium	1.085	.792	1.486
High	1.23	.772	1.959
Restaurant mix within 1000m			
Low	.841	.572	1.234
Medium	1.151	.856	1.547
High	1.166	.731	1.859
Fast food density within 3000m			
Low	.894	.574	1.392
Medium	1.014	.691	1.487
High	.916	.602	1.393
Restaurant mix within 3000m			
Low	1.012	.659	1.555
Medium	.975	.664	1.431
High	.852	.567	1.281

Note. Reference category is zero access to fast food. Access measures are categorized into low/medium/high by tertile.

Tables 11a-11d show the predicted odds of fast food consumption in adjusted model for all four fast food access measures (fast food density within 1000m, restaurant mix within 1000m, fast food density within 3000m, and restaurant mix within 3000m). There were no significant associations for any of the four access measures on fast food consumption in models adjusted for relevant covariates. Adjusted models were also run with continuous fast food access measures and within age groups with no significant results.

Table 11a
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by fast food density within 1000m, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Fast food density within 1000m			
Low	.904	.624	1.311
Medium	1.049	.757	1.454
High	1.251	.772	2.025
Educational attainment			
High school	1.017	.651	1.618
Some advanced training	.825	.531	1.276
University or more	.873	.542	1.430
Age			
25-44 years old	.816	.537	1.241
45-64 years old	.738	.485	1.122
Male	1.326	1.023	1.718
Marital status	.787	.601	1.029
Working status	1.632	1.148	2.320

Note. Fast food density reference category is zero access within 1000m. Educational attainment reference category is less than high school. Age reference category is 18-24 years old. Marital status is for single compared to married. Working status is for working compared to unemployed.

Table 11b
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by restaurant mix within 1000m, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Restaurant mix within 1000m			
Low	.801	.538	1.193
Medium	1.134	.832	1.547
High	1.145	.714	1.836
Educational attainment			
High school	1.019	.650	1.599
Some advanced training	.818	.530	1.261
University or more	.895	.559	1.431
Age			
25-44 years old	.833	.549	1.263
45-64 years old	.751	.494	1.142
Sex	1.326	1.026	1.715
Marital status	.767	.586	1.003
Working status	1.627	1.145	2.311

Note. Restaurant mix reference category is zero access within 1000m Educational attainment reference category is at least a bachelor's degree. Age reference category is 18-24 years old. Marital status is for single compared to married. Working status is for working compared to unemployed.

Table 11c
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by fast food density within 3000m, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Fast food density within 3000m			
Low	.889	.561	.615
Medium	1.006	.678	.977
High	.893	.568	.624
Educational attainment			
High school	.983	.621	1.557
Some advanced training	.818	.524	1.275
University or more	.894	.548	1.458
Age			
25-44 years old	.811	.531	1.238
45-64 years old	.731	.479	1.117
Sex	1.336	1.031	1.730
Marital status	.775	.589	1.021
Working status	1.631	1.139	2.337

Note. Fast food density reference category is zero access within 3000m. Educational attainment reference category is less than high school. Age reference category is 18-24 years old. Marital status is for single compared to married. Working status is for working compared to unemployed.

Table 11d
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by restaurant mix within 3000m, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Restaurant mix within 3000m			
Low	1.019	.643	1.615
Medium	.963	.646	1.435
High	.844	.553	1.290
Educational attainment			
High school	1.026	.651	1.618
Some advanced training	.823	.531	1.276
University or more	.880	.542	1.430
Age			
25-44 years old	.827	.544	1.257
45-64 years old	.741	.487	1.126
Sex	.787	.601	1.029
Marital status	1.326	1.023	1.718
Working status	1.632	1.148	2.320

Note. Restaurant mix reference category is zero access within 3000m Educational attainment reference category is at less than high school. Age reference category is 18-24 years old. Marital status is for single compared to married. Working status is for working compared to unemployed.

Models were also run by educational attainment subgroup. For Canadians with less than high school education, a modest association was found between continuous restaurant mix at 1000m and fast food consumption (*OR* = 1.01, 95% *CI*: 1.004-1.018; Table 12). However, when participants with zero access to fast food were excluded from analyses, the association was no longer significant, (*p* = .09, *OR* = 1.01, 95% *CI*: .999-1.02; Table 13).

Table 12
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by restaurant mix within 1000m in respondents with less than high school education, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Restaurant mix within 1000m	1.010	1.004	1.017
Age	.988	.974	1.002
Male	.908	.601	1.371
Marital status	1.002	.647	1.551
Working status	1.526	1.006	2.315

Note. Sex is for males compared to females. Marital status is for single compared to married. Working status is for working compared to unemployed.

Table 13
Predicted odds of fast food consumption, CCHS-Nutrition, 2015, by restaurant mix within 1000m in respondents with less than high school education, restricted to non-zero access participants, adjusted

	Odds Ratio	95% Confidence Interval for Odds Ratio	
		Lower	Upper
Restaurant mix within 1000m	1.009	.998	1.020
Age	.983	.964	1.002
Male	.766	.428	1.373
Marital status	1.159	.629	2.136
Working status	1.786	.990	3.224

Note. Sex is for males compared to females. Marital status is for single compared to married. Working status is for working compared to unemployed.

4.6 Summary of results

Just over 12 percent of adult Canadians reported eating fast food on the previous day in 2015. This is comparatively lower than American consumption reported from a similar methodology at 36.6% (Fryar et al., 2018). Fast food consumption varied by demographics, with certain groups having a higher frequency of fast food consumption than others. On average, fast food consumption was higher in men, overweight or obese adults, single adults, working adults, and adults aged 18-24. These findings are consistent with a similar American study that also found that fast food consumption declined with age and was more common among men than women (Fryar et al., 2018).

Neighbourhood fast food access varied across Canada, with the majority of rural Canadians having zero access to fast food within 1000m or 3000m. Quebec and British Columbia have, on average, lower restaurant mix- that is, a lower proportion of their restaurants as fast food restaurants- than other provinces. Newfoundland and Labrador and New Brunswick had higher restaurant mix than other provinces. Restaurant mix also varied by census metropolitan area. Restaurant mix also varied by census metropolitan area. Vancouver and Montreal had significantly lower mean restaurant mix- a smaller proportion of fast food restaurants out of total restaurants - than other census metropolitan areas, while Hamilton had significantly higher restaurant mix- a larger proportion of fast food restaurants out of total restaurants.

Overall, results do not provide evidence for a link between fast food access and fast food consumption at the neighbourhood scale in Canada. There was no significant difference in frequency of fast food consumption between individuals with and without fast food access in their neighbourhoods. The one exception is the university education subgroup with zero fast food

access, which did show a lower frequency of fast food consumption. In multivariate analyses, there was no conclusive association between overall fast food access and fast food consumption for any level of access (low, medium, high). I will discuss implications of these results, study design strengths and limitations, and the major substantive, methodological, and policy contributions of this thesis.

CHAPTER SIX: DISCUSSION

This chapter summarizes the main findings of this thesis and discusses implications of these findings; the major substantive, methodological, and policy contributions of this thesis; and limitations of the study design. The main objective of this master's thesis was to examine the relationship between neighbourhood fast food access and fast food consumption in Canada. This study also investigated the role of socioeconomic status in determining the relationship between fast food access and fast food consumption. This study asks the questions 1) Does neighbourhood fast food access impact fast food consumption? 2) Is this relationship stronger in individuals with low socioeconomic status?

6.1 Overview of main findings

The results of this thesis do not support the overarching hypothesis that neighbourhood fast food access is associated with higher fast food consumption in Canada. However, the descriptive statistics included in this thesis provide context on fast food access and fast food consumption across Canada. First, I discuss the implications of the descriptive statistics on fast food consumption and neighbourhood fast food access within the sample. Second, I discuss the results of the multivariate analyses that examine this relationship and provide potential explanations for why results were not significant.

My first research question investigated whether there would be a positive relationship between neighbourhood fast food access measures—fast food density (number out fast food outlets/m^2) and restaurant mix (proportion of fast food restaurants out of total restaurants) within both 1000m and 3000m network buffers. Neighbourhood fast food access was not associated with fast food consumption, with no significant association between fast food density or restaurant mix and fast

food consumption. There was no significant difference in frequency of fast food consumption between individuals with and without fast food access in the total sample. For multivariate analyses, there was no association between fast food access and fast food consumption in the total sample. However, differences in frequency of fast food consumption existed across provinces and cities, which suggests that the larger urban environment—perhaps even a city identity or food 'culture'—may play a role in determining fast food consumption.

My second research question investigated whether the relationship between neighbourhood fast food access and fast food consumption would be stronger among individuals with low educational attainment. There was mixed evidence for the influence of socioeconomic status on this relationship. Among participants with less than high school education, 15.7% of participants with at least one fast food outlet within 1000m reported consuming fast food compared with 9.6% of participants with zero access within 1000m. In multivariate analyses, an association emerged for the lowest educational attainment subgroup for continuous restaurant mix within 1000m. However, this association was no longer significant when participants with zero fast food access were excluded from analyses.

Descriptive statistics

This thesis describes fast food consumption patterns of Canadians and describes neighbourhood fast access across Canada. These statistics provide an overview of fast food consumption by demographic groups and fast food access by geography. Overall results suggest that frequency of fast food consumption is fairly consistent across different neighbourhoods regardless of level of access. There are, however, differences in frequency of fast food consumption at the province-level and city-level, which suggests that fast food 'culture'—something to be explored in more detail in future work—may be determined at a larger geographic scale than previously thought.

Fast Food Consumption

Overall 12.7% of adult Canadians reported consuming fast food in the last 24 hours in 2015. This is comparatively lower than American consumption reported from a similar methodology at 36.6% (Fryar et al., 2018). There were several differences in frequency of fast food consumption across demographic groups. Overweight (13.5%) and obese (13.3%) participants had a higher frequency of fast food than normal weight participants (11.7%), which provides support for the link between fast food consumption and higher body-mass index. There was also a higher frequency of fast food consumption among males (14.9%) compared to females (10.7%), which is consistent with past literature (Laxy et al., 2015). The same is true for the higher-than-average frequency of fast food consumption among young adult participants aged 18-24 (19%). Young adults tend to think less about nutrition than older adults when making food choices, and fast food is often marketed toward younger demographics (Ogilvie & Eggleton, 2016). One interesting group difference was the higher frequency of fast food consumption in single participants (14.5%) compared to married/cohabitating participants (11.5%). Married individuals may be more likely to eat more home-cooked meals with their partner or family. Past research suggests that households with one stay-at-home partner report higher diet quality than households with two working adults (Neumark-Sztainer et al., 2003).

Fast food consumption by socioeconomic status varied less than expected. Past literature suggests that individuals with low socioeconomic status are more likely to consume fast food. University-educated participants showed a lower frequency of fast food consumption (10.9%) than participants with lower levels of education. However, there was no significant difference in frequency of fast food consumption across income quintiles (11.8% in lowest and 13.3% in

highest). There was also no difference between participants who reported being part of a food insecure household (12.7%) compared to a food secure household (12.8%). These results suggest that education may play a larger role than financial security in determining whether an individual consumes fast food. This explanation would be consistent with past research that shows lack of education about nutrition can negatively influence people's food choices (Wang & Brownell, 2005). It also likely suggests that some level of income is required to consume meals outside of the home and that many low income families may forego meals outside of the home to reduce costs.

Work food environments may also play a role in determining Canadians' fast food consumption. Working participants reported a higher frequency of fast food consumption (13.2%) than unemployed participants (10.9%). Some food environment researchers have begun studying the food choices available on the commute to work/school (Widener et al., 2016). Considering the convenience of fast food as an option on-the-go, food consumed or acquired on work commutes could represent a significant proportion of some individuals' overall fast food consumption. However, more research is needed in this area to further elucidate why working people might consume more fast food. Another possibility is that working people have less time available to devote to food preparation than those who are not working outside the home. Interestingly, there was no difference in fast food consumption between single parent households (12.6%) and other household types (12.8%). This result was unexpected because there may be an argument that single parents would also have less time available for preparing home-cooked foods. The income story may be playing out here as well with single-parent households foregoing meals outside of the home more often than other households to conserve resources. Further research is needed to examine how time available may contribute to overall fast food consumption.

Neighbourhood Fast Food Access

Many Canadians live with zero easy access to fast food within their neighbourhoods, especially in rural areas. 49.7% of participants had no access to fast food within a 1000m buffer and 22.7% had no access within a 3000m buffer. In rural settings, 96.5% of participants had no access to fast food within 1000m and 85.9% had no access within 3000m. However, despite only 3.5% of rural participants having any access to fast food in their neighbourhood, there was no difference in frequency of fast food consumption between rural and urban participants (12.7%). These results suggest that 3000m network buffers are not sufficient to capture individuals' access to fast food within rural areas. 1000m network buffers have been used to measure fast food access in many past food access studies (Fleischhacker et al., 2011). However, it is possible that this measure of fast food access needs to be reconsidered outside of large metropolitan areas. Even among participants living in urban areas with 500,000 people or more, 29.2% of participants had no fast food outlets within 1000m from the weighted centroid of their dissemination area. These results suggest that Canadians are willing to travel further for fast food than previously thought. It is also possible that Canadians are consuming fast food at other times in the day when they are away from home. Another consideration beyond the scope of this thesis is the influence of food delivery services on fast food consumption. In recent years, app-based food delivery services (i.e., *Uber Eats*) have emerged, which make it easier for individuals to have food delivered to their home from a wide range of restaurants, although presumably the local food environment would still be influential. Further research is needed to examine what proportion of fast food consumed is accessed through these services.

Restaurant mix by geography. Results show differences in restaurant mix across provinces and city metropolitan areas. Restaurant mix shows what proportion of restaurants available are fast food outlets. This measure gives an idea of what options individuals have when they decide to dine out. The average restaurant mix for the total sample was 40.31 at 1000m and 34.22 at 3000m. Provincial mean restaurant mix ranged from 29.85 (British Columbia) to 54.81 (Newfoundland and Labrador) at 1000m and ranged from 25.29 (British Columbia) to 52.31 (Newfoundland and Labrador) at 3000m. This suggests that province of residence may have an impact on what restaurant choices are available to individuals. There were also differences in average restaurant mix by city. City mean restaurant mix ranged from 25.00 (Vancouver) to 51.12 (Hamilton) at 1000m and ranged from 21.45 (Montreal) to 41.03 (Hamilton) at 3000m. These results suggest that availability of fast food varies by province and census metropolitan area. Future research should investigate the relationship between restaurant mix and diet-related health outcomes, such as body-mass index and type 2 diabetes.

Access and geographic scale. More attention is needed on how the relationship between fast food access and consumption varies by geographic context, particularly by scale and location. There was considerable variation in frequency of fast food consumption and restaurant mix by province. In some cases, provinces and cities with higher restaurant mix (indicating a higher proportion of fast food restaurants) also had higher frequency of fast food consumption. These results suggest that the city and province where someone resides may have more of an influence than their neighbourhood on whether they consume fast food. One possible explanation is that frequency of fast food consumption is influenced by the eating behaviour 'culture' of an area. Further research is needed that looks at the intersection of geographic food access and social norms around eating behaviour in determining diet.

Neighbourhood Fast Food Access and Consumption

The descriptive statistics show limited support for the link between neighbourhood fast food access and fast food consumption. There was no significant difference in frequency of fast food consumption between participants with no access (12.4%) or any access (14.1%) at 1000m or between participants with no access (12.8%) and any access (14.1%) at 3000m (*p*s > .05). These results suggest that participants will consume fast food at the same rate regardless of whether they have access to fast food in their neighbourhood.

However, at the provincial level, there seemed to be a link between high mean restaurant mix and higher frequency of fast food consumption. For example, Newfoundland and Labrador had the highest mean restaurant mix at both 1000m (54.8) and 3000m (52.31) and also the highest frequency of fast food consumption (15.4%). Quebec had one of the lowest mean restaurant mixes at both 1000m (29.87) and 3000m (25.70) and also one of the lowest frequencies of fast food consumption (11.1%). While we cannot draw conclusions from this data alone, this pattern suggests that there may be some relationship between fast food availability and fast food consumption at the provincial level.

Educational attainment. The descriptive statistics also provide limited support for the hypothesis that fast food consumption of individuals with lower educational attainment will be more influenced by fast food density than consumption of individuals with higher education. Participants with at least a bachelor's degree and no fast food access within 3000m had a lower frequency of fast food consumption (9.9%) than average. Furthermore, among participants with less than high school education, 15.7% of participants with at least one fast food outlet within

1000m reporting consuming fast food compared with 9.6% of participants with zero access within 1000m. These results suggest a combination of education level and fast food access may influence overall fast food consumption.

Multivariate analyses

Overall multivariate analyses showed no significant relationship between any of the four neighbourhood fast food access measures and fast food consumption in fully adjusted models. These results suggest that the availability of fast food around individuals' homes does not influence their intake of fast food. There are several methodological limitations of this study that could have affected these results, which will be discussed in the following section. Further research in this area should consider different measures of fast food access and consumption that may improve accuracy. In particular, more attention is needed on determining the proper scale to measure neighbourhood food access in non-urban areas.

6.2 Research Contributions

Substantive Contributions

This thesis has implications for research on neighbourhood food environments and geographic access. Past research suggests that aspects of the built food environment shape individual eating behaviour (Glanz et al., 2005). However, the results of this thesis question the link between neighbourhood fast food access and fast food consumption. While there was substantial variation in restaurant mix across provinces and census metropolitan areas and some variation in fast food consumption across demographics, no significant link was found between fast food access and fast food consumption. Results suggest that variation in fast food density and restaurant mix at the neighbourhood level does not impact individuals' fast food consumption.

This thesis also contributes to literature on the social determinants of health and eating behaviour. Past studies show that people with low socioeconomic status tend to consume fast food more frequently (Laxy et al., 2015; Turrell & Giskes, 2008). One study also demonstrated that neighbourhood fast food access had more of an impact on fast food consumption for individuals with low educational attainment (Burgoine et al., 2016). The results of this thesis provide limited support for the link between socioeconomic status, fast food access, and fast food consumption. Individuals with a university degree were less likely to have consumed fast food than individuals with lower educational attainment. Among participants with less than high school education, individuals living in areas with access to fast food had a higher frequency of fast food consumption than those in areas with access to fast food. However, there was no significant relationship between fast food access measures and fast food consumption across educational subgroups in multivariate analyses.

Methodological Contributions

The main methodological contribution of this thesis is the use of two high-quality datasets to measure the exposure, neighbourhood fast food access, and the outcome, fast food consumption. This thesis is the first study to use the Statistics Canada Business Register to measure fast food access. The Business Register provides a higher level of food outlet data accuracy than proprietary datasets, which are typically used for this type of research. Categorization of all food outlets in the Business Register was completed by researchers from our research group, which provided more flexibility in designating food outlet categories. We were able to differentiate between fast food outlets and other types of limited service establishments, whereas most past research in Canada has lumped these two types of outlets together (Hollands et al., 2013; Polsky et al., 2016).

This study also includes high quality data from the 2015-CCHS nutrition, a large nationally representative survey of the nutrition of people in Canada. The outcome measure of fast food consumption was taken from a question in the 24-hour dietary recall portion of the survey. This is the first study to use this measure for research on fast food consumption in Canada, and the first time that the link between fast food access and fast food consumption has been looked at in a large nationally representative sample with wide geographic reach. However, while the CCHS data is strong, the question asked for fast food consumption in the last 24 hours may not have been ideal for accurately measuring fast food consumption, a problem which I will discuss further in the limitations section.

Another methodological contribution of this thesis is the use of both an absolute fast food access measure (number of fast food outlets/m and relative density measure for fast food access. Using both measures allowed us to investigate whether the proportion of fast food outlets out of all restaurants available had more of an impact on individuals' diets than the density of fast food outlets alone. Another strength of the relative measure of fast food access (restaurant mix) is that is easily interpretable. Restaurant mix makes it easy to compare average fast food access across geographic areas, which allows us to examine differences by province and census metropolitan area. There was substantial variation in average restaurant mix across the sample. Going forward, more research is needed to determine the appropriate scale at which to measure restaurant mix and to investigate whether restaurant mix may be linked to diet-related health outcomes.

Policy Contributions

The results of this thesis suggest that policy around fast food access should look beyond the neighbourhood environment. It may be the case that individuals travel outside the vicinity of their homes to purchase fast food, but further research is needed to investigate what distance people

typically travel to purchase fast food. Successful policy limiting fast food consumption may need to consider the availability of fast food in workplaces and schools in addition to the area around the home. It might also be beneficial to consider larger scale policy interventions beyond the neighbourhood. Significant variation in frequency of fast food consumption across provinces and census metropolitan areas suggests that fast food cultures may be determined at a larger scale than previously thought. Policy that targets social norms around fast food consumption might have a greater impact on reducing fast food consumption than restricting fast food access alone.

As a society we should consider how to make healthier food more accessible to consumers. Past research suggests that as much as 62% of the Canadian diet consists of highly processed convenience foods (Ogilvie & Eggleton, 2016). The results of this thesis reflect the high availability of unhealthy food options around Canadians' homes. The results show that many Canadians live in neighbourhoods with a high proportion fast food. On average, 40% of restaurants available within 1000m were fast food. Policy that works to increase affordable access to healthy food options may have a positive impact on the health of Canadians. However, policies to increase access to healthy food are often difficult to enact on a large scale because they must go against the interests of the fast food industry, which has significant financial clout (Marmot & Wilkinson, 2005). Furthermore, as this thesis shows, it is difficult to provide concrete support for such policies, given the challenges of accurately measuring fast food access across a range of settings.

6.3 Limitations and Future Directions

This thesis contained several methodological limitations, with potential for future research. Geographic fast food access and fast food consumption are both measures that are notoriously difficult to capture accurately. Overall, the results of this thesis highlight the challenges of studying neighbourhood food access, particularly in creating access measures.

One limitation of the study design was determining how to accurately measure fast food access across all of Canada. While the large scale and wide geographic reach of this study was an advantage, it also provided a substantial challenge in creating accurate neighbourhood access measures. Specifically, how can we create measures for neighbourhood fast food access that apply across a variety of settings? The concept of a neighbourhood greatly differs between different census metropolitan areas and even more so between urban and rural settings. This thesis included 1000m and 3000m network buffers around the population-weighted centroid of participants' dissemination areas in the hopes that the larger buffer size would be more appropriate in measuring food access for participants living in rural areas. However, it may be that the 3000m network buffer was not sufficient in capturing the distance people will travel to purchase fast food, considering that 85.9% of rural participants had zero access to fast food within 3000m. The high number of participants with zero access also presented a problem for analyses. For some models, zero access participants were left out, which greatly reduced overall sample size.

Future research on neighbourhood food environments in rural areas will need to consider the distance rural residents will travel to access fast food. This area of research would benefit from qualitative analyses on rural individuals' behaviour around fast food consumption. There are many pertinent questions that would help elucidate how to make an appropriate access measure for rural areas. For instance, how far do rural residents travel on average to purchase fast food? Do they purchase fast food on the way to work or is it reserved for weekends? Will they drive out of their way to purchase fast food? It would be useful to collect car ownership data on participants in future studies, which would give a better idea of what means of transport participants have available to visit fast food outlets. Lastly, it would also be useful to do a GPS study tracking the movement of

participants. This type of study would allow researchers to pinpoint at what times in the day and what point in participants' routines they are more likely to consume fast food.

Another limitation of this thesis was the way that fast food consumption was measured. Fast food consumption was measured using one question from the 24-hour dietary recall portion of the 2015 CCHS-Nutrition. Past research suggests that dietary recall has higher accuracy than food frequency questionnaires (Kirkpatrick, 2015). However, the question in the 2015 CCHS-Nutrition did not ask directly whether participants consumed fast food in the past 24 hours. Instead, it asked where each food they ate in the past 24 hours was consumed, and participants had the option of answering "fast food restaurant (including takeout/pizzerias)." The wording of this question allows for ambiguity in how participants interpret it. Perhaps participants purchased fast food at a fast food outlet but then consumed the food at home or at work. In these cases, participants may not have reported consuming an item of fast food. This could explain why the frequency of fast food consumption is lower than expected. Research from the 2004 CCHS-Nutrition showed that 24% of Canadians consumed fast food on an average day (Garriguet, 2006). The 2004 CCHS-Nutrition included a question on where each item of food was prepared in addition to where each item of food was consumed. This additional question could help account for the difference in fast food consumption reported between the two studies.

Future research looking at fast food access and fast food consumption would benefit from using different measures of fast food consumption. While 24-hour dietary recall data has higher accuracy, a fast food frequency measure might provide a better idea of peoples' fast food consumption habits over time. Looking at a single day may poorly represent an individuals' usual fast food consumption. An ideal study on fast food consumption would include both a 24-hour dietary recall measure and a frequency measure over the past week. Additionally, it might be worth

repeating this study with a sample that was asked a more direct question on fast food consumption. The strengths of the 2015 CCHS-Nutrition, such as its high quality nutrition data and large nationally representative sample, are less useful without a direct question on fast food consumption.

Another future direction is looking at neighbourhood fast food access with other diet-related outcomes, including body-mass index. This thesis focused on the link between food environment and diet because fast food consumption has been linked to many diet-related health outcomes beyond obesity, including increased risk for type-2 diabetes and cardiovascular disease (CIHI, 2011). However, further research on the food environment and body-mass index would be a useful addition. Whereas fast food consumption on a single day has the potential to be too random, body-mass index represents a long-term health outcome that would be less to susceptible to chance.

6.4 Conclusion

The main objective of this master's thesis was to examine the relationship between neighbourhood fast food access and fast food consumption in a representative Canadian population-based sample. To explore my research questions, I conducted a population-based cross-sectional study using 2015 Canadian Community Health Survey-Nutrition (CCHS-Nutrition) data linked to fast food density measures developed from the Statistics Canada Business Register at the census dissemination area level of survey respondents

Overall results do not support the overarching hypothesis that fast food access is associated with fast food consumption at the neighbourhood level. 12.7% of adult Canadians reported consuming fast food in the last 24 hours, and there was no significant difference in fast food consumption between individuals with access to fast food in their neighbourhoods and individuals with no fast food access. Significant variation in frequency of fast food consumption across

provinces and census metropolitan areas suggests that fast food consumption may be determined at a larger geographic scale than previously thought. Neighbourhood access may matter less than the surrounding urban environment as a whole in determining fast food consumption.

This thesis also investigated whether the relationship between neighbourhood fast food access and fast food consumption varied by socioeconomic status, measured by individual educational attainment. Individuals with university education were less likely to report consuming fast food than individuals with lower educational attainment. However, there was no evidence for a link between neighbourhood fast food access and fast food consumption across levels of educational attainment. A significant main effect emerged for individuals with less than high school education for 1000m restaurant mix, but it was no longer significant when participants with zero fast food access were excluded from analyses.

The results of this thesis contribute to the literature on neighbourhood food environments, geographic fast food access, and eating behaviour in Canada. This thesis contains several methodological contributions, including high-quality fast food access measures derived from the new Statistics Canada Business Register food environment dataset. This is the first study to look at neighbourhood fast food access and fast food consumption on a pan-Canadian level. Most studies to date have been smaller in scale and more local in scope, possibly obscuring the true range in scale of food environments and dietary behaviour in the Canadian population.

The results of this thesis suggest several future research directions for examining fast food access and fast food consumption in Canada. More research is needed to determine the appropriate scale for measuring neighbourhood access in non-urban areas, where the distances people will travel to purchase food tend to be much greater. Additionally, further research is needed that looks beyond individuals' immediate neighbourhoods. It would be useful to examine what percentage

of fast food is consumed away from home, such as on commutes or at work. The geographic variation in fast food consumption should also be further explored in order to elucidate the ways in which fast food consumption cultures are shaped at the provincial and metro levels.

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