THE ASSOCIATIONS AMONG ETHNICITY, CONTEXTUAL FACTORS, AND DIETARY INTAKE IN THE CANADIAN ALLIANCE FOR HEALTHY HEARTS AND MINDS: A CROSS-SECTIONAL STUDY.

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TITLE: The Associations Among Ethnicity, Contextual Factors, And Dietary Intake In The Canadian Alliance For Healthy Hearts And Minds: A Cross-Sectional Study.

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Lay Abstract

Unhealthy diets are significant contributors to chronic diseases. Diverse influences from the nutrition environment also impact consumption. To better inform public health strategies promoting healthy eating, it is imperative to ascertain whether modifying the food environment of individuals would be more effective in transforming their eating behaviours. This cross-sectional study, utilizing data from 7,077 adults from the CAHHM cohort, assessed the influence of elements of the nutrition environment and ethnicity on dietary intake. Differences in carbohydrate, junk food, meat, and cholesterol intake were found among Asians and White Europeans. Carbohydrate, fat, protein, vegetable, meat, and sweet drink intakes varied between rural and urban settings. Increased vegetable prices were associated with reduced consumption, while food advertisements were not associated with dietary intake. This study shows that the costs of healthy foods impact dietary choices more than advertisements. Policymakers can utilize these findings to promote healthy food environments in Canada.

Abstract

Introduction: Unhealthy diets are significant contributors to chronic diseases. Variations in CVD rates across ethnicities in Canada could be attributable to diverse dietary habits and nutrition environmental influences. The extent to which individuals' food environment perceptions influence dietary intake is also understudied.

Methods: This cross-sectional study, utilizing data from 7,077 of the 10,100 adults in the Canadian Alliance for Healthy Hearts and Minds (CAHHM) cohort, assessed associations of elements of the nutrition environment (food prices, advertisements, and availability) and ethnicity with dietary intakes.

Results: Self-reported intakes of carbohydrates, junk foods, meat, and cholesterol varied significantly across Asians and White Europeans ($p<0.0001$). Rural/urban differences were also observed in carbohydrate, fat, protein, cholesterol, vegetable, meat, and sweet drink intakes ($p<0.0001$), excluding junk foods, and fruits. Interestingly, while individuals' perceptions of their food environment did not correlate with objective measures of the same environment, a 1$ increase in vegetable prices was significantly associated with a decrease in vegetable consumption by 0.0078 In(servings/day) ($p= 0.0233$), after adjusting for rural/urban living, ethnicity and BMI. No associations were found between fruits, meat, bread, eggs, cola, chocolate, poultry, rice, and milk prices and respective intakes. No association was also found between fruit/vegetable availability and consumption; nor between junk foods, sweet drinks and fruit/vegetable ads and consumption. Notably, alcohol advertisement was associated with alcohol intake.

Discussion/Conclusion: The price-inelastic nature of foods like milk and eggs due to their perceived essentiality, implies the superimposing effects of other factors on consumption aside, price. While food advertisements undoubtedly impact eating behaviours, their influence might be subtle considering factors like price which could pose barriers to healthy eating. These findings emphasize the intricate interplay between prices, availability, advertisement, and other factors and dietary choices. Policymakers, food industries, and health advocates can leverage these insights to create healthier food environments for improved health.

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List of Abbreviations

ABC	(Aboriginal Birth Cohort)
AIC	(Akaike information criterion)
BMI	(Body Mass Index)
CAHHM	(Canadian Alliance for Healthy Hearts and Minds)
CCDSS	(Canadian Chronic Disease Surveillance System)
CCHS	(Canadian Health Community Survey)
CHILD	(Canadian Healthy Infant Longitudinal Development)
CPTP	(Canadian Partnership for Tomorrow Project)
CVD	(Cardiovascular Disease)
DALYs	(Disability Adjusted Life Years)
DGA	(Dietary Guidelines for Americans)
EPOCH	(Environmental Profile of Community Health)
FAMILY	(Family Atherosclerosis Monitoring in Early Life)
FFQ	(Food Frequency Questionnaire)
GBD	(Global Burden of Disease)
HEI	(Healthy Eating Index)
IOM	(Institutes of Medicine)
IPAQ	(International Physical Activity Questionnaire)
MASALA	(Mediators of Atherosclerosis in South Asians Living in America)
MHI	(Montreal Heart Institute)
MRI	(Magnetic Resonance Imaging)
NCD	(Non-Communicable Disease)
PATH	(Partnership for Tomorrow's Health),
PURE	(Prospective Urban Rural Epidemiology)
SAS	(Statistical Analysis Software)
SHARE	(Study of Health Assessment and Risk Evaluation)
START	(South Asian Birth Cohort Study)
WHR	(Waist-to-Hip Ratio)
USA	(United States of America)
USDA	(United States Department of Agriculture)

Declaration of Academic Achievements

The following is a declaration that the content of the research in this document has been completed by Nina Naa Awura Randolph-Koranteng and recognizes the contributions of Dr. Russell de Souza, and Dr. Andrew Mente in both the research process and the completion of the thesis.

CHAPTER 1

INTRODUCTION

1.1 Background

The role of diet in various health issues is of considerable global importance and cannot be overstated. Suboptimal diets, characterized by high sodium, refined carbohydrate, and saturated fat intake and low consumption of essential nutrients, among others, are significant risk factors for non-communicable diseases (NCDs) like cardiovascular diseases (CVDs) (GBD 2017 Diet Collaborators, 2019). According to the GBD study, dietary risk factors were responsible for an estimated 11 million deaths and 255 million DALYs globally in 2017 (Afshin et al., 2019). CVDs are the primary cause of mortality worldwide, posing substantial barriers to sustainable human development and placing immense financial burdens on healthcare systems, including those in Canada (Roth et al., 2017; Clark, 2013).

Significant variations in dietary behaviours have been reported among and within diverse ethnic minority groups compared to host populations, which are often affected by numerous factors including income, health, religion, dietary laws, and food beliefs (Leung & Stanner, 2011). Eating behaviours are a complex and personalized phenomenon, influenced by the interplay of a range of factors (Marcone et al., 2020), harmonizing to form the nutrition environment, which is characterized by food availability, accessibility, food prices, food marketing, regulatory frameworks, and physical surroundings, among others. It has been posited by several scholars that the impact of dietary patterns on health may surpass that of individual nutrients (Wirfält et al., 2013; Reedy et al., 2014; Liese et al., 2015). However, recommendations to adopt healthier diets often fail to acknowledge the intricate, and often ubiquitous, influence of the nutrition environment on individuals' access to affordable and nutritious food. Associations have been reported between the food environment and diabetes

among Canadians residing in areas characterized by a substantial concentration of fast-food establishments (Polsky et al, 2016). Food prices have also been reported as a key determinant of food choices, besides taste (Glanz et al., 1998). The impact of government regulations on aspects of the food environment such as pricing and food advertisement is thus an important driver, affecting healthy consumption behaviours such as increased fruits and vegetables intake.

Additionally, studies from the fields of behavioural economics, social psychology, and neuroscience find that a significant number of decisions regarding food are made impulsively, i.e., without conscious awareness (Cohen & Babey, 2012). Media-driven food marketing, a key component of the nutrition environment, contributes significantly to this phenomenon. Loewenstein (1996) explains that most food advertisements employ sensationalism to enhance the appeal and allure of food products to potential consumers. Advertising and product promotions have thus substantially impacted individuals' decisions pertaining to food, beverages, and restaurants. To this end, empirical research has indicated a plausible association between television advertisements and the escalating prevalence of obesity (Hill & Peters, 1998).

It is noteworthy that the nutrition environment not only influences food choices but also the overall quality and diversity of diets, which might not always be positive influences on health (Glanz et al., 2005). In Canada, CVD prevalence and death rates differ among ethnic groups, between urban and rural areas, and across provinces (Anand et al., 2000; Kapral et al., 2019; Maclagan et al., 2014). This could be attributable to dietary behaviour disparities. Based on the 2017-2018 data from the Canadian Chronic Disease Surveillance System (CCDSS), approximately 1 in 12 (2.6 million) Canadian adults aged 20 and above, have been diagnosed with heart disease (Public Health Agency of Canada, 2022). Additionally, implementation of policies aimed at establishing healthy heart environments through enhanced diet quality has been proposed in the Canadian Heart Health Strategy and Action Plan (Smith, 2009).

Considering the susceptibility of ethnic groups in Canada to chronic diseases (Filate et al., 2003), it is therefore crucial to understand the impacts of the nutrition environment. To better inform public health strategies promoting healthy eating, it is imperative to ascertain whether efforts to transform individuals' eating behaviours would yield more pronounced effects if their food environments were also modified. By examining the impacts of the nutrition environment on food consumption patterns, we can gain insights into how certain factors influence dietary behaviours in Canada and work towards fostering healthy food environments to improve the health and well-being of Canada's diverse population.

1.2 Problem Statement

The dietary habits of individuals can be significantly impacted by various factors such as cultural values, acculturation of immigrants, nutritional information awareness, socio-economic status, and other multidimensional aspects. Due to immigration, the demographic composition of Canada is experiencing a notable surge in diversity. Nonetheless, there is a dearth of ethnic-specific nutritional intervention studies aimed at identifying the dietary patterns of various ethnic groups in Canada. de Souza et al. (2018) have reported variations in contextual factors, i.e., factors that are not intrinsic to food itself, but rather shared by a common environment, that may impact dietary intake across over 2,000 communities in Canada. Certain components within the nutrition environment tend to exhibit a more robust association with dietary or health outcomes in comparison to others (Caspi et al., 2012; Minaker et al., 2013). It is also unclear the extent to which contextual nutritional factors such as food prices, food advertisements, or food availability influence dietary intake and individual perceptions of the food environment in Canada. Additionally, there is limited knowledge of how dietary intake varies based on these factors. Understanding the ethnic disparities in

cardiovascular risk factors, specifically unhealthy dietary habits, and the various contextual factors influencing eating behaviours could establish a basis for policymakers, researchers, and healthcare professionals to develop suitable strategies for improving the health of Canada's expanding multi-cultural population.

1.3 Statement of Purpose

The primary objective of this research is to assess the influence of the nutritional contextual environment on self-reported nutrient and food intake across White European, South Asian, and Chinese ethnicity participants in the Canadian Alliance for Healthy Hearts and Minds study. The present study aims to examine disparities in dietary consumption among these ethnicities and evaluate whether the magnitude of these disparities differs between individuals residing in urban and rural areas. The study will also assess the congruence between individuals' perceptions of the food environment in their respective communities and the characteristics of these communities that were identified in a prior objective audit study.

The increasing diversity of Canada's population underscores the necessity for a comprehensive understanding of dietary patterns to facilitate the development of interventions that consider the significant role of culture in diet and health. This study will help address the existing void in this important area. Additionally, the outcomes will enhance the existing knowledge base to guide policymaking and forthcoming research endeavors aimed at advancing nutritional well-being among individuals from diverse ethnic backgrounds. The study findings can additionally provide healthcare professionals with ethnicity-specific nutritional information, thereby enabling them to thoroughly understand ethnic dietary trends and nutritional concerns so they are fully equipped to offer culturally sensitive nutritional guidance.

1.4 Implications of this Study to the Global Health Context

The global concern regarding the prevalence of diseases associated with unhealthy diets is noteworthy, particularly the health issues that arise due to the coexistence of undernutrition, overweight, and obesity. Unhealthy dietary patterns play significant roles in the prevalence of morbidity and mortality rates associated with various non-communicable ailments such as diabetes, cardiovascular diseases among others (WHO, 2022). In 2019, 36.9% of CVD deaths globally were reported to be attributed to dietary risks, with low intake of whole grains (19.2%), high intake of sodium (17.1%), low intake of fruits (13.5%), low intake of nuts and seeds (13.0%), low intake of vegetables (9.7%) and low intake of seafood omega-3 fatty acids (9.6%) accounting for these mortalities (Dong et al., 2022). Additionally, the World Health Organization (WHO) reported in 2020 that alterations in dietary patterns have occurred due to the rise in processed food production, urbanization at a fast pace, and changes in lifestyles (WHO, 2020). Improving dietary habits is a multifaceted issue that involves a wide range of factors. As such, implementing policies that address various sectors of the food system and fostering collaboration among multiple stakeholders is necessary to improve diet. It is against this background that the 2004 "WHO Global Strategy on Diet, Physical Activity and Health" urged various entities such as governments, international partners, the private sector, and civil society to implement measures that promote healthy diets and physical activity (WHO, 2004). As per the World Health Organization's (WHO's) latest report in 2022, healthy eating behaviours are crucial in the attainment of the Sustainable Development Goals (SDGs), and the World Health Assembly global nutrition targets (WHO, 2022). According to WHO (2013), its Member States have reached a consensus to decrease the worldwide consumption of salt by 30% and halt the rise in diabetes and obesity in adults and adolescents as well as childhood overweight by the year 2025. The WHO has therefore developed a strategic plan, known as the REPLACE action package, aimed at expediting efforts by countries to eradicate industrially

produced trans-fat (WHO, 2018). Consistent with the WHO's approaches to attaining the Sustainable Development Goals, Health Canada (2013) emphasized the need for a better understanding of how individual and environmental variables function in various populations and life circumstances, especially nutritionally vulnerable populations. Comprehending the dietary patterns of a populace requires considering various individual and contextual elements that impact the decision-making process surrounding food selection. Hooper et al. (2005) state that endeavors to lower disease risks, and prevent chronic ailments, and the global attention to the enormous rise in overweight and obesity accentuate the importance of understanding individual dietary choices and behaviours. Through this study, the determination of the association between these contextual factors and the dietary intake of individuals across ethnic groups and between rural and urban areas will help drive policies aimed at creating healthy food environments for improved nutrition, health, and well-being and ultimately support the achievement of the third Sustainable Development Goal of 'Good health and Well-Being'.

1.5 Objectives

- To describe differences in dietary intake across South Asians, White Europeans and East Asians and between urban and rural communities in Canada.
- To describe differences in individual perceptions of the contextual food environment by ethnicity and urban/rural setting in Canada.
- To assess the congruence between individual perceptions of the food environment within a community and objective community-level assessments of the food environment
- To assess the association between intake of "healthy" and "unhealthy" food items and the price of these items.
- To assess the association between objective measures of the food environment and

dietary intake

1.6 Research questions

1. What are the differences in dietary intake among South Asians, East Asians and White Europeans between the ages of 35 and 69 years in Canada?
2. Are there differences in dietary intake between rural and urban South Asians, East Asians and White Europeans between the ages of 35 and 69 years in Canada?
3. What is the association between the intake of "healthy" and "unhealthy" food items and the price of these items?
4. What is the relationship between individual perceptions of the food environment within a community and objective community-level assessments of the food environment?
5. What is the association between objective measures of the food environment and dietary intake?

1.7 Thesis Outline

The subsequent chapter provides a comprehensive review of literature pertaining to dietary patterns observed among some ethnic groups in Canada, as well as various factors that influence dietary intake. In Chapter 3, a concise summary of the Canadian Alliance of Healthy Hearts and Minds (CAHHM) study is presented, along with an exposition of the research design and methodology. Research findings are presented in Chapter 4. Chapter 5 provides in-depth explanations of the research findings, along with the study's strengths and limitations. Finally, a summary of the study's overall findings, as well as recommendations for future research are highlighted in Chapter 6. Chapter 7 outlines all bibliographies used in this research.

CHAPTER 2

LITERATURE REVIEW

2.1 Diet as a Risk Factor for Cardiovascular Disease

Dietary intake has been shown to significantly contribute to the risk of CVD. According to WHO (2021), about 17.9 million lives are lost yearly due to CVDs. In 2016, CVDs constituted 29.8% of the total mortality rate in Canada, resulting in the demise of more than 81,300 individuals annually (Lang et al., 2018). Additionally, Vanderlee and L'Abbé (2017) have reported a noteworthy escalation in the occurrence of overweight, obesity, and NCDs associated with diet in Canada, particularly among marginalized groups, including individuals of low socioeconomic status. It is against this background that numerous research proposing nutrition recommendations have focused on relationships between specific foods, nutrients, and dietary patterns and CVD in mitigating its associated risks (Dietary Guidelines Advisory Committee, 2015; Afshin, et al., 2017; Micha et al., 2017; Willett et al., 2019; Howard et al., 2006; Estruch et al., 2013). Specifically, there has been an emphasis on increased consumption of fruits, vegetables, legumes, nuts, and fish, while some variations exist in the prioritization of specific types of fats and the inclusion of dairy or red meat in diets for disease prevention (Dietary Guidelines Advisory Committee, 2015). Increased consumption of fruits and vegetables was found to significantly reduce the risk of stroke in a meta-analysis of prospective cohort studies involving 760, 629 participants (Hu et al, 2014). The American Heart Association (AHA) has also recommended the substitution of saturated fat with unsaturated fat, specifically polyunsaturated fatty acids (PUFA) to reduce the risk of CVD (Sacks et al. (2017).

To fully elucidate and understand the relationship between diet and CVD, it is important to understand associations of individual nutrients, food groups, and dietary patterns as well as

various influences from the nutrition environment on health and disease. Ethnic-specific dietary intake information from this study can thus prove useful for future research aimed at ascertaining ethnic groups in Canada most at risk of CVDs.

2.2 Dietary Patterns of Canadians

The dietary patterns of Canadians are a subject of interest in academic research. Analysing a population's dietary patterns can offer insight into the consumption of foods and nutrients and shed light on their general eating behaviors (Quatromoni et al., 2002, Khani et al.,2004, as cited in Keshavarz, 2022). Humans generally follow dietary patterns that combine different diets made up of various nutrients that complement each other effectively. According to Moubarac et al. (2017), unhealthy foods comprise more than 50% of the food supply in Canada. Findings from another cross-sectional study based on the Canadian Community Health Survey (CCHS) conducted in 2004 revealed that the average daily sugar consumption among Canadian adults was estimated to be about 110 grams/day, which is equivalent to approximately 26 teaspoons (21% of the total energy intake) for a daily diet of 2000 calories (Langlois and Garriguet, 2011). The Canadian Heart and Stroke Foundation, however, recommends that individuals limit their consumption of free sugars to no more than 10% of their total daily calorie intake to mitigate potential risks of heart disease (Heart and Stroke Foundation, 2014). Furthermore, the average sodium consumption of Canadians has been reported to be about 3,500mg/day, with about 75% coming from processed, packaged and restaurant foods, and which surpasses the recommended limit of 2,300 mg/day. (Garriguet, 2007; Campbell, 2016; Health Canada, 2010). Garriguet (2007) and Langlois and Garriguet (2011) again add that, the consumption of processed foods that are high in calories, salt, sugar,

and saturated fat, coupled with a lack of whole grains, nuts, seeds, legumes, fruits, and vegetables, is the primary cause of unhealthy eating habits among Canadians.

2.3 Dietary patterns of ethnic groups in Canada

Modifications in diet and lifestyle have the potential to decrease the likelihood of developing diabetes and other cardiometabolic risk factors that contribute to heart disease (Merchant et al., 2008; Ramachandran, Arun, Shetty, & Snehalatha, 2010). Lauderdale and Rathouz (2000) and Koya and Egede (2007) explain that obesity is prevalent among immigrants as they tend to become sedentary and adopt high-calorie diets, due to longer periods of stay after migration to developed countries. The dietary patterns of different ethnic groups in Canada are influenced by a multitude of factors. As per the data provided by Statistics Canada (2021), South Asians constitute one of the largest non-white ethnic groups in Canada. In a study conducted in Canada, which focused on South Asian immigrants aged 30-65, immigration was reported to be associated with increased consumption of fruits and vegetables as well as reduced intake of fat and fried foods (Block, Gillespie, Rosenbaum, & Jenson, 2000). Contrarily, Block et al. (2000) found that that South Asian immigrants in Canada consumed a higher quantity of convenience foods, sugary beverages, and red meat compared to their dietary habits in their country of origin. Kandola et al. (2016) also add that the consumption of whole milk and culturally specific sweets and snacks constitutes a major component of the dietary habits of South Asian Canadians. In a cross-sectional study that analyzed the Canadian Community Health Survey (CCHS) data, it was reported that recent Chinese immigrant women consumed a greater proportion of energy from protein and carbohydrate and less energy from fat compared to the non-recent Chinese immigrants or Western-born Chinese women (Tam et al., 2011). High socioeconomic status has also been reported to be linked to lower consumption of unhealthy foods among Thais (Papier et al., 2017, as cited in Keshavarz, 2022).

Furthermore, research has demonstrated the presence of unhealthy dietary habits within the African-American community, which have been shown to be linked to limited neighbourhood availability to nutritious foods, higher cost of healthy foods, personal preferences, and Black individual-centered marketing (Airhihenbuwa et al., 1996; Tirodkar and Jain, 2003; Block et al., 2004; Drewnowski, 2004; Baker et al., 2006). Another study based on the Canadian Community Healthy surveys conducted in 2004 and 2015 identified unhealthy dietary patterns, as well as fruits and vegetables consumption patterns among Black adults in 2004, while consumption behaviours constituting fast foods, "Healthy-like", and "Mixed" were observed in 2015 (Keshavarz, 2022). Furthermore, a study on 'Acculturation and dietary acculturation among Arab Muslim immigrants in Canada' also reported that the consumption of convenience foods, such as pizza, processed meat, and snack foods, was common Arab immigrants in Canada (Aljaroudi, et al., 2019). In addition, Hassan and Hekmat (2012) reported that individuals with a high degree of acculturation in Canada reported incorporating nutritious food items such as whole grains, fruits, and vegetables into their diets. The Arab populace was observed to also partake in a blend of both conventional and contemporary Western cuisine.

A cross-sectional study on 'The Comparison of Dietary Intake between Francophones and Anglophones in Canada' revealed that elderly francophone men, aged 70 and above, had a weekly vegetable intake that was almost three times lower than that of their Anglophone counterparts; francophone men between 51 and 70 years consumed two times fewer fruits, and francophone men in the same age group had a higher sugar intake from "Other" food sources; carbohydrates, fat, saturated fat, and proteins, accounted for 50%, 31%, 10%, and 17% of the average energy consumption, respectively (Batal et al., 2013).

The Canadian multicultural populace encompasses an environment characterized by diverse food perceptions and dietary habits. The present study aims to ascertain the dietary behaviors of diverse ethnic groups in Canada, encompassing both Asian and non-Asian

populations, while also examining the disparities in determinants that impact their food choices.

2.4 Physical environment (Food availability and accessibility)

The extent to which individuals are compelled to make certain dietary decisions is contingent upon a multitude of factors, including the availability and accessibility of food within the environment, as well as internal factors such as personal food preferences. Raine (2005) explains that the physical environment comprises the built environment, including physical structures and geographical regions, which impact the availability and accessibility of food. The food environment according to Glanz et al. (2005), constitutes the community, consumer, organizational, and informational environments. Wicthell and Sheehka (2011) also add that features in the built environment, such as infrastructure including roads and buildings that contribute to the formation of communities and transportation systems, proximity to grocery stores, and fast-food establishments, and accessibility to home-cooked meals have been identified as significant determinants of consumption.

The assessment of the physical surroundings typically centres on its capacity to facilitate or impede the adoption of nutritious dietary practices and guaranteeing access to adequate food supplies. Recent research has demonstrated that there exists a disparity in access to food and grocery options between low-income communities and seniors' facilities and affluent districts (Wicthell and Sheehka, 2011). The latter enjoy the presence of multiple stores and conveniences that offer a wide range of food products. Individuals residing in low-income communities may thus be forced to select from a restricted range of choices that may be deficient in essential nutrients and occasionally come with high food prices (Raine, 2005). On the contrary, high-earning individuals have access to big grocery stores with a wide range of

affordable foods to choose from, and a lesser number of fast-food outlets. According to Marcone et al. (2020), there is a common assumption that individuals who are obese have access to high-quality food. However, obesity has been reported to be disproportionately prevalent among individuals who are economically disadvantaged. This could be attributed to the consumption of inexpensive, high-calorie foods that are extensively marketed and convenient to consume due to their extended shelf life and ready-to-eat nature (Duhurandhar, 2016). A cross-sectional study that assessed the relationships between residential food environment and dietary habits in urban-dwelling older individuals found that a less prudent dietary habit was associated with a larger proportion of fast-food outlets but not with lower availability of healthy food stores (Mercille et al., 2012). Again, Mercille et al. (2012) state that food stores create competitive food environments that offer a variety of both healthy and unhealthy options simultaneously. These findings suggested that the detrimental impact of fast-food establishments outweighs the beneficial impact of health-conscious food stores on the intake of healthy foods.

2.5 Factors that influence dietary behaviors in Canada

2.5.1 Economic Ecosystem

2.5.1.1 Food Security

As per the definition provided by the Food and Agriculture Organization (FAO) of the United Nations, food security denotes “a situation where a given population has access to safe, nutritious, and adequate food that is readily available, enabling them to fulfill their nutritional requirements and lead a healthy and active life while retaining their dignity” (FAO, 1996, as cited in Marcone et al., 2020). Various factors contribute to hunger and food insecurity in Canada. These factors include high rates of unemployment, homelessness, drug abuse, high

costs of medical services, and the unavailability or unaffordability of food in one's immediate environment (Boyle and Holben, 2006). According to Boyle and Holben (2006), individuals who are most vulnerable to experiencing food insecurity include those who fall under the categories of low-income households, recent immigrants, individuals with limited employment opportunities, those who are homeless, and senior citizens. Power (2005) states that it is imperative to understand that the impact of food insecurity is not significantly mitigated by education. In situations where food is either excessively costly or inaccessible, individuals possessing a degree in nutrition and healthy eating would experience comparable challenges to those lacking any formal education in similar fields.

The present study is based on the hypothesis that food insecurity, specifically the high cost of food, may act as a deterrent to the consumption of certain foods that have proven health benefits. This study, therefore, has as one of its aims, an assessment of associations between food prices and self-reported dietary intake.

2.5.1.2 Prices of Food

The financial aspect of food is a significant determinant of food choices, particularly in Canadian households with limited economic resources. Marcone et al. (2020) explain that a significant number of affluent Canadians tend to consume an excess of calories due to the relatively low cost of food and the sedentary nature of their occupations, which require minimal physical activity. This trend is attributed to their limited availability of time to prepare meals at home, leading to a greater reliance on food establishments for their daily sustenance. Additionally, the relative affordability of food, the prevalence of dual-income employment patterns, and the proliferation of fast-food establishments may contribute to unhealthy dietary practices among Canadians, particularly the wealthy (Statistics Canada, 2004). Fast foods and

junk foods are typically more cost-effective than whole foods including milk, meat, grains, and vegetables.

According to an online survey comprising 1,600 Canadian adults, it was found that a considerable number of low-income households are incapable of procuring nutritious food items without incurring significant financial burdens (Angus Reid Institute, 2019). If it is verified that purchasing unhealthy food is more convenient and cost-effective than acquiring healthy alternatives, it could pose a significant challenge to the development of effective public policies. The selection and intake of healthy foods, such as fresh produce, dairy and animal products with high-quality proteins, are greatly influenced by pricing. In a cross-sectional study by de Souza et al. (2018), it was reported that the cost of fruits and vegetables was higher in rural communities compared to urban communities in Canada; households residing in rural areas were reported to incur an additional expenditure of $249 annually on these food items in comparison to their urban counterparts. The comparatively reduced cost of unhealthy food items such as junk food in contrast to their healthier counterparts may render them a persuasive dietary option for individuals. Consequently, understanding the influence of socioeconomic determinants is an initial step in ascertaining the efficacy of community-based food pricing policies that can improve the eating habits of Canadians.

The present study posits that food prices tend to affect consumption behaviors. It is against this background that this study seeks to assess the association between food prices and intake of healthy and unhealthy foods among ethnic groups in Canada.

2.5.1.3 Socioeconomic factors

Socioeconomic status may be a compelling factor in the individual dietary pattern given that many immigrants to Canada may be unemployed upon arrival, which may affect their ability to afford food and eventually their food choices (Fatihah et al., 2015). In a cross-sectional study that assessed data from about 98,733 Canadians (12 to 75+ years), who responded to questions on food choices, it was revealed that the food choices of Canadians were influenced by education, income, gender, age, disease state, and physical activity and were based on health concerns and nutritional contents (Ree et al., 2008). Education was found to play a significant role in food choices and health, particularly with respect to literacy and obtaining nutritional information from food labels. Ricciuto et al. (2006) highlight that individuals with higher levels of education and income are anticipated to make healthier dietary choices as compared to their less educated and lower-income counterparts.

Furthermore, a cross-sectional study that examined the impact of economic conditions on fruit and vegetable consumption, revealed that individuals responded to fluctuations in local economic conditions by altering their consumption patterns (Milicic and DeCicca, 2017). Fruits and vegetable consumption decreased with increasing unemployment rates regardless of gender or education. It was also found that in times of economic recession, there was a rise in snack and fast-food intake, while the consumption of fresh produce declined. Furthermore, individuals with a bachelor's degree or higher exhibited a higher consumption of fruits and vegetables compared to those with educational attainment below a bachelor's degree.

Socioeconomic factors, namely income and education, are widely recognized as significant determinants in shaping individuals' dietary preferences and decisions. Diverse income levels may potentially lead to disparities in how different ethnic groups respond to fluctuations in food prices.

2.6 Rural vs. urban factors

Food availability, affordability, accessibility and acceptability affect access to healthy food choices in both urban and rural food environments (Caspi et al., 2012). There has been a notable focus on how rural characteristics, such as geographical remoteness from food establishments, insufficient infrastructure within communities, and limited dietary alternatives, impact the accessibility of healthy food options (Morton and Blanchard, 2007; Liese et al., 2007; Krukowski et al., 2010). Willows (2005) also asserts that communities situated at the periphery of the map encounter limited availability of fresh food, dairy products, and leaner meats. Findings from a cross-sectional study by de Souza et al. (2018), revealed that in contrast to urban regions, rural areas had less promotion of healthy restaurant options and less availability of nutritional information in restaurants, and experienced higher food prices and greater seasonal variation in fruit and vegetable selection. In a US-based qualitative study on 'Factors Influencing Food Choices Among Older Adults in the Rural Western USA', cost and food quality were found to be the major barriers to healthy food choices for rural older individuals (Byker et al., 2017). The study participants emphasized that their limited income prevented them from being able to afford adequate food. Again, in terms of cost, food prices were reported to be higher in eastern Canada, which is more rural-based (de Souza et al., 2018). This is in consistency with the 2016 consumer price index of food which indicated that food is 4.9% higher than the Canadian average in eastern provinces, 0.5% higher in central provinces, and 1.0% lower in western provinces. (Statistics Canada, 2017, as cited in de Souza et al., 2018).

Unlike rural regions, urban areas typically exhibit a greater abundance of amenities due to their higher population density (Glaeser et al., 2001; Couture, 2013). Thus, the abundance of food establishments may enhance the diversity of available food options, lower food prices due to market competition, and reduce the amount of time required to travel to

obtain food (Couture, 2013). The increased accessibility may facilitate the adoption of healthier food choices among individuals residing in areas with greater food destination density while eliminating the limitations of travel and expenses.

The current study posits that features of rural and urban communities in Canada may contribute to differences in dietary intakes in both settings. This study therefore seeks to identify any variation in consumption behaviors of different ethnic groups residing in rural and urban areas.

2.7 Social factors

2.7.1 Food advertisements

Food marketing refers to promotional activities that are designed to stimulate the demand for specific food items or food products. The pervasive marketing of unhealthy food and drink products is a ubiquitous aspect of our daily existence and constitutes a significant component of our nutritional environment, which encompasses the multifaceted interplay between the physical and social context in which individuals reside, and their ability to obtain affordable and healthy food options (Glanz et al., 2005). Food advertisement is regarded as an environmental factor that affects health outcomes as it significantly shapes individuals' dietary decisions (Cairns et al., 2013; Norman et al., 2016). Studies conducted in Canada and other high-income nations have revealed that the majority of food advertisements on television (Czoli et al., 2020), digital media (Buchanan et al., 2018), print media (Cairns et al., 2013), and outdoor advertising (Hastings et al., 2007), particularly those aimed at children, tend to promote unhealthy food items such as fast food, sweetened breakfast cereals, candy, desserts, sugary beverages, and salty snack foods (Harris and Frazier, 2018). Advertisements and product

promotions have thus successfully affected people's food, beverage, restaurant, and cafeteria choices.

A study conducted in Canada that assessed the influence of 96 selected food commercials brands on breads and pastries, candies, breakfast cereals, cookies, fruit juices, non-carbonated and carbonated drinks, salty snacks, among others that had heavily been advertised to children, disclosed that children were exposed to a minimum of 21 advertisements daily, resulting in an estimated 7,600 advertisements annually (Moore, 2006). These advertisements predominantly featured chocolates, candies, and other sugary treats, with no instances of fruits and vegetables being marketed among the advertisements scrutinized. These suggest that it is imperative to establish policies that govern food marketing by food and beverage industries, as well as restaurants, with the aim of prioritizing the promotion of healthy foods for the Canadian populace.

Participants in this study were asked questions about their exposure to food advertisements. This study perceives that food marketing has the potential to influence the food choices of various ethnic groups in Canada. This factor could thus account for the healthy or unhealthy dietary habits of individuals.

2.7.2 Acculturation

Acculturation is a key factor that is associated with migration and tends to influence individual dietary habits. The term "acculturation" refers to the phenomenon whereby migrants and their offspring assimilate the values, behavioral norms, and attitudes of the host society (Rissel, 1997) and is typically facilitated by continuing interactions between individuals from diverse cultural backgrounds (Berry, 1997). Dietary acculturation, which refers to the assimilation of the dietary habits and/or food preferences of immigrants to those of the host nation, is a crucial aspect of acculturation (Satia-Abouta, 2002). According to Deng and Chan

(2013), the process of acculturation is influenced by various factors such as age, gender, duration of stay in the host country, socioeconomic status, cultural traditions, and individual food preferences. The relationship between acculturation and eating a healthy diet is thus more complex (Carrera et al., 2007; Liu et al., 2010; Batis et al., 2011). Benavides-Vaello (2005) explains that different food-acculturation experiences sometimes lead to a bicultural environment where both "new" and "old" meals are eaten.

Several studies conducted in Canada and the US have revealed that extended periods of residence in these countries are associated with heightened levels of dietary acculturation (Aljaroudi et al., 2019; Yang et al., 2007; Yang, 2005; Creighton et al., 2012). This phenomenon is characterized by an increase in energy intake and the consumption of processed and high fat/sugar foods, as well as a decrease in the consumption of traditional dishes, fresh fruits, vegetables, seeds, and nuts. Contrarily, individuals who had been residing in Canada for a longer duration were observed to exhibit a greater tendency to comply with lower-fat dietary recommendations (Varghese and Moore-Orr's, 2002). Similarly, Lesser et al. (2014) revealed that a significant proportion of South Asian immigrants (more than 40%), had decreased their intake of high-fat and fried meals after immigrating. Most participants attributed this change to the affordability of low-fat foods in Canada as opposed to their countries of origin. The process of acculturation could thus potentially be instigated by a dearth of reasonably priced opportunities to obtain customary cuisine.

Nonetheless, another study reported that Middle Eastern women residing in Canada had altered their dietary intakes from traditional dishes to Western-style foods (Keshavarz, 2022). This shift was ascribed to the high cost of Halal food products and the unavailability of traditional food ingredients in the Canadian market. Concurrently, residing in an immigrant community could also facilitate the consumption of traditional cuisine due to the lack of

dominant cultural influences (Yang et al., 2005; Craig et al., 2010; Aljaroudi et al., 2019; Yang et al., 2007

These findings suggest that with a greater degree of acculturation, customary dietary practices undergo a transformation owing to expanded access to diverse food items in Canada. Although the scope of this study does not cover the impact of acculturation on dietary intake, this study assumes that certain dietary behaviours among ethnic groups in Canada could be potentially ascribed to acculturation. This perception is being held based on questions that the CAHHM participants were asked regarding the duration of their stay in Canada.

2.8 Nutritional information

Health and nutrition become more of a priority as people age and with the concomitant emergence of chronic illnesses (Mercille et al., 2016). Nonetheless, the limited awareness among consumers regarding the nutritional composition of menu items could deter healthy eating in restaurant environments (Block et al., 2013; Burton et al., 2006; Scourboutakos and L'Abbe, 2012). Propositions of mandatory labelling of nutrient information have thus been put forth as a strategy to increase consumer awareness of nutritional information about restaurant foods (Block and Roberto, 2014; Kasapila and Shaarani, 2016). It is against this background that in 2004, the government of Canada mandated that all packaged foods be labelled with their calorie and nutritional content (Marcone et al., 2020). Food industries were also granted permission to promote specific health benefits associated with their products. Similarly, in 2017, restaurants in Ontario, Canada were mandated to display calorie information on their menus (Government of Ontario, 2016).

Furthermore, there has been some evidence of the potential influence of nutritional information awareness on dietary intake. In a cross-sectional study utilizing data from 848 of

1,793 adults, aged 67 -84 years, in the Nutritional and Successful Aging (NuAge) study conducted in Montreal and Laval Islands, Canada, it was reported that reduced levels of diet knowledge were linked to poor diet quality (Mercille et al., 2016). Contrarily, findings from another study involving 1146 adults that completed a survey on 12 Health Check and non-Health Check restaurants in Southern Ontario, Canada, revealed that awareness of nutritional information in restaurants displaying the Health Check symbol in their menus compelled consumers to opt for low-caloric food options (White et al., 2016). McEntee (2009) however explains that the acquisition of nutritional information does not guarantee the adoption of healthy eating habits. Nevertheless, it remains an essential component in influencing healthy dietary choices, considering the existence of a highly competitive food environment characterized by both nutritious and unhealthy food options.

In this study, awareness of nutritional information is hypothesized to influence dietary intake. Participants in the CAHHM study were inquired about their knowledge of policies that mandated nutrient labelling, as well as their exposure to food advertisements/programs with health claims or that promoted the importance of a good diet for maintaining good health. Responses to these questions were used to assess participants' perceptions of the food environment in the present study.

2.9 The Role of Policies in Promoting Healthy Eating

According to Gorski and Roberto (2015, as cited in Marcone et al., 2020), a policy refers to a strategic approach or strategy employed by an individual, corporation, or government to address a particular issue. Government policy can greatly influence the nutritional health of Canadians. Perhaps the most influential of these policies with respect to chronic disease risk has been the banning of trans-unsaturated fats (Health Canada, 2018). The

impact of diet on the health of Canadians can be significantly influenced by government policy, as stated by the Canadian Hypertension Advisory Committee (2016). For example, The Eating Well strategy with Canada's Food Guide was developed by the federal government with the aim of promoting healthy and balanced nutrition for Canadians as young as 2 years old (Health Canada, 2009). Furthermore, Health Canada has developed policies under the Healthy Eating Strategy and anticipates that industry stakeholders will adhere to them, thereby facilitating substantial enhancements in the dietary habits of Canadians. Even anticipated policies can have positive effects on the food supply. As an illustration, McDonald's took proactive measures upon Health Canada's recommendation to prohibit trans-fat (Health Canada, 2008). The proposal to reduce the consumption of salt among Canadians has also been put forth by Health Canada (2022). Ralston (1999) also adds that fruits, vegetables, beef, and pork purchases are impacted by government policies affecting food prices.

While the Canadian government possesses the authority to regulate Canadian dietary patterns through the management of food packaging and labelling, it is limited in its ability to regulate food advertisements. Advertising campaigns frequently endorse food and drink items that possess diminished nutritional value, yet exhibit elevated levels of fat, sodium, and sugar. According to Story et al. (2008), advertisements are usually aimed at susceptible children and adolescents. Considerable discourse has centered on the question of whether it is appropriate for the government to regulate or establish standards or fundamental principles for the food and beverage industry to adopt and execute. Marcone et al. (2020) have however reported that certain districts have implemented regulations that limit the types of food items that can be offered in school cafeterias, as well as restrict certain public activities such as fundraising initiatives. Additionally, special events such as pizza and hot dog days may also be subject to such restrictions. Phorson (2015) emphasizes that policies and interventions related to the food environment should aim to transfer the responsibility of making healthy dietary choices from

individuals to the community. This can be achieved by promoting healthy diets or discouraging unhealthy food choices through communal behavior. The Calgary Statement (2018) has also highlighted the necessity of governmental policies that facilitate Canadians in maintaining healthy diets in the environments where they reside, acquire knowledge, work, and engage in recreational activities. The Healthy Eating Strategy can thus be perceived as an initial step towards the advancement of policies promoting the health and well-being of Canadians.

To gain a deeper understanding of the influence of policies on the dietary habits of ethnic populations in Canada, and also assess individuals' perceptions regarding diet-related policies, this study analyzed the CAHHM study data pertaining to responses on individuals' knowledge of policy directives on healthy eating, nutritional labelling, lower taxation on fresh fruit or vegetables, as well as laws that discouraged advertising of junk food to children.

CHAPTER 3

METHODOLOGY

3.1 Philosophical Orientation

The post-positivism philosophical orientation will be used in this research. According to Creswell and Creswell (2018), 'the knowledge that develops through a postpositivist lens is based on careful observation and measurement of the objective reality that exists "out there in the world''. Thus, generating numerical measures of observations and studying human behaviours using quantitative methods is crucial for a postpositivist. It is, for this reason, a quantitative measure of the dietary intake of individuals under the CAHHM study was taken using food frequency questionnaires to characterize their eating patterns. Creswell and Creswell (2018) also state that post positivists embrace a deterministic philosophy in which causes (which in this study will be contextual factors) influence effects or outcomes (dietary intake with respect to this study). By establishing the link between variables and articulating this in terms of questions or hypotheses, post-positivist research aims to provide meaningful, truthful assertions that explain the situation of concern or that define the causal relationships of interest. As a result, evidence is always imperfect and fallible. It is for this reason that researchers state that they do not prove a hypothesis; instead, they indicate a failure to reject the hypothesis. With quantitative data on dietary intake and contextual factors likely to influence their dietary intake, the current study seeks to draw conclusions through hypothesis testing of differences in dietary intake across ethnicities and checking for probable associations that may exist between some contextual factors in the nutrition environment and individuals' eating behaviours.

3.2 Conceptual Framework

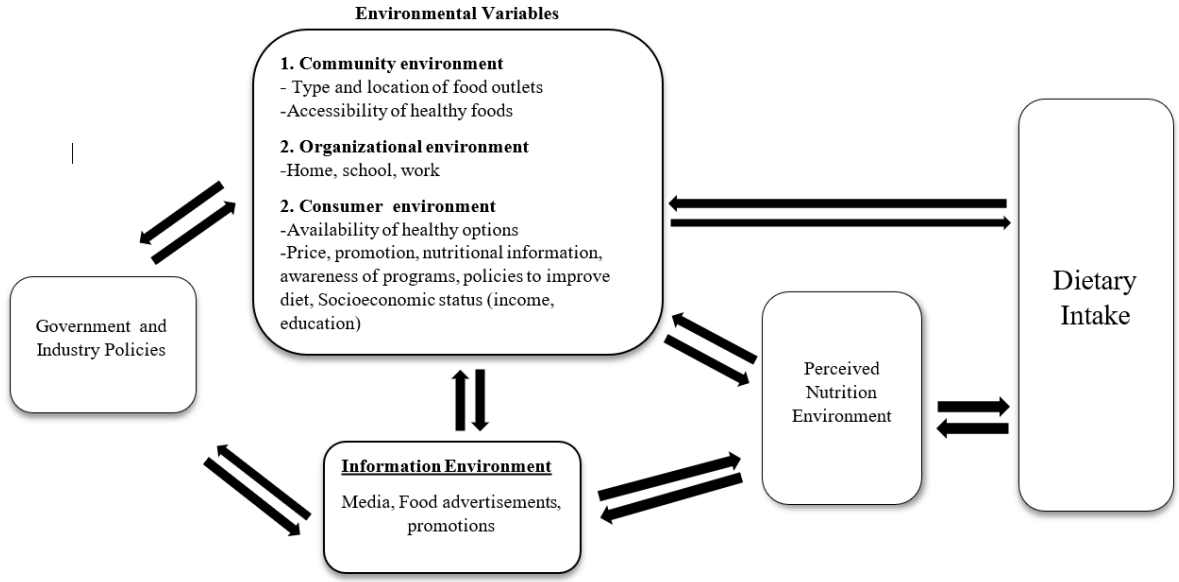


Figure 1: Conceptual Framework

This framework was developed from Glanz et al.'s (2005) concept of the nutrition environment.

This study's conceptual framework is on the basis that variations in dietary intake may be present among ethnic groups and in rural and urban areas in Canada, potentially attributable to different exposures to contextual factors within the nutrition environment. The existence of a bidirectional relationship between dietary intake, perceptions of the nutritional environment and contextual factors within the nutrition environment is also assumed. Drawing from Glanz et al.'s (2005) concept of the food environment, the present framework postulates that the community, consumer, organizational, informational environments and policies harmonize to form the nutrition contextual environment. At the community and organizational level, food availability, accessibility and type of food outlets affect consumers' eating behaviours. Dietary intake patterns are thus reflections of foods that individuals within a community perceive as available and desirable, and therefore prefer to consume. Simultaneously, these consumption patterns create a demand for certain foods, which in turn influences the supply of foods in the

community. For example, high demand for unhealthy foods in the local food environment would lead to a concentration of fast-food establishments in those communities. Likewise, positive perceptions of healthier food options can drive the establishment of grocery stores, farmers' markets, and health-focused eateries, thereby improving overall food availability. Nonetheless, keeping in mind the existence of these components, this research gives precedence to the "consumer nutrition environment" and the "information environment nutrition environment" as they have received comparatively less consideration in previous studies, yet have the potential to significantly impact dietary intake.

The consumer environment constitutes the experiences of individuals within and in the vicinity of commercial food establishments, such as restaurants or supermarkets (Mah et al., 2016). At the consumer level, variables such as the cost of food, socioeconomic status, the availability and accessibility of nutritious food alternatives, and food marketing strategies have been observed to influence individuals' perceptions of the food environment and dietary intake. Numerous studies have highlighted that 'healthy' foods are perceived to be more expensive than unhealthy foods (Drewnowski, 2009; Townsend et al., 2009). If unhealthy foods are perceived as easier to find, and more affordable relative to income, individuals may opt for convenience over health. Per the scope of this study, it was postulated that increased healthy food prices would be associated with reduced consumption of those foods, considering key variables like socioeconomic status. Conversely, awareness of nutritional information influences individuals' perceptions of a food's healthiness, which can lead to healthier food choices. Also, considering the multicultural nature of Canada's population, Asians and White Europeans who perceive cultural or social value in consuming certain types of foods (e.g., traditional dishes) may be more likely to choose those foods.

Furthermore, the informational environment pertains to the predominance and impact of marketing strategies utilized by food industries, which encompass the promotion of high-

calorie food items, pricing strategies, and health claims, among others and their corresponding consumer effects. According to Marcone et al. (2020), food-based advertisements and product promotions have effectively influenced the food choices of individuals in Canada. If unhealthy foods are highly promoted, individuals might be more likely to consume them. On the other hand, consumer awareness and concerns about health, and nutrition could also influence the way foods are advertised. Advertisers may respond to these trends by highlighting health benefits, and nutritional content to appeal to health-conscious consumers. Similarly, individual perceptions of high food costs could also, in turn, compel food industries to emphasize affordability, value for money, or family-centered deals in advertisements, to appeal to consumers. A modest level of agreement was projected would exist between individual perceptions of the food environment and objective measures of the environment in this study. Similarly, this research anticipated that perceptions of the food environment at the consumer and informational level, regarding food advertisements, would exhibit greater prevalence in rural as opposed to urban communities. That is, more advertisements for junk foods, with fewer advertisements for fruits and vegetables, nutritional information, and less awareness of foods with health claims. It is noteworthy that government and industry policies tend to affect types and locations of food establishments in communities, food prices and advertisement strategies which eventually impact consumers' eating behaviours.

In conclusion, what is perceived in the nutrition environment impacts consumption and concurrently, eating behaviours are reflections of what individuals perceive.

3.3 Overview of the Canadian Alliance for Healthy Hearts and Minds (CAHHM) Study

This study used data collected from the Canadian Alliance for Healthy Hearts and Minds (CAHHM) Study, a prospective cohort study designed to investigate the impact of

community-level factors, individual health behaviours, and access to health services, on cognitive function, subclinical vascular disease, fat distribution, and the development of chronic diseases among adults living in Canada (Anand et al., 2016). CAHHM is a 'cohort of cohorts' as most participants (>80 %) were recruited through existing cohorts under 1. the Canadian Partnership for Tomorrow Project (CPTP), a harmonized longitudinal population study capturing health data, physical measures and biologics of over 300,000 Canadians (Anand et al., 2016). CPTP is a federation of five regional cohorts: the British Columbia Generations Projects, Alberta's Tomorrow Project, the Ontario Health Study, CARTaGENE, and Atlantic PATH (Partnership for Tomorrow's Health), 2) the Prospective Urban Rural Epidemiology study (PURE)-Canada cohort, 3) the Montreal Heart Institute (MHI) Biobank, and 4) a newly formed First Nations Cohort study (Anand et al., 2016). Research Ethics Board approval was obtained, and all participants provided informed consent. Participants between 35 and 69 years of age were recruited from existing cohorts to undergo a detailed assessment of health behaviours (including diet and physical activity), cognitive function, assessment of their local home and workplace environments, and their health services access and utilization. Personal and Medical History were collected using standardized questions including family history, and health behaviors. Diet and physical activity were collected using ethnic-specific, validated food frequency questionnaires (FFQ) (Kelemen et al., 2003) and the short-form International Physical Activity Questionnaire (IPAQ). Physical measures including weight, height, waist/hip circumference, body fat percentage, and blood pressure were collected. In addition, eligible participants underwent magnetic resonance imaging (MRI) of the brain, heart, carotid artery, and abdomen to detect early subclinical vascular disease and ectopic fat deposition. Participants also filled out questionnaires on contextual factors that characterize the nutrition, physical and tobacco environments of communities from which participants were recruited. The total population for the CAHHM study was 10,100 participants.

3.4 Data Sources

3.4.1 Demographics

Demographic information was collected in the sample participant questionnaire. Demographics data from the CAHHM study used for the purposes of this study included information on the participants' age, sex, country of birth, ethnicity based on ancestral country of origin, Geographic Region across Canada, Rural/Urban residence, time spent in Canada, Smoking status, Alcohol intake status, Body Mass Index (BMI), Waist-to-Hip ratio, and Interheart Risk Score. For this study, demographic data was solely used to identify the target population as well as to categorize participants by rurality and ethnicity.

3.4.2 Dietary Intake

Dietary intake data was collected using ethnic-specific, validated food frequency questionnaires (FFQ) (Kelemen et al., 2003). Dietary assessments capturing the amount and frequency of food intake and nutrient intake of the participants (White Europeans, East Asians, and South Asians) were conducted. Responses from the FFQ were analyzed, converted into daily average nutrient values using either the Canadian Nutrient File (2010 version) which is based on the USDA's Food and Nutrient Database with modifications for the Canadian setting. Foods were also harmonized into 36 categories or "food groups" based on similar properties of foods (de Souza, 2016). Data on food prices were also used in the current study.

3.4.3 Contextual Factors Measured at the Individual and Community Level

Data describing contextual factors that characterize the nutrition, physical and tobacco environments of communities from which participants were recruited as well as individual behaviours in these domains were collected using the modified Environmental Profile of Community Health (EPOCH-1) and modified EPOCH-2 questionnaires from the PURE study

(Chow et al., 2010; Corsi et al., 2012). EPOCH-1 is a standardized community audit developed and validated in the PURE study and EPOCH-2 captures individual's perceptions of their food, activity, and tobacco environment also developed in the PURE study (Corsi et al., 2012) with added questions on social ties, alcohol use, and workplace activity and food choices and behaviors. The questionnaire assesses the individual contextual factors in the built environment of participants in the study that may have an impact on health, such as: community advertising related to smoking/tobacco, food, alcohol, and physical activity; community environments related to tobacco, alcohol, nutrition/physical activity, and socializing; relationships with family and friends; civic engagement; life satisfaction; individual home and workplace environment.

For the purposes of this study, data collected on community-level assessment audits of the food environment comprising availability of fruits and vegetables and presence of food advertisements and nutritional information in grocery stores and restaurants, as well as participants' responses to questions on exposure to community food and nutrition-related advertisements were used. The concept of the individual perceptions of the food environment was based on the participants' responses on coming across food-related advertisements within the last 6 months as at the time the study was being conducted, and awareness of diet-related policies and programs.

3.5 Study Design

This study is a cross-sectional analysis of data collected from the CAHHM cohort study data. Different sampling methods were employed in recruiting the participants for the cohorts of the CAHHM Study, which have been described (Anand et al., 2016).

<u>Population of current study</u>

The analyses described in this thesis used a source population of all CAHHM study participants between the ages of 35 and 69 years (n=10,100). The participants varied with different backgrounds, including gender, age, ethnicity, birthplace, length of years living in Canada, among others.

Sample of current study

All non-First Nations Cohort of the CAHHM study participants, between the ages of 35 and 69 years, who satisfactorily completed the Food Frequency Questionnaire (FFQ) and answered questions regarding perception of individual nutritional contextual factors in the community were included. The sample size is 7,077 participants. Comparisons of individual data (aggregated) between urban and rural environments was limited to those communities with at least 20 participants per community Detailed demographic information is displayed in the Demographic characteristics section in Chapter 4 (**see Table 2).**

Inclusion criteria:

- CAHHM study Non-First Nations participants
- Satisfactorily completed the FFQs
- Satisfactorily completed individual contextual factors data (≤ 10 missing items)
- White Europeans, East Asians and South Asian ethnic groups

Exclusion criteria:

- Participants from the First Nations cohort.
- Participants who did not answer questions related to individual perception of the nutritional contextual environment.
- Participants who did not satisfactorily complete the FFQ (i.e., their FFQ had >10 missing items, or total reported energy was <500 kcal or >4000 kcal).

Sample Size Justification

1. All available data were used (i.e., those with valid FFQ's reporting between 500 and 4000 kcal, with fewer than 10% missing items) were used in all analyses. (With a sample size of 7077 and assuming a standard deviation of 92g, we will be able to estimate the mean carbohydrate intake of participants precisely, with a margin of error of 2g [Sample size calculation was derived from LaMorte (2020)].

Figure 2: Consort Diagram

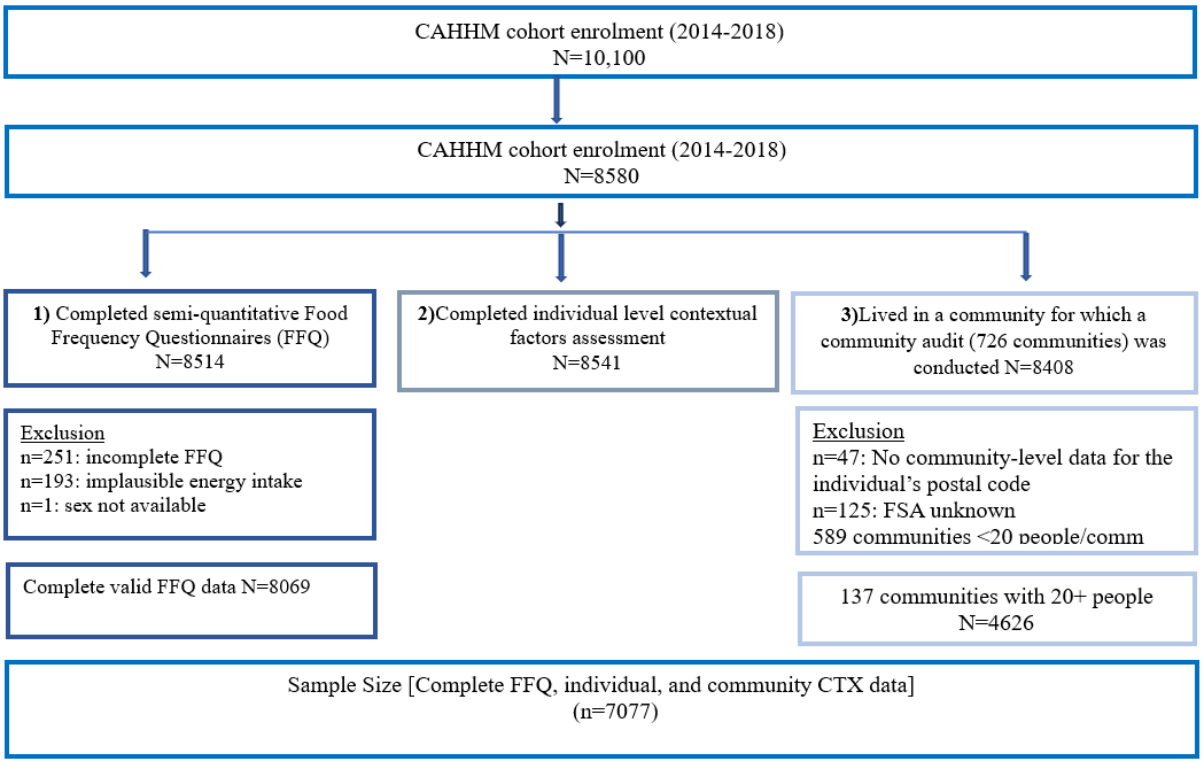


Table 1: Table Showing Exposures and Outcome

Primary Exposure	**Primary Outcome**	**Test**	**Power**
Ethnicity (3 groups) - South Asians, East Asians, White Europeans	Mean intakes each of carbohydrate, fat, protein, cholesterol, junk foods, sugar-sweetened beverages, meat and fruit and vegetables	ANOVA	>90% to detect 100% difference across groups
Rural/Urban setting -Rural vs. Urban	Mean intakes each of carbohydrate, fat, protein, cholesterol, junk foods, sugar-sweetened beverages, meat and fruit and vegetables	ANOVA	>90% to detect 100% difference across groups
Secondary Exposure	**Secondary Outcome**	**Test**	**Power**
Price of food basket	Intake of food basked items	Correlation coefficient/linear regression beta	>90% to detect a correlation coefficient of >0.20
Individual perception of community environment	Objective measure of community environment	Kappa Statistic Value/ % agreement	>90% to detect a Kappa statistic value of >0.20
Objective measure of Community Environment (Presence of Food advertisements and nutritional information in stores/restaurants and availability of fruits and vegetables in grocery stores)	Intake of foods (junk foods, sweet drinks, alcohol, fruits and vegetables)	Correlation coefficient/linear regression beta	>90% to detect a correlation coefficient of >0.20

3.6 Analytical approach

Approval was sought prior to accessing the CAHHM study data. The analytical approach involved data cleaning, descriptive statistical analyses, and linear regression analysis. The data was exported into Statistical Analysis Software (SAS) (version 9.4), cleaned, transformed as needed to meet distributional assumptions, and analyzed.

Data Cleaning

Missingness of some variables of interest are as follows: Standard Basket Price [n=1997 (28.23%)]; Unhealthy Basket Price [n=1060 (14.99%)]; sex (n=0); age (n=0); ethnicity (n= 0); rural/urban setting [n=31 (0.37%)]; carbohydrate (0); calories (0); fat (0); protein (0). To assess whether the intake of nutrients of interest (carbohydrates, calories, protein, fat, vitamin C, sodium, potassium, and iron), age, sex, rural/urban setting and ethnicity differed between those who had values for the standard or unhealthy basket price, and those who did not, the mean values of continuous variables were compared using a t-test; and categorial variables using a chi-square test. These tests were done to assess whether missingness was due to random variations. Based on the t-tests and chi-squared tests for continuous and categorical variables respectively, participants with missing data for Standard Basket price differed significantly in terms of rural/urban setting, carbohydrate, calories, vitamin C, potassium and iron intake (all p values< 0.05), but not in terms of sex, ethnicity, age, proteins, fats, and sodium intake (all p-values > 0.05), from those with complete data. On the other hand, participants with missing data for the Unhealthy Basket differed significantly with respect to rural/urban setting, ethnicity, carbohydrates, calories and iron intakes (p-values <0.05) from those with complete data. However, no statistically significant differences were found between participants with missing data on the Unhealthy Basket price and those with complete data in terms of sex, age, fats, vitamins C, sodium, and potassium intake (p-values> 0.05).

Data Analysis

Differences or associations in linear regression models were declared significant where p-values < 0.05. Descriptive data were presented as mean ± standard deviations for continuous variables, and as counts (percent) for categorical or dichotomous variables. The details of the data analysis are explained in the following section for each objective separately:

a) The null hypotheses of no difference between ethnic groups (n=3) with respect to carbohydrate, fat, protein, cholesterol, junk foods, sugar-sweetened beverages, meat and fruit and vegetables, was tested using one-way ANOVA (overall alpha = 0.05, adjusted for multiple comparisons), after which post-hoc Scheffe tests were used to assess which groups differed.

b) The null hypotheses of no difference between urban and rural Canadians with respect to carbohydrate, fat, protein, cholesterol, junk foods, sugar-sweetened beverages, meat and fruit and vegetables was tested using an independent samples t-test (overall alpha = 0.05 for each test).

c) The distribution of responses to questions about perceptions of the food environment was compared across ethnicities and between rural and urban communities. These included, e.g., advertisements for fruits and vegetables, advertisements for unhealthy foods, awareness of labels, awareness of programs to improve diet, awareness of articles promoting the importance of diet for good health, and awareness of food advertisements with health claims.

d) The congruence between the community-level assessments of advertisements, health claims was assessed using the Kappa Statistic based on Cohen's (1960) interpretation of Kappa Statistic Value : values ≤ 0 = No agreement; 0.01–0.20 = None to slight

agreement; 0.21–0.40 = Fair agreement; 0.41– 0.60 = Moderate; 0.61–0.80 = Substantial agreement; 0.81–1.00 =Almost perfect agreement.

e) The associations between intakes of components of the "healthy" and "unhealthy" food baskets with the prices of these items, as well as objective measures and consumption were assessed using linear regression while adjusting for other factors such as rural/urban living, ethnicity, and BMI. Before statistical analyses were done, data on food and nutrient intakes was log-transformed to normalize the distributions. Multicollinearity among the variables included in the models were assessed prior to model building. Model fitness was examined using the least Akaike Information Criterion (AIC) values.

CHAPTER 4

RESULTS

The results of the data analysis to answer each research question are presented in this chapter.

4.1 Demographic Findings

Table 2: Demographic Characteristics

			Ethnicity						
	Total	**ALL**	**East Asian 963(13.61%)**			**South Asian 312(4.41%)**	**White European 5802(81.98%)**		
			Total East Asian	**Urban 959(99.7%)**	**Rural 3(0.3%)**	**Urban* 311(100%)**	**Total White**	**Urban 5575 (96.6%)**	**Rural 198(3.4%)**
Sex									
Male	7046	45.6%(3215)	42.9%(413)	42.7%(412)	33.3%(1)	57.2%(178)	45.5%(2638)	37.2%(2543)	40.3%(81)
Female		54.4%(3831)	57.1%(2638)	56.8%(547)	66.7%(2)	42.7%(133)	54.5%(3164)	44.3%(3032)	58.2%(117)
Mean age, SD	7077	57.7(9)	56.1(9.1)	56.0(9.1)	58(15.6)	53.25(9.4)	58.2(8.9)	58.25(8.9)	57.7(8.1)
Region									
West	7046	17.6%(1244)	30.8%(297)	4.3%(291)	0.5%(1)	1.1%(74)	15.1%(874)	11.7%(800)	36.8%(74)
BC	7046	11.10%(782)	29.2%(281)	29.1%(279)	33.3%(1)	22.8%(71)	7.4%(431)	6.7%(371)	30.3%(60)
AB/SK/MB		6.6%(462)	1.7%(16)	1.7%(16)	0	1.0%(3)	7.6%(443)	7.7%(429)	7.1%(14)
Central		69.8%(4919)	68.5%(660)	9.6%(658)	1.0%(2)	3.4%(233)	69.8%(4050)	57.1%(3905)	60.2%(121)
ON		56.6%(3986)	68.2%(657)	68.3%(655)	66.7%(2)	74.6.4%(232)	53.5%(3103)	54.1%(3016)	40.9%(81)
PQ		13.2%(933)	0.3%(3)	0.3%(3)	0	0.3%(1)	16.3%(947)	16.0%(889)	20.2%(40)
Atlantic		12.5%(883)	0.6%(6)	0.09%(6)	0	0.06%(4)	15.1%(878)	12.7%(870)	12.9%(198)
NB/NS/PEI/NF		12.5%(883)	0.6%(6)	0.6%(6)	0	1.3%(4)	15.1%(878)	15.6%(870)	1.5%(3)
Smoking Status									
Current Smoker	7028	5.1%(360)	1.8%(17)	1.8%%(17)	0	3.9%%(12)	5.8%(333)	5.7%%(316)	7.7%(15)
Former smoked	7028	33.4%(2347)	15.7%(151)	15.8%%(151)	0	11.0%(34)	37.6%(2174)	37.5%%(2084)	40.0%(78)
Never smoked	7028	61.4%(4337)	82.6%(795)	82.5%%(791)	100.0%(3)	85.1%(263)	56.7%(3279)	56.9%(3162)	52.3%(102)
INTERHEART Risk Score , SD	7007	10.4(5.9)	9.1(5.3)	9.1(5.3)	12.3(2.5)	10.6(5.9)	10.6(6.0)	10.6(6.0)	10.9(6.0)
BMI, kg/m2 (SD)	7040	26.9(5.1)	23.9(3.7)	23.9(3.7)	26.1(5.1)	26.5(3.8)	27.4(5.2)	27.4(5.2)	28.2(5.0)
Male	3213	27.4(4.3)	25.0(3.2)	24.97(3.2)	31.8(0)	26.7(3.4)	27.8(4.4)	27.8(4.4)	28.3(4.5)
Female	3827	26.5(5.6)	23.1(3.8)	23.1(3.9)	23.3(2.0)	26.2(4.2)	27.1(5.7)	27.1(5.7)	28.1(5.4)
% Abdominal Obesity (%,n)	7077	50.8%(3601)	39.6%(381)	39.7% (381)	0	58.2%(181)	52.4%(3038)	52.3%(2913)	54,0%(107)
Male	2134	59.3%(2134)	47.2%(180)	47.2%(180)	0	60.6%(126)	60.1%(1827)	60.2%(1754)	58.9(63)

Female	1467	40.7%(1467)	52.8%(201)	52.8%(201)	0	30.4%(55)	39.9%(1211)	39.8%(1159)	41.1%(44)
Urban/Rural									
Urban	7046	97.2%(6845)	99.7%(959)	99.7%%(959)	0	100%(311)	96.6%(5575)	96.6%(5575)	0
Rural		2.9%(201)	0.3%(3)	0(0)	0.3%(3)	0	3.4%(198)	0	3.4%(198)
No alcohol intake%(Alcohol< 0.5g)	7046	21.9%(1546)	50.7%(488)	50.7%(486)	33.3%(1)	51.5%(160)	15.6%(904)	15.6%(867)	16.2%(32)
Percent of life lived in Canada%	6932	88.63(22.52)	63.8(27.7)	63.7(27.7)	83.0(29.4)	53.9(26.4)	94.7(15.7)	94.7(15.7)	95.1(15.2)
Years in Canada									
<10 years	7046	1.6%(114)	0.3%(3)	0.3%(3)	0	1.6%(5)	1.8%(106)	1.9%(106)	0
10 years		1.7%(115)	5.3%(51)	5.3%(51)	0	10.3%(32)	0.6%(33)	0.6%(32)	0.5%(1)
25 years		7.6%(521)	24.7%(238)	24.8%(238)	0	35.1%(109)	3.0%(174)	3.1%(170)	2.0%(4)
50years		13.7%(943)	42.5%(409)	42.5%(408)	33.3%(1)	41.2%(128)	41.4%(129)	7.3%(407)	9.1%(18)
75years		4.1%(278)	3.1%(30)	3.1%(30)	0	2.6%(8)	4.2%(246)	4.3%(240)	3.0%(6)
Born in Canada		71.7%(5075)	24.1%(232)	23.9%(229)	66.7%(2)	9.3%(29)	83.0%(4814)	82.9%(4620)	85.4%(169)

Urban*= Predominantly urban

[**Table 2**] presents an overview of the demographic composition of the participants in terms of ethnicity and rural/urban living. This study included 7077 participants, with the majority being females (54.4%). The average age of the participants was 57.7 ± 9.0 years old. Participated were from 5 provinces in Canada, most of whom (97.2%) resided in urban settings. Approximately 82% percent (n=5802) identified as White Europeans, 13.6% (n=963) identified as East Asians and 4.41% (n=312) were South Asians. All South Asian participants predominantly lived in urban centres. Overall, 17.6% (n=1244) of the participants lived in Western Canada (British Columbia, Alberta); 56.6% (n=3986) lived in Ontario; 13.2% (n=933) lived in Quebec; and 12.5% (n=883) lived in the Eastern province of Nova Scotia. This sample generally over-represented Ontario (Canada's most populous province). Most of the participants (61.4%) had never smoked, but this figure was higher (about 82%) in non-white ethnic groups than in White Europeans (about 57%). The mean BMI was 26.9 kg/m^2, about half of the participants had abdominal obesity (50.8%; waist > 85 cm in women; or > 90 cm in men), which was predominant among South Asians (58.2%), followed by White Europeans (52.4%), and East Asians (39.6%) respectively. South Asians (51.5%) and East Asians (50.7%) were more likely to abstain from alcohol than White Europeans groups (15.6%). Most White Europeans were born in Canada (83%), compared to East Asians (24.1%) and South Asians (9.3%).

4.2 Dietary Intake Findings

Table 3: Macronutrient Intake

	Total	**ALL**	**East Asian 963(13.61%)**			**South Asian 312(4.41%)**	**White European 5802(81.98%)**		
Macronutrients			**Total East Asian**	**Urban 959(99.7%)**	**Rural 3(0.3%)**	**Urban 311(100%)**	**Total White European**	**Urban 5575(96.6%)**	**Rural 198(3.4%)**
Calories (in kcal),Std	7046	1850.3(619.3)	1721.2(608.2)	1722.5(608.7)	1376.7(502.93)	1825.1(672.4)	1872.3(615.3)	1869.8(612.9)	1965.7(678.6)
Carbohydrate (g)	7046	232.8(84.49)	209.7(78.6)	209.8(78.7)	178.2(65.5)	247.1(92.8)	235.9(84.3)	235.5(84.1)	247.3(90.1)
Fibre (g)	7046	23.02(10.2)	19.2(8.5)	19.2(8.5)	12.2(5.6)	24.7(10.37)	23.6(10.3)	23.6(10.32)	23.0(9.6)
Protein (g)	7046	79.8(29.6)	82.2(33.7)	82.3(33.7)	62.6(26.0)	68.6(29.1)	80.0(28.8)	79.8(28.7)	83.8(30.36)
Fat(g)	7046	64.3(24.9)	63.0(25.3)	63.1(25.4)	47.3(16.6)	63.4(26.6)	64.6(24.7)	64.4(24.6)	69.5(28.6)
Sugar (g)	7046	90.7(42.1)	66.9(30.5)	66.9(30.5)	68.5(26.1)	86.74(38.7)	94.8(42.6)	94.6(42.6)	101.4(41.9)
Cholesterol (mg)	7046	251.4(137.6)	323.6(178.4)	323.9(178.6)	240.5(111.2)	174.9(119.7)	243.4(125.6)	242.6(125.4)	268.2(132.0)
Saturated Fat (g)	7046	21.6(9.6)	17.1(7.4)	17.1(7.4)	14.0(3.4)	19.4(9.1)	22.5(9.7)	22.4(9.7)	24.8(11.1)
Monosaturated fat (g)	7046	24.3(9.8)	25.7(10.8)	25.7(10.8)	18.4(6.3)	24.9(11.0)	24.0(9.6)	24(9.5)	25.6(10.8)
Polyunsaturated fat (g)	7046	11.7(4.9)	14.3(6.1)	14.3(6.1)	10.1(4.3)	13.5(5.9)	11.2(4.4)	11.2(4.4)	11.8(5.1)
% Calories from Carbs	7046	47.9(6.9)	46.8(7.2)	46.8(7.2)	50.1(0.7)	51.8(6.3)	47.9(6.7)	47.9(6.8)	48.0(6.6)
% Calories from Proteins	7046	17.4(3.1)	19.1(3.3)	19.1(3.3)	18.0(0.9)	15.1(2.7)	17.2(2.9)	17.2(2.9)	17.3(2.9)
%Calories from Fat	7046	31.3(5.8)	33.0(5.5)	33.0(5.6)	31.1(0.4)	31.3(5.6)	31.0(5.8)	31.0(5.8)	31.7(5.6)
% Saturated Fat	7046	10.4(2.6)	9.0(2.1)	9.0(2.1)	9.4(1.1)	9.6(2.3)	10.7(2.6)	10.7(2.6)	11.3(2.7)
% Monounsaturated Fat	7046	11.9(2.7)	13.4(2.7)	13.4(2.7)	12.1(0.3)	12.3(2.8)	11.6(2.6)	11.6(2.6)	11.7(2.4)
% Polyunsaturated	7046	5.8(1.6)	7.4(1.6)	7.5(1.6)	6.5(0.5)	6.7(1.6)	5.4(1.3)	5.4(1.3)	5.4(1.2)

Table 4: Micronutrients Intake

	Total	**ALL**	**East Asians 963(13.61%)**			**South Asians 312(4.41%)**	**White Europeans 5802(81.98%)**		
MICRONUTRIENTS			**Total East Asian**	**Urban 959(99.7%)**	**Rural 3(0.3%)**	**Urban 311(100%)**	**Total White Europeans**	**Urban 5575(96.6%)**	**Rural 198(3.4%)**
Vitamin A(IU)	7046	10912.6(7350.7)	10220.5(6603.8)	10224.5(6608.6)	6545.5(3190.3)	10229.9(8788.7)	11061.4(7366.3)	11068.8(7367.4)	10987(7640.9)
Vitamin D(IU)	7046	219.4(139.3)	166.1(102.3)	166.3(102.3)	136.8(92.7)	167.2(110.2)	231.0(143.3)	230.7(143.5)	241.0(135.8)
Vitamin E (mg)	7046	7.5(3.2)	9.0(4.0)	9.0(4.0)	6.0(2.7)	8.6(3.8)	7.2(2.9)	7.2(2.9)	7.3(3.0)
Vitamin K (mcg)	7046	247.3(245.5)	332.1(275.7)	332.1(276.0)	213.8(136.0)	183.2(146.0)	236.6(241.2)	238.1(243.4)	197.9(170.9)
Vitamin B1 (mg)	7046	1.5(0.6)	1.6(0.7)	1.6(0.7)	1.2(0.4)	1.4(0.6)	1.5(0.6)	1.5(0.6)	1.6(0.7)
Vitamin B2 (mg)	7046	2.3(1.9)	4.1(4.3)	4.1(4.3)	2.0(0.6)	1.8(0.9)	2.1(0.8)	2.0(0.8)	2.2(0.8)
Vitamin B3 (mg)	7046	19.6(7.3)	19.8(8.2)	19.8(8.2)	14.7(5.9)	15.7(6.4)	19.7(7.1)	19.7(7.1)	20.1(7.8)
Vitamin B6 (mg)	7046	1.9(0.7)	1.9(0.7)	1.9(0.7)	1.4(0.7)	1.8(0.7)	1.9(0.7)	1.9(0.7)	1.9(0.6)
Vitamin B12 (mcg)	7046	5.2(3.9)	6.6(7.6)	6.6(7.6)	4.3(2.8)	3.7(2.7)	5.1(2.9)	5.1(2.9)	5.6(3.0)
Vitamin C (mg)	7046	154.7(88.0)	137.2(76.0)	137.4(76.1)	81.9(46.1)	189.2(102.8)	155.7(88.2)	155.4(88.0)	164.5(97.1)
Biotine (mg)	7046	3.0(2.2)	3.3(2.2)	3.3(2.2)	2.7(1.3)	4.2(2.6)	2.9(2.2)	2.9(2.2)	2.9(1.7)

Folate (mcg)	7046	357.6(138.1)	362.3(153.0)	362.7(153.1)	243.8(102.7)	402.1(163.7)	354.3(133.2)	354.1(133.3)	361.6(136.1)
Pantothenic acid(mg)	7046	6.4(2.3)	6.7(2.6)	6.7(2.6)	5.0(1.9)	5.9(2.4)	6.4(2.2)	6.4(2.2)	6.6(2.2)
Calcium (mg)	7046	960.2(466.7)	783.0(377.7)	783.6(378.1)	592.5(239.8)	923.2(515.3)	991.6(470.1)	989.5(469.5)	1056.2(498.1)
Chromium (mcg)	7046	0.2(0.2)	0.2(0.2)	0.2(0.12)	0.3(0.2)	0.3(0.3)	0.2(0.2)	0.2(0.2)	0.2(0.2)
Copper (mg)	7046	1.5(0.7)	1.8(1.2)	1.8(1.2)	1.0(0.4)	1.5(0.7)	1.4(0.6)	1.5(0.6)	1.5(0.6)
Fluorine (mg)	7046	0	0	0	0	0	0	0	0
Iodine (mcg)	7046	0.7(0.9)	2.0(1.8)	2.0(1.8)	1.4(1.4)	1.4(1.1)	0.4(0.3)	0.4(0.3)	0.4(0.2)
Iron (mg)	7046	13.0(5.0)	13.4(5.4)	13.4(5.4)	9.7(3.3)	12.8(4.9)	12.9(4.9)	12.9(4.9)	13.4(5.0)
Potassium (mg)	7046	3340.6(1182.8)	3001.7(1131.3)	3004.3(1132.1)	2270.3(925.4)	3293.9(1272.7)	3398.4(1175.0)	3396.7(1176.8)	3476.8(1175.4)
Sodium (mg)	7046	2318.3(1043.8)	3282.2(1486.2)	3284.0(1487.9)	2518.6(959.7)	2814.1(1296.2)	2130.4(817.0)	2123.4(809.5)	2346.8(997.5)
Zinc (mg)	7046	10.9(4.1)	10.4(4.1)	10.4(4.1)	8.0(3.1)	9.5(3.9)	11.1(4.1)	11.1(4.1)	11.8(4.3)
Magnesium (mg)	7046	353.2(123.5)	322.5(119.2)	322.8(119.3)	232.8(94.5)	370.5(137.7)	357.2(122.5)	357.3(122.8)	357.5(117.2)
Manganese (mg)	7046	4.2(1.8)	3.9(1.5)	3.9(1.5)	2.6(1.1)	5.2(2.0)	4.2(1.8)	4.2(1.8)	4.2(1.8)
Molybdenum (mcg)	7046	1.1(0.9)	1.3(1.0)	1.3(1.0)	1.3(1.0)	1.9(1.9)	1.0(0.8)	1.0(0.8)	1.0(0.7)
Selenium (mcg)	7046	104.2(39.9)	113.0(46.8)	113.1(46.8)	85.6(40.5)	98.9(44.0)	103.0(38.1)	102.8(38.0)	109.0(42.7)
Omega3 fatty acid (g)	7046	1.5(0.7)	2.0(1.0)	2.0(1.0)	1.5(0.9)	1.8(0.8)	1.4(0.6)	1.4(0.6)	1.5(0.7)
Omega6 fatty acid (g)	7046	9.5(4.02)	11.6(5.0)	11.6(5.0)	8.1(3.2)	11.2(5.0)	9.0(3.6)	9.0(3.6)	9.5(4.2)

Table 3 and **Table 4** give overviews of the nutrient composition of the foods consumed by East Asians, South Asians and White Europeans. The mean energy intake of the sample was found to be 1850 (619) kcal/d, with 46.8% from carbohydrate (23 g of fibre), 31.3% from fat (10.4% saturated), and 17.4% from protein (**Table 3**). In general, South Asians had higher carbohydrate and fiber intakes, and lower cholesterol, protein, vitamin D, and vitamin B12 intakes. East Asians had higher protein, cholesterol, polyunsaturated fat (notably n-3 fat), vitamin K, vitamin B12, and sodium intakes, and lower carbohydrate, sugar, fiber, vitamin D, and calcium intakes. White Europeans had higher intakes of sugar, cholesterol, saturated fat, vitamin D, and calcium and lower intakes of polyunsaturated fat, vitamin E, vitamin C, and sodium. White European rural Canadians consumed more energy compared White European urban Canadians, South Asians and East Asians.

Table 5: Food groups

	Total	**ALL**	**East Asians 963(13.61%)**			**South Asians 312(4.41%)**	**White Europeans 5802(81.98%)**		
Food Groups (Daily servings			**Total East Asians**	**Urban 959(99.7%)**	**Rural 3(0.3%)**	**Urban 311(100%)**	**Total White Europeans**	**Urban 5575(96.6%)**	**Rural 198(3.4%)**
Alcohol	7046	0.75(1.04)	0.22(0.51)	0.22(0.51)	0.10(0.12)	0.41(0.94)	0.86(1.08)	0.87(1.08)	0.73(0.90)
Artificial Sweets	7046	0.33(1.08)	0.11(0.60)	0.11(0.61)	0.03(0.06)	0.27(1.17)	0.37(1.12)	0.37(1.12)	0.49(1.34)
Coffee	7046	1.71(1.74)	1.01(1.32)	1.00(1.32)	2.05(2.13)	0.87(1.01)	1.87(1.79)	1.87(1.79)	1.88(1.94)
Condiments	7046	1.20(0.99)	1.13(1.07)	1.13(1.08)	0.93(0.24)	0.86(1.32)	1.23(0.95)	1.23(0.95)	1.37(1.11)
Cruciferous Vegetables	7046	0.51(0.55)	0.52(0.50)	0.52(0.50)	0.19(0.15)	0.23(0.31)	0.52(0.57)	0.52(0.56)	0.64(0.64)
Eggs	7046	0.38(0.45)	0.53(0.53)	0.53(0.54)	0.40(0.20)	0.45(0.57)	0.35(0.43)	0.35(0.43)	0.35(0.39)

Fats	7046	0.92(1.19)	0.30(0.56)	0.30(0.56)	0.18(0.16)	0.76(1.05)	1.03(1.25)	1.02(1.23)	1.35(1.67)
Fermented Dairy	7046	0.50(0.63)	0.37(0.55)	0.37(0.55)	0.24(0.29)	0.81(1.12)	0.50(0.60)	0.50(0.60)	0.47(0.58)
Fish/Seafood	7046	0.27(0.28)	0.27(0.27)	0.27(0.27)	0.21(0.20)	0.19(0.25)	0.28(0.28)	0.28(0.28)	0.27(0.25)
French Fries	7046	0.09(0.12)	0.05(0.07)	0.05(0.07)	0.09(0.06)	0.06(0.09)	0.09(0.13)	0.09(0.13)	0.09(0.13)
Fried Foods	7046	0.09(0.14)	0.19(0.22)	0.19(0.22)	0.13(0.09)	0.12(0.14)	0.07(0.11)	0.07(0.11)	0.09(0.13)
Fruits	7046	2.45(1.86)	2.10(1.49)	2.10(1.49)	1.22(0.86)	2.44(1.67)	2.51(1.91)	2.50(1.91)	2.77(2.20)
Full Fat Dairy	7046	0.76(0.81)	0.31(0.48)	0.31(0.49)	0.23(0.02)	0.50(0.67)	0.85(0.84)	0.85(0.83)	0.96(0.85)
Leafy Greens	7046	1.16(1.53)	1.00(1.04)	1.00(1.05)	0.56(0.36)	0.66(0.86)	1.21(1.62)	1.17(1.55)	2.43(2.72)
Legumes	7046	0.13(0.28)	0.06(0.12)	0.06(0.12)	0.01(0.02)	0.61(0.71)	0.11(0.23)	0.11(0.23)	0.11(0.22)
Low Fat Dairy	7046	0.95(1.08)	0.53(0.72)	0.53(0.72)	0.39(0.35)	0.87(0.95)	1.02(1.12)	1.02(1.12)	1.21(1.27)
Meat	7046	0.38(0.37)	0.43(0.43)	0.43(0.43)	0.58(0.33)	0.14(0.23)	0.38(0.36)	0.38(0.35)	0.51(0.47)
Meat Dishes	7046	0.20(0.40)	0.82(0.75)	0.83(0.75)	0.59(0.40)	0.18(0.24)	0.10(0.17)	0.10(0.17)	0.11(0.13)
Nuts and Seeds	7046	0.86(0.94)	0.63(0.65)	0.63(0.65)	0.06(0.02)	0.85(0.94)	0.90(0.97)	0.90(0.97)	0.95(1.00)
Organ Meats	7046	0.01(0.09)	0.07(0.22)	0.07(0.22)	0.01(0)	0 (0.02)	0.01(0.02)	0.01(0.02)	0.01(0.03)
Other Dishes	7046	0.33(0.46)	0.56(0.53)	0.56(0.53)	0.40(0.28)	1.12(1.10)	0.25(0.31)	0.25(0.31)	0.27(0.35)
Other Vegetables	7046	2.16(1.76)	1.55(1.35)	1.56(1.35)	0.66(0.34)	2.93(2.15)	2.22(1.77)	2.21(1.76)	2.56(1.94)
Pasta	7046	0.25(0.26)	0.11(0.18)	0.11(0.18)	0.12(0.10)	0.14(0.19)	0.28(0.27)	0.28(0.27)	0.28(0.27)
Pizza	7046	0.13(0.17)	0.07(0.10)	0.07(0.10)	0.08(0.04)	0.11(0.15)	0.14(0.17)	0.13(0.17)	0.21(0.23)
Poultry	7046	0.24(0.25)	0.23(0.26)	0.23(0.26)	0.05(0.03)	0.08(0.18)	0.26(0.25)	0.26(0.25)	0.24(0.28)
Processed Meats	7046	0.30(0.38)	0.13(0.21)	0.13(0.21)	0.16(0.14)	0.11(0.24)	0.34(0.40)	0.34(0.39)	0.47(0.52)
Refined Grains	7046	0.95(1.31)	1.07(0.99)	1.07(0.99)	0.99(0.38)	1.09(1.09)	0.92(1.36)	0.90(1.32)	1.40(2.15)
Seasonings	7046	0.40(0.61)	0.66(0.83)	0.66(0.84)	0.50(0.44)	1.34(1.43)	0.31(0.41)	0.31(0.41)	0.36(0.43)
Snacks	7046	0.87(2.02)	0.36(0.76)	0.36(0.77)	0.27(0.28)	0.63(1.36)	0.96(2.17)	0.91(2.04)	2.46(4.31)
Starchy Vegetables	7046	0.31(0.35)	0.13(0.19)	0.13(0.19)	0.03(0.01)	0.42(0.42)	0.34(0.36)	0.34(0.36)	0.33(0.33)
Stir Fried Noodles/Rice	7046	0.06(0.12)	0.20(0.24)	0.20(0.24)	0.09(0.04)	0.07(0.11)	0.03(0.07)	0.03(0.07)	0.04(0.06)
Sweet Drinks	7046	0.66(0.95)	0.33(0.55)	0.33(0.55)	0.74(0.68)	0.44(0.92)	0.72(0.99)	0.72(0.99)	0.81(0.84)
Sweets	7046	1.83(1.87)	1.23(1.38)	1.23(1.38)	1.73(1.13)	2.06(1.91)	1.92(1.92)	1.91(1.91)	2.23(2.31)
Tea	7046	0.99(1.63)	1.34(1.92)	1.34(1.92)	0.39(0.29)	1.34(1.35)	0.91(1.58)	0.91(1.58)	1.02(1.76)
Tofu	7046	0.05(0.17)	0.18(0.32)	0.18(0.32)	0.15(0.24)	0.05(0.14)	0.03(0.12)	0.03(0.12)	0.06(0.18)
Vegetable Medley	7046	0.63(0.57)	0.39(0.42)	0.39(0.42)	0.41(0.16)	0.49(0.59)	0.67(0.58)	0.67(0.58)	0.76(0.74)
Whole Grains	7046	1.65(1.80)	0.87(0.97)	0.87(0.98)	0.48(0.35)	2.05(1.87)	1.76(1.86)	1.73(1.82)	2.71(2.56)
Dairy Combined	7046	1.71(1.39)	0.84(0.91)	0.85(0.91)	0.62(0.36)	1.37(1.20)	1.88(1.41)	1.87(1.40)	2.17(1.63)
Meat Combined	7046	0.60(0.63)	1.32(1.05)	1.32(1.06)	1.17(0.32)	0.32(0.39)	0.49(0.43)	0.49(0.42)	0.63(0.52)
Vegetables Combined	7046	4.45(3.31)	3.46(2.44)	3.47(2.44)	1.82(0.80)	4.31(3.07)	4.62(3.41)	4.56(3.35)	6.39(4.75)
Healthy Diet	7046	10.50(5.80)	7.84(4.31)	7.85(4.31)	4.05(2.13)	11.04(5.65)	10.91(5.89)	10.81(5.80)	13.88(7.68)
Unhealthy Diet	7046	4.69(4.04)	3.18(2.32)	3.17(2.32)	3.98(2.15)	4.39(3.35)	4.95(4.23)	4.87(4.11)	7.47(6.44)
Diet Index	7046	5.81(6.54)	4.66(4.60)	4.68(4.60)	0.08(2.99)	6.65(6.33)	5.96(6.78)	5.94(6.70)	6.41(9.13)

[Table 5] shows the average daily servings from each of the 36 food categories for East Asians, South Asians, and White Europeans. On average, White Europeans had the highest alcohol intake (predominantly in urban areas) compared to South Asians and East Asians. Generally, East Asians consumed the most daily servings of coffee, eggs, fried foods, meat dishes [steamed Chinese dumplings, rice congee (including meat, poultry, fish or vegetables), steamed lotus leaf (rice, pork, or chicken-filled, Ba bao fan), stir-fried bean curd with pork, beef, chicken, turkey or fish)], organ meat (e.g. liver), stir fried noodles and rice, tofu, and meat (beef, pork, baked ham, among others) and consumed less of fats, fermented dairy, fruits, full-fat dairy, legumes, low fat dairy, nuts and seeds, pasta, pizza, snacks, starchy vegetables, sweets, vegetable medley, whole grains, dairy products, and vegetables. In terms of condiments, cruciferous vegetables, French fries, fish and other seafoods, meat, organic meats, poultry, processed meat, sweet drinks, and tofu, intake of these foods were low among South Asians. However, the intake of eggs, fats, fermented dairy, fried foods, fruits, full fat dairy, legumes, low fat dairy, nuts and seeds, pasta, pizza, seasonings, snacks, sweets, tea, whole grains, dairy products, and vegetables was high. White Europeans on the other hand, had higher average intakes of artificial sweets, coffee, cruciferous vegetables, condiments, fats, fish and other seafoods, fruits, full-fat dairy, leafy green vegetables, legumes, low-fat dairy, nuts and seeds, pasta, pizza, poultry, processed meats, refined grains, snacks, sweet drinks, sweets, whole grains, dairy products, and vegetable in general, with lesser consumption of eggs, fried foods, meat dishes, organic meats, other dishes, and tofu.

4.3 Perceptions of the Food Environment

Table 6: Individual Perceptions of the Food Environment

	N	ALL	East Asians			South Asians	White Europeans		
Exposure to Food Advertisements (%, n)		**7046**	**Total East Asians**	**Urban 959(99.7%)**	**Rural 3(0.3%)**	**Urban (n=311)**	**Total White Europeans**	**Urban 5575(96.6%)**	**Rural 198(3.4%)**
Have you seen any junk food/unhealthy food advertisements?	6455	91.2%(6455/7077)	88.9%(856/963)	88.8%(852/959)	100%(3/3)	91.0%(283/311)	91.6%(5315/5802)	91.7%(5111/5575)	90.4%(179/198)
Have you seen any soft drinks/sodas/sweetened drinks advertisements?	6523	92.2%(6523/7077)	90.3%(870/963)	90.4%(867/959)	66.7%(2/3)	93.9%(292/311)	92.4%(5360/5802)	92.5%(5155/5575)	90.9%(180/198)
Have you seen any alcohol advertisements?	6508	92.0%(6508/7077)	84.1%(810/963)	84.2%(807/959)	100%(3/3)	86.5%(269/311)	93.6%(5428/5802)	93.6%(5220/5575)	91.4%(181/198)
Have you seen any fruit and vegetable advertisements?	5608	79.2%(5608/7077)	78.7%(758/963)	78.6%(754/959)	100%(3/3)	79.1%(246/311)	79.3%(4603/5802)	79.3%(4418/5575)	80.8%(160/198)
Have you seen any advertisements/programs/articles promoting the importance of good diet to maintaining good health?	6100	86.2%(6100/7077)	82.9%(798/963)	82.9%(795/959)	(66.7%2/3)	81.0%(252/311)	87.0%(5049/5802)	87.0%(4849/5575)	87.4%(173/198)
Have you seen any food/drink advertisements with Health Claims?	7077	85.8%(6072/7077)	84.2%(811/963)	84.4%(809/959)	66.7%(2/3)	84.9%(264/311)	86.1%(4996/5802)	86.3%(4809/5575)	79.6%(160/198)
Are you aware of any...									
Programs to improve diet	7056	56.7%(3999/7056)	43.2%(416/963)	43.3%(415/959)	0	45.5%(141/310)	59.5%(3442/5783)	59.6%(3313/5557)	58.9%(116/197)
Policies that encourage healthy eating	7077	25.7%(1821/7077)	23.1%(222/963)	23.0%(221/959)	33.3%(1/3)	24.1%(75/311)	26.3%(1524/5802)	26.4%(1471/5575)	20.7%(41/198)
Official Dietary Guidelines on health foods/diets	7055	70.4%(4968/7055)	66.6%(641/963)	66.5%(638/959)	66.7% (2/3)	67.3% (210/311)	71.0%(4117/5802)	71.4% (3983/5575)	59.09%(117/198)
Laws that mandate nutrient labeling on foods/beverages	7055	86.3%(6089/7055)	80.7%(777/963)	80.6%(773/959)	100%(3/3)	76.5.0%(238/311)	87.4%(5073/5802)	87.9%(4900/5575	75.2%(149/198)
Laws that subsidize or lower tax paid on fresh fruit and/or vegetables such that they are cheaper to buy?	7057	9.1%(640/7057)	10.5%(101/963)	10.5%(101/959)	0	19.1%(59/309)	8.3%(480/5784)	8.3%(461/5558)	8.6%(17/197)
Laws that discourage advertising junk food to children	7056	18.9%(1334/7056)	19.1%(184/962)	19.2%(184/958)	0	13.6%(42/309)	19.1%(1107/5784)	19.2%(1069/5558)	13.2%(26/197)

Generally, there was good awareness of aspects of food advertising, with small differences between ethnicities (**Table 3**). Overall, >90% of participants reported seeing or hearing junk food/unhealthy food advertisements, including those for soft drinks (i.e. sodas or sweetened drinks) and alcohol. A lower percentage of participants (79.2%) reported seeing advertisements for fruits and vegetables. Generally, white Europeans were more likely (>85%) than East Asian or South Asian participants (about 80%) to have seen advertisements promoting the importance of diet to maintaining health. Urban participants of all ethnicities (>84%) were more likely to have seen Health Claims on foods than rural participants (81%). Awareness of programs, policies, and dietary guidelines was also generally low with only 56.7% of participants reporting being aware of programs to improve diet, 25.7% of participants were aware of policies that encourage healthy eating, and 70.4% being aware of official dietary guidelines. Over 83% of participants were aware of laws that mandate nutrient labeling, but only 9% were aware of subsidies provided to fresh fruits and vegetable growers. This was lowest (<9%) in urban White Europeans, and highest (19%) in urban South Asians. About 19% of the participants were aware of laws that discouraged junk food advertising to children, and this was highest among East Asians (19%) and Urban White Europeans (19%); and lowest in South Asians (about 14%) and rural White Europeans (about 13%).

Table 7: Objective measures: Presence of Food Advertisements in stores

	N	**All (%,N)**	**Urban N=6845 (%,N)**	**Rural N= 201 (%,N)**
Junk Food ads	7046	(89.5%)6309	(73.17%) 5009	(92.0%)185
Sweet drinks ads	7046	(68.18%)4825	(67.7%%)4637	(2.7%)188
Fruit/Vegetable ads	7046	(52.82%)3738	(52.1%)3567	(85.1%)171
Alcohol ads	7046	(13.96%)988	(13.9%)950	(18.9%)38
Nutritional information in restaurants	7046	(23.7%)1670	(23.5%) 1652	(0.3%) 18
Availability of fruits and vegetables in stores	7046	90.3%(6360)	(87.5%)6168	(2.7%)198

Generally, advertisements promoting junk foods, sweet drinks and fruits and vegetables were present in more than 50% of all the stores that were considered for the community-level assessment of the food environment. A substantial majority of grocery stores (89.5%), prominently displayed advertisements for junk foods, compared to fruits/vegetables (52.8%) and alcohol (14%). Similarly, 68.2% of the sampled stores featured advertisements promoting sweet drinks, while a comparatively lower proportion of grocery stores (52.8%) displayed advertisements endorsing fruits and vegetables. Junk food advertisements were more predominant in rural areas (92%) than in urban areas (73.2%). Similarly, fruit and vegetables ads were found more (85.1%) in rural areas than in urban communities. On the contrary, sweet drink ads were more evident in stores in urban settings (67.7%) compared to those in rural areas (2.7%). In general, there were relatively less alcohol advertisements each in both rural and urban communities (< 20%) compared to junk foods ads. Nonetheless, stores in rural areas still had more alcohol ads (about 19%) being displayed than in urban areas (about 14%). 23.7% of restaurants provided nutritional information or had at least 1 dish with a health claim on offer, and this was more prevalent in urban communities (23.5%) than in rural settings (0.3%).

Table 8: Congruence between Individual Perceptions of the Food Environment within a Community with Objective Community-Level Assessments of the Food Environment.

		Presence of Junk food adverts in stores			Presence of sweet drink adverts			Presence of fruit and vegetable adverts			Presence of alcohol adverts			Restaurant with at least 1 health claim		
		Yes	**No**	**Kappa statistic, p-value, %agreement**	**Yes**	**No**	**Kappa Statistic, p-value, %agreement**	**Yes**	**No**	**Kappa Statistic, p-value, %agreement**	**Yes**	**No**	**Kappa Statistic, p-value, %agreement**	**Yes**	**No**	**Kappa Statistic, p-value, %agreement**
Have you seen any junk food/unhealthy food advertisements?	**Yes**	4731 (91.09%)	1007 (92.3%)	-0.0151 <0.0001 76.6%												
	No	463 (8.9%)	84 (7.7%)													
Have you seen any soft drinks/sodas/sweetened drinks advertisements?	**Yes**				4450 (92.2%)	1383 (92.7%)	-0.0061 <0.0001 72.2%									
	No				375 (7.8%)	109 (7.3%)										
Have you seen any fruit and vegetable advertisements?	**Yes**							2982 (79.8%)	2034 (79.1%)	0.0068 <0.0001 55.8%						
	No							756 (20.2%)	536 (20.9%)							
Have you seen any alcohol advertisements?	**Yes**										934 (94.5%)	4758 (91.6%)	0.0099 <0.0001 22.1%			
	No										54 (5.5%)	434 (8.4%)				
Have you seen any food/drink advertisements with Health Claims?	**Yes**													1423 (85.2%)	4412 (86.1%)	-0.0046 <0.0001 31.5%
	No													247 (14.8%)	715 (14.0%)	

Criteria used to assess congruence were based on Cohen's (1960) interpretation of Kappa statistic values: values ≤ 0 as indicating no agreement; 0.01–0.20 as none to slight; 0.21–0.40 as fair; 0.41– 0.60 as moderate; 0.61–0.80 as substantial; 0.81–1.00 as almost perfect agreement. % agreement (third value under the Kappa Statistic columns) was calculated as ((a + d) /n)*100%, *where a=proportion of times measures (exposure to ad and presence of ad) both had only ' Yes' responses; d=proportion of times the two measures both had only 'No' responses.; n= total proportion of times both measures had responses.*

Generally, there was no agreement (Kappa Statistic values ≤0) between the individual perceptions of the food environment(in terms of exposure to food advertisements in grocery stores) and the objective community level measures of the food environment (presence of food adverts in grocery stores and nutritional information in restaurants). However, the level of agreement between being exposed to or not exposed to a junk food advertisement and the existence or nonexistence of a junk food ad was high (76.6%). Comparatively, encountering or not encountering a fruit/vegetable ad and the presence or absence of fruit/vegetable ads displayed exhibited a lower level of agreement (55.8%).

Table 9: Food Prices

Food Prices ($)	N	All	All (Mean, SD)	Urban N=6845 (Mean, SD)	Rural N=201 (Mean, SD)
Price of Standard Basket	7077	5080	64.37(9.62)	64.16(9.6)	69.85(9.9)
Price of Unhealthy Basket	7077	6017	1.60(0.57)	1.60(0.6)	1.70(0.5)
Total Basket price (standard+unhealthy)	7077	4963		65.68(9.8)	71.54(10.2)
Price of fruit (apple, banana, orange, pear, strawberries, blueberries, grape)	7077	4735	41.22(11.16)	41.28(11.3)	39.69(5.1)
Price of vegetables (tomatoes, carrot, lettuce, spinach)	7077	5908	11.65(3.47)	11.62(3.5)	12.49(2.5)
Price of bread (white bread, stone ground bread)	7077	3695	7.19(1.35)	7.19(1.4)	7.02(0.7)
Price of rice	7077	5959	5.17(1.72)	5.14(1.7)	6.1(1.5)
Price of Meat (chicken drumstick, breast and pork)	7077	5807	32.13(8.60)	31.96(8.6)	37.27(4.9)
Price of egg	7077	6253	3.02(0.40)	3.02(0.4)	3.10(0.4)
Price of cola	7077	6144	0.43(0.41)	0.43(0.4)	0.45(0.3)
Price of chocolate	7077	6174	1.14(0.37)	1.13(0.4)	1.27(0.19)

The study revealed that the mean cost of a food basket comprised of both nutritious and unhealthy foods was comparatively lower in urban areas than in rural areas, by $5.86. The standard food basket was found to be relatively more expensive in rural communities ($69.85) than in urban areas ($64.16) by $5.69 (p-value for t-test<0.05). In general, the average cost of the unhealthy food basket was observed to be low, (amounting to less than $2.00) across both rural and urban settings. However, it was noted that the unhealthy food basket was relatively cheaper in urban areas as compared to rural areas, with a significant difference of $0.10 (p-value for t-test <0.05). Broadly speaking, the fruits and bread were more expensive in urban localities as opposed to rural regions. The mean price of fruits in urban regions was observed to be greater ($41.28) than that in rural regions by a margin of ($1.59). Conversely, it was also

observed that prices of vegetables, rice, meat, eggs, cola, and chocolate were higher in rural localities as compared to their urban counterparts.

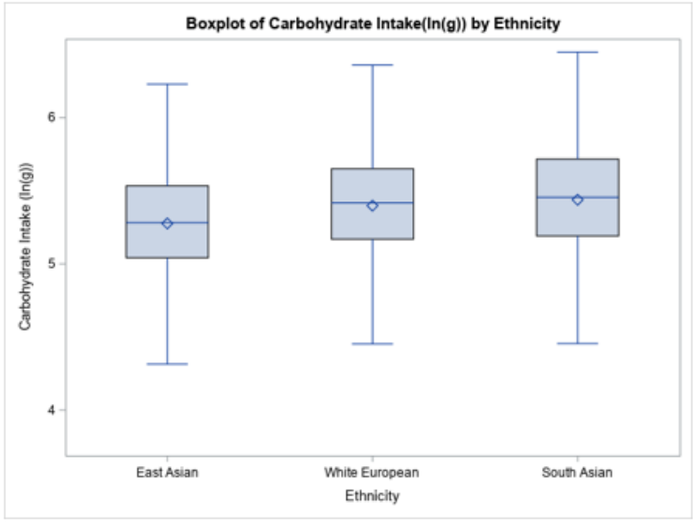
4.4 Dietary Intake Differences

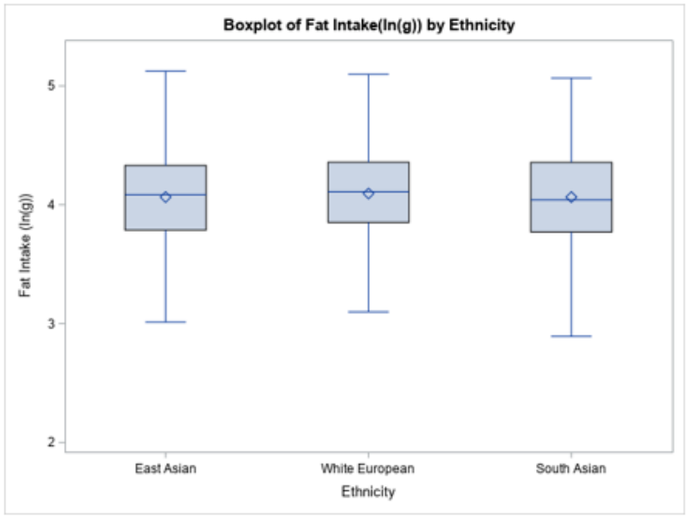
4.4.1 Ethnicity

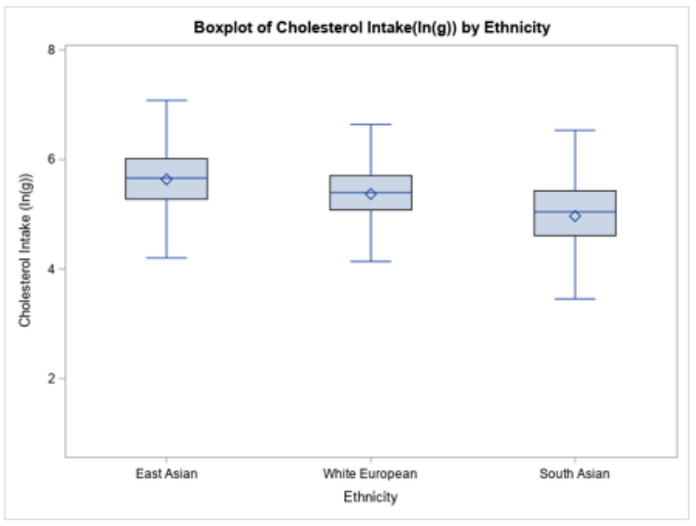
Hypothesis Testing Using ANOVA of No Difference in Carbohydrate, Proteins, Fat, Cholesterol, Meat, Junk Foods, Sugar-Sweetened Beverages, Fruits and Vegetables Intakes Among the Ethnic Groups (N=3).

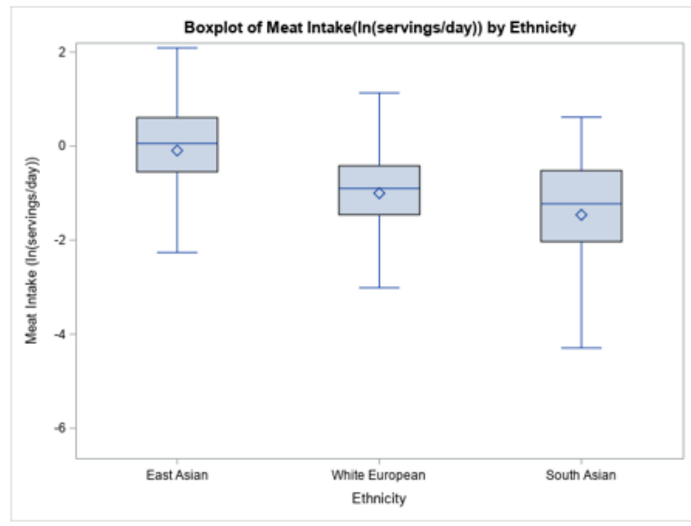
Generally, the intake of carbohydrates, junk foods (French fries, chocolate, cola and other soft drinks), meat and cholesterol varied significantly across all the 3 ethnic groups ($p<0.0001$). With respect to sugar-sweetened beverages and fat, consumption varied significantly between White Europeans and East Asians and White Europeans and South Asians ($p<0.0001$), but not between South Asians and East Asians. No significant differences were observed in terms of fruit and vegetable intake between White Europeans and South Asians. Protein intake varied significantly between White Europeans and South Asians, as well as East Asians and South Asians, except between White Europeans and East Asians ($p<0.0001$).

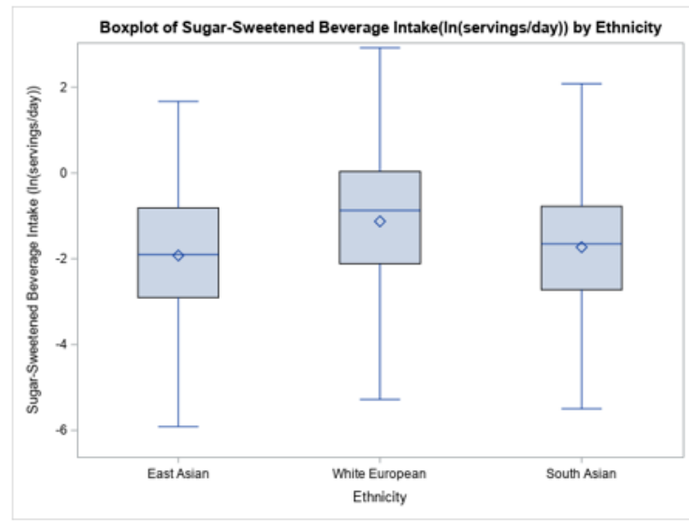
Figure 3: Boxplots Showing difference in Dietary intake Across Ethnicities

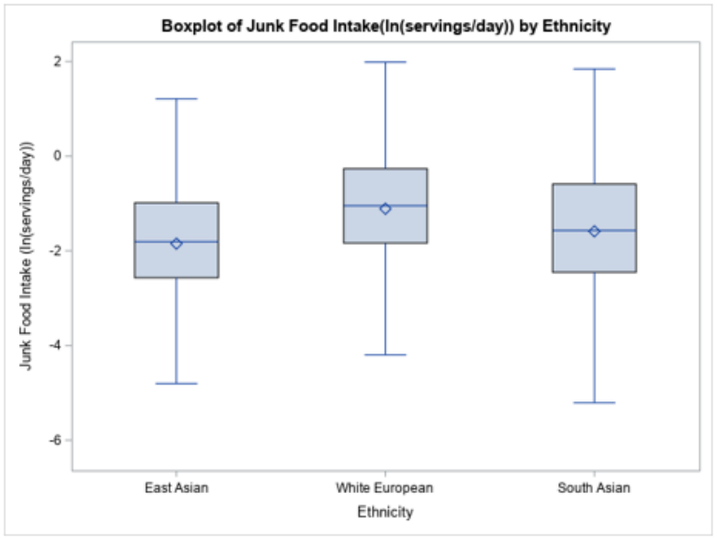


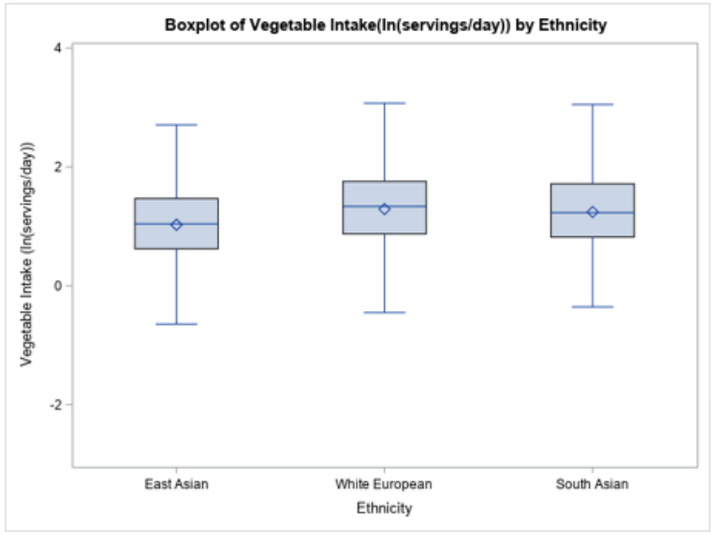


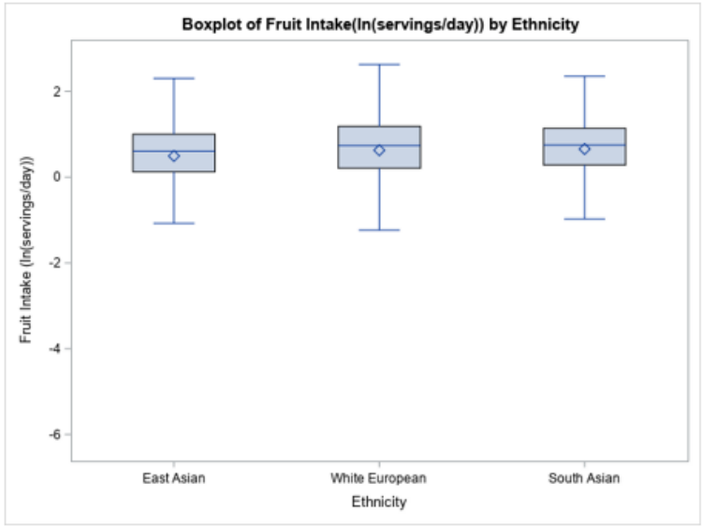










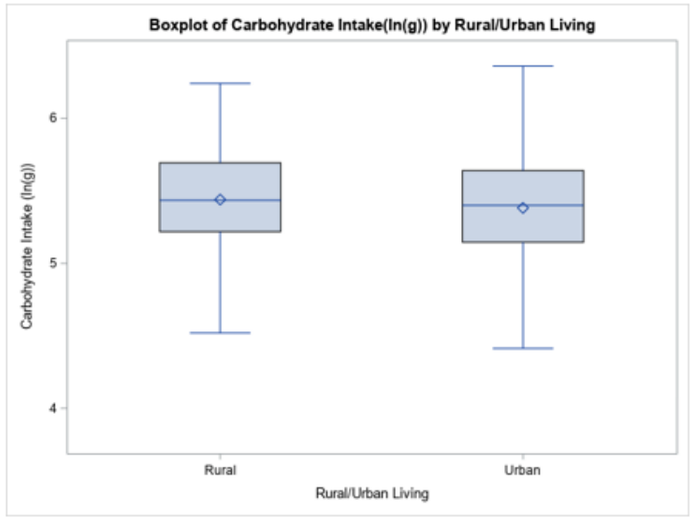


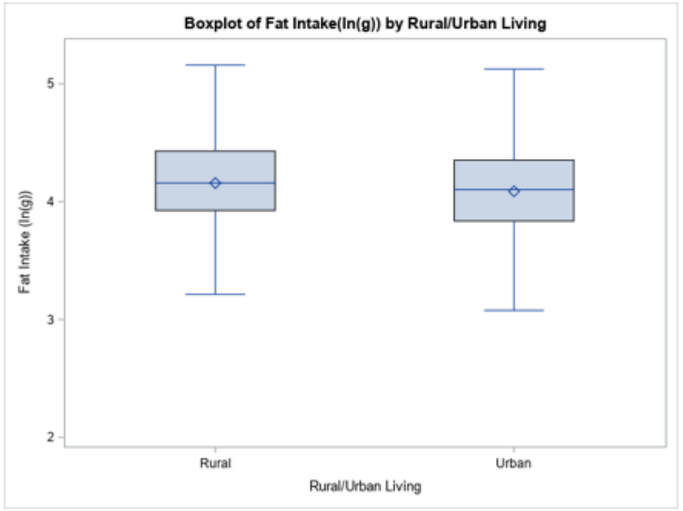
4.4.2 Rural and Urban

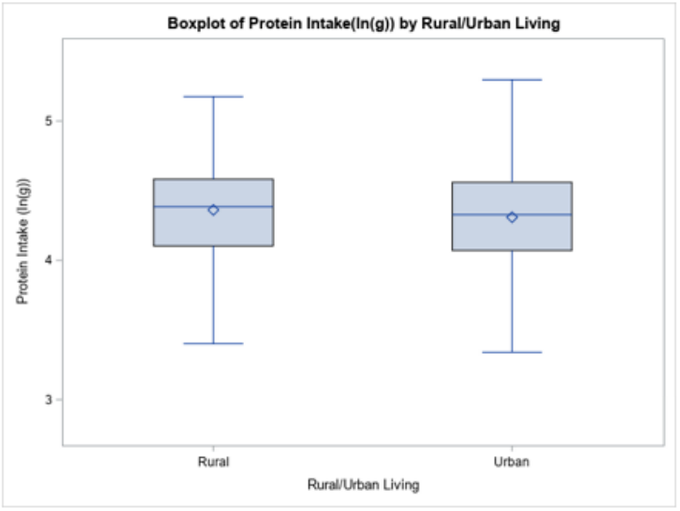
Hypothesis Testing Using ANOVA Of No Difference In Carbohydrates, Fat, Protein, Cholesterol, Sugar-Sweetened Beverages, Junk Foods, Fruit And Vegetables Intakes (In(servings/day) Between Rural And Urban Areas.

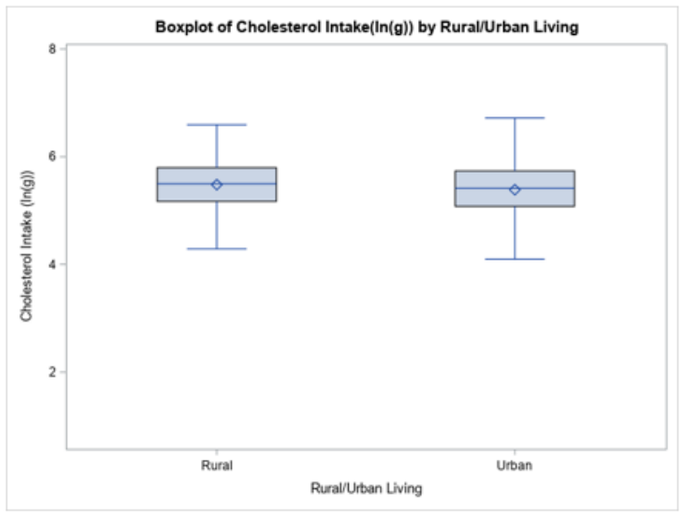
After adjusting for energy, the consumption of carbohydrates, fats, proteins, cholesterol, vegetables, meat, and sweet drinks in In(servings/day) was different between rural and urban communities ($P<0.0001$). However, no significant differences were observed with respect to junk foods, and fruit intakes (In(servings/day)) in rural and urban communities.

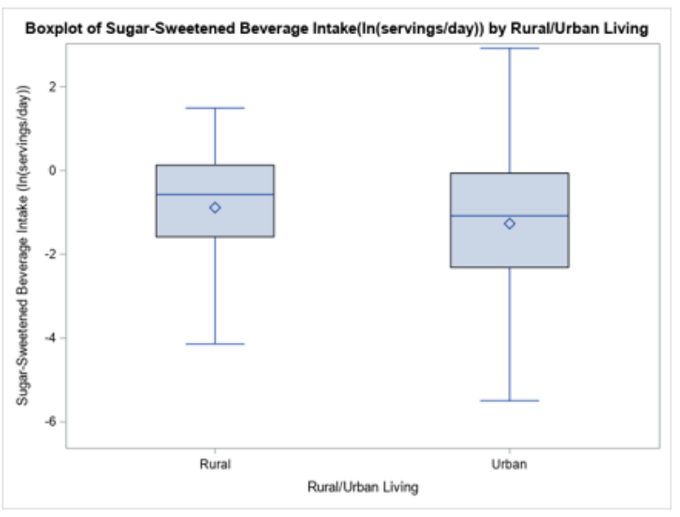
Figure 4: Boxplots Showing Differences in Dietary Intake between Rural and Urban Communities in Canada

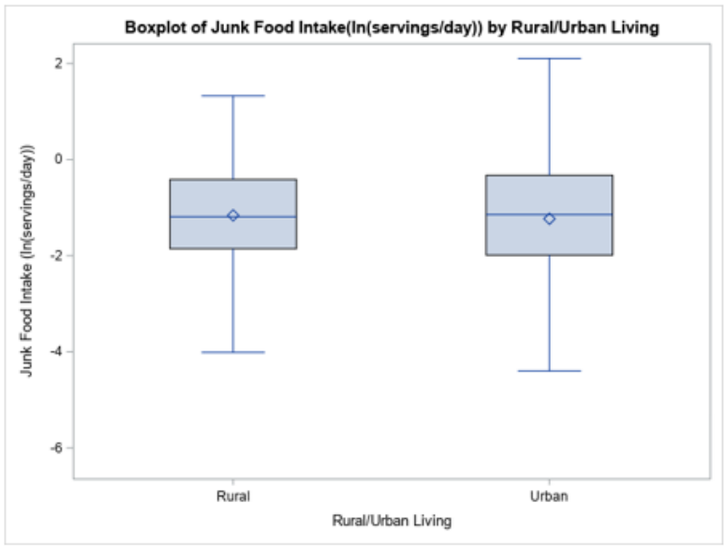


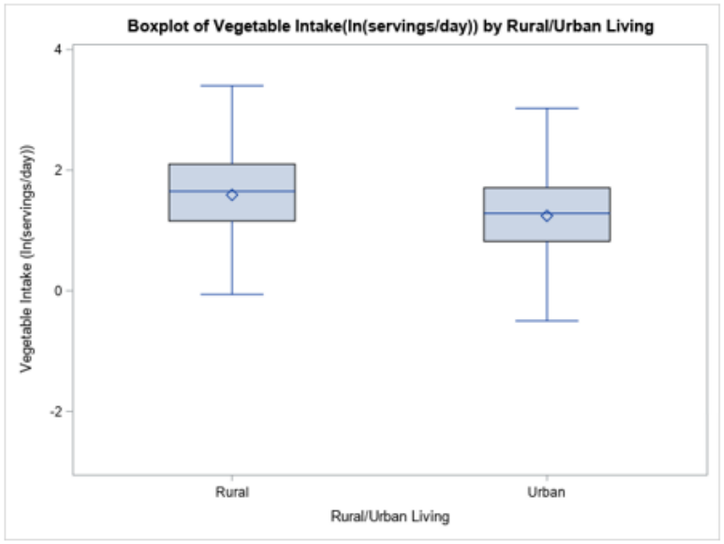


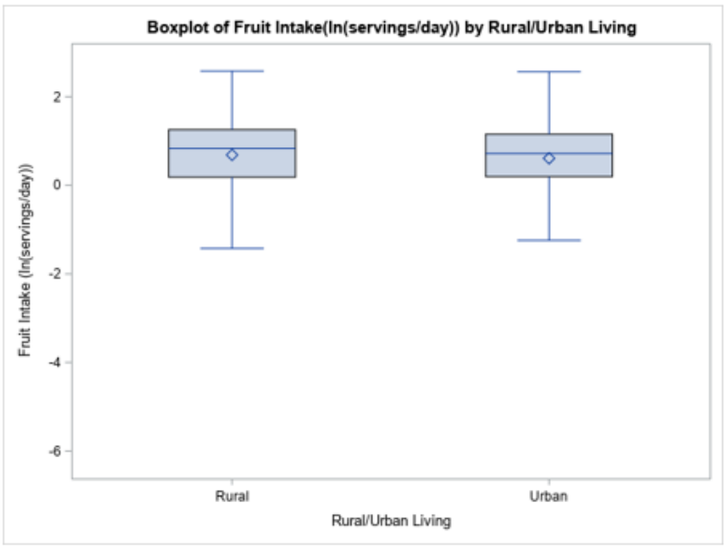












4.5 Association between Food Price and Consumption

Table 10: Association between Vegetable Price and Vegetable Intake .

Price of Vegetables ($) and Vegetable Intake (ln(Servings/day))	β	95% CI	ρ	β	95% CI	ρ	β	95% CI	ρ	β	95% CI	ρ
		Model 1			Model 2			Model 3			Model 4 (Main)	
Intercept	0.7989	(0.7153, 0.8825)	<0.0001	0.7957	(0.7125, 0.8788)	<0.0001	0.7819	(0.6983, 0.8656)	<0.0001	1.4296	(1.2768, 1.5824)	<0.0001
Price of Vegetables	0.0073	(0.0004, 0.0141)	0.039	0.006	(-0.0008, 0.0129)	0.0851	0.0072	(0.0003, 0.0141)	0.0408	-0.0078	(-0.0145, 0.0011)	0.0233
Rural/Urban (Ref=Urban)				0.5796	(0.4414, 0.7177)	<0.0001	1.5273	(0.8237, 2.2308)	<0.0001	0.4778	(0.3446, 0.6111)	<0.0001
Ethnicity: East Asian (ref=White)										-0.7396	(-0.8082, -0.671)	<0.0001
South Asian										-0.4833	(-0.5959, -0.3707)	<0.0001
BMI										-0.0128	(-0.0174, -0.0081)	<0.0001
Price*Rural/Urban(Ref=Urban)							-0.0759	(-0.1312, -0.0207)	0.0071			

Model 1 represents the unadjusted model; Adjustments were made for Rural/Urban residences and interactions in model 3. Model 4 is the model of focus to check for associations between price of vegetables and intake, after adjusting for Rural/Urban residence, Ethnicity, and BMI. Best model fitness was assessed using the least AIC value. Variables were determined as confounders if they were 1) associated with outcome/dependent variable (consumption); 2) not on the causal pathway between exposure and outcome; 3) associated with the exposure (food price) 4) the inclusion of the variable in the model altered the association of the main exposure (food price) with the outcome (consumption) by at least 10%; 5) statistically significant.

[**Table 11]** and [**Table 12**] represent the linear regression models for the association between the intake of "healthy" and "unhealthy" food items and the price of these items respectively

(**See Appendix for full tables)**. Model 4 in [**Table 10**] showed that a one-dollar increase in the price of vegetables was significantly associated with a decrease in vegetable consumption by 0.0078 In(servings per day) (p-value = 0.0233), after adjusting for rural/urban living, ethnicity and BMI. Rural/urban residence, ethnicity, and BMI were found to be confounders for the association between price and vegetable intake ($p<0.0001$) ; Residing in a rural area compared to an urban area increased consumption of vegetables by 0.4778 In(servings per day) ($p<0.0001$), holding all other variables constant, while South Asians and East Asians had reduced vegetable intakes by 0.7396 and 0.4833 In(servings per day) respectively compared to White Europeans, for every one-dollar increase in price after controlling for all other variables. Also, for every one kg/m^2 increase in BMI, vegetable consumption was found to decrease by 0.0128 servings per day. There was no statistically significant association ($p= 0.8778$) between the price of the standard basket (comprising apples, citrus, bananas, lettuce, tomatoes, white bread, white rice, chicken, pork, eggs, and 2% Milk) and the intake of foods in the standard basket, holding all other variables (Rural/Urban residence, Ethnicity and BMI) constant (**see Model 4 of Table 11**). Significant interactions were observed each between the prices of fruits ($p=0.034$), vegetables ($p=0.0071$), meat ($p=0.0027$), rice ($p=0.0016$), eggs (0.0088), and chocolate (0.0194) and rural/urban residence (**see models 3 in Tables 11 and 12**). No significant association ($p= 0.0785$) was also found between the price of the unhealthy basket (cola and chocolate) and the intake of foods in the basket, after adjusting for Rural/Urban residence, Ethnicity and BMI (**see Model 4-Main of Table 12**). There was no statistically significant association between the prices of fruits, meat, bread, eggs, cola, chocolate, poultry, rice, and milk and the consumption of these foods, after controlling for rural/urban living, ethnicity and BMI (**Model 4 in Tables 11 and 12**).

4.6 Objectives Measures and Dietary Intake

4.6.1 Food Advertisements and Consumption

Table 13 : Association between Objective Measures of the Food Environment and Dietary Intake

Presence of Junk Food Ads and Intake of Junk Foods (In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3 (Main)**	
Intercept	-1.2422	(-1.2753, -1.209)	<0.0001	-1.245	(-1.2787, -1.2113)	<0.0001	-1.1031	(-1.1393, -1.0669)	<0.0001
Presence of Junk Food Ad (Ref= present)	0.0438	(-0.0204, 0.108)	0.1812	0.0497	(-0.0151, 0.1144)	0.1327	-0.0131	(-0.0767, 0.0505)	0.6871
Rural/Urban (Ref=Urban)				0.0799	(-0.0913, 0.2511)	0.3604	-0.0459	(-0.2136, -0.1218)	0.5917
Ethnicity East Asian (Ref=White)							-0.7409	(-0.8227, -0.659)	<0.0001
South Asian							-0.479	(-0.6151, -0.3429)	<0.0001
Presence of Sweet drink Ads and Intake of Sweet drinks (In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3 (Main)**	
Intercept	-1.26	(-1.3038, -1.2163)	<0.0001	-1.2754	(-1.32, -1.2309)	<0.0001	-1.1234	(-1.1712, -1.0756)	<0.0001
Presence of Sweet Drink Ad (Ref= present)	0.0108	(-0.0671, 0.0887)	0.7855	0.0282	(-0.0503, 0.1068)	0.4812	-0.0305	(-0.108, 0.047)	0.4408
Rural/Urban (Ref=Urban)				0.3881	(0.1716, 0.6047)	0.0004	0.2518	(0.0384, 0.4653)	0.0208
Ethnicity: East Asian (Ref=White)							-0.7935	(-0.8996, -0.6874)	<0.0001
South Asian							-0.5967	(-0.7753, -0.4181)	<0.0001
Presence of Fruit and Vegetables Ads and Intake of Fruits/Vegetables(In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3 (Main)**	
Intercept	1.7457	(1.7254, 1.766)	<0.0001	1.7337	(1.713, 1.7544)	<0.0001	1.7624	(1.741, 1.7839)	<0.0001
Presence of Fruit/Veg Ad (Ref= present)	0	(-0.0296, 0.0296)	0.9998	0.0098	(-0.02, 0.0396)	0.52	0.0158	(-0.0139, 0.0454)	0.2976
Rural/Urban (Ref=Urban)				0.2634	(0.1741, 0.3527)	<0.0001	0.2369	(0.1481, 0.3258)	<0.0001
Ethnicity: East Asian (Ref=White)							-0.2176	(-0.2606, -0.1746)	<0.0001
South Asian							0.0255	(-0.0973, 0.0463)	0.4861
Presence of Alcohol Ads and Intake of Alcohol (In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3 (Main)**	
Intercept	-1.1836	(-1.2297, -1.1376)	<0.0001	-1.181	(-1.2277, -1.1343)	<0.0001	-0.8934	(-0.9413, -0.8454)	<0.0001
Presence of Alcohol Ad (Ref= present)	0.3386	(0.2175, 0.4597)	<0.0001	0.3356	(0.2145, 0.4568)	<0.0001	0.1463	(0.0319, 0.2606)	0.0122
Rural/Urban (Ref=Urban)				0.0083	(-0.244, 0.2605)	0.9488	-0.2133	(-0.4503, 0.0237)	0.0777
Ethnicity: East Asian (Ref= White)							-1.8031	(-1.9267, -1.6794)	<0.0001
South Asian							-1.04	(-1.2634, -0.8166)	<0.0001

Model 1 represents the unadjusted model; Adjustments were made for Rural/Urban residences in model 2. Model 3 is the model of focus to check for associations between the presence of food advertisements and intake, after adjusting for Rural/Urban residence, Ethnicity, and BMI. Best model fitness was assessed using the least AIC value.

Results of the linear regression models designed to investigate associations between objective measures of the food environment and dietary intake, while controlling for rural/urban living are shown in [**Table 13**]. Generally, no statistically significant associations were found between the presence of junk food ads, sweet drink ads and fruit/vegetable ads in grocery stores and junk food, sweet drinks and fruits and vegetables consumption respectively, after adjusting for Rural/Urban Residence and ethnicity (**Model 3-Main**). The presence of alcohol ads in stores was significantly associated with an increase in alcohol intake by 0.1463 servings per day (p=0.0122), controlling for ethnicity and rural/urban living (**Model 3**). Alcohol intake Rural/Urban Residence and ethnicity were found to be confounders influencing the impact of the presence of sweet drinks, fruits and vegetable advertisements on the consumption of these foods.

4.6.2 Fruit and Vegetable availability and Dietary Intake

Table 14: Association between the Availability of Fruits and Vegetables in Grocery stores and Intake of Fruits and Vegetables

Availability of Fruits and Vegetables and Intake (ln(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3 (Main)**	
Intercept	1.7485	(1.7329, 1.764)	<0.0001	1.7406	(1.7249, 1.7564)	<0.0001	1.7729	(1.7556, 1.7901)	<0.0001
Availability of Fruits/Vegetables	-0.0273	(-0.0762, 0.0217)	0.2752	-0.0233	(-0.0731, 0.0266)	0.3603	-0.0306	(-0.0802, 0.0189)	0.2257
Rural/Urban (Ref=Urban)				0.2589	(0.1701, 0.3477)	<0.0001	0.2303	(0.1418, 0.3187)	<0.0001
Ethnicity East Asians (Ref=White)							-0.2174	(-0.2604, -0.1744)	<0.0001
South Asian							-0.0225	(-0.0941, 0.0492)	0.539

Model 1 represents the unadjusted model; Adjustments were made for Rural/Urban residences in model 2. Model 3 is the model of focus to check for associations between availability of fruits and vegetables and intake, after adjusting for Rural/Urban residence, Ethnicity, and BMI. Best model fitness was assessed using the least AIC value.

[**Table 14**] shows linear regression models of the association between the availability of fruits and vegetables in grocery stores and consumption. There was no statistically significant association between the fruits and vegetables being available in stores and intake of fruits and vegetables (p=0.2257), after adjusting for Rural/Urban residence and Ethnicity (**Model 3)**. Ethnicity and Rural/Urban living were however found to be confounding variables.

CHAPTER 5

DISCUSSION

5.1 Findings

This study sought to describe differences in dietary intake among South Asians, East Asians and White Europeans in Canada and assess the associations between contextual factors within the nutrition environment and dietary intake. The main findings of this study are as follows:

The study finds significant differences in carbohydrate, cholesterol, junk foods (French fries, chocolate, cola), and meat intakes among South Asians, East Asians, and White Europeans in Canada, after adjusting for energy. Intakes of fat, sugar-sweetened beverages, as well as fruits and vegetables were greater among White Europeans than Asians. Protein intake was observed to be comparatively higher in East Asians and White Europeans than in South Asians. Additionally, consumptions of carbohydrates, fats, cholesterol, vegetables, meat, and sweet drinks varied between rural and urban settings, after adjusting for energy, with the exception of junk foods and fruit intakes which did not differ. Furthermore, the study revealed a significant association between increased prices of healthy foods, specifically vegetables, and reduced vegetable intake. This study's findings also showed that the cost of a Standard food basket (comprised of apples, citrus, bananas, lettuce, tomatoes, white bread, white rice, milk, eggs, chicken, and pork) was not associated with the overall intake of foods in the basket (p-value= 0.88), after controlling for ethnicity, BMI and Rural/Urban setting. Similarly, there was no significant association between the cost of an unhealthy food basket (cola and chocolate), and the intake of these foods, after adjusting for ethnicity, BMI and Rural/Urban residence. There were no associations between objective measures of the food environment and dietary intake, except for alcohol advertisements and alcohol intake. Generally, there was also no congruence between individuals' perceptions of the food environment, in relation to exposure

to food advertisements, and objectives measures of the food environment, regarding the presence of food advertisements in stores and restaurants.

The discussions for these findings have been categorized under three headings: i) Dietary Intake differences across ethnicities and between rural and urban communities ii) Impact of Food Prices on consumption and iii) Impact of objective measures and individual perceptions of the food environment on Dietary Intake. These areas of inquiry have been identified as crucial in understanding the complex dynamics of contextual factors that shape individuals' dietary choices.

5.2 Dietary Intake Differences

5.2.1 Ethnic Differences

Understanding variations in dietary intake behaviours among ethnic groups in Canada is of considerable significance owing to the country's multicultural demographic composition. The South Asian population, comprising individuals originating from Bangladesh, India, Nepal, Pakistan, and Sri Lanka, is one of the ethnic groups, experiencing notable demographic expansions in the country (Statistics Canada, 2021). Numerous factors play a role in the observed differences in dietary intake, including cultural customs, socioeconomic status, and the impact of the nutritional environment.

In this study, South Asians were found to consume the most carbohydrates, followed by White Europeans and East Asians respectively. This was in consistency with the SHARE Study conducted in Canada that also reported the highest carbohydrate intake among South Asians, followed by Europeans, Aboriginal Peoples, and Chinese, with the latter group exhibiting the lowest consumption levels (Merchant et al., 2007). Keshavarz (2022) explains that the traditional dietary patterns observed in numerous East/Southeast Asian populations are frequently intertwined with religious customs and deeply rooted cultural traditions. These

Asian diets predominantly consist of vegetables, spices, rice and noodles, seafood, and soy-based products. This is in congruence with this study's findings regarding the dietary behaviours of South Asians and East Asians in Canada.

Another study on 'Dietary Patterns of Canadians across Different Ethnic Groups and the Association with Chronic Diseases in 2004 and 2015' found a comparable result, indicating that Chinese and South Asian adults had a greater preference for traditional cuisine and adhered to healthier dietary patterns characterized by a higher intake of vegetables and rice (Keshavarz, 2022). This potentially indicates an inclination among South Asians to embrace more health-conscious dietary behaviours. This was also evident in a study that utilized cross-sectional survey data of 244 Chinese women living in Seattle, or Washington, USA and Vancouver or British Columbia, Canada to assess the influence of diet-related psychosocial constructs on the dietary practices of Chinese populations living in North America (Satia-Abouta, 2002). It was reported in that study that the traditional Chinese diet was perceived to be healthier compared to the conventional Western diet. Consumption of low-fat, high-fruit and vegetable diets was thus highly prioritized among Chinese Americans and Canadians. Furthermore, although South Asians inherently seem to be more inclined to adopt healthy diets, it is imperative to acknowledge the coexistence of some unhealthy dietary patterns such as the intake of junk foods like pizza, and sweets that were also observed in this study. This finding may be ascribed to the concept of acculturation which Gadgil et al. (2020) define as 'the adjustment of cultural traditions to adapt to a host country'. This phenomenon has been discovered in previous studies that indicated that adverse transformations in dietary patterns, characterized by heightened consumption of added sugars, saturated fats, and animal proteins, and reduced diet quality, were associated with acculturation and immigration to Canada and the United States (Mukherjea et al., 2013, Rajpathak et al., 2010). Other studies have also corroborated this trend of embracing Western dietary behaviours by Chinese immigrants in Canada (Satia et al., 2001;

Rosenmöller, et al., 2011). Similarly, another cross-sectional study, analysing data of 906 South Asians who participated in the Mediators of Atherosclerosis in South Asians Living in America (MASALA) community-based cohort study, found that there was an association between reduced adherence to traditional cultural beliefs and practices and higher consumption of non-vegetarian foods, fried snacks, sweets, and high-fat dairy as well as an increased preference for the animal protein dietary pattern among South Asians residing in America (Gadgil et al., 2020). Keshavarz (2022) also highlights that the consumption of sugar and refined starch-dense snacks is also widespread among South Asians. Additionally, much like the current study's findings, other studies have also indicated a relatively high consumption of protein (Kelemen et al., 2003), mainly composed of meat and fish (Whittemore, 1990), among Chinese immigrants compared to South Asians in North America.

Previous research has also demonstrated that among Japanese and Korean populations (East-Asians), predominant dietary behaviours include the Korean/Japanese traditional diet (comprised of fish, vegetables, soy products, kimchi, noodles, and rice), Westernized dietary pattern (high intake of soda, eggs, processed foods and sweets)" and "New" diet (a reduced intake of sugar and increased consumption of fruits and dairy) (Lim et al., 2014; Nanri et al., 2017). Furthermore, a study conducted by Kim et al. (2004) revealed that there was an increase in the consumption of meat, fruits, milk, and fat among the Korean American population following immigration. Erber et al. (2010) also found that Asians exhibited a greater prevalence of vegetable and rice consumption in comparison to White and Latin populations, a finding that aligns with the current study's results.

In contrast, the present study revealed that White Europeans exhibited greater consumption of various food items, including artificial sweets, coffee, cruciferous vegetables, condiments, fats, fish, seafood, fruits, dairy products, vegetables, nuts, seeds, pasta, pizza,

poultry, processed meats, refined grains, snacks, sweetened beverages, sweets, and whole grains. Conversely, their intake of eggs, fried foods, meat dishes, organic meats, and tofu was comparatively lower. The results indicate a resemblance to a previous study that documented the prevalence of "Mixed" and "Unhealthy" dietary patterns among the White population in Canada in 2004 and 2015, respectively (Keshavarz, 2022). Similarly, the Toronto Nutrigenomics and Health Study of 1153 adults conducted in Canada in 2011 revealed that White participants predominantly had Westernized dietary patterns, while a minority adhered to healthy dietary pattern (Brenner et al., 2011). In the present investigation, it was observed that a significant proportion of the White European population tended to consume unhealthy diets. It is however worth noting that despite the elevated prevalence of unhealthy dietary choices among the White European population, this study revealed that they also had the highest consumption of fruits and vegetables.

5.2.2 Rural and Urban Differences

The observed variations in dietary consumption patterns in rural and urban Canada can be ascribed to the discernible variability in the accessibility and availability of food retailers. Urban communities are predominantly characterized by the heightened promotion of low-nutritious food choices, especially in fast-food outlets and convenience stores; this phenomenon, commonly referred to as "food swamps," stands in stark contrast to the scarcity of such food establishments in rural areas, which are commonly referred to as "food deserts" (Health Canada, 2013; Black, 2014). The concept of ‘food swamps’ and ‘food deserts’ is in congruence with previous studies that have indicated reduced intakes of fruits and vegetables in more socioeconomically deprived communities (Shohaimi, et al., 2004; Lim et al., 2012). Similarly, it was discovered in a study that individuals residing in communities characterized by a dense concentration of fast-food establishments had a higher tendency of consuming fast

food (Burgoine et al., 2016) and processed meat products (Scourboutakos, & L'Abbé, 2013), compared to those residing in areas with a lower density of such establishments. Contrary to conventional assumptions that urban centers, with their higher population density and concentration of fast-food outlets and convenience stores, would exhibit higher junk food consumption rates, Minaker et al. (2016) found that proximity to junk food outlets alone was not a determining factor for increased consumption in urban areas. In this study, junk food ads were present in more than 50% of grocery stores each in rural and urban settings. The convergence of junk food consumption patterns between rural and urban areas in Canada could thus be ascribed to increased junk food advertisements in both settings. This could account for the absence of any differences in junk food intake in rural and urban areas. de Souza et al. (2018) however explains that urban restaurants are more likely to promote healthy options and provide nutritional information than rural restaurants. The noted variations in carbohydrate, fats, cholesterol, vegetables, meat, and sugar-sweetened beverage intakes could also be due to the fact that urban areas offer a broader array of produce options due to the presence of supermarkets and specialized healthy food stores compared to rural communities in Canada.

5.3 Food Prices and Dietary Intake

Food affordability is a crucial contextual factor within the nutrition environment influencing dietary choices and intake. According to economic theory, prices hold a significant influence over consumers' decision-making processes, and alterations in prices can have an impact on both the quantity and nature of consumers' purchases (Deaton and Muellbauer, 1980). A burgeoning body of research consistently demonstrates that healthier diets tend to be more expensive than unhealthy diets (Herforth and Ahmed, 2015). This was observed in this study as the average prices of unhealthy food items, such as cola and chocolate, were found to be about $10.00 lower than the prices of healthy foods like fruits and vegetables. Furthermore,

there was a notable disparity in the pricing of healthy foods with respect to the geographical location of residence; nutritious food options like fruits were found to be relatively more costly in urban areas than in rural areas. This finding is however contrary to another study that assessed grocery stores in rural and urban counties in the US and discovered that healthy foods were less expensive in urban areas than in rural areas (Hardin-Fanning and Rayens 2015). The affordability of food could therefore pose a barrier to the adoption of healthy eating habits, particularly within rural communities. Kondro (2006) and Pong et al. (2009) add that the limited availability and elevated cost of nutritious food options in rural areas are linked to suboptimal dietary patterns, potentially contributing to the relatively poorer health outcomes observed in rural regions compared to urban communities in Canada.

Recent research has shown intriguing trends regarding the association between food prices and dietary intake among the Canadian population. According to Statistics Canada (2022), a substantial proportion of Canadians (47%) have resorted to procuring more economical food substitutes, while 45% have opted to defer their intended food purchases in response to the escalation in food prices. In consistency with these statistics, the findings of this study revealed a concerning trend of reduced vegetable intake among South Asians, East Asians and White Europeans in Canada, coinciding with a surge in vegetable prices. Factors such as the cultural significance of food categories in Asian and White culinary traditions, and income levels, among others, could play key roles in the response of individuals to price fluctuations. Keshavarz (2022) explains that vegetables form a major constituent of numerous Asian diets, with a significant proportion of South Asians adhering to vegetarian diets. However, Carlson and Frazão (2014) explain that the sensitivity of consumers to changes in food prices is contingent upon whether the product in question is specifically defined, such as grapes, or broadly defined, such as fruit. For example, if the price of grapes goes up, consumers may readily transition from the consumption of grapes and instead opt for alternative fruits

such as oranges, or bananas. Likewise, in the event of a decrease in the price of grapes, consumers may revert to purchasing grapes and less of bananas. It can be inferred from this that East Asians, South Asians and White Europeans who primarily consume vegetables may have the tendency to resort to cheaper food alternatives in response to price fluctuations and not necessarily reduce their overall consumption of vegetables probably due to dietary preferences and the cultural significance of vegetables. Nonetheless, BMI was found to impact the effect of price on consumption of foods such as vegetables. Saelens & Epstein (1996) explain that individuals classified as 'Obese' may be more sensitive to fluctuations in food prices because of their elevated food consumption, characterized by increased caloric intake. Nonetheless, it was reported in a Canada-based study that individuals categorized as obese tended to consume lesser quantities of fruits and vegetables than individuals within healthy weight ranges (Perez, 2002). These findings also suggest that the impact of price on consumption varies for Whites and Asians of different BMIs.

Furthermore, the presence of ethnic disparities in dietary intake may be indicative of socioeconomic inequalities among various ethnic groups (Zilanawala et al., 2015; Corlett, 2017). The results of this study suggest that diverse socioeconomic statuses have an impact on dietary behaviours and the concept of price elasticity of demand may offer explanations to certain observations made in the study. Andreyeva et al. (2010) defines price elasticity of demand as a measure of "the percentage change in purchased quantity or demand resulting with a 1% change in price". Herforth and Ahmed (2015) explain that the impact of price fluctuations on the consumption of staples and non-essential foods could be determined by considering factors such as income elasticities of demand, which measure the responsiveness of demand for a particular item to changes in income. For example, Kirkpatrick and Tarasuk (2003) found that households with lower incomes tend to allocate a smaller portion of their budget toward the acquisition of fruits and vegetables. Additionally, previous research has

disclosed that foods of low nutritional value such as non-enriched refined grains, fats or added sugars tend to be relatively more economically accessible. Consequently, low-income individuals are thus more prone to consuming more of these foods, while high-income-earners tend to have higher intakes of nutrient-rich foods (Darmon & Drewnowski, 2008; Kirkpatrick et al., 2010; Kirkpatrick & Tarasuk, 2003; Olstad et al., 2021). However, contrary to the present study's finding, a Canada-based study showed that individuals from households with higher incomes were less susceptible to consuming less than five servings of vegetables and fruits daily, compared to those in lower-income households (Garriguet, 2007). Similarly, some research conducted at household levels has also demonstrated a positive correlation between higher income or higher education and increased consumption of recommended foods, such as vegetables, fruit, low-fat milk, and high-fibre foods (James et al., 1997; Trichopoulou et al., 2002; Kirkpatrick and Tarasuk, 2003). Additionally, the findings of another study indicated that individuals with higher levels of education tend to consume more vegetables, fruits, and milk products and less meat, irrespective of income and household size (Ricciuto et al., 2006). In congruence with the present study's finding, the PURE study however reported a decline in the consumption of fruits and vegetables with a surge in prices relative to household income (Miller et al., 2016). These findings suggest that individuals with limited financial resources may be incapable of allocating a larger portion of their budget towards purchasing healthy foods such as vegetables, presumed to be more costly compared to junk foods.

In addition, contrary to this study's hypothesis of an influence of price on consumption, the findings revealed no significant associations between the prices of rice, bread, rice, chicken, junk foods, meat, eggs, milk, and their respective food intakes. The lack of significant associations between food prices and intake in our study diverges from some prior research that has shown relationships between food prices and consumption. Adekunle et al., (2011) explain that although affordability is a crucial factor in shaping food choices, consumers might

be willing to spend more for a desired commodity due to factors such as quality, the staple of the ethnic group, freshness, and health implications. For example, rice holds significant cultural importance, as indicated by its regular consumption and cultural affiliations (Lv and Cason, 2003; Washington, G., & Wang-Letzkus, 2009; Chesla et al., 2009). Also, both traditional Asian and Western diets commonly incorporate a substantial quantity of meat, which are regarded as essential constituents of meals. This aligns with a study conducted in the United States that found that a significant number of participants considered meat to be the essential element of their breakfast and dinner meals and were therefore eager to prioritize meat purchases compared to other food groups regardless of price (Wiig and Smith, 2009). Additionally, foods like eggs and dairy products, including milk, yogurt, and cheese, constitute the most substantial food category within the Canadian diet and align with Canada's Food Guide's recommendations for protein sources. It could be hypothesized that foods such as milk, rice, eggs, and bread, are considered essential or staple foods necessary for meeting basic dietary needs, and may thus have a relatively inelastic demand, indicating that price fluctuations exert a limited impact on consumption patterns (Kuchler et al., 2005). It can therefore be inferred that the perceived essentiality of certain foods may superimpose the effect of price on consumption, accounting for the absence of any relationships between some food prices and consumption observed in this study. This lack of association, however, raises intriguing questions about the intricate nature of dietary behaviours, necessitating a more thorough investigation into other potential influential factors such as the cultural significance of food, income levels, and dietary preferences, among other variables.

The present study was limited in its ability to examine dietary behaviours across different socioeconomic statuses due to the unavailability of data on socioeconomic statuses. The explanations offered for the observed findings, linking diverse income and educational levels to the impact of food prices on dietary intake, are thus grounded in their alignment with

previous scholarly literature. Nonetheless, considering the findings of the present study, it could be postulated that lower income levels among South Asians, East Asians, or White Europeans may substantially modify their consumption patterns in response to the concurrent escalation in prices. This goes further to demonstrate the impact of the nutrition environment in terms of food affordability in shaping dietary choices.

5.4 Impact of objective measures of the food environment

Availability of healthy food options and advertisements on healthy and unhealthy foods in grocery stores were considered objective measures of the food environment. Caspi et al. (2012) explain that it is crucial to acknowledge the significant and unique implications of perceived measures of the food environment in shaping dietary behaviours, despite the reliance on objective measures in many research endeavours pertaining to the food environment. In consistency with this, some studies have posited that individual perceptions may wield a more profound influence on the processes of food acquisition, dietary patterns, and overall health outcomes, when compared against other objective metrics such as proximity (Turner et al., 2018). The correlation between perceived measures of the food environment and objective measures has therefore garnered significant attention due to their pivotal role as a mediating factor influencing consumer behaviours (Brown et al., 2021). Per the scope of the current study, individual perceptions of the food environment were assessed based on exposure to food and nutrition-related advertisements. Below are the explanations for the findings on the objective measures and individual perceptions of the food environment.

5.4.1 Availability of healthy options

Although no significant association was found between the availability of fruits and vegetables in grocery stores and consumption in this study, there has been some empirical evidence that suggests that the availability of a diverse range of affordable and fresh fruits and

vegetables in the local community may encourage individuals to consume more of these nutritious foods (Jago et al., 2007). A study conducted in Montreal, Canada revealed that a higher percentage of stores selling healthy foods was associated with lower western diet scores (Mercille et al. (2012). However, this association was no longer significant after adjusting for residential neighbourhood characteristics such as income, language fluency, and education. The relationship between shelf space for fruits and vegetables and their purchase and consumption has also been explored in various studies (Rose et al., 2010). Additionally, establishments that primarily specialize in the sale of energy-dense food items, such as convenience stores and corner/liquor stores, have the potential to exert a detrimental influence on the consumption of fruits and vegetables (Drewnowski et al., 2004; Monsivais and Drewnowski, 2007). This can occur through the disproportionate promotion of unhealthy food options, the provision of lower-cost food items, or shifts in individual food preferences.

Furthermore, it is also worth noting that the link between food availability and consumption could be dependent on the area of residence, that is urban or rural residence. Fruits and vegetables were found to be more available in grocery stores in urban communities compared to rural areas. This observation also aligns with the findings of the PURE study conducted by Miller et al. (2016). de Souza et al. (2018) explain that effectively tackling the disparities in food prices and accessibility in urban and rural communities in Canada necessitates a comprehensive approach that addresses a multitude of challenges. These challenges encompass the low population density, resulting in reduced demand, as well as increased isolation, longer distances to travel amidst unfavourable road conditions, and a deficiency in storage and processing facilities.

Also, the presence of nutritious choices such as fruits and vegetables in retail establishments has the potential to enhance the adoption of healthy dietary patterns. However,

the extent to which individuals embrace these diets may also be influenced by various factors, including their level of awareness regarding nutritional information and the presence of policies that promote and support healthy eating behaviours, among others. The results of this study indicated that the majority of participants (exceeding 50%), demonstrated awareness regarding official dietary guidelines pertaining to healthy diets, programs designed to enhance dietary habits, and legislation concerning nutritional labelling of food products. A study conducted in the United States and Canada, reported an association between heightened consumption of fruits and vegetables among Chinese immigrants and the belief in the importance of adopting healthy dietary behaviours and being knowledgeable about nutritional information (Satia-Abouta et al., 2002). Notably, the participants in that study did not consider factors such as food cost, convenience, and availability as determinants of their healthy eating habits. Rather, their personal conviction regarding the importance of maintaining a nutritious diet played a pivotal role in their dietary choices. Washington and Wang-Letzkus (2009) also add that Chinese immigrants place significant importance on diet as a crucial element in maintaining good health and the prevention and control of diseases.

These findings suggest that individuals who personally prioritize healthy eating may be more inclined to maintain or increase their intake of healthy foods once healthy options are available, overriding the influence of price fluctuations on consumption patterns.

5.4.2 Food Advertisements

The prevalence of exposure to food-related advertisements was observed among a significant majority of participants, with over 80% reporting having heard or seen such advertisements. However, there was generally no agreement between the presence of these food-related advertisements and individuals' exposure to food advertisements. The minimal variations observed regarding responses to individual perceptions of the food environment may

have contributed to this outcome. Another potential assumption is that participants may have encountered these food advertisements in other grocery stores that were not included in the scope of the community-level food environment assessment audits conducted during the CAHHM study. Interestingly, no significant associations were also found between the presence of junk foods, sweet drinks and fruits and vegetables adverts and the intake of these foods. Contrary to this finding, Bargh and Morsella (2008) assert that the impact of food advertisements on consumer behaviour is often subtle but can have significant and often unnoticed influences. Cohen and Babey (2012) also add that the vulnerability of customers to the persuasive influence exerted by in-store food marketing is indicated by the fact that two-thirds of food-related purchase decisions are made within the confines of the food retail environment. The present study's finding, therefore, seems counterintuitive and challenges this common assumption that increased exposure to food promotions directly translates to higher consumption of advertised foods. This study's findings may thus be influenced by various contributing factors.

Food marketing is accomplished through a diverse array of channels, including print media, billboards, event sponsorship, product placement, and television commercials (Vukmirovic, 2015). Moreover, research has indicated that children exhibit a higher susceptibility to marketing messages compared to their adults (Calvert, 2008; Garretson and Niedrich, 2004; Gunter and Furnham, 1998). Consistent with the current study's findings, previous literature has yielded incongruous findings regarding the potential impact of food advertising on adult populations (Kanoski & Boutelle, 2022; Mills et al., 2013). This study's findings may however be ascribed to the fact that adults have heightened cognitive maturation, making them discerning consumers of advertising, and thereby potentially rendering them less susceptible to the persuasive impact of food advertisements (Story and French, 2004). Nonetheless, Vukmirovic (2015) highlights that the influence of food marketing extends also

to the adult population. In consistency with this, alcohol intake was the only food group observed to be associated with alcohol advertisements in this study. Similarly, another study reported that interventions promoting, for example, healthy food options, were shown to exert an influence on consumer behaviour, leading to increased purchases of healthy foods (Escaron et al., 2013). These findings, therefore, confirm that food advertisements in grocery stores do indeed influence consumption.

It is however important to consider the complexities involved in individuals' decision-making processes regarding food choices when assessing the impact of food advertisements. Exposure to a consummatory image of unhealthy foods serves to alleviate internal conflicts within an individual (Poor et al., 2013, as cited in Vukmirovic, 2015). This consequently engenders a sense of justification for the subsequent consumption of the food, resulting in an enhanced perception of its taste quality. Notably, also, some research has also shed light on the role of transportability, that is, the inclination to become deeply engrossed in a narrative, in determining the influence of food marketing on consumption (Wonderlich-Tierney et al. (2013). Specifically, some findings suggest that individuals characterized by high levels of transportability exhibit a heightened susceptibility to the persuasive influence of food advertisements, leading to greater consumption of food compared to their counterparts with low levels of transportability (Wonderlich-Tierney et al., 2013). This intriguing line of inquiry underscores the importance of considering individual differences in transportability when examining the impact of food advertisements on consumption behaviours.

While food advertisements have the potential to influence preferences and create awareness, it is crucial to recognize that the ultimate decision to consume a specific food item may be predominantly contingent upon a multitude of individual-level factors, including personal preferences, cultural influences, individual motivations, food affordability and

accessibility, among others. The present study's findings, thus, remain inconclusive considering previous research that has indicated that exposure to food advertising has a significant impact on food consumption among adults (Arrona-Cardoza, 2022).

Based on this study's findings, the intricate nature of the food environment renders it implausible to solely attribute unhealthy eating behaviours to the influence of food advertising and media. The present study however acknowledges the undeniable influence exerted by media and food advertisements on individuals' food-related behaviours as seen in alcohol consumption. Additionally, this study posits that the impact of food advertisements on individuals' dietary choices could be comparatively less significant when juxtaposed with the influential role played by the availability of healthy foods, and food affordability in the nutrition environment. The potential impact of food-related advertisements on individuals' dietary intake may thus be eclipsed by a multitude of broader contextual factors.

5.5 Policy Implications and Recommendations

The findings from this study may provide valuable insights for use in policy initiatives aimed at enhancing and advocating for healthy eating habits among ethnic groups in Canada. For example, the observed disparities in dietary intake across ethnic groups emphasize the relevance of culturally specific interventions that focus on specific dietary preferences and traditions of different ethnic groups.

Furthermore, the observed association between the price of healthy foods such as vegetables and vegetable intake underscore the need for targeted strategies to mitigate the potential impact of price fluctuations. Evidence from this study, in alignment with previous literature, suggests that the high cost of vegetables may deter consumption among low-income individuals (Perez, 2002; Kirkpatrick and Tarasuk, 2003; Miller et al., 2016). Also, the interaction effect of food prices and rural/urban living indicates that strategies to promote

vegetable consumption should be tailored to the unique needs and challenges of both urban and rural settings. To address this, policymakers could consider implementing measures geared towards enhancing the availability and accessibility of fresh and affordable vegetables for rural communities, often geographically disadvantaged. Specifically, policymakers could provide incentives to encourage the establishment of grocery stores in rural communities. Nonetheless, given the significant influence of income on consumption, as documented in this study, it remains uncertain to what extent the increased availability of more healthy food options can counteract the effect of income. It has been reported in numerous literatures that the reduction of prices of healthy foods could increase consumption (Afshin et al., 2017; Cobiac et al.,2017; Ferdinand et al., 2017; Pearson-Stuttard et al., 2017; Li et al., 2018). Strategies including subsidies, incentives, or discounts on vegetables, in both rural and urban areas could therefore be considered to mitigate the negative impact of higher prices, thereby increasing food affordability for low-income earners.

In addition, the impact of advertisements on the dietary habits of the public is a well-established phenomenon. The outcomes of this study's analysis, which indicate a lack of significant association between the presence of food advertisements and dietary intake, suggest that although advertising may play a role in shaping food preferences, it is not the sole determinant of eating behaviours. This highlights the importance of acknowledging the autonomy of consumers and the various factors that influence their perception of the food environment and dietary choices. This understanding can serve as a foundation for policymakers to develop interventions that enable individuals to acquire precise information and acquire the necessary skills to make well-informed decisions regarding their food choices, even in the face of external influences. It is worth noting that this has been initiated through Health Canada's revised food labelling regulation, governing the mandatory placement of the front-of-package nutrition symbol on prepackaged foods high in sodium, sugars and saturated

fat (Health Canada, 2016). Additionally, Gorski and Roberto (2015) state that there is a paucity of advertisements promoting the consumption of fruits and vegetables. Consequently, by continuously engaging in discussions with food manufacturers and marketers, policymakers can encourage responsible advertising practices that prioritize the promotion of healthier food choices. Encouraging food industries to willingly reduce the advertising of products high in added sugars, salt, and unhealthy fats can thus foster a more health-conscious food environment.

5.6 Strengths and Limitations

The study's major strength lies in its comprehensive scope and overarching objectives. Some strengths that can be recognized from this study include the identification of diverse eating habits of South Asians, East Asians and White Europeans in Canada. This study provides ethnic-specific nutrition information, which can be disseminated to healthcare providers, enabling them to gain insights into ethnic dietary patterns and nutritional concerns, and to be fully equipped to offer culturally sensitive nutritional guidance.

Contrarily, it is important to acknowledge that this study has a number of limitations that should be considered in future research. First, the utilization of cross-sectional data imposes constraints on the study's capacity to establish causal relationships between food prices and consumption. Longitudinal designs have the potential to proffer a more comprehensive understanding of the progressive dynamics between these variables. Additionally, the absence of associations could also be ascribed to the heterogeneity in socioeconomic status variables such as income levels across this study's population. This study was unable to incorporate these variables in the linear regression models due to the inaccessibility of data on these key variables. Future research should therefore consider factors

like income levels when drawing up relationships between food prices and consumption. Also, it should be noted that the grocery stores included in the community audits, which evaluated the food environment based on food prices and the presence of food advertisements, may not have corresponded to the stores regularly visited by the study's participants. This could thus also explain the lack of associations and congruence between food prices and dietary intake, as well as food advertisements and consumption. The invariability of responses to questions on individual perceptions of the food environment was also a limitation in the study, which could have accounted for the lack of agreement between exposure to food advertisements and the presence of food advertisements. Furthermore, this study lacked sufficient representation of East and South Asians residing in rural areas compared to urban areas. This vast disparity in the distribution between rural and urban residences is therefore inadequate to substantiate the study's findings comparing the dietary intake of Asians in rural and urban communities in Canada.

CHAPTER 6

CONCLUSION

In conclusion, this study highlights the diversity in dietary intake among Asians and White Europeans in Canada, as well as the detrimental impact of a surge in vegetable prices on consumption. The findings also accentuate the urgency of addressing food affordability and equity to guarantee equal access to healthy foods for all populations. Targeted policy interventions, coupled with culturally sensitive approaches, can play a pivotal role in promoting healthier dietary patterns and mitigating the adverse effects of escalating food prices on vulnerable communities. High-income individuals, among Asians and White Europeans, may possess sufficient resources to maintain healthy dietary behaviours despite food price fluctuations. Conversely, low-income individuals may have constrained budgets that hinder their capacity to purchase high-priced foods like vegetables or alter their food choices in response to price changes. Also, BMI plays a contributing role in food consumption regardless of price. This study did not find significant associations between food prices of rice, cola, chocolate, meat, milk, chicken, eggs, or bread and their respective dietary intakes among Asians and White Europeans in Canada. This was probably due to the price-inelastic nature of these foods and their perceived essentiality, indicating a superimposing effect of other factors, aside from price. No congruence was also found between objective measures of the food environment in relation to the presence of food advertisements and individual perceptions in terms of exposure to food advertisements. The availability of fruits and vegetables and the existence of food advertisements in stores did not exert any influence on dietary intake, with the exception of alcohol-centred promotions. While unexpected, these results underscore the multifaceted nature of dietary behaviors, influenced by cultural, economic, and individual factors. Future research should explore additional determinants, such as cultural preferences

and income levels, to better understand the intricacies of food consumption patterns and their response to price fluctuations.

The results from this study's analysis offer a comprehensive overview of some contextual factors within the nutrition environment influencing dietary intake among diverse population groups in Canada. Policymakers can leverage these insights to design evidence-based interventions that promote vegetable consumption, considering factors such as price sensitivity, cultural diversity, and rural-urban disparities. This study's findings emphasize the necessity of collaborative endeavours between policymakers, community organizations, food industries, healthcare professionals, and local communities in creating healthy food environments to improve the health and well-being of Canada's diverse populace.

CHAPTER 7

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APPENDIX

Table 11: Association between the Price of Food in the Healthy Basket and Intake of Foods in the Basket

Price of Standard Basket ($) and intake of foods in the Basket (ln(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	1.9873	(1.8898, 2.0848)	<0.0001	1.99	(1.8926, 2.0875)	<0.0001	1.9928	(1.8952, 2.0905)	<0.0001	1.9576	(1.828, 2.0872)	<0.0001
Standard Basket Price	-0.0001	(-0.0016,0.0014)	0.9383	-0.0001	(-0.0016, 0.0014)	0.874	-0.0002	(-0.0017, 0.0013)	0.8301	-0.0001	(-0.0008, 0.0014)	0.8778
Rural/Urban (Ref=Urban)				0.1217	(-0.0812, 0.2615)	0.0881	-0.6611	(-2.3459, 1.0237)	0.4418	0.1213	(-0.0186, 0.2612)	0.0893
Ethnicity:EastAsian(Ref=White)										0.0279	(-0.013, 0.0688)	0.1815
South Asian										-0.0657	(-0.1323, 0.0008)	0.0529
BMI										0.0012	(-0.0018, 0.0041)	0.4372
Price*Rural/Urban							0.0114	(-0.013, 0.0357)	0.3608			

Price of Vegetables ($) and Vegetable Intake (ln(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	0.7989	(0.7153, 0.8825)	<0.0001	0.7957	(0.7125, 0.8788)	<0.0001	0.7819	(0.6983, 0.8656)	<0.0001	1.4296	(1.2768, 1.5824)	<0.0001
Price of Vegetables	0.0073	(0.0004, 0.0141)	0.0387	0.006	(-0.0008, 0.0129)	0.0851	0.0072	(0.0003, 0.0141)	0.0408	-0.0078	(-0.0145, 0.0011)	0.0233
Rural/Urban (Ref=Urban)				0.5796	(0.4414, 0.7177)	<0.0001	1.5273	(0.8237, 2.2308)	<0.0001	0.4778	(0.3446, 0.6111)	<0.0001
Ethnicity:EastAsian(Ref=White)										-0.7396	(-0.8082, -0.671)	<0.0001
(South Asian)										-0.4833	(-0.5959, -0.3707)	<0.0001
BMI										-0.0128	(-0.0174, -0.0081)	<0.0001
Price*Rural/Urban(Ref=Urban)							-0.0759	(-0.1312, -0.0207)	0.0071			

Price of Fruits ($) and Fruit Intake (ln(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	0.9026	(0.8073, 0.998)	<0.0001	0.9043	(0.8087, 0.9999)	<0.0001	0.9167	(0.8208, 1.0125)	<0.0001	1.4095	(1.2392, 1.5798)	<0.0001
Price of Fruits	0.002	(-0.0003, 0.0042)	0.0819	0.0011	(-0.0003, 0.0042)	0.0841	0.0017	(-0.0006, 0.0039)	0.1442	0.0018	(-0.0004, 0.004)	0.1123

Rural/Urban (Ref=Urban)				-0.0292	(-0.1591, 0.1007)	0.6596	-1.522	(-2.528, -0.516)	0.003	-0.0358	(-0.1655, 0.0938)	<0.0001
Ethnicity:EastAsian(Ref=White)										-0.2075	(-0.2884, -0.1266)	<0.0001
South Asian										-0.0788	(-0.2037, 0.046)	0.2158
BMI										-0.0174	(-0.0225, -0.0124)	<0.0001
Price*Rural/Urban(Ref=Urban)							0.0376	(0.0125, 0.0627)	0.0034			
Price of Meat ($) and Meat Intake (In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-2.1091	(-2.2034, -2.0148)	<0.0001	-2.1184	(-2.2129, -2.0239)	<0.0001	-2.1387	(-2.2341, -2.0434)	<0.0001	-3.101	(-3.3024, -2.8995)	<0.0001
Price of Meat	0.004	(-0.0037, 0.0117)	0.3106	0.0056	(-0.0023, 0.0134)	0.1631	0.0073	(-0.0005, 0.0152)	0.0677	0.0048	(-0.0028, 0.0123)	0.217
Rural/Urban (Ref=Urban)				-0.2601	(-0.4454, -0.0747)	0.006	0.9301	(0.1321, 1.7281)	0.0223	-0.1986	(-0.3783, -0.019)	0.0302
Ethnicity:EastAsian (ref=White)										0.8124	(0.7207, 0.9042)	<0.0001
(South Asian)										-0.8217	(-1.0656, -0.5778)	<0.0001
BMI										0.0327	(0.0263, 0.0391)	<0.001
Price*Rural/Urban(Ref=Urban)							-0.0813	(0.1344, -0.0283)	0.0027			
Price of Poultry ($) and Intake of Poultry (In(Servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-1.2272	(-1.3265, -1.1278)	<0.0001	-1.2271	(-1.3264, -1.1278)	<0.0001	-1.2268	(-1.3264, -1.1272)	<0.0001	-1.4045	(-1.5976, -1.2114)	<0.0001
Price of Poultry	0.0028	(-0.0018, 0.0074)	0.2338	0.003	(-0.0015, 0.0076)	0.1945	0.003	(-0.0016, 0.0076)	0.1979	0.004	(-0.0004, 0.0085)	0.0738
Rural/Urban (Ref=Urban)				-0.1658	(-0.3389, 0.0073)	0.0606	-0.2113	(-1.51, 1.0873)	0.7498	-0.2796	(-0.4479, -0.1114)	0.0011
Ethnicity:EastAsian (ref=White)										-0.4159	(-0.5048, -0.3271)	<0.0001
(South Asian)										-1.4265	(-1.5945, -1.2584)	<0.0001
BMI										0.0097	(0.0037, 0.0158)	0.0016
Price*Rural/Urban(Ref=Urban)							0.002	(-0.0545, 0.0585)	0.9447			
Price of Egg ($) and Intake of Egg (In(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-0.6952	(-0.9372, -0.4533)	<0.0001	-0.6952	(-0.9372, -0.4533)	<0.0001	-0.7231	(-0.9657, -0.4804)	<0.0001	-1.1217	(-1.4184, -0.8251)	<0.0001

Price of Egg	-0.0029	(-0.0828, 0.077)	0.077	-0.003	(-0.0829, 0.0769)	0.9406	0.0062	(-0.0739, 0.0864)	0.8788	0.0109	(-0.0686, 0.0904)	0.7879
Rural/Urban (Ref=Urban)				0.0237	(-0.2658, 0.3131)	0.8726	3.8044	0.9623, 6.6465)	0.0087	0.0666	(-0.2203, 0.3534)	0.6492
Ethnicity:EastAsian (ref=White)										0.4358	(0.3515, 0.52)	<0.0001
(South Asian)										0.1802	(0.0768, 0.0297)	0.019
BMI										0.0114	(0.0297, 0.3307)	0.0003
Price*Rural/Urban(Ref=Urban)							-1.2389	(-2.1655, -0.3124)	0.0088			

Price of Rice ($) and Intake of Rice (ln(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-1.0631	(-1.1684, -0.9578)	<0.0001	-1.077	(-1.1821, -0.9719)	<0.0001	-1.0519	(-1.1581, -0.9457)	<0.0001	-1.2339	(-1.4384, -1.0294)	<0.0001
Price of Rice	-0.0325	(-0.0518, -0.0131)	0.001	-0.0265	(-0.0459, -0.007)	0.0075	-0.0314	(-0.051, -0.0117)	0.0017	-0.0013	(-0.0198, 0.0172)	0.8906
Rural/Urban (Ref=Urban)				-0.5433	(-0.7343, -0.3523)	<0.0001	-1.8017	(-2.6066, -0.9968)	<0.0001	-0.3863	(-0.5681, -0.2045)	<0.0001
Ethnicity:EastAsian (ref=White)										1.0741	(0.981, 1.1672)	<0.0001
(South Asian)										0.7776	(0.6225, 0.9327)	<0.0001
BMI										-0.0006	(-0.0127, 0.0002)	0.0587
Price*Rural/Urban(Ref=Urban)							0.2039	(0.0772, 0.3305)	0.0016			

Price of Bread ($) and Intake of Bread (ln(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-0.5134	(-0.7878, -0239)	0.0002	-0.5197	(-0.7942, -0.2451)	0.0002	-0.5098	(-0.7851, -0.2346)	0.0003	-1.5462	(-1.9423, -1.1502)	<0.0001
Price of Bread	-0.0029	(-0.0405, 0.0347)	0.8812	-0.0026	(-0.0402, 0.035)	0.8933	-0.0039	(-0.0416, 0.0337)	0.8375	0.0182	(-0.019, 0.0554)	0.3372
Rural/Urban (Ref=Urban)				0.2247	(-0.152, 0.6013)	0.2423	-1.6194	(-5.3052, 2.0664)	0.3892	0.1461	(-0.2244, 0.5165)	0.4396
Ethnicity:EastAsian (ref=White)										-0.5205	(-0.6838, -0.3573)	<0.0001
South Asian										-0.6364	(-0.9263, -0.3464)	<0.0001
BMI										0.0354	(0.0253, 0.0456)	<0.0001
Price*Rural/Urban(Ref=Urban)							0.2618	(-0.2587, 0.7823)	0.3242			

Price of Milk ($) and Intake of Milk (ln(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	0.3067	(0.159, 0.4545)	<0.0001	0.2887	(0.1404, 0.437)	<0.0001	0.2932	(0.1428, 0.4435)	<0.0001	0.1803	(-0.1601, 0.5206)	0.2992
Price of Milk	-0.0306	(-0.069, 0.0077)	0.1176	-0.0294	(-0.0677, 0.009)	0.1335	-0.0306	(-0.0696, 0.008)	0.1238	-0.0042	(-0.0427, 0.0343)	0.8303

Rural/Urban (Ref=Urban)	0.4047	(0.105, -0.0677)	0.0081	0.271	(-0.5322, 1.0742)	0.5084	0.3407	(-0.0427, 0.6386)	0.025
Ethnicty:EastAsian(ref=White)							-0.6823	(-0.8462, -0.5184)	<0.0001
South Asian							0.4508	(0.1964, 0.7052)	0.0005
BMI							0.0034	(-0.0076, 0.0143)	0.5462
Price*Rural/Urban(Ref=Urban)				0.0392	(-0.1794, 0.2579)	0.725			

Model 1 represents the unadjusted model; Adjustments were made for Rural/Urban residences and interactions in model 3. Model 4 is the model of focus to check for associations between availability of fruits and vegetables and intake, after adjusting for Rural/Urban residence, Ethnicity, and BMI. Best model fitness was assessed using the least AIC value. Meat price- pork and sausage; poultry price – chicken drumstick, breast; price of vegetables – carrots, tomatoes, lettuce); price of fruits- apples, oranges, bananas, grapes, pears; bread- white bread;

Table 12: Association Between Price of the Unhealthy Food Basket and Consumption of Foods in the Basket

Price of Unhealthy Basket ($) and intake of foods in the Basket (In(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-1.0609	(-1.17, -0.9518)	<0.0001	-1.0618	(-1.1709, -0.9526)	<0.0001	-1.0557	(-1.1659, -0.9456)	<0.0001	-1.8149	(-2.0421, -1.5877)	<0.0001
Unhealthy Basket Price	0.0138	(-0.0505, 0.0781)	0.6741	0.0133	(-0.051, 0.0776)	0.6857	0.0095	(-0.0555, 0.0744)	0.7745	-0.0564	(-0.1193, 0.0064)	0.0785
Rural/Urban (Ref=Urban)				0.0561	(-0.154, 0.2662)	0.6007	-0.2649	(-1.0709, 0.541)	0.5194	-0.1015	(-0.3058, 0.1028)	0.3302
Ethnicity:EastAsian(ref=White)										-0.7331	(-0.8389, -0.6272)	<0.0001
South Asian										-0.4123	(-0.5881, -0.2365)	<0.0001
BMI										0.0368	(0.0295, 0.0441)	<0.0001
Price*Rural/Urban(Ref=Urban)							0.1897	(-0.2701, 0.6495)	0.4187			
Price of Cola ($) and Intake of Cola (In(servings/day)	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
		Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**	
Intercept	-2.0599	(-2.1407, -1.9792)	<0.0001	-2.0659	(-2.1472, -1.9845)	<0.0001	-2.0668	(-2.1486, -1.9851)	<0.0001	-3.9772	(-4.2892, -3.6653)	<0.0001
Price of Cola	0.0151	(-0.1218, 0.152)	0.8285	0.0152	(-0.1217, 0.152)	0.8282	0.0174	(-0.1207, 0.1556)	0.8045	-0.0622	(-0.1936, 0.0693)	0.3539
Rural/Urban (Ref=Urban)				0.2028	(-0.1272, 0.5329)	0.2284	0.2566	(-0.2916, 0.8048)	0.3589	-0.0319	(-0.3489, 0.2851)	0.8436
Ethnicity:EastAsian(ref=White)										-0.7745	(-0.9383, -0.6107)	<0.0001
South Asian										-0.641	(-0.8947, -0.3873)	<0.0001

BMI										0.0756	(0.0649, 0.0864)	<0.0001
Price*Rural/Urban(Ref=Urban)							-0.1256	(1.1482, 0.897)	0.8098			
Price of Chocolate ($) and Intake of Chocolate (ln(servings/day))	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**	**β**	**95% CI**	**ρ**
	Model 1			**Model 2**			**Model 3**			**Model 4 (Main)**		
Intercept	-1.7501	(-1.867, -1.6333)	<0.0001	-1.7501	(-1.8669, -1.6333)	<0.0001	-1.7381	(-1.8553, -1.621)	<0.0001	-1.5392	(-1.7713,-1.3072)	<0.0001
Price of Chocolate	0.0819	(-0.0158, 0.1796)	0.1002	0.0818	(-0.0161, 0.1797)	0.1015	0.0712	(-0.027, 0.1695)	0.1554	0.0228	(-0.0746, 0.1203)	0.6465
Rural/Urban (Ref=Urban)				0.0052	(-0.2018, 0.2122)	0.961	-1.6347	(-3.0251, -0.2441)	0.0212	-0.0715	(-0.2769, 0.1339)	0.4953
Ethnicity:EastAsian(ref=White)										-0.5872	(-0.6943, -0.48)	<0.0001
South Asian										-0.3093	(-0.4874, -0.1312)	0.0007
BMI										-0.0018	(-0.0091, 0.0055)	0.6323
Price*Rural/Urban(Ref=Urban)							1.299	(0.2099, 2.3882)	0.0194			

Model 1 represents the unadjusted model; Adjustments were made for Rural/Urban residences and interactions in model 3. Model 4 is the model of focus to check for associations between availability of fruits and vegetables and intake, after adjusting for Rural/Urban residence, Ethnicity, and BMI. Best model fitness was assessed using the least AIC value. Variables were determined as confounders if they were 1) associated with outcome/dependent variable (consumption); 2) not on the causal pathway between exposure and outcome; 3) associated with the exposure (food price) 4) the inclusion of the variable in the model altered the association of the main exposure (food price) with the outcome (consumption) by at least 10%; 5) statistically significant.