Heterogeneity of Food Consumption Pattern across different Ethnic groups in Ontario, Canada

by

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A Thesis

presented to

The University of Guelph

In partial fulfillment of requirements

for the degree of

Master of Science

in

Food, Agriculture and Resource Economics

Guelph, Ontario, Canada

ABSTRACT

HETEROGENEITY OF FOOD CONSUMPTION PATTERN AMONG DIFFERENT ETHNIC GROUPS IN ONTARIO, CANADA

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The purpose of this research is to examine the heterogeneity of food consumption pattern across different ethnic groups in Ontario. Specific objectives of this study are: (1) to examine the role of different ethnic groups on fruit and vegetable consumption, and (2) to examine the role of different ethnic groups on convenience food consumption. Negative binomial and Zero-inflated negative binomial models were used to model fruit and vegetable consumption, while bi-variate probit regression was used for convenience food consumption. The Canadian Consumer Health Survey 2012/2013 data was used for analysis. Results revealed that different ethnic groups have a significant different fruit and vegetable consumption and convenience food consumption pattern. The length of residence and immigrant residential status in Canada has significant impact on few categories of food.

Keywords: Ethnicity, heterogeneity, fruit and vegetable, convenience food

DEDICATION

To my beloved parents, my brother and my husband for their endless love and support

ACKNOWLEDGEMENT

"*It always seems impossible until it's done"*

- Nelson Mandela

Without the support of my advisor, this thesis couldn't able to come to this fruition. I am sincerely grateful for all support provided by Prof. John Cranfield for his patience, motivation and immense knowledge. He has continuously supported me in all stages in this thesis while allowing me the room to work in my own way. Besides my advisor, I would like to thank my committee members, Prof. Andreas Boecker and Prof. Getu Heilu for provided invaluable feedback that honed this work into its present form. My acknowledgement goes to Social, Science and Humanities Research Council (SSHRC) for allowing me to use their database for this study.

I greatly appreciate the support provided by the faculty, staff and friends at the Department of Food, Agricultural and Resource Economics, University of Guelph. It is really happy to work with FARE family. I would like to thank my friends who encouraged me during my masters and for all the fun we had last two years.

I also thank my family who encouraged and prayed for me throughout the time of research. I would like to convey my sincere thanks to my mom who believed in me and sent me to a farther land to complete my thesis. I am really thankful for her support for my entire career.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Canada is a multicultural society whose ethno cultural makeup has been shaped by immigrants and their descendants over time (Statistics Canada, 2011b). For instance, in 2011, the Canadian population had individuals from more than 200 ethnic groups, with13 different ethnic groups' accounting for more than 1 million people (Statistics Canada, 2011b). Further, in 2011, the foreign born population in Canada was about 6,775,800 people, or about 21 percent of the total Canadian population (Statistics Canada, 2011a). Between 2006 and 2011, Asia accounted for the largest source of new immigrants in Canada, followed by Africa, the Caribbean and Central and South America (Figure 1).

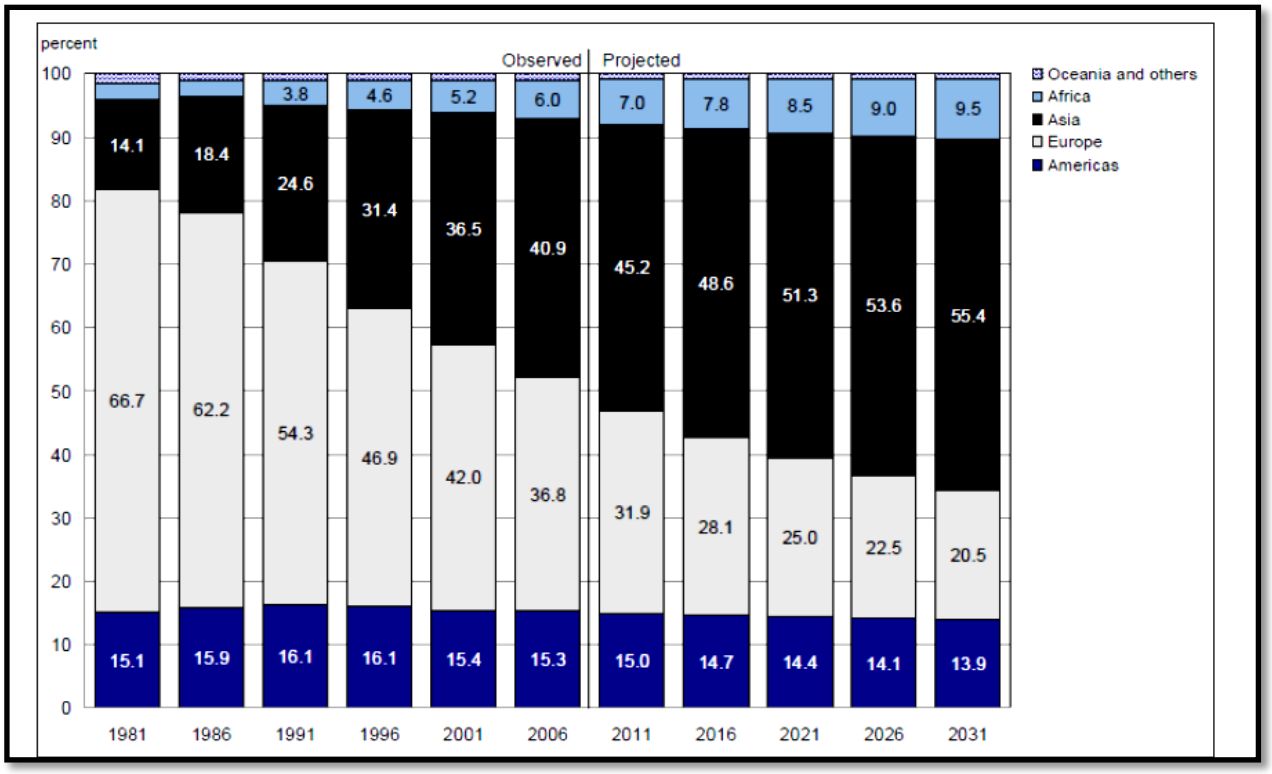


Figure1.1: Observed and projected diversity of the Canadian Population
Source: Statistics Canada, 2010

While the vast majority of immigrants live in Ontario (Statistics Canada, 2011), many immigrants settle in economically well-developed areas, such as Toronto, Montreal and Vancouver (Bourne & Rose, 2001). As well, naturalization[1] rates are higher for migrants to Canada than migrants to other countries[2] (Statistics Canada, 2011b). Further, during the last two decades, there has been significant growth in the number of people with visible minority status in Canada (Statistics Canada, 2011a).For instance, the size of the visible minority population in Canada increased from 16.2 percent in 2006 to 19.1 percent in 2011 (Statistics Canada, 2006 & 2011), with the three largest visible minority groups being South Asians, Chinese, and Africans. The rise in the prevalence of different ethnic groups has brought different cultural practices and norms to Canada. These differences have begun to influence food choices made by those residing in Canada (Ricciuto, Tarasuk & Yatchew, 2006; Ristovski-Sijiepcevic, Chapman & Beagan, 2008; Sanjur, 1982).

Migration leads individuals to change their food habits (Petresu et al., 2011). According to Luna and Gupta (2001), the consumption behaviour of individuals is influenced by the culture and values inherited over time. Further, economic and social factors can also influence migrants' food consumption behavior (Petresu et al., 2011). Migration yields two different perspective changes in terms of acculturation[3] (Douglas & Craig, 1997; Saseanu & Petrescu, 2011). The first is that migrating groups bring new values and customs, which will increase the diversity of the host country's population (Douglas & Craig, 1997; Saseanu & Petrescu, 2011). The second is

[1]Naturalization is the process through which immigrants acquire Canadian citizenship. Landed immigrants who have met certain criteria are eligible for Canadian citizenship by naturalization. The criteria for acquiring citizenship generally include a residency requirement, knowledge of English or French and basic knowledge of Canada.
[2]Based on 2011 National Health Survey (NHS), 78.3 percent of the Canadian population was a Canadian citizen by birth, another 15.8 percent were Canadian by naturalization, and the remaining 6 percent were temporary residents.
[3]Acculturation is a process where people started to adapt new majority of the society, when people from one ethnicity move to an area with different cultural norms. Acculturation takes place along a continuum of behavior patterns than can be very fluid, moving back and forth between traditional practices and adopted customs (Kilter et al. 2012).

when members of a minority group adopt the eating patterns/food choices of the host country (Satia-Abouta et al., 2002). However, the degree of acculturation is influenced by different socioeconomic characteristics of the immigrant population (Saseanu & Petrescu, 2011).

Changes in food choice can influence the health of an individual (McDonald & Kennedy, 2005).This is particularly important for immigrants in Canada, a group which is seeing an increase in chronic diseases (McDonald & Kennedy, 2005; Newbold & Danforth, 2003; Perez, 2002). Among the studies focused on Canadians, McDonald and Kennedy (2005) and Newbold and Danforth (2003) identified the vulnerability of immigrant populations towards health problems compared to Canadian-born. Compare to non-immigrants, immigrants, for instance, are more likely to report poor health status and less likely to report better states of health (Newbold & Danforth, 2003). McDonald and Kennedy (2005) demonstrated that immigrants are substantially less likely to be obese or over-weight upon arrival in Canada, while Newbold and Danforth (2003) and Perez (2002) found that excess weight increases with length of residence in Canada. Furthermore, the prevalence of obesity and excess weight varies within ethnic groups (Dressler et al.,1998; McDonald & Kennedy, 2005).For example, during the period 1996 to 2001, about 48 percent of blacks in Canada were overweight, while 36 percent of South Asians were overweight (McDonald & Kennedy, 2005). Moreover, there is a higher prevalence of poor health among lower socioeconomic status Canadian households (Abraido-Lanza, Chao &Florez, 2005; McDonald & Kennedy, 2005).

Even though the above studies show immigrants to be vulnerable towards obesity and overweight, there are no statistics regarding obesity/ overweight rates particularly for immigrants in Canada. However, in Canada, the prevalence of overall overweight and obesity has increased over recent decades among both children and adolescents in all areas of the country (Figure 2).

For instance, 59 percent of the adult population is overweight (i.e., Body Mass Index (BMI)[4]>=25Kg/m^2) and 23 percent is obese (i.e. BMI>=30Kg/m^2) (Statistics Canada, 2004). The most alarming problem is the increasing number of obese children and adolescents in Canada (CIHI & PHAC, 2011; Wilkinson & McCargar, 2014). In 2004, 26 percent of Canadian children and adolescents, aged 2-17 years, were overweight (Statistics Canada, 2004). The obesity rate has increased dramatically in the last 15 years; from 2percent to 10percentamong boys and from 2% to 9% among girls (Statistics Canada, 2004). This increase is cause for concern, since there is a tendency for obese children to remain obese as adults. Moreover, obesity related health problems are now occurring at a much earlier age and continue to progress into adulthood (CIHI & PHAC, 2011).

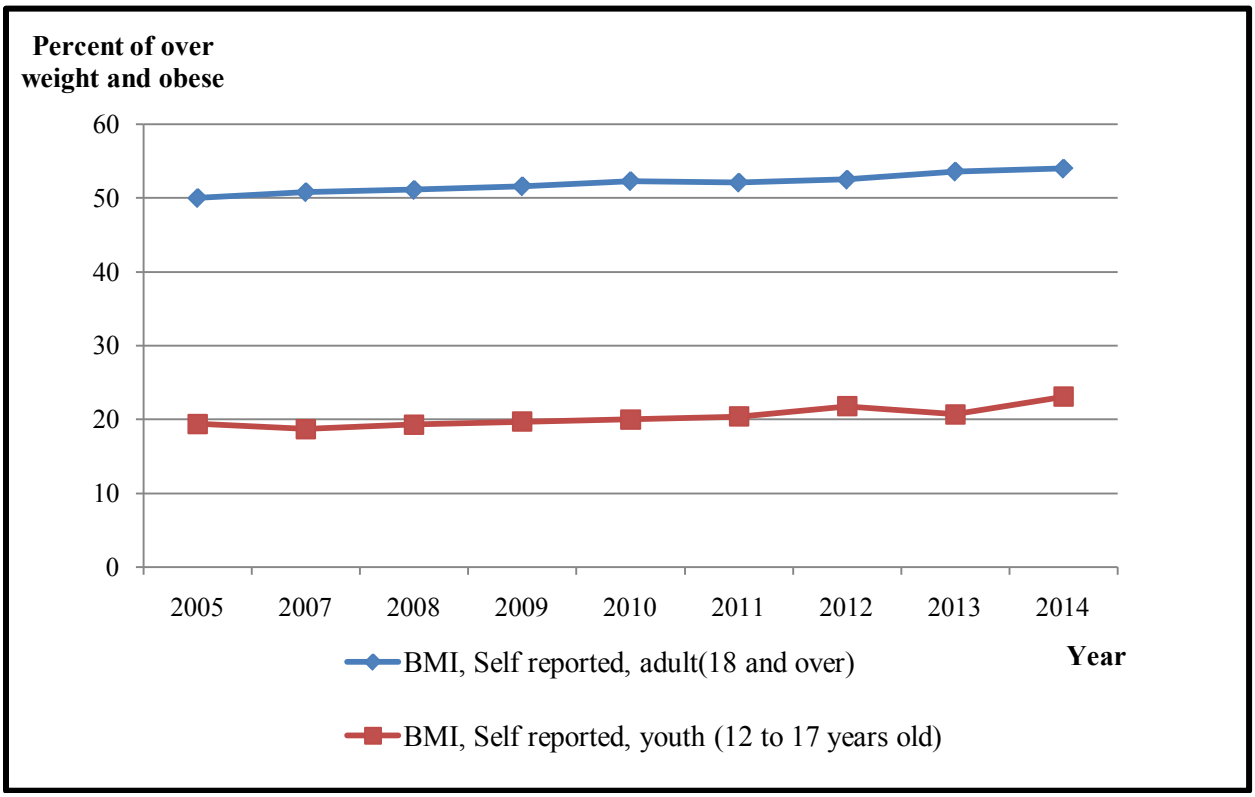


Figure 1.2: Prevalence of Obesity, Adult and Youth, Canada, 2005-2014
Source: Statistics Canada, retrieved at: http://www5.statcan.gc.ca/cansim/a47

[4]Body mass index (BMI is calculated as weight in kilograms (kg) divided by height in meters squared (m^2), rounded to one decimal place (Statistics Canada, 2013)

The cause of obesity is complex and multi-factorial (CIHI & PHAC 2011; Lau et al., 2007; McDonald & Kennedy, 2005). Within the context of environmental, social and genetic factors, obesity results from long-term positive energy balance – energy intake exceeds energy expenditure (Gorden- Larsen et al., 2003; Lau et al., 2007; NewBold & Danforth, 2003). The rapid increase in obesity over the past 20 years has been attributed to environment and cultural influences, rather than genetic factors (Lau et al., 2007). This is especially important for migrants who move to a new area where different cultural norms are practiced and new dietary behaviors can emerge (Kittler, Sucher & Nelms, 2011). It has been suggested that the new food environments alter the dietary behaviours of individuals because of heavily marketed unhealthy foods and deficit of traditional healthy foods (Harrison et al. 2005; Yang & Read, 1996). Further, there is an underutilization of immigrant working skills, and wage/income inequality among immigrants compared to native-born Canadians (Reitz, 2001). This wage/income can lead to lower economic status and limit the migrant's ability to procure healthy foods (Beiser et al., 2002; Sanjur, 1982).

1.2 Economic Problem

Overweight is no longer considered a cosmetic issue (Lau et al., 2007). There is compelling evidence that obesity causes a variety of health problems, such as type 2 diabetics, hypertension, dyslipedemia, coronary heart diseases, stroke, osteoarthritis and certain cancers (Lau et al., 2007; McDonald & Kennedy, 2005; Patterson et al., 2004). It has been estimated that about 1 in 10 premature deaths among Canadian adults 20-64 years of age are directly attributable to being overweight and obesity (CIHI & PHAC, 2011). In addition to affecting personal health, increased health risk translates into an increased burden on the health care system. To combat obesity, the Government of Canada invested in a number of programs at the community and

individual level, as well as formulated a number of public policies at a national level (CIHI & PHAC, 2011). To promote healthy weight, Health Canada invested in number of subsidy programs (e.g. Food mail program for northern Canada) and financial incentives (e.g. the Children's fitness tax credit and the federal tax credit for public transit), etc. School food programs were implemented in some provinces in Canada. Furthermore, Health Canada signed a joint partnership with the Public Health Agency of Canada (PHAC) and Canadian Institute for Health Information (CIHI) to combat overweight and obesity issues in Canada. The main focus of the partnership was to identify the current understanding of determinants of health and economic burden. In a joint report of PHAC and CIHI from 2011, it was identified that there is little or no research interventions focusing on immigrant children and youth. Further, there is less understood about the relationship among healthier eating patterns, individual behaviors and environment in Canada.

1.3 Economic Research Problem

Rising rates of obesity have been linked to food supply trends and growing consumption of energy dense foods (Drewnowski & Spector, 2004). The role of diet in the prevention of chronic disease is well established: fruit and vegetable consumption has a strong protective effect on the development of chronic diseases (Drewnowski & Spector, 2004; Gray Donald et al., 2000). Saturated fat intake is clearly associated with coronary heart disease (Lichtenstein et al., 1998). Increased consumption of snacks, caloric beverages and fast foods by children and young adults has been shown repeatedly to be associated with obesity and excess weight gain (CIHI & PHAC, 2011). As well, overconsumption of dietary sugars and fats, lower nutrient density foods and food eaten away from the home has been identified as vital contributors to obesity (Fitzgibbon & Stolley, 2004; Hemphill et al., 2008; Morland, Roux & Wing, 2006). Moreover, Liu et al. (2000)

showed that there is an inverse relationship between fruit and vegetable consumption and coronary heart disease. A higher intake of fruit and vegetable consumption prevents the chances of developing cardiovascular diseases.

Despite the importance of nutrition for good health, information on changes in food consumption patterns over time and variation of food consumption with socio-demographic factors at the national level is scarce in Canada (Perez 2002, Gray-Donald, Jacobs-Starkey and Johnson-Down 1999; Starkey, Johnston-Down and Gray-Donald 2000). Studies done in the United States and Australia offer insights into the role of acculturation which might play role in enhancing health inequality (Cantero et al., 1998; Franzen & Smith, 2009; Gordon-Larsen et al., 2003). The main emphasis of the U.S. and Australian studies is the role of length of residence in the new country, ability to speak and read English, education level, generation, age and gender on immigrants' changing eating patterns. However, differences in cultural norms and the source ethnicities of migrant populations in the U.S. and Australia, relative to Canada, limit the usefulness of these studies in understanding the Canadian context. Further, many of the acculturation studies targets only one ethnic group and identify the role of acculturation variables on either food choices or health status of immigrants (Gordon-Larsen et al., 2003; Hrboticky & Krondl, 1984; Varghese & Moore-Orr, 2002; Yang & Read, 1996). Since there is a demographic shift in migrating ethnic groups in Canada during the last two decades, it is necessary to understand the food consumption pattern among different ethnic groups in Canada. Focusing the studies on national and/or regional level will provide more information to make future inferences towards food consumption patterns. Understanding the relationship between diet and ethnicity of citizens is vital for building a healthy community in Canada. It is imperative that this extends to immigrants and the new Canadian population. Without further research on the relationship

between ethnicity (and other socioeconomic factors) and food consumption patterns, diseases caused by obesity and excess weight will continue to put a significant burden on the health and economic sectors of Canada. In addition, this study provides necessary information for CIHI and PHAC to plan their future programs to combat obesity.

1.4 Food Policies and Obesity

A number of studies have made a link between poor dietary behaviors and the rising rates of obesity/overweight (Fitzgibbon & Stolley, 2004; Hemphill et al., 2008; Morland, Roux & Wing, 2006). Perez (2002) notes that Canadian households, on average, fail to meet Health Canada's dietary recommendations. To curb obesity amongst Canadians, the various levels of government in Canada have invested in a number of food subsidy programs, nutritional awareness programs, and financial incentives. However, these government policy interventions for treating and/or preventing obesity amongst Canadians can cause unintended negative externalities such as higher private-group health insurance premiums and higher the tax percentages for day to day goods and services (Powell & Chaloupka, 2009). These negative externalities can cause significant burden to taxpayers in Canada. Further, the cultural diversity amongst Canadians has increased over the last two decades. The prevalence of increasingly diverse ethnic groups in Canada has brought with it diverse food cultures to Canada. In order to combat obesity, it is necessary to formulate proper policy that can address the relationship between diverse food consumption patterns and overweight/obesity. However, food consumption patterns in Canada tend to vary across individual's socio-demographic profile (including ethnicity). As such, it is important to understand the relationship between food consumption and different socio-demographic characters of individuals. This study aims to examine the relationship between food consumption patterns across different ethnic groups. The importance of this comes to bear when

one recognizes that implementing a singular set of policy interventions across different groups may not produce the same set of expected outcomes across diverse ethnic groups. As such, understanding the heterogeneity of food choices across different ethnic groups will help in the formulation of heterogeneous policies rather than a single policy related to food consumption.

1.5 Purpose and Objectives

The purpose of this study is to understand the heterogeneity of food consumption pattern across different ethnic groups in Ontario. The specific objectives of the study are:

1) To identify research gaps by reviewing the previous literature on (a) food choice models, (b) ethnographical change in Canada, (c) changing health status of immigrants, (d) food choices and health, and (e) acculturation and ethnicity. The review of literature will help to conceptualize the research problem, and help to identify the factors (other than ethnicity) influence on food choices.
2) To construct a conceptual framework that enables incorporation of the ethnicity and other socio-demographic characters into a food demand model by customizing the demographic translating model. Construction of conceptual framework is necessary to identify an accurate empirical model to test this research hypothesis.
3) To estimate (a) the impact of different ethnic groups on fruit and vegetable consumption by using a count data econometric model, and (b) the impact of different ethnic groups on convenience food consumption by using bi-variate probit econometric model. The coefficients from the count data regression will highlight the magnitude and direction of different ethnic groups on fruit and vegetable consumption. The coefficient of bivariate model estimate the predicted probability of consuming convenience foods related to each ethnic group.

4) To provide conclusions and recommendations by interpreting the findings. This will help to compare and contrast the differences of food consumption among different ethnic groups. And it will help to identify the ethnic groups who have tied to poor diet practices.

1.6 Research hypotheses

The working hypotheses of this study are:

1. The following hypotheses are tested by using entire sample (includes immigrants and non-immigrants) in Ontario
    a. There is a significant variation of fruit and vegetable consumption across different ethnic groups
    b. There is a significant variation of convenience food consumption across different ethnic groups
    c. Immigration status has a significant impact on fruit and vegetable consumption
    d. Immigration status has a significant impact on convenience food consumption
2. The following hypotheses are tested by using migrant sample in Ontario
    a. There is a significant variation of fruit and vegetable consumption across different ethnic groups
    b. Length of residence has a significant impact on fruit and vegetable consumption

1.7 Organization of Thesis

This thesis has five subsequent chapters. Chapter 2 presents the past research findings on food choices, ethnography of Canada, obesity, acculturation and ethnicity. Chapter 3 explains the conceptual framework, while Chapter 4 explains the empirical model and description of data. Chapter 5 provides the research findings and discussion. Finally, Chapter 6 presents the main conclusions and suggestions for future research.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a critical review of past literature related to food choices, ethnic diversity in Canada, changing health status of immigrants, food choices and health, and acculturation and ethnicity. Section 2.2 describes different food choice models, and then discusses factors influencing individual food decisions. Section 2.3 presents the history and composition of ethnographical change in Canada, and is followed by a discussion of changes in the health status of immigrants in section 2.4.In section 2.5,the concept of acculturation is discussed, with a focus on factors influencing acculturation and food choices. Finally, the chapter concludes with the introduction of ethnicity and a brief discussion of the relationship between food choices and ethnicity.

2.2 Individual Food Choices

Food choices are expressed as a cultural meaning of individual life. However, there are a number of other aspects, such as biological, psychological, economic, social and epidemiological factors that can influence on food choices (Kittler, Sucher & Nelms, 2011; Sobal et al., 2006). Three general approaches have been used in previous food choice studies. The first approach includes existing theoretical models and frameworks, such as the theory of planned behavior, health belief model, trans-theoretical model, social cognitive theory and hedonic consumer choice model, etc (e.g. Axelson & Brinberg, 1989; Baranowski et al., 1999; Conner & Armitage, 2002; Lancaster 1991). The second approach includes new models where analysts create their own explanations about how food choices are made (e.g. Krondl, 1990; Nestle et al., 2001). The third approach includes inductively developed qualitative research models of food choices (e.g. Furst et al., 1996, Palojoki & Tuomi-Gröhn, 2001). These approaches are used to understand

individual food choices in variety of ways related to: what to eat, when to eat, where to eat, with whom and why to eat.

Individual food choice is shaped by multiple factors such as health, nutritional belief, financial status, and social lifestyles, environment and family (Furst et al., 1996; Shepard, 1999; Sobal et al., 2006; Verghese & Moore-Orr, 2002).Cognitive and motivational factors can also influence food choices (Furst et al., 1996; Rappoport et al., 1993). In addition, flavor represents a strong food related stimulus (Kittler, Sucher & Nelms, 2011). More than individual factors, social factors such as norms and relationships can also influence food choices (Worsley et al., 1983).

A large number of qualitative studies used constructionist orientation to understand food choice; this approach reflects the role of individual beliefs and cultural norms on food choices. These factors are rarely used in quantitative studies (Furst et al., 1996; Rappoport et al., 1993). This constructionist approach allows a food choice model to express how people engage in choice by incorporating individuals' meaning and understanding of food choices. Qualitative studies have grouped the factors that influence food choices into three different categories: (1) life courses; (2) influences; and (3) personal system (Furst et al., 1996; Sobal et al., 2006). Life course is identified as a key component of the model, since it deals with roles of social, cultural and physical environments to which an individual has been exposed (Sobal et al., 2006). The second group, influences, covers the personal factors[5], resources[6], social framework and food context[7] and ideals[8] (note that these influences can interact with each other as well as shape life

[5]Personal factors include physiological factors (e.g. sensory, endocrinological and genetic), psychological characteristics (preferences, personalities, phobias) and relational factors (e.g. identities, self-concept).
[6]Resourcesare the assets that available to people for making food choices
[7]Context includes broader physical surroundings and behavioral settings, social institutes and policies where people make their food decisions.
[8]Ideals are culturally learned knowledge from families and other institutions

courses also). Finally personal food system represents the ways where options, trade-offs and boundaries are constructed based on food choice values and negotiation and management. Food choice values include sensory perceptions, monetary conditions, convenience, health and nutrition, quality and managing relationships.

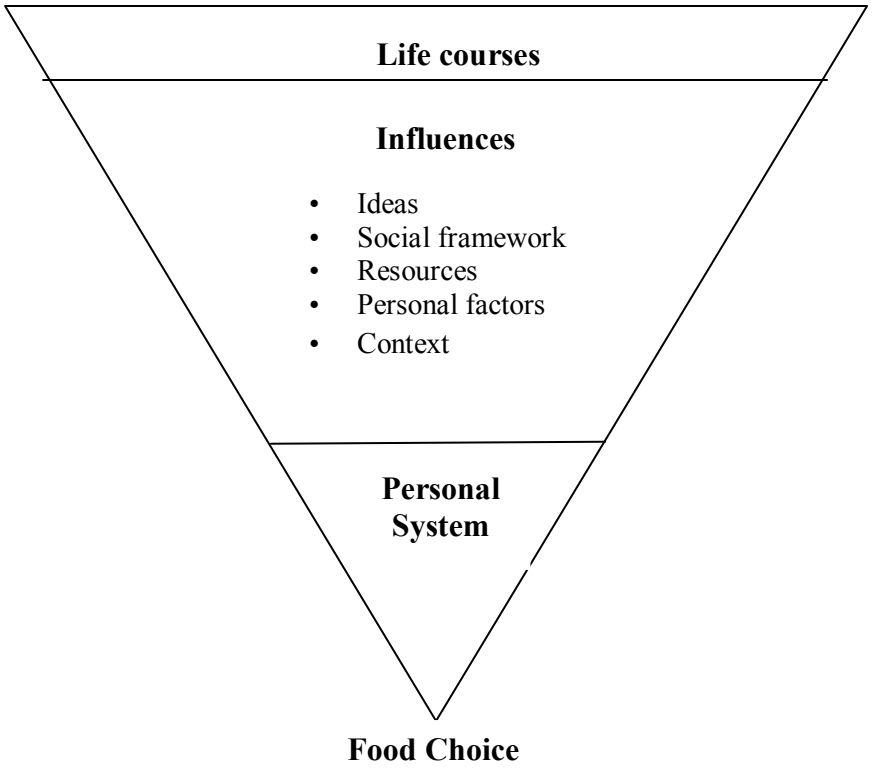


Figure 2.1: A conceptual model of the components in the food choice process
Source: Adapted from Furst et al., (1996) and Sobal et al., (2006).

Besides personal and environmental factors, an individual's health status and health beliefs influence food choices (Patterson et al., 2004). However, health beliefs vary among individuals based on how people define a healthy diet (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). The definition of health value reflects either traditionally derived health concepts or newly acquired nutritional knowledge (Hrboticky & Krondl, 1984). These latter two points can be particularly important for new migrants, where, during the process of adapting to a new country,

several complex factors can influence immigrants' food choices (Ristovski-Sijiepcevic, Chapman & Beagan, 2007; Hrboticky & Krondl, 1984). However, the relationship between the different factors and food choices, especially in multicultural societies is not well understood.

2.3 Ethnographical change among Immigrant Population in Canada

Increased migration has resulted in a social, cultural and demographic shift in Canada. Since the 1960s, Canada has been characterized as undergoing dramatic social transformation that led to increase diversity[9]of the Canadian population (Bourne & Rose, 2001). During the 19th and early part of the 20th century, Canada's immigration policy was discriminatory and favored immigrants from the United States and Europe (Cranfield, 2013). However, in 1960Canada's immigration and refugee act underwent significant changes designed to address the need for skilled labour. This act opened migration from nontraditional source regions/countries, such as Asia, Africa, the Caribbean and Latin America (Bourne & Rose, 2001). Since then, number of immigrants from European countries and United States has declined while the proportion of immigrants from Asian, African and Latin American region countries has grown (Boyd & Vickers, 2000). As a result, by 1990, 80 percent of Canada's new immigrants were from by Asia, Africa, Caribbean and Latin American countries (Bourne & Rose, 2001). Growth in migration has been so strong, that growth in migration surpassed the level of natural population increase[10] in some regions of Canada (Boyd & Vickers, 2000). By 2011, 50.8 percent of the immigrant population in Canada was from Asian and Pacific countries, while only 19.2 percent of the immigrant population was from the USA, UK or Europe (Statistics Canada, 2011a). One consequence of this shift in region of origin of migrants is that the population of visible minorities in Canada increased from 3.2

[9] Diversity is defined as cultural, social, linguistic and racial heterogeneity (Bourne & Rose2001).
[10]Natural increase is the change in population size over a given period as a result of the difference between the number of births and the number of deaths

million in1996 to 5.06 million in 2006 (Statistics Canada, 2006). Furthermore, most immigrants, who are entering into Canada, desire to live economically well develop areas (Bourne & Rose, 2001), but especially Alberta, British Columbia and Ontario (Bourne & Rose, 2001). Compared with Canadian-born, proportionally more immigrants have settled in urban areas likely due to the availability of economic opportunities and presence of other immigrants from the same countries or region of the world. By 2001 around 74 percent of immigrants settled in Toronto, Montreal and Vancouver (Bourne & Rose 2001). This increase in the immigrant population contributed 62.8 percent of increase in the labor force segment in 2011 (Statistics Canada, 2011) especially in the manufacturing and service sectors in Canada (Boyd &Vickers, 2000).

2.4. Health status of immigrant population

Changes in Canada's migrant population have led to several important research questions. First, do migrants utilize Canada's health care system in an effective manner? Second, are there changes in migrant's health status after the arrival in Canada? A healthier population is more productive, will lead to reduce health care and social costs, and will enjoy a better quality of life (Ristovski-Slijepcevic, Chapman & Beagan, 2008). Each year, Canadian governments are spending considerable sums of money to spread healthier lifestyle messages among its citizens[11]. As a part of this, Health Canada re-designed its food guide for residents to promote healthy eating and diet practices (Ristovski-Slijepcevic, Chapman & Beagan, 2008). Despite the wide availability of healthy lifestyle information, gap remains between availability and utilization of this information among Canadian residents (Starkey, Johnson-Down & Gray-Donald, 2000).

[11]The total projected health spending at 2014 is $214.9 millionCanadian Institute of Health Information (2014). National Health Expenditure Trend, 1975-2014. Retrieved from http://www.cihi.ca/CIHI-ext-portal/pdf/internet/nhex_2014_report_en

Migrant epidemiologic studies (McDonald & Kennedy, 2005; Newbold & Danforth, 2003; Ristovski-Slijepcevic, Chapman & Beagan, 2008) in Canada confirmed the prevalence of chronic diseases among Canada's migrant population. During the past few decades being obesity and overweight has become a major health issue among North Americans (NewBold & Danforth, 1995; McDonald & Kennedy, 2005). One in four adult Canadians and one in ten children are clinically obese, meaning six million Canadians are obesity (Canadians Obesity Network, 2014). The prevalence of adult obesity in Canada increased from 5.6 percent in 1985 to 17.7 percent in 2011 (Statistics Canada, 2011). The increasing rate of obesity has both health and economic consequences because individuals have greater risk of developing comorbidities[12] such as high blood pressure, arthritis, diabetes, heart disease, asthma and even some cancers(McDonald & Kennedy, 2005; Morland, Diez Roux & Wing, 2006; Patterson et al., 2004).

Only a few studies explore changes in the health status of migrant populations over time, along with changing social, cultural, economic and physical environment (Morland, Roux & Wing, 2006; Newbold & Danforth, 2003). Immigrants are generally healthy at the time of arrival. However, their health status starts to converge toward the Canadian average with the length of stay in Canada (Lou & Beaujot, 2005; Dunn & Dyck, 2000; Frisbie, Cho & Hummer, 2001). McDonald and Kennedy (2005) note unhealthy weight gain begins after approximately 20-30 years residence in Canada. The research shows that Black, Arab, Hispanic and West Asians are more vulnerable to overweight issues (Table 1). The rise in unhealthy weight of migrants can be traced to variations in migrants' knowledge and accessibility to health care

[12]Comorbidity is the presence of one or more additional disorders (or diseases) *co-occurring with* a primary disease or disorder.

facilities (Gee, Kobayashi & Prus, 2004; McDonald & Kennedy, 2005; Newbold & Danforth, 2003), as well as socio-economic status.

Table 2.1: Overweight percentage of visible minority group and white

	Women		Men	
	Native-born	Foreign-born	Native-born	Foreign-born
All	39.3	34.6	58.8	50.5
White	39.6	39.5	59.1	62.1
Non-white	25.4	29.7	42.9	39.0
Black	39.0	51.0	50.5	49.0
Chinese	13.0	9.6	28.5	24.5
South Asian	17.2	36.7	50.1	44.0
South East Asian		24.1	41.9	37.3
Korean	33.7	9.8	51.3	24.9
Japanese	11.8	6.9	50.4	19.4
Hispanic		44.3		62.7
Arab/West Asian	44.2	33.6	17.1	50.1
Filipino		21.5		28.6
Other	30.1	44.8	56.6	51.4

Source: Adapted from McDonald and Kennedy (2005)

The healthy immigrant effect hypothesis maintains that recent immigrants are healthier and consequently their health will be deteriorating with length of residence. For instance, Gee, Kobayashi and Prus (2004) observed a strongest healthy immigrant effect among immigrants

from non-European countries such as China, Hong Kong, Taiwan and India and their health status has been deteriorating with the number of years in Canada. The healthy immigrant effects is strongest among new immigrants because: (1) healthy behaviors in the home country (2) health screening by immigrant officers and (3) immigrant self-selection whereby healthiest and wealthiest are the ones most likely to migrate (Gee, Kobayashi & Prus, 2004). The healthy immigrant effect is an important policy for evaluating and monitoring health indicators of immigrant population (McDonald & Kennedy, 2005; Gee, Kobayashi & Prus, 2004; Newbold & Danforth, 2003).Many Canadian studies have focused on understanding the existence of the healthy immigrants' effect, with less attention on why immigrants' health deteriorates (McDonald & Kennedy, 2005). However, McDonald & Kennedy (2005) found that immigrants' dietary practices, exercise, exposure to common environmental factors, persistent language, cultural and economic barriers to access to health services associated with deterioration of immigrants' health behavior in Canada (McDonald & Kennedy, 2005).

Abraído-Lanza, Chao & Flórez, (2005) and Frisbe et al. (2001) argued that acculturation into a host society quickly erodes any health advantages arising from home country practices. Based on general health indicators scores used in Newbold and Danforth (2003), white immigrants of European origin had lower health scores compared with "other" races and origins. However, immigrants from Asia and Africa were more vulnerable to developing obesity (Newbold & Danforth, 2003). Such results would suggest that with the passage of time, immigrants have become more assimilated into Canadian society and have begun to adopt more Westernized health beliefs and behaviors.

Many studies are limited by the lack of a temporal depth, which can provide insight whether the health status of immigrants has changed over time. Further, there is little known

about factors that contribute to excess weight and obesity. However, my study focused on the relationship between foods, which can cause and can prevent the excess weight, and socio-demographic characters of households.

2.5 Food Environment and Obesity

Even though total fat and saturated fat consumption had decreased over the last past 30 years, the intake of calories and carbohydrate dense foods, soft drinks and sugar has increased (Morland, Roux & Wing, 2006). A higher level of caloric intake and fat intake are identified as contributors to excess body weight. These energy rich foods are mostly categorized as fast foods (i.e. pastas, pizza, and burger) and prepackaged foods (Morland, Roux & Wing, 2006). Further, energy content of food choice was strongly affected by eating site of individuals. Morland, Roux & Wing (2006) identified that the site, where people choose to eat, has a major influence on how much people eat. Further evidence shows that environment is a key factor in the rapid development of the obesity (Block et al., 2004; Hill & Peter, 1998; Koplana & Dietz, 1999). Recently, food availability at the neighborhood level has been given more attention as an environmental determinant of diet (Fitzgibbon & Stolley, 2004; Sooman, Macintyre & Anderson, 1993). Some research focused on availability of different types of foods within food stores and the variation of offering healthy foods in supermarkets with different socio-demographic characteristics of neighborhoods (Austin et al., 2005; Block et al., 2004; Zenk et al., 2005). There are different varieties of healthy food options in the market. However, the price of these healthy foods limits the consumption of health food options by some low-income groups (Morland, Roux & Wing, 2006).

Increased fast-food consumption has been an important factor in the emerging obesogenic human environment (Block et. al., 2004; Jeffery et al., 2006; Swinburn, Egger &

Raza, 1999). Fast foods are typically energy dense foods and are sold in a ready-to-eat fashion (Hemphill et al., 2008). Fast food outlets are high palatability choice for consumers due to its convenience and lower prices (Morland, Roux & Wing, 2006). With a limited food budget, these outlets are providing more energy and satiety for the amount of money spent (Hemphill et al., 2008). Due to the above reasons, fast foods have become a desirable choice for lower economic status individuals (Hemphill et al., 2008). According to a British study, lower socio-economic groups had diets with less vegetables and fruits and more meat products, fats and sugars compare to higher socio-economic groups (Block et al., 2004).

Some studies from the U.S. and Australia focused on factors related to fastfood consumption (Block et al., 2004; Morland et al., 2002; Reidpath et al., 2002); only one similar study has been undertaken for Canada (i.e. Hemphill et al., 2008). Hemphill et al. (2008) identified the relationship between establishment of fastfood outlets and the socio-demographic factors of the surrounding neighborhoods in Edmonton (Hemphill et al., 2008). Hemphill et al. (2008) findings revealed that greater access of fast food outlets are associated with higher unemployment, and low income of immigrants groups. Morland et al. (2002) examined the relationship between fastfood restaurants and race/ethnicity in the United States, and found there is no difference between numbers of fast-food restaurants in black and white neighborhoods. In contrast, Block et al. (2004) found that black and low-income populations have more access to fast food compared to white people (they also note that consumption of fast food causes longer-term health risks among lower income groups). Reidpath et al. (2002) found there is a significant relationship between fast-food restaurant density and median individual income in Melbourne, Australia. Their results show that residents in the lowest income neighborhoods had 2.5 times more exposure to fast-food restaurants than those who are living in the most affluent

neighborhoods (Reidpath et al., 2002). The above studies showed that lower income groups face more exposure and a higher likelihood of consuming more fastfood.

Further, availability of supermarkets is identified as a reason for decreasing obesity and overweight. However, availability of grocery stores and convenience stores are identified as a causal factor for the prevalence of overweight and obesity among residents (Morland, Diez Roux & Wing, 2006).Convenience is an important predictor for people food choices (Morland, Roux & Wing, 2006), but they carry a larger proportion of energy dense foods (Morland, Roux & Wing, 2006). Nevertheless, little is known about who consumes convenience foods in the market. Further, individual's food choices are limited by what is available to them (Cheadle et al., 1991; Morland, Roux & Wing, 2006). If individuals have only access to convenience stores in their residential area, they may be more likely to adopt an energy-dense diet (Morland, Roux & Wing, 2006). Cheadle et al. (1991) found that household's buy more "healthful products" if the healthy products are available at nearby grocery stores.

2.6 What is Acculturation?

Acculturation is defined as the process by which immigrants adopt the attitudes, values, customs, norms, believes and behaviors of a new culture (Abraído-Lanza, Chao & Flórez, 2005). Acculturation has both negative and positive effects on food consumption, and healthy behaviors (Abraído-Lanza, Chao & Flórez, 2005). On the one hand, alcohol consumption, smoking and consuming energy dense diets increases with acculturation (Abraído-Lanza, Chao & Flórez, 2005). On the other hand, acculturation is also associated with healthy behaviors, such as exercise, leisure time, and physical activity (Abraído-Lanza, Chao & Flórez, 2005).

2.6.1 Acculturation and immigrants

Abraído-Lanza, Chao and Flórez (2005) found that greater acculturation increases the chances of adopting less healthy diets. Consumption of less healthy diets can lead to higher BMI (Body Mass Index). The consumption of low-fat foods (e.g. beans, rice and vegetables) is part of traditional cuisines of most of Asians', Africans' and Latinos' diets, but tends to decrease with greater acculturation (Gorden-Larsen, Harris, Ward & Popkin, 2003). Abraido-Lanza, Chao & Florez (2005) proposed their "Descending limb" hypothesis to explain changes in health behaviors association with modernization. This hypothesis states that decreasing healthy behaviors is a function of an increase intake of unhealthy diets (e.g. greater consumption of total calories, fat and sucrose) and decreased physical activities (Abraído-Lanza, Chao & Flórez, 2005). The process of acculturation suggests that the immigrants' health behaviors converge from a home country's lifestyle to a Canadian (or westernized) lifestyle with additional years in Canada (Abraído-Lanza, Chao & Flórez, 2005).

2.6.2 Acculturative factors on food choices of immigrants

Among socio-demographic variables, the extent of dietary change is largely related to the length of exposure to a new country (Hrboticky & Krondl, 1984; Penaloza, 1994). In addition, the ability to speak the host country language and social contacts become important determinants for acculturation (Hrboticky & Krondl, 1984). Generally, it is easier for the younger generation of an immigrant population to change their food habits compared to older generations (Hrboticky & Krondl, 1984; Sutton-Brady, Davis & Jung, 2010). Since intergenerational difference exist, younger migrants have greater ability to negotiate between host and the "recreated" home cultures (Sutton-Brady, Davis & Jung 2010). Further, Sutton-Brady, Davis & Jung (2010) explained that immigrants switch their cultural codes and adapt easily to the home and host

culture based on the situation demands. Further, Wallendorf & Reilly (1983) argued that consumption behaviour is a function of income or education level of individuals, but it is not necessarily controlled by cultural codes. However, they also explained that there might be a combined effect of income, education and culture on food choices. Gender is another determinant of acculturation (Abraido-Lanza, Chao & Florez, 2005). With respect to the analysis of food intake, males demonstrated a significant increase in the servings of milk and fat intake, but a significant decrease in consumption of vegetable and the bread group. Compared to non-immigrants, lower vegetable and bread intake is note for both male and female migrants (Yang & Read, 1996). In addition to age, it would thus appear that income, gender, education and number of generations, culture, and ethnicity influences food choices.

2.7 What is ethnicity?

The term "ethnicity" is generally defined as people who perceive themselves as constituting a community because of common culture, ancestry, language, history, religion or customs (Holland & Gentry, 1999; Isajiw, 1993). Laroche, Kim and Tomiuk (1998) defined ethnicity in two different forms: as a subjective form, and an objective form. The subjective form defined ethnicity as a "psychological phenomenon which can be expressed in any identity display" (Laroche, Kim & Tomiuk, 1998). The objective form stresses cultural traits, national origin, wealth, social status, political power and segregated neighborhoods.

Two divergent models of immigrant adaptation have been used in the past literature (Keefe & Padilla, 1987; Phinney, 1990; Laroche, Kim & Tomink, 1998). These models are: the linear bipolar model; and the concomitant model. The linear bipolar models assume that one who adapts to a new culture in a host country (e.g. adapt the cultural norms in Canada), will lose aspects of their own cultural origin. The concomitant model assumes that acquisition of host

cultural traits is not necessarily concomitant with loss of owns ethnic identity. The concomitant approach is more appropriate for a country like Canada where assimilation to Canada may not force to lose owns cultural practices of immigrants (Laroche, Kim & Tomink, 1998).

Apart from acculturation, ethnicity can play an important role in food choices (Berry & Laponce, 1994; Lambert & Taylor, 1990; Sutton-Brady, Davis & Jung, 2010). Ethnic traditions and regional cuisines have been recognized as key sources of dietary patterns in the United States and Canada (Devine et al., 1999). McDonald and Kennedy (2005) gave two major reasons for dietary change amongst migrants after arrival in Canada. These include: (1) increased availability foods and/or (2) lower price of particular goods (i.e. food products) compared with food in immigrant's home country. Barry and Miller (2005) suggested that retaining a traditional behavior is easier in areas with high concentrations of one's own particular ethnic group, since the market for traditional goods is typically large enough to support merchants who can supply goods locally and at reasonable cost.

Acculturation is a key factor in ethnicity and migrant studies (Sutton-Brady, Davis & Jung, 2010). When a contact of different cultural groups influences each other in a geographical area, the dominant groups has high influence on minority groups (Sutton-Brady, Davis & Jung, 2010). Wallendorf and Reilly (1983) found that the Mexican American consumption patterns differ from their Anglo counterparts. This shows the differences among pure Angelo Mexican consumption and mix of American Mexicans. This explains the complex relationship among ethnicity, acculturation and food consumption. Kim and Kang (2001) found difference among black, Hispanics and whites on product purchase decision making. Similar results were found between different groups on direct purchasing behaviors, purchase decision making behaviors, attitudes towards advertisement, informational services and media usage (Sutton-Brady, Davis &

Jung, 2010). Differences in these studies were attributed to acculturative processes, ethnicity, or both, or to the interaction of either one with other factors (Sutton-Brady, Davis & Jung, 2010). Further, when cultural and moral values are more connected with food decisions, the definition of healthy eating behaviour becomes more complex (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). Previous research findings suggest that it is hard to predict that immigrants' cultural food choices are mostly healthy compared to the host country food practices (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). However the nutritionally inadequacy of some cultural/traditional foods may be a factor as to why certain ethnic groups have higher thanaverage risk and or prevalence for developing diet-related chronic diseases(Satia-Abouta et al., 2002). In contrast, stronger cultural identity has been associated with healthier dietary behaviours in some ethnic groups (Bedaiko, Kwate & Rucker, 2004). Acculturation to a western diet has also been associated with adverse health outcomes (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). Understanding the cultural/traditional interpretations of healthy eating is important to identify the reasons for varying health discourses (Ristovski-Sijiepcevic, Chapman & Beagan, 2007).

Many immigrants follow their own traditional perception of nutritional guidelines as a basic information source for healthy eating, where healthy eating is defined as decreasing high-fat foods and increasing fruits and vegetables. However, beyond the general guidelines, people may define healthy eating in their own ways (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). As an example, Bottorff et al., (2001) shows that the ways immigrant women from South Asia express their food consumption pattern is based on their own cultural values. There are few studies that compare the differences between eastern and western dietary practices. A major difference here is in fat and fiber content (Yang & Read, 1996). A typical Asian diet is characterized as low fat, especially low in animal fat, and high in fiber compared to western diet

(Yang & Read, 1996),while many western foods are high in fat and energy dense (e.g. pasta and pizza) (Ristovski-Sijiepcevic, Chapman & Beagan, 2007). So, the acculturation into new food environment started to have consequences on migrant health status.

2.8 Summary

This chapter explained the factors that influence food choices. Then it described prevailing health disparities amongst immigrants in Canada. Food choices play an important role in shaping an individual's health status. However, immigrants' food choices change with a new country's culture and environment. Further, the degree of acculturation is influenced by different socio-demographic characteristics of immigrants. During the acculturation process, an immigrant's ability to speak the host country's language, number of years in Canada, education, income, gender influence food choices. Apart from these factors, culture or ethnicity of immigrants can also attribute to their food choices; however, the relationship between ethnicity and food choice is still relatively unclear in the literature.

CHAPTER THREE: CONCEPTUAL MODEL

3.1. Introduction

Chapter 2 provided a detailed literature review related to: food choice, ethnographical change in Canada and acculturation. To explore the relationship between the food choices and ethnicity, this chapter begins with a brief discussion of choice theory that incorporates heterogeneity related to individual ethnicity and socio-economic status. Discussion then focuses on different demographic specification models of consumer demand. The demographic specification models begin with modified Prais-Houthakker demand theory, and conclude with demographic translating. The conceptual model is used to test the hypothesis that there is heterogeneity in consumption of convenience foods and fruit and vegetables across ethnic groups.

3.2 Consumer food choice and demographic characters

Due to increasing multicultural plurality in Canada, differences in socioeconomic status and ethnic diversity has influenced individual eating behaviors (Ristovski-Sijiepcevic, Chapman and Beagan, 2008; Sanjur, 1982; Ricciuto, Tarasuk &Yatchew, 2006). Ethnicity is a complex and multi-dimensional concept (Devine et al., 1999). It represents differences among groups in a population. Further, these differences are associated with lineage and religion (Devine et al., 1999). Often, different ethnic groups have unequal access to social position due to the existing prejudice and discrimination (Devine et al., 1999). There are few qualitative studies which addressed the issues of ethnic influence on food choices (Devine et al., 1999), but most studies focus on food preferences of a particular ethnic group (Block et al., 2004; Bottorff et al., 1999; Hrboticky & Krondl, 1984; Laroche et al., 1998). No study has compared differences in food consumption with multiple ethnic groups. Compared to the Canadian-born population, the immigrant population is also diverse and showing greater variation with respect to education,

income and poverty (Kobayashi, Moore & Rosenberg, 1998). In addition, the prevalence of obesity and excess weight also varies across different ethnic groups, and the prevalence of poor health is high among lower socio-economic status groups (Abraido-Lanza, Chao & Florez, 2005; McDonald & Kennedy, 2005).

In Sociology, Furst et al. (1996) and Devine et al. (1999) used a constructionist approach to build their respective food choice models[13]. Devine et al. (1999) used this approach to explain the relationship between ethnicity and food choices among three different ethnic groups in the United Status. They emphasized the function of individuals' identities, ideals and roles on individual food choices. Ideals were defined as an individual's deeper beliefs and expectations of food and eating. These ideals and identities are built based on the individual's ethnicity. Moreover, individual's ideals were acquired through socialization into ethnic, family and religion food traditions. These ideals, identities and roles are overlapping with life course, personal system and influences (Furst et. al 1996). Based on the food choice model used by Furst et al. (1996) and Devine et al. (1999), this study will identify the role of ethnicity on consuming convenience foods and fruit and vegetable consumption. The decline of fruit and vegetable consumption and the rise of convenience food consumption are leading causes of obesity (Hemphill et al., 2008; He, Nowson & MacGregor, 2006; Perez, 2002).

[13]Furst et al. (1996) food choice model was explained in chapter two. Both studies, theFurst et al. (1996) and the Devine et al. (1999), used constructivist approach to build the food choice models. Both of them classified the same factors into three different groups but they labeled differently.

This study assumes that consumers obtain utility by consuming different categories of foods. However, the level of consumption is hypothesized to vary with ethnicity. To motivate this approach, we begin with demand equation:

$$x_i = \overline{h^i}(P, \mu) \tag{3.1}$$

where P's denote prices, x_i's quantities consumed by i^{th} individual and μ is total expenditure. We assume that these original demand systems are "theoretically plausible," and they can be derived from well-behaved preferences. To incorporate ethnicity and other control variables into the demand function, the next section has a discussion that begins with the modified Prais-Houthakker procedure, and then focuses on demographic translating and scaling.

3.3 Literature on the Demographic Specification

Pollak and Wales (1981) compared and contrasted five different empirical approaches to incorporating demographic variables into a demand function. Based on their likelihood findings using the generalized Constant Elasticity Substitution (CES) demand system and British household budget data, the modified Prais-Houthakker procedure was identified as most suitable specification compared to: demographic translating; demographic scaling; the Gorman procedure and; the Reverse Gorman procedure. The modified Prais-Houthakker procedure has a single equation rather than complete systems and it uses expenditure as an independent variable. In addition to demographic variables, the modified Prais-Houthakker procedure includes household income scales as a control variable in the demand specification (Pollak &Wales, 1981). However, note that demographic translating and demographic scaling procedures, two demand function modifications, arewidely used to incorporate demographic variables into demand equations (Pollak & Wales, 1992).

Demographic translating includes n translation parameters $\{d_1,\ldots,d_n\}$ into a demand system (Pollak & Wales, 1992). And the translation parameter (d) depends on demographic variables $\{d_i=D^i(\boldsymbol{\eta})\}$ (Pollak & Wales, 1992). More specifically, translating replaces each demand equation in the class by:

$$\overline{h}^i(\mathrm{P}, \mu) = d_i + \bar{h}\mathrm{i}\ (\mathrm{P}, \mu - \sum p_k d_k) \tag{3.2}$$

where d_i's are translation parameters. In some cases, there is a misleading interpretation of allowing "necessary" and "subsistence" parameters of a demand system to depend on demographic variables (Pollak & Wales, 1992). Further, there are two distinct problems in demographic translation. First, the d_i's can be negative. Second, d_i can be greater than x_i with demand regularity conditions; it results that negative quantities of consumption even though it is not possible[14]. Pollak and Wales (1992) explain that with translating, there is a close relationship between the effects of changes in demographic variables and the effects of changes in total expenditure. Specifically, changes in demographic characteristics cause a reallocation of expenditure among consumption categories. Since total expenditure remains unchanged, any increases in the consumption of one category of goods must be balanced by decreases in the consumption of other goods. Furthermore, there is no assumption for the direction of d_i and demographic variables. For an instance, any demographic variable (e.g. increases in number of children in a family) can either increase or decrease d_i (Pollak & Wales, 1992).

[14]Any further increase in demographic translators may reduce satisfaction of an individual consumption but the minimum level is zero, not further than that.

Demographic scaling also includes n parameters $\{m_1,\ldots,m_n\}$ into the original demand system, and these parameters only depend on demographic variables $\{m_i=M^i(\boldsymbol{\eta})\}$ (Pollak & Wales, 1992). Demographic scaling introduces scaling parameters into the original demand system as follows:

$$\bar{h}^i(P, \mu) = m_i \bar{h}i\ (p_1 m_1\ ,\ldots,\ p_n m_n, \mu) \tag{3.3}$$

where the m's are scaling parameters. Under the effect of demographic scaling, the effects of changes in demographic variables are closely associated with effects of price changes. However, an increase in a demographic variable will either increase or decrease the m_i's (Pollak & Wales, 1992). It implies that reallocation of expenditure among the goods but no change in total expenditure.

3.4 What is the Modified Prais-Houthakker Procedure?

Let the consumer utility function for food be defined as:

$$U_i = U(X) \tag{3.4}$$

where U_i is utility of i^{th} individual and X is category of foods. Assume that both quantity and price of goods are nonnegative, and that consumers maximize utility subject to a budget constraint, and the total expenditures (μ) cannot exceed available income. Even if demographic variables for an individual are fixed or predetermined, the differences in consumption patterns for individuals with their different demographic profiles enable one to infer "conditional preferences" (i.e. preferences over convenience foods conditional on the ethnicity of individuals). Pollak and Wales (1981) study's notation is used in the following section. The demand equation of the modified Prais-Houthakker Procedure is specified as:

$$h^i(P, \mu) = s_i \bar{h}^i(P, \mu/s_o) \qquad i=1,\ldots,n \tag{3.5}$$

where the s_i are "specific scales" for commodities that depend on the demographic variables (i.e. ethnicity):

$$s_i = S^i(\eta) \tag{3.6}$$

whereη is demographic variables. Furthermore, the individual's budget constraint is now expressed as:

$$\sum p_k s_k \bar{h}^k(P, \mu/s_o) = \mu \tag{3.7}$$

where s_o is an "income scale". Thus, the income scales area function of all prices and expenditure, as well as the demographic variables:

$$s_o = S^o(P, \mu, s_1, \ldots, s_n) \tag{3.8}$$

Prais and Houthakker proposed techniques for incorporating demographic variables into demand equations. They used a single income scale and a specific scale for each good in the equation, but they did not constrain their function by overall budget constraint[15]. Further, the modified Prais-Houthakker procedure acts as a theoretically plausible demand system if and only if the original demand is an additive direct utility function (Pollak & Wales, 1998)[16]. In order to obtain an explicit expression for the income scale and a closed form demand expression, Pollak and Wales (1981) illustrated that the modified Prais-Houthakker procedure linear in expenditure:

$$\bar{h}^i(P, \mu) = f_i(P) - \frac{g_i(P)}{g(P)} f + \frac{g_i(P)}{g(P)} \mu \tag{3.9}$$

$$\bar{h}^i(P, \mu) = f_i(P) + \gamma^i(\mu - f) \tag{3.10}$$

[15]Prais and Houthakker used data from a single budget study to estimate the effect of changes in demographic variables and expenditure (but not prices) on household consumption patterns.

[16]To prove this credence, Pollak and Wales (1981) used two theorems(1) If the modified Prais-Houthakker procedure is applied to a demand system corresponding to an additive direct utility function, and (2) If the modified Prais-Houthakker procedure is applied to a theoretically plausible demand system linear in expenditure, then the resulting demand system is theoretically plausible only if the original demand system corresponds to an additive direct utility function.

where$\gamma^{i}= \frac{g_i}{g}$ and $f(P)$ and $g(P)$ are functions homogenous of degree one. Using the modified Prais-Houthakker procedure, we write the demand function in 3.10 as:

$$h^i(P,\mu) = s_i f_i + s_i \gamma^i \left(\frac{\mu}{s_0} - f\right) \tag{3.11}$$

where s_0 is defined by:

$$s_0 = \frac{\mu}{\frac{\mu - \sum p_k s_k f_k}{\sum p_k s_k \gamma^k} + f} \tag{3.12}$$

To find the implicit demand functions, the s_0 (from 3.12) substituted into 3.11

$$h^i(P,\mu) = s_i f_i + \frac{s_i \gamma^i}{\sum p_k s_k \gamma^k} \left(\mu - \sum p_k s_k f_k\right) \tag{3.13}$$

With the modified Prais-Houthakker procedure, the effects of changes in the demographic variables are closely related to the effects of changes in expenditure. Based on Engel's theory, we assume that income share for food consumption falls with increasing income. This is connected with lower socio-economic status of some ethnic groups. Prevalence in the lower socio economic status limits the households to procure healthy foods.

However, the application of the Prais-Houthakker model is difficult with the available data. This study used data from 2013 Consumer Community Health Survey (CCHS). Unfortunately, implementation of the 2013 CCHS did not include collection of prices or household expenditure. However, in the 2013 CCHS, responses to the fruit and vegetable consumption were captured on a frequency basis (e.g. number of servings per day, week, month, year), while responses for convenience foods were discrete in nature (i.e. yes/no).Moreover, most of the independent variables in the analysis were measured as dummy variables. This limits the ability to use demographic scaling for analysis because multiplying a scalar with a dummy value will produce zeros. This will reduce the ability to interpret the scalar effect since the

product of multiplication is zero. Due to the above shortcomings, this study used the demographic translating procedure for conceptualize research problem.

3.5 Summary

This chapter explained three different demand specification procedures to incorporate demographic variables into a demand function. Even though the modified Prais-Houthakker procedure is identified as a better approach to measure the impact of demographic variables on consumption, lack of prices and expenditure and the presence of many dummy variables in the right hand side restricted the application of the modified Prais-Houthakker procedure. Further, the nature of dummy variables limits usage of demographic scaling procedure. Finally, demographic translating was chosen due to its convenience. The next chapter explains the empirical model and data of the study.

CHAPTER 4: METHODS AND DATA

4.1 Introduction

The previous chapter presented the conceptual framework that accounts for the incorporation of demographic variables in demand functions. This chapter presents the empirical methods used for the study. Section 4.2 provides an empirical model to estimate: (1) the role of ethnicity on fruit and vegetable consumption; (2) the role of ethnicity on convenience foods consumption Section 4.3 presents the description of data. In the final section, the dependent and independent variables are described.

4.2. Empirical Model Specification

Based on the demand function from the theoretical framework, this subsection presents the empirical framework that enables estimation of the role of ethnicity on consumption of convenience foods, and fruits and vegetables. Based on demographic translating, the demand function for fruit and vegetable consumption and convenience food consumption is

$$x_i = \bar{h}\mathrm{i}(\mathrm{P}, \mu, d_i) \tag{4.1}$$

where P's denote prices, x_i's quantities consumed by i^{th} individual, μ is total expenditure and d_i captures the socio-demographic characteristics of i^{th} individual. As discussed in the Chapter 3, there are no commodity prices and household expenditure information in 2013 CCHS. However, instead of household expenditure, the household income was used for demand function. Nonetheless, commodity prices couldn't able to incorporate in my study due to its unavailability. To assess the effect of ethnicity on fruit and vegetable consumption and convenience food consumption, we estimate the following regression,

$$x_i = b_0 + b_1 E_i + b_2 I + \sum_j^n b_3 D_j + \varepsilon_i \tag{4.2}$$

where the dependent variable x_i measures quantities consumed by i^{th} individual; E_i represents ethnic group of i^{th} individual, I denotes household income, D_j's are a respondent's other socio-demographic characteristics which varies with type of sample: (1) entire sample: D_j's captures household size, number of kids under the age of 12, ability to speak host country language, education, age, multi ethnicity, location of the household and residential status and (2) migrant sample: D_j's captures household size, number of kids under the age of 12, ability to speak host country language, education, age, multi ethnicity, location of the household and length of residence in Canada. Finally, b's are unknown parameters to be estimated, and ε_i is an error term.

4.2.1 Estimation for Demand Specification for Fruit and Vegetable Consumption

The CCHS[17]captured the consumption of fruits and vegetables as an event count, where the event count refers to the number of times that fruit and/or vegetable was consumed in a day/week/month/year. Hence, the dependent variable is a non-negative, integer-valued variable. Because Ordinary Least Square (OLS) assumes that true values are normally distributed around the expected value, and doesn't account for the data being truncated at zero, it can predict negative and/or fractional values that are clearly meaningless in count data (Sturman, 1999). Further, the validity of hypothesis testing in an OLS regression depends on the assumptions that are unlikely to be met in count data (Gardener, Mulvay & Shaw, 1995). To overcome the unsuitability of OLS, a Poisson (log-linear) regression was adapted. The number of events in a Poisson distribution is assumed to be independently and identically distributed[18].If the discrete random variable **Y** is distributed as a Poisson with mean (a number of times that an event occurs

[17] The data used in this analysis is from the 2013 Canadian Community Health Survey (CCHS)

[18] If each random variable has the same probability distribution as the others and all are mutually independent.

within an interval) $\boldsymbol{\mu}$, $\boldsymbol{\mu>0}$, and $\boldsymbol{t}$ is the length of time during which the event is recorded, then $\boldsymbol{Y}$ has density:

$$\Pr[Y = y] = e^{-\mu t} (\mu t)^{y}/y! \qquad y = 0, 1, 2,\ldots \tag{4.3}$$

where E[Y] =V[Y] = μt. If the length of exposure period $t$is set equal to 1, then

$$\Pr[Y = y] = e^{-\mu} (\mu)^{y}/y! \qquad y = 0, 1, 2,\ldots \tag{4.4}$$

The major assumption of Poisson distribution is that the mean and the variance are equal (which is called as equi-dispersion).Cameron and Trivedi (2013) list four major characteristics of a Poisson distribution:

1. Law of rare events: an event may occur in any large number of trials, but the probability of occurrence in any given trial is small.

2. Poisson counting process: the counting process is stationary if the distribution of the number of events depends only on the length of the interval.

3. Waiting time distribution: instead of analyzing the number of events occurring in the interval of length, this character helps to analyze the duration of the time between two successive occurrences of the events.

4. Poisson-stopped binomial: it involves mixtures of the Poisson and the binomial in which the count is generated by a random number of repetitions of a binary outcome.

A typical cross-section consists of n independent observations and a i^{th} observation: (y_i, x_i), where the scalar dependent variable, y_i, is the number of occurrences of an event of interest, and x_i is the vector of linearly independent regressors. These independent regressors are used to

determine y_i. A regression model based on this distribution follows by conditioning the distribution of y_i on a k –dimensional vector of covariates, $x_i' = [x_{1i}, \ldots, x_{ki}]$. The model parameters, β, are estimated through a continuous function $\mu(x_i, \beta)$, such that an $E[y_i|x_i] = \mu(x_i,\beta)$ (Cameron & Trivedi, 2013).

For the present case, y_i given x_i follows a Poisson distribution with density:

$$f\left(\frac{y_i}{x_i}\right) = \frac{e^{-\mu}i\ (\mu_i)^{y}i}{y_i!} \qquad y_i = 0,1,2,\ldots \tag{4.5}$$

In a log-linear version of the model, the mean parameter is parameterized as

$$\mu_i = \exp(x'_i\beta) \tag{4.6}$$

to ensure μ>0the variance,

$$V(Y_i) = \exp\left(x_i'\beta\right) = \mu_i \tag{4.7}$$

In count data models, a consistency requires correct specification of the mean and variance (Cameron & Trivedi, 2013). In addition, the strength of the results from hypothesis testing also depends on distributional assumptions (Cameron & Trivedi, 2013). As mentioned, Poisson distribution is restricted by the assumption of equidispersion. This assumption is equivalent with homoskedasticity in the linear model (Cameron & Trivedi, 2013). If errors are heteroskedastic in the linear model, a simple Poisson model is not suitable for the analysis. In order to avoid the heteroskedastic nature, three alternative models are estimated such as (1) Poisson quasi-MLE(QMLE)[19] with corrected standard errors; (2) Poisson quasi-generalized pseudo-MLE with corrected standard errors and; (3) MLE of parametric model for count data such as a negative binomial (Cameron & Trivedi, 2013).

[19]MLE means Maximum Likelihood Estimation

Approaches 1 and 2 are valid if the conditional mean is correctly specified, usually as exp(x'β); however the conditional mean changes as regressors change. Compared to approach 1, approach 2 provides potentially more efficient estimations; however, this gain can often be relatively small with cross sectional data. Approach 3 is generally used to not only specify the conditional mean but also to estimate a proper parametric model. The stronger assumption can lead to more efficient estimate and allows one to analyze conditional probabilities (Cameron & Trivedi, 2013). Further, count data is often over-dispersed, which can lead to over inflated t-statistics in the maximum likelihood estimation of a Poisson distribution. Because of this, it is necessary to use a more appropriate parametric model, such as a Negative Binomial model.

4.2.2 The Negative Binomial Regression

In the Poisson regression model, y_i has a mean $\mu_i = \exp(x_i'\beta)$ and a variance μ_i. Since the data are almost always over dispersed or under dispersed, alternative models for the variance are used. In a Negative Binomial model, the conditional variance $\boldsymbol{\omega_i}$ is defined as a function of the mean:

$$\omega_i = \omega(\mu_i, \alpha) \tag{4.8}$$

for some specified function $\omega(.)$,where $\boldsymbol{\alpha}$ is a scalar parameter.

Many models specify $\omega_i$as:

$$\omega_i = \mu_i + \alpha\mu_i^p \tag{4.9}$$

where the constant $\boldsymbol{p}$ is specified. Analysis is usually restricted to two special cases, in addition to the Poisson case of $\alpha = 0$.

The NB1 variance function assumes $p = 1$, in which case the variance becomes:

$$\omega_i = (1 + \alpha)\mu_i \tag{4.10}$$

In the GLM framework this is usually rewritten as

$$\omega_i = \emptyset\mu_i \tag{4.11}$$

where $\emptyset = 1 + \alpha$.

The NB2 variance function assumes $p = 2$:

$$\omega_i = \mu_i + \alpha\mu_i^2 \tag{4.12}$$

In both cases, the dispersion parameter, α, needs to be estimated. The most common method to handle over-dispersion or under-dispersion is the NB2 model. A general procedure to identify over-dispersion in Negative Binomial models is to test null hypothesis $H_0: \alpha = 0$ against the alternative $\alpha > 0$. A Likelihood Ratio test (LR test) and Wald test can be performed to test the hypothesis. If null hypothesis is rejected, the data is over-dispersed.

Many statistical packages offer NB2 as a standard option to use negative binomial models. Further the NB2 has a number of special features, which are not shared with other models, such as block diagonality of the information matrix, being a member of the Linear Exponential Family (LEF) if α is known, robustness to distributional misspecification and nesting as a special case of the geometric distribution when $\alpha = 1$. On other hand, NB2 has some weaknesses itself. The associated maximum likelihood standard errors of the NB2 MLE are generally inconsistent if there is any distributional misspecification. If the standard errors are

inconsistent, the variance and alpha α become inconsistent. In order to avoid the inconsistency, robust standard errors are generally used for NB2 MLE.

4.2.3. The Zero-Inflated Negative Binomial Model (ZINB)

The distribution of some category of fruit and vegetable consumption data is skewed to the right and contains a large proportion of zeros (i.e. excess zeros). To deal with this distributional characteristic, zero inflated negative binomial models were used in this study. Zero inflated models allow for the modeling for zero counts using both binary and count models. Further, ZINB models were designed to deal with over-dispersion in addition to excess zeros (Cameron & Trivedi, 1998;Hilbe, 2011).The probability of an outcome is defined as:

$$\Pr[y_i = 0] = \varphi_i + (1 - \varphi_i)e^{-\mu_i} \tag{4.13}$$

$$\Pr[y_i = r] = (1 - \varphi_i)\frac{e^{-\mu_i}\mu_i^r}{r!} \qquad r=1,2,\ldots. \tag{4.14}$$

Wherey_i is number of events for individual *i* and $\varphi_i$is the proportion of zeros, μ is the mean. This distribution is interpreted as a finite mixture with a degenerate distribution whose mass is concentrated at zero (Cameron & Trivedi, 1998). If $\varphi_i$is added to the P[μ_i] distribution, and the other point frequencies are reduced by a corresponding amount. The proportion φ_i may be further parameterized by a (logistic) transformation of $z_i\gamma$:

$$\varphi_i = \frac{e^{z_i'\gamma}}{1+e^{z_i'\gamma}} \tag{4.15}$$

This model puts extra weight on the probability of observing excess zero through a mixing specification. Further, it divides individuals into nonusers, with the probability of φ_i, and potential users, with the probability of $1 - \varphi_{i.}$. The observed probability of zeros is generated

through a logistic function of the observable covariates that will ensure non-negativity (Sheu et al., 2004). Therefore, if φ_i approaches zero, a Negative Binomial distribution emerges without a zero inflation model.

4.2.4. Model fit tests

Even though a fit test is necessary to understand if the data are well modeled by the methods applied, count models typically fail to fit the data being modeled because of over-dispersion. R^2 and pseudo-R^2 statistics, deviance statistics and likelihood ratio test are commonly used for count models (Hilbe, 2011). In addition to traditional fit test models, information criteria fit tests such as an Akaike Information Criterion (AIC), and a Bayesian Information Criterion (BIC), are used (Hilbe, 2011),with lower values indicating better (Hilbe, 2011). Cameron & Windmeijer (1997) proposed a preferred R square for count models that is based on residuals. The standard measures for goodness of fit for Poisson regression models are the deviance and Pearson statistic (Cameron & Windmeijer, 1997). More general count models relax equi-dispersion restriction by introducing a dispersion parameter. This dispersion parameter complicates computation of both deviance R square and Pearson R square (Cameron & Windmeijer, 1997). Furthermore, the deviance R square constructed for generalized linear models, yet not all count data models falls in the class (Cameron & Windmeijer, 1997). Even though a number of options are available, there are limited options for model test with "svy" prefix in STATA. Deviance R square and DP R square methods were used in the study. DP R square is similar to Deviance R square; however, DP R square also measure the cross sectional validation of the model (i.e. In STATA, DP R square compares the NB model with Poisson regression to see model fits for the negative binomial compared to Poisson).

4.2.5. Estimation for a Demand Function for Convenience Food Consumption

Convenience food consumption was captured in the 2013 CCHS as a part of a main question for the usage of main ingredients in main meal preparation. Responses of choice of convenience foods were treated as binary output (i.e. 0 or 1). In this case, the appropriate model is one that allows measurement of the probability of an outcome:

$$\text{Prob}[Y=1] = F(x\,\beta) \tag{4.16}$$

$$\text{Prob}[Y=0] = 1 - F(x\,\beta) \tag{4.17}$$

Where F(.) is a cumulative distribution function, and β is a vector of parameters. Parametric distribution specify the distribution of error term upto a finite number of parameters and assume it is distributed independently of the covariates x. Further, if F(.) is distributed as a standard normal, the Probit model will result, while if F(.) is a logistic density function, the Logit model will result as the cumulative density function .

4.2.6. Bivariate Probit Model

A bivariate probit model was used to analyze the convenience foods[20] consumption because the categories of frozen food and fast food depended on the same set of independent variables. Further, if a respondent replied yes to fastfood, then there is a change that he/she replied yes to frozen food. In such as case, the error terms from the two models explain choice could be correlated. So, it is necessary to incorporate the correlation. If I used the regular probit model separately, the standard errors would have been incorrect. The bivariate probit model is a probit model with more than one equation with correlated disturbances. The model is where two

[20]In the study, convenience food is classified into two different categories: Frozen food and Fastfood

dependent variables depend on the same list of independent variables and the residuals are correlated. The general specification for a two-equation model is:

$$y_1^* = \beta_1' x_{1+\ \varepsilon_1} y_1 = 1 \qquad if\ y_1^* > 0,\ \ 0 \text{ otherwise} \tag{4.18}$$

$$y_2^* = \beta_2' x_{2+\ \varepsilon_2} y_2 = 1 \qquad if\ y_2^* > 0,\ \ 0 \text{ otherwise} \tag{4.19}$$

where y_1^* and$y_2^*$are the binary variables representing individual observations (in this study , frozen food and fast food) , β_1' and $\beta_2'$are the vectors of coefficients associated with the x_1 and x_2 sets of explanatory variables, and ε_1 and ε_2 are the error terms. This model is built on the assumptions of jointly normal distribution with zero means, unit variances and correlationρ:

$$E[\varepsilon_1] = E[\varepsilon_2] = 0, \tag{4.20}$$

$$V[\varepsilon_1] = V[\varepsilon_2] = 1,$$

$$Cov\,[\varepsilon_1, \varepsilon_2] = \rho$$

If the correlation coefficient is significantly different from zero, then y_1^* and $y_2^*$are not independent. This approach allows for the possibility that socio-demographic characters of respondents are jointly determined the fastfood and frozen food consumption rather than the result of independent probit. Further, a significant covariance estimate suggests that the decisions under consideration are interrelated, and the coefficients of the explanatory variables should be superior compared with independent probit model.

4.3 Data

4.3.1 Data Description

In this study, the Canadian Community Health Survey 2013 – Annual component (F1) and Rapid Food Skills (F2) were used. The master file data[21] collected from Ontario were used in this analysis. And all regression equations were replicated among two different groups: (1) all Ontario residents and, (2) immigrants population in Ontario.

4.3.2 Canadian Community Health Survey (CCHS) description

The Canadian Community Health Survey has two major components: an annual component and a health component. The annual component covers information related to the socio-demographic characteristics of households, and fruit and vegetable consumption. In addition to the regular information in the annual component, CCHS 2013 collected information related to the food skills of households. The health component covers information related to the health status, health care utilization and health determinants of the Canadian households.

The CCHS data is always collected from persons aged12 and above, living in ten provinces[22] and three territories[23] in Canada. The survey excludes persons who are living on reserves and other aboriginal province, full-time members of the Canadian forces, the institutionalized population in the Quebec health regions of Region du Nunavik and Region des Terres-Cries-De-La-Baie-James. Altogether, these exclusions represent less than 3 % of the target population.

[21]The CCHS produces three types of micro data files: master files, share files, public use micro data files (PUMF). Due to the unavailability of required data for this study in PUMF, I used master files data for analysis.
[22]Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia
[23] Yukon, Northwest territories and Nunavut

Multi-stage sampling strategy was used to collect data from 110 health regions. The 2013 survey included 65,000 respondents. At first, the sample was allocated based on population size of the provinces and then the assigned sample was re-allocated amongst its health regions proportionally to the square root of the population in each health regions. For the 2013 CCHS, the information was collected in two different times of the year. The first phase (F1 survey) collected information at the beginning of the year from an all Canada sample of about 65,000 respondents. The second phase (F2 survey) collected information at the midyear, and it was a subsample of F1 survey. The F2 survey collected information related the food skills of households.

CCHS uses three sampling frames to select households. In 2013 CCHS survey, 40.5 percentage of the sample was selected from an area frame[24], 58.5 percent from a list frame of telephone numbers, and the remaining one percent was selected using random digit dialing. The CCHS questionnaire was administrated using computer-assisted interviewing. Sample units selected from the area frame were interviewed by using the Computer-Assisted Personal Interviewing (CAPI) method.

4.3.2. The Principle of Weights in CCHS

The principle behind estimation with a probably sample is that each person in the sample "represents" several other persons not in the sample. This step facilitated calculation of weights for each person regarding his or her associated sampling weight. Calculating weights is important to enhance the quality of variance estimates. Moreover variance estimates are important to calculate coefficient of variation, standard deviation and confidence intervals.

[24] Area frame is a sampling frame which designed used for the Canadian Labour Force Survey. In this frame, each province is divided into three types of regions: major urban centers, cities, rural regions. Within the strata, respondents will be selected.

4.4 Definition of Variables in Demand Specification

The F1 survey was used to estimate the demand function for fruit and vegetable consumption, while the F2 survey was used to estimate the demand function for convenience food consumption.

4.4.1 Fruit and vegetable consumption frequency data description

Frequency of fruit and vegetable consumption was collected in the F1 survey. There were seven different questions that addressed the frequency of fruit and/or vegetable consumption of respondents. The respondents were asked for either daily, weekly, monthly, or yearly consumption. The information about daily consumption was available for all respondents in the master files. The daily consumption was converted to monthly for estimation[25]. In the survey, respondents were asked to report how frequently they consumed a serving of fruit and/or vegetable. However, the servings or times should not interpret as quantity of consumption. Table 4.1 provides a description of the fruit and vegetable consumption of respondents in Ontario.

Table 4.1: Description of Dependent variables in Count Model

Label of variable	Description	Mean	Standard Deviation
FRUM	Number of times per month, the respondent consumes fruit, excluding fruit juice	41.81	33.37
JUICEM	Number of times per month, the respondent drinks fruit juice	18.71	25.18
SALM	Number of times per month, the respondent consumes green salad	17.54	17.20
POTATOM	Number of times per month, the respondent consumes potatoes, excluding French fries, fried potatoes, or potato chips	8.96	10.05
CARROM	Number of times per month, the respondent consumes carrots	10.05	11.68
OTHERVEGM	Number of servings per month, the	42.94	36.06

[25]Since the daily consumption values were mostly non-integer

	respondent consumes other vegetables, excluding carrots, potatoes and salad		
TFVM	Number of times per month, the respondent eats fruits and vegetables	140.02	73.32

4.4.2. Convenience food consumption data description

Convenience food is defined in many different ways in the literature (Capps et al. 1985; Verlegh and Candel1999; de Boer et al. 2004). However this study adopted the definition given by Traub and Odland (1979). Based on their broad definition, convenience food is defined as any fully or partially prepared food in which significant preparation time, culinary skills, or energy inputs have been transferred from the homemaker's kitchen to the food processor and distributor. Convenience food is measured as part of question from F2 survey. Respondents were asked to mention the most often used ingredient in main meal preparation.[26] Hence, convenience foods were categorized into two different classes: (1) complex convenience, (e.g: frozen lasagna, frozen pizza) which have time saving and/or high level of energy inputs as well as culinary expertise built in and, (2) manufactured convenience foods, which includes ready to eat foods and takeout delivery foods which have no requirements for home preparation (Traub and Odland, 1979). Table 4.2 describes the definitions and descriptive statistics of categories of convenience food.

[26]Main meals refers to the meal of the day that requires the most preparation

Table 4.2: Description of Dependent variables in Bi-variate Probit Model

Label of the variable	Description	Mean	Standard Deviation
Convenience foods			
FASTFOOD	You buy ready-to eat food or order takeout or delivery	0.111	0.105
FROZEN	You use mostly easy to prepare foods such as frozen lasagna	0.039	0.193

4.4.3 Independent variables

Ethnicity, country of birth, household income, education, residential status and multi-ethnicity are defined as dummy variables, while age, household size, length and number of kids under the age of 12 are continuous. The variable of respondent's ethnicity was collected by asking "to which ethnic or cultural groups did your ancestors belong?". For example, the Canadian ethnicity captures the respondents who are third generation of an immigrant or greater than third generation. The way that the data coded in both F1 and F2 survey is similar. These variables and their constructions are described in table 4.3 that also provides summary statistics of the variables in F1 and F2 survey.

Table 4.3: Description of Independent Variables

Independent Variable	Description	Data Coding	F1 Survey				F2 Survey			
			Immigrants		Non-immigrants		Immigrants		Non-immigrants	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
Ethnicity	The ethnicity or cultural group in which household's ancestors belongs to	Measured as dummy variable. 17 different ethnic groups were included in the analysis								
Language usage	First official language spoken: This variable identifies the people who can able to speak first two official languages (English and French) and people who cannot able to speak official language.	Measured as dummy variable - English only - French only - Both English and French - Neither English nor French								
Immigrant status	The variable indicates if the respondent is immigrant or not	Measured as dummy variable Immigrant D=1 Non-immigrant D=0								
Length	Length of time in Canada since immigration. Non-immigrants were excluded from the sample	Continuous Variable	23.89	17.69			25.27	17.46		

Independent Variable	Description	Data Coding	F1 Survey				F2 Survey			
			Immigrants		Non-immigrants		Immigrants		Non-immigrants	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
Income	Total income received by all household members, from all sources, before tax and deductions, in the past 12 months	Measured as dummy variables D1 <=30,000 D2<=50,000 &> 30,000 D3 <= 100,000 &> 50,000 D4>100,000								
Education	Highest level education acquired by any member of the household	Measured as dummy variables D1= Less than secondary school graduation D2= Secondary school graduation, no post secondary education D3 = Post secondary certificate/ diploma D4= University degree								
Household size	Number of person occupy the house	Continuous Variable	3.25	1.24	2.97	1.50	3.35	1.27	2.95	1.48
Number of kids age 12	Number of kids under the age 12, families have	Continuous Variable	0.46	0.67	0.35	0.81	0.48	0.66	0.37	0.83
Age of respondent		Continuous Variable	47.67	14.81	42.87	20.81	47.90	14.25	42.67	21.25
Location	This variable identifies whether household are in CMA (Central Metropolitan Area)	Dummy Variable 14 different CMAs and Other (Rural) was included								

Independent Variable	Description	Data Coding	F1 Survey				F2 Survey			
			Immigrants		Non-immigrants		Immigrants		Non-immigrants	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
	or Rural Area. Further it shows which CMA									
Multi ethnicity	Measures if households have more than one ethnicity.	Dummy Variable If households have more than one ethnicity D=1 If households have only one ethnic group D=0								

Note:
SD= Standard Deviation

4.4.4 Multi Ethnicity

This indicator was created after screening the data. The data shows that there are considerable numbers of households composed of more than one ethnic group. If a household as more than one ethnic group, there is higher probability of having diverse food choices (Devine et al., 1999). Difference ethnic groups might bring different types of foods to the food table. It might influence on healthy eating behaviour of an individual in a family.

4.4.5. Measurement of Ethnicity

In this study, I tried to measure ethnicity by assigning a relative weight for an each ethnic group. The idea was created from Brown and Langer (2010), who proposed a polarization index to measure the change in ethnic cleavage[27] over time. With respect to ethnic demographic changes, societies contain multiple dimensions of ethnic cleavage, each of which can be salient in different settings and historical moments (Posner, 2005). This polarization index[28] captures the ethnic diversity in a geographical area at a time only. In order to measure ethnicity in a cross sectional setting, relative weights are used for each ethnic groups and these relative weights regressed against a dependent variable. Where each group – ethnic, religious or other – constitutes proportion p_i of the total population T, the relative measure is given by

$$RM = \frac{p_i}{T} \tag{4.21}$$

Relative weights will be higher if a group has more members in a geographical area. However, it is also biased with sampling method. Nonetheless, the values were not significant in the regression model.

[27]Ethnic cleavage means change in relative size of particular ethnic group

[28]The polarization index is simply a Herfindhal Concentration Index, It represents the probability that two randomly selected individuals in the population belongs to a different group.

4.5. Summary

This chapter presented the empirical framework and data for the study. Initially Poisson model was identified for count data analysis. Due to violation of the equi-dispersion assumption, other models were also discussed, including Negative Binomial Model and Zero-inflated Negative Binomial Model. The probit and bi-variate probit models were used to analyze the binary output of convenience foods. It was necessary to create a vector for measuring multi-ethnicity since it brings a different variety of food choices to the households. The results will be presented in the next section.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Introduction

The previous chapters introduced the context and goals of this research and described the data and methods. The objective of this chapter is to present key findings from the study. These results will help to examine the heterogeneity of consumption of fruit and vegetables, and convenience foods across different ethnic groups. Section 5.2 presents socio-demographic characteristics of the surveys from which the data used in the analysis are drawn. Section 5.3 shows the patterns of respondents' fruits and vegetable consumption in Ontario. Section 5.4 shows the regression results of fruit and vegetable consumption and is followed by discussion of factors influencing fruit and vegetable consumption in section 5.5. Then, section 5.6 shows the regressions results for the model explaining convenience food consumption. Finally, section 5.7 provides a summary of the main findings.

5.2. Socio-demographic characteristics of F1 Survey

It is useful to understand the characteristics of the 2013 CCHS sample derived from the F1 and F2 surveys. The F1 survey had around 20,000 respondents from Ontario, of which around 19.5 percent were immigrants. The F2 survey had 3,369 respondents from Ontario, around which 661 were immigrants. Table 5.1 compares the socio-demographic characteristics of the F1 and F2 survey samples with the broader Canadian population (the basis of comparison is the 2011 Census of Canada). Respondents of French, English, Scottish, Irish origin were over-sampled in both F1 and F2 surveys compared to the 2011 Canadian census, while respondents of Canadian, South Asian and Chinese were under sampled compared to the Canadian census. Even though other ethnic groups deviated slightly from the census, the ethnic groups broadly represented the Canadian population. In both surveys, the variable *other* captures the remaining ethnic groups

not explicitly listed in the questionnaire (including those of African, South, Central America and Caribbean and Middle East Asian and South East Asian ethnicity). The use of this *other* category in the survey limited the ability to understand the food consumption of these ethnic groups, even though some of these groups were identified as vulnerable for obesity and overweight (McDonald & Kennedy, 2005).

In both surveys, immigrants were underrepresented and non-immigrants were overrepresented. In addition, the lower income class group was underrepresented in both surveys. This limits the ability to make inferences regarding the food consumption of lower socioeconomic groups, whom were identified as vulnerable for poor health conditions (McDonald & Kennedy, 2005). There is no information about the location of the respondents in the F2 survey's master files. And the information on language use or country of birth of respondent in F2 survey is not presented in the table 5.1 due to confidentiality restrictions associated with CCHS's master files[29]. In both F1 and F2 surveys, the majority of participants were born in Canada (and self-associated with the English ethnic group). As one might expect given Canada's founding origins - many ethnic groups in the questionnaire were from European origin. Moreover, only around 20 percent of the total sample was migrants. More than 80 percent of the sample was able to speak English and one third of respondents lived in rural counties. Table 5.1 shows the percentages of respondents from different socio-demographic characteristics of F1 and F2 survey samples and Canadian population.

[29]The observations for some levels of these variables (i.e. country of birth and language usage) in F2 survey fail to meet the minimum number of observation requirement which is associated in CCHS master files. In CCHS, the minimum required frequency for unweighted descriptive output is 15.

Table 5.1: Socio-demographic characteristics of F1 and F2 survey samples and Canadian Population

Variables		F1 Survey Sample %	F2 Survey Sample %	Canadian Population[1]%
Ethnicity	Canadian	15.59	15.70	23.29
	French	15.70	15.15	10.78
	English	29.92	28.58	23.12
	German	10.53	10.56	9.13
	Scottish	21.05	20.09	16.44
	Irish	19.07	18.59	16.35
	Italian	5.54	5.63	6.99
	Ukrainian	2.68	2.50	2.70
	Dutch	4.88	4.47	4.02
	Chinese	2.08	2.19	5.64
	Jewish	0.64	0.50	1.37
	Polish	3.39	3.44	3.76
	Portuguese	1.41	1.42	2.33
	South Asian	3.17	3.63	7.93
	Norwegian	0.51	0.39	0.44
	Welsh	1.34	1.08	1.52
	Swedish	0.83	1.05	0.54
	Other	17.61	19.38	
Language usage	English Only	83.36		95.79
	French Only	0.31		1.30
	Both English and French	13.31		0.75
	Neither English nor French	0.83		1.46
Country of Birth	Canada	76.45		78.03
	Other North American countries	1.13		0.96
	South, Central America and Caribbean	2.54		2.58
	Europe	10.38		6.78
	Africa	0.87		1.59
	Asia	5.51		9.85
	Oceania	0.18		0.19
Income	Income <=30,000	24.13	24.23	50.39
	Income (<=50,000 &>30,000)	22.07	20.98	22.65
	Income (<=100,000 &> 50,000)	33.23	34.21	22.29
	Income > 100,000	20.52	20.58	4.66
Education	Primary education	22.37	23.78	17.38

	Secondary education	21.50	21.53	24.92
	Diploma	36.11	35.27	35.93
	University	20.03	19.42	21.77
Location	Toronto	22.72		43.64
	Guelph	1.51		1.10
	Kitchener	3.35		3.71
	Oshawa	2.46		2.78
	Sudbury	2.25		0.17
	Windsor	2.51		2.49
	Barrie	2.04		1.46
	Hamilton	5.11		5.60
	Ottawa	5.14		9.61
	Kingston	1.91		1.22
	London	4.15		3.69
	Thunder Bay	2.56		0.94
	St.Catharines	3.08		3.03
	Peterborough	1.62		0.92
	Brantford	1.84		1.05
	No CMA	37.76		18.58
Residential status	Immigrant	19.88	19.63	28.85
	Non-immigrant	80.12	80.37	71.15

1 The data are from the 2011 Canadian census. All the data are obtained from Statistics Canadawebsite.

5.3. Respondent's Fruits and Vegetable Consumption Patterns

This section provides discussion on the differences in reported percentage of fruit and vegetable consumption among immigrants and non-immigrants groups. Immigrants were coded as one while non-immigrants were zero. The histograms show the percentage of households reporting various ranges of frequency of fruit and vegetable consumption (these intervals are used as a histogram based on the counts cannot be reported for confidentiality reasons[30]). This helps to compare and contrast fruit and vegetable consumption amongst immigrant and non-immigrants[31]. The left hand side of the respective histogram shows the percentage of fruit and

[30] In CCHS, the minimum required frequency for unweighted descriptive output is 15.

[31] Since the sample size of immigrants and non-immigrants are different, it is hard to compare their consumption pattern using frequency histograms.

vegetable consumption pattern of non-immigrants while the right hand side of diagrams shows the frequency of fruit and vegetable consumption pattern of immigrants. The legend to the right side of the histogram shows the intervals that captured the frequency of reported consumption. The length of interval varies from one commodity to another in order to meet the minimum required frequency level in CCHS. For instance, in the legend of figure 5.1, the zero count captures the interval between zero to 50 times of monthly consumption of fruits while in the legend of figure 5.2, the zero count captures the interval between zero to 25 times of monthly consumption of fruit juice.

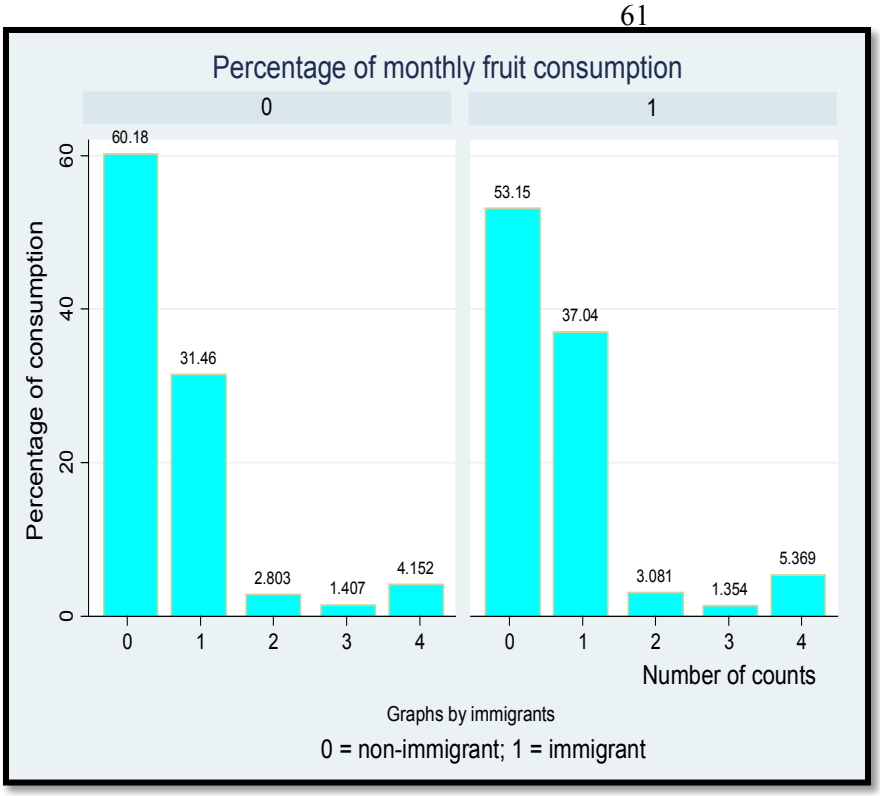
Figure 5.1 shows the percentage of individuals reporting various frequencies of monthly fruit consumption, across immigrants and non-immigrants. While the pattern of the histograms for fruit consumption is similar for migrant and non-migrant groups, the percentage of respondents falling within each range of frequency of consumption does vary. For instance, amongst non-migrants, about 60 per cent report a monthly frequency of fruit consumption between zero and 50 times, while amongst migrants 53 per cent report frequency of fruit consumption between zero and 50 times. A similar pattern of histogram was observed for fruit juice consumption (Figure 5.2).

The pattern of the percentage histograms for frequency of potato[32]consumption is similar for both immigrant and non-immigrant groups (see Figure 5.3). The most frequently reported range of potato consumption was between zero and five times. Further, the histogram bars fall as one progress through the intervals of frequency of consumption. The sudden peak on the right tail of each histogram in figure 5.3 there is a not-trivial massing of respondents reporting frequency of potato consumption 30 or more times per month. The histogram for reported range

[32]As discussed in Chapter 4, potato excludes French fries, fried potatoes, or potato chips.

of frequency of carrot consumption shows a relatively large number of respondents reporting the lowest range, and that the histogram bars fall as one moves through higher ranges of reported frequency of consumption. Moreover, the histograms for carrot frequency of consumption are similar across migrant and non-migrant groups. The reported range of frequency of salad consumption does not vary markedly across migrant and non-migrant groups (see figure 5.5).Amongst non-migrants, the highest frequency was observed at the lowest interval (zero to five times per month), while amongst migrants the highest frequency of consumption was between 30 and 35 times per month.

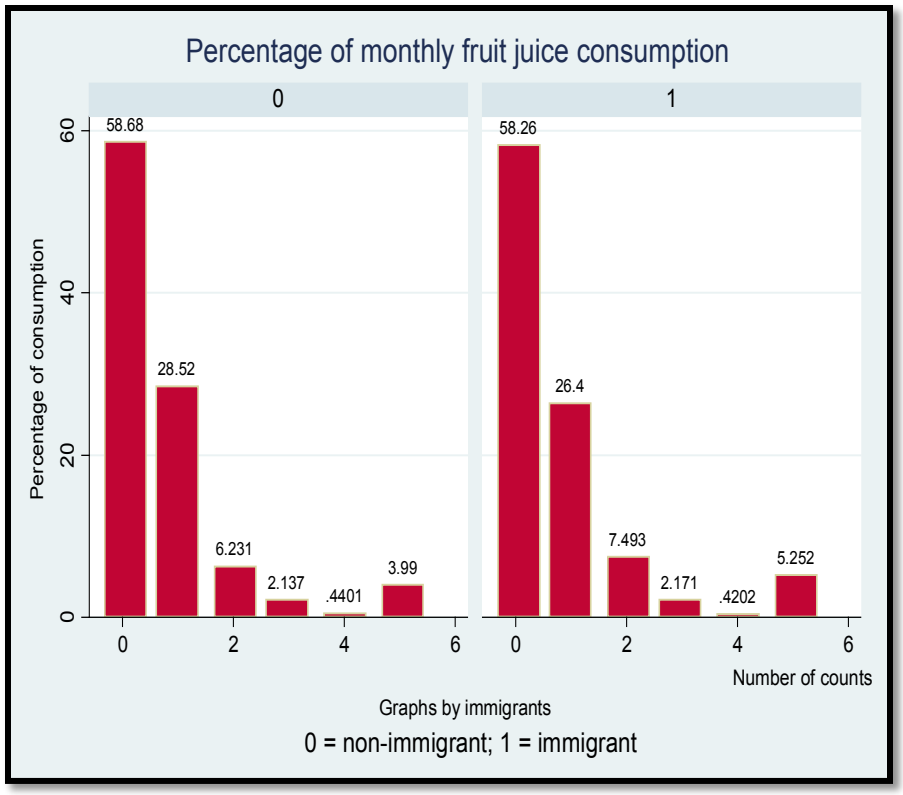
Figure 5.6 shows the histogram of the range of frequency of monthly other vegetable consumption. In contrast, to carrot, salad and potato consumption, the pattern of percentage of other vegetable histograms shows an increasing trend with a number of counts. The highest percentage of other vegetable consumption was observed at the highest interval. Moreover, the pattern of the histograms across migrants and non-migrants is similar. Finally, figure 5.7 shows a bell shape of total fruit and vegetable consumption for both immigrants and non-immigrants. For both immigrant and non-immigrants samples, the highest percentage of respondents was observed at 100 -150 times of servings per month. After that interval, the frequency of fruit and vegetable consumption declines. The lowest percentage was observed at the interval of 350-400 servings per month. However, there is a sudden increase of total fruit and vegetable consumption at the highest tail of counts.



Legend

Counts	Interval
0	≥ 0 &< 50
1	≥ 50 &< 100
2	≥ 100 &< 150
3	≥15 0 &< 200
4	≥ 200

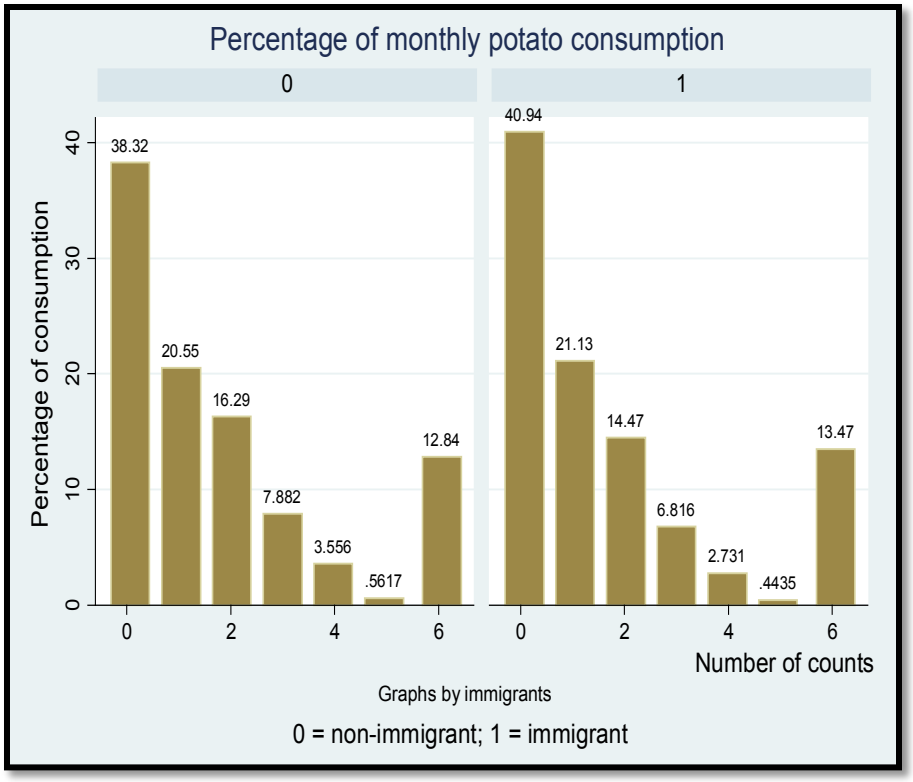
Figure 5.1: Frequency of monthly fruit consumption of non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 25
1	≥ 25 &< 50
2	≥ 50 &< 75
3	≥75 &< 100
4	≥ 100 &< 125
5	≥ 125

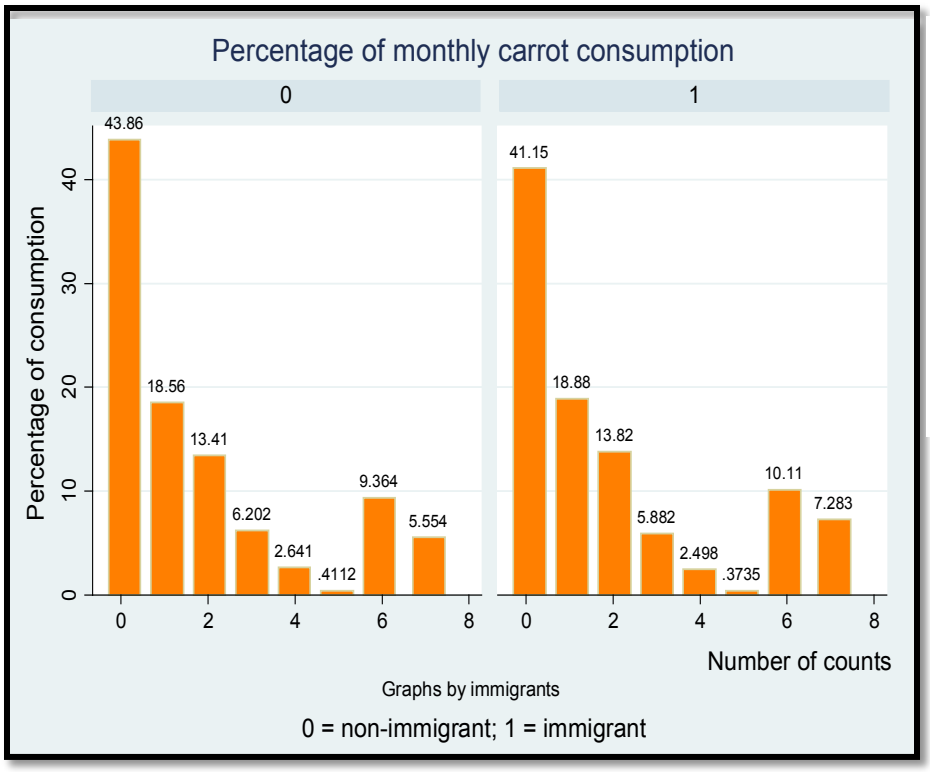
Figure 5.2: Frequency of monthly fruit juice consumption of non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 5
1	≥ 5 &< 10
2	≥ 10 &< 15
3	≥15&< 20
4	≥ 20 &< 25
5	≥ 25 &< 30
6	≥ 30

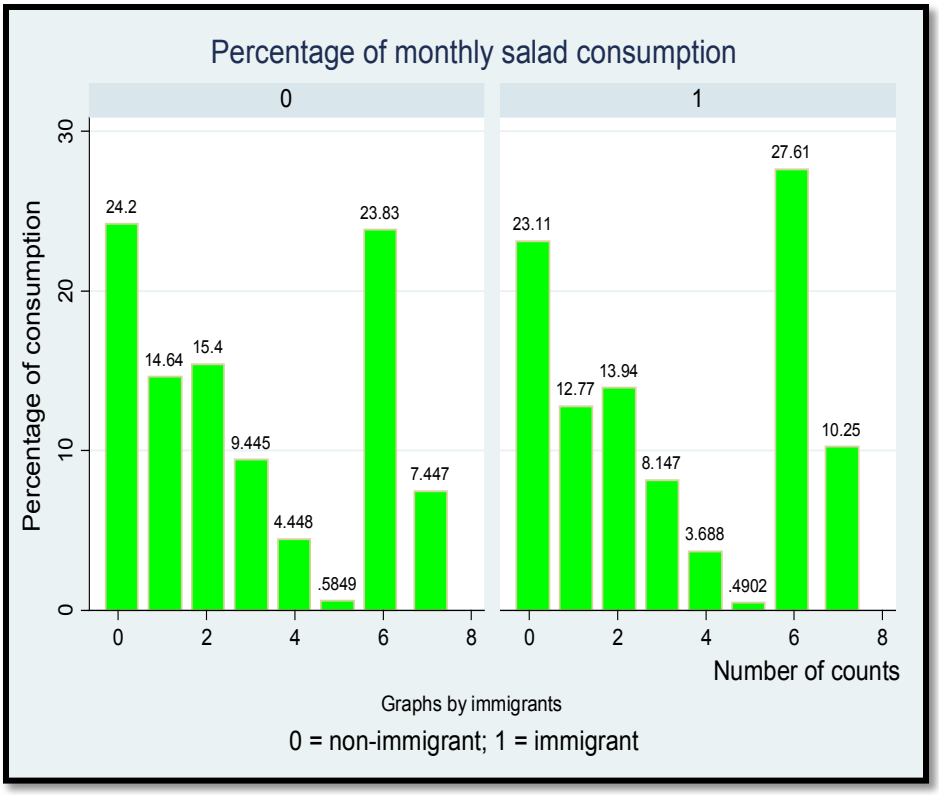
Figure 5.3: Frequency of monthly potato consumption among non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 5
1	≥ 5 &< 10
2	≥ 10 &< 15
3	≥15&< 20
4	≥ 20 &< 25
5	≥ 25 &< 30
6	≥ 30 &< 35
7	≥ 35

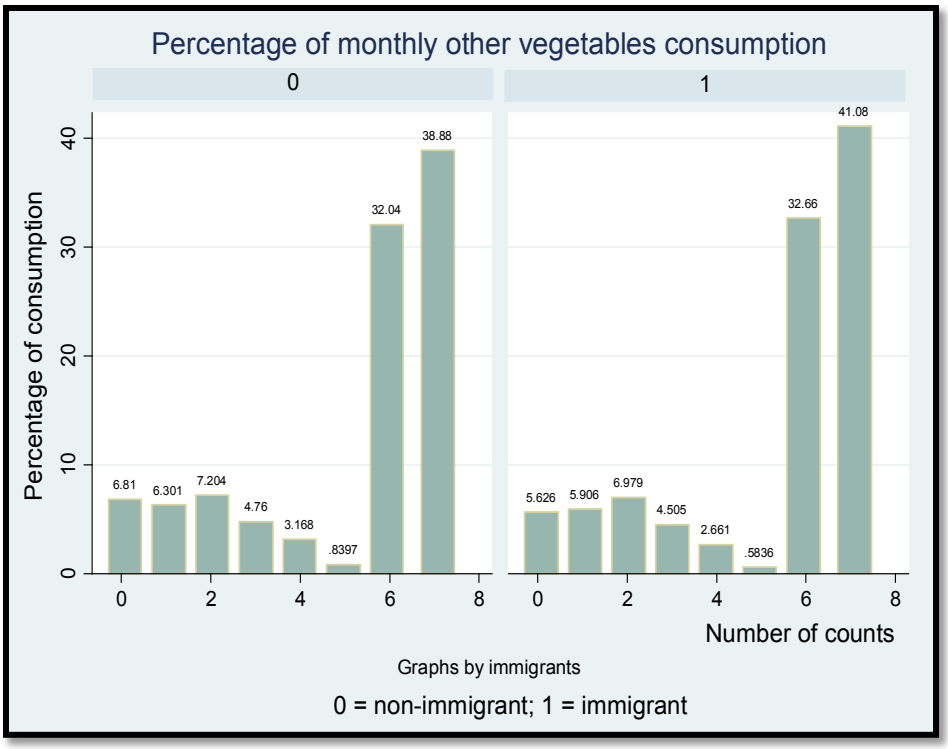
Figure 5.4: Frequency of monthly carrot consumption among non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 5
1	≥ 5 &< 10
2	≥ 10 &< 15
3	≥15&< 20
4	≥ 20 &< 25
5	≥ 25 &< 30
6	≥ 30 &< 35
7	≥ 35

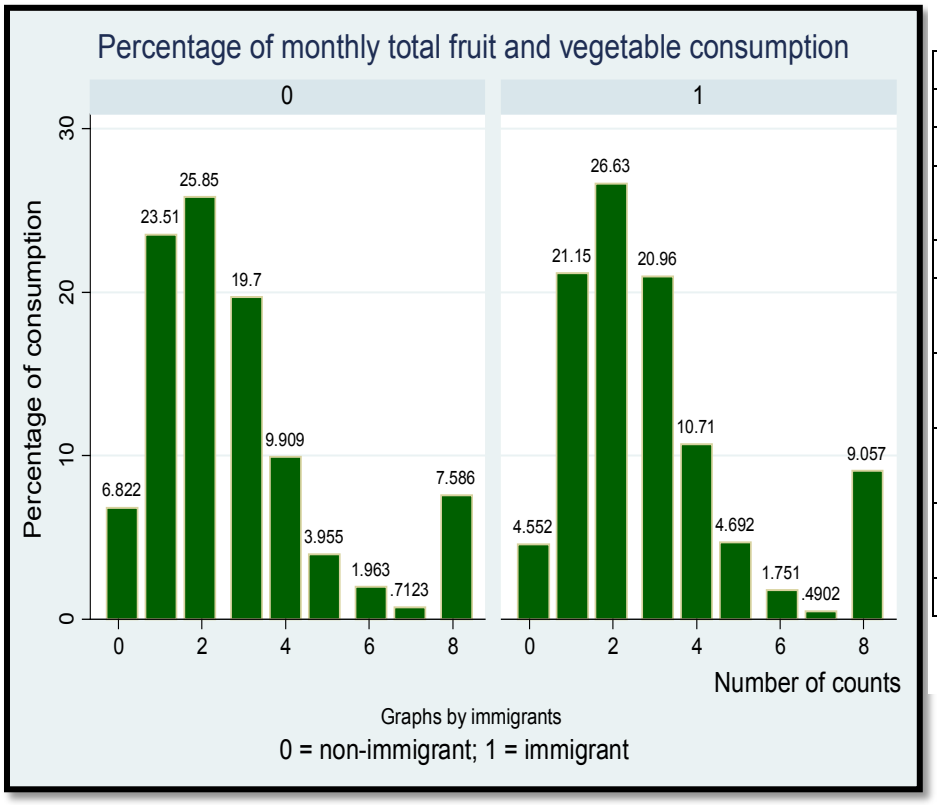
Figure 5.5: Frequency of monthly salad consumption among non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 10
1	≥ 10 &< 20
2	≥ 20 &< 30
3	≥30 &< 40
4	≥ 40 &< 50
5	≥ 50 &< 60
6	≥ 60 &< 70
7	≥ 70 &< 80
8	≥ 80

Figure 5.6: Frequency of monthly other vegetables consumption among non-immigrants and immigrants



Legend

Counts	Interval
0	≥ 0 &< 50
1	≥ 50 &< 100
2	≥ 100 &< 150
3	≥150 &< 200
4	≥ 200 &< 250
5	≥ 250 &< 300
6	≥ 300 &< 350
7	≥ 350 &< 400
8	≥ 400

Figure 5.7: Frequency of monthly total fruit and vegetables consumption among non-immigrants and immigrants

5.4 Results of the Fruit and Vegetable regressions

The impact of ethnicity on fruits and vegetable consumption was analyzed using the entire Ontario sample, and also a sub-sample that only included migrant respondents. The separate models help to understand whether immigrants are vulnerable regarding food consumption compared to Canadian born and whether immigrants' food consumption pattern changes with length of residence. Section 5.4.1 provides a summary of statistical analysis. Section 5.4.2 provides the regression results of all respondents in Ontario while section 5.4.3 presents the regression results of immigrant population only.

5.4.1 Statistical Analysis

Data were analyzed by using STATA14. Initially, the data were examined for the errors entry, outliers and missing values. CCHS sampling weights were used for the analysis. Since the responses for fruit and vegetable consumption were stated in terms of frequency, the data were initially analyzed using Poisson regression. However, goodness of fit test was significant ($p<0.01$) and indicated that the data were over-dispersed. To overcome this, a Negative Binomial model was estimated and the significance of the over-dispersion parameter (alpha) was tested using an Adjusted Wald test[33]. The Adjusted Wald test shows that alpha was significant, thus reinforcing that the Poisson distribution was not appropriate for the analysis.

As discussed in the chapter 4, because the dependent variable contain a large proportion of zeros in some categories (e.g. carrot and potato), a Zero-inflated Negative Binomial (ZINB) regression was estimated. In ZINB, the income and location of households were identified as inflated variables. I believed that unavailability of food (represented by location of households) and inaccessibility of food (represented by household income) might be a reason for excess zeros

[33]With "svy" prefix, the likelihood ratio test was unable to perform in STATA

in some category of fruit and vegetables. ZINB also has an over-dispersion parameter (alpha), along with a natural log of over-dispersion parameter. If the alpha coefficient is zero, then the model is better estimated with Zero-inflated Poisson (ZIP) regression. However, in almost all ZINB models, the alphas are statistically significant. Table 5.2 shows the type of models estimated with the different dependent variables and different samples. For the entire Ontario sample, for instance, the Negative Binomial regression model was used to estimate the demand function for fruit, other vegetables and total fruit and vegetables.

Table 5.2: Description of type of model with category of group and category of fruit and vegetables

	Negative Binomial Regression model	Zero-inflated Negative Binomial Regression model
Entire Ontario	• Fruit • Other vegetables • Total fruit and vegetables	• Fruit Juices • Carrot • Potato • Salad
Immigrant sample	• Fruit • Salad • Other vegetables • Total fruit and vegetables	• Fruit Juices • Carrot • Potato

Deviance R square (R^2_{DEV}), DP R square (R^2_{DP}) and F-statistics were used to assess goodness of fit of the models. R^2_{DEV} measures the explanatory power of the regressors based on the deviance residuals. In addition to the explanatory power of regressors, R^2_{DP} also measures the cross validation of the model (i.e. In STATA, R^2_{DP} compares the NB model with Poisson regression to see model fits for negative binomial compared to Poisson). By comparing Negative Binomial model, R^2_{DP} implicitly tests whether the dispersion parameter in the NB model is equal to zero (Cameron & Windmeijer, 1997). If R^2_{DP} is closer to 1, the probability of the dispersion parameter

equals to zero becomes zero. However, as discussed in Chapter 4, the dispersion parameter in the over-dispersed data limits the explanatory power R square(Cameron & Windmeijer, 1997).By default, the use of the "svy" prefix in STATA (needed to use the sample weights) means the standard errors were computed using a linearized standard error estimator. In a non-survey context, a linearized standard error estimator refers to the robust variance estimator[34].This accounts for heteroscedasitcity in a survey data set. Further, the adjusted Wald test was used to test whether the independent variables are statistically different from zero. As well, a joint test was undertaken to test whether are there difference between in frequency of consumption of fruit and vegetables across ethnic groups. These tests strongly rejected the hypothesis of that there are no differences among ethnic groups.

Variables were added to the model in the following order: Ethnicity, immigrant status/length of residence, ability to speak English and French, household characteristics, education, multi ethnicity, income and location of households. The control variables, income captures the food access of an individual and the location of household explains the food availability. In addition, in the immigrant subsample model, I introduced two new dummy variables other than ethnic groups listed in the questionnaire. These dummy variables represent the ethnic groups belong two different regions: (1) Africa, and (2) South, Central America and Caribbean. As mentioned in section 5.2, in the CCHS survey, these groups were captured under a variable called, *other*. I created these variables by cross tabulating the variables of "*country of birth*" and "*other*" (from ethnic groups). For instance, this shows that any immigrant born in Africa and classified under the *other* category was identified as an African ethnic group. However, it is important to recognize that these dummy variables capture broad ethnic groups

[34]Reference available at http://www.stata.com/manuals13/svy.pdf

which exist in these regions. This limits the ability to make inferences about the food consumption pattern of diverse ethnic groups who are from these regions (i.e. Africa, South, Central American, and the Caribbean). Note that the applicability of these new two dummy variable is only possible for the immigrant sample since, in the entire sample, country of birth for the respondents from these ethnic groups can be either (1) foreign-born or, (2) native born (in this case, native born is Canada).

5.4.2. Regression results of Fruits and Vegetable consumption among entire Ontario

This section includes regression results of fruits and vegetable consumption of entire respondents in the Ontario province. Section 5.4.2.1 describes results from Negative Binomial regressions while section 5.4.2.2 provides the discussion of Zero-inflated Negative Binomial Regressions.

5.4.2.1 Negative Binomial Regressions Results of Ontarians

Table 5.4 shows the results of Negative Binomial regressions of fruits, other vegetables, and total fruit and vegetable consumption. At first, these regressions were run using the Poisson model and it was tested against the hypothesis of equi-dispersion and tested for goodness of fit. The equi-dispersion hypothesis was rejected (p-value< 0.01). Further, the log of dispersion parameter (alpha) was significant in all three regressions. Table 5.3 shows the values of the log Alpha and results of goodness of fit measures. The significance of the log Alpha shows that the dispersion parameter (alpha) is significantly different from zero. The joint test for ethnicity was significant for all three regressions. Further, an Adjusted Wald test was performed for each variable in the regression. The adjusted Wald test results show that variables are statistically different from zero (Table A1, A6 and A7 – Appendix A).

Table 5.3: Statistics of model fit

	Fruits	Other vegetables	Total Fruit and Vegetables
Log Alpha	-0.369***	-0.464***	-1.328***
F-statistics	4.68	8.55	4.71
Deviance R- square	0.022	0.043	0.027
DP R-square	0.829	0.838	0.874

Significance p< 0.01 "***", p<0.05 "**", p<0.1"*"

As discussed in the Chapter 4, Negative binomial model is a log of the expected counts model as a function of the predictor variables. The coefficients of negative binomial model are interpreted as follows: for a one unit change in the predictor variable, the difference in the logs of expected counts of a response variable is expected to change by the respective regression coefficient, given that other predictor variables are held constant. This assumption was followed throughout this chapter.

Compared to Canadians, Italians, Polish and Swedish consumed fruit more often, while French and Chinese consumed fruit less frequently. For instance, compared to Canadians, the difference in the log of expected monthly fruit consumption counts is 0.097 times lower for French and 0.103 times lower for Chinese (holding other variables constant in the model). Further, those of South Asian, English, Italian, German, Dutch, and Chinese or Polish origin consumed other vegetables at a higher frequency compared to Canadians. For example, the log of expected monthly other vegetable consumption is 0.328 times higher for Chinese compared to Canadians. Altogether, compared with Canadians, the frequency of total fruit and vegetable consumption is lower among the Chinese and French ethnic groups while the frequency of expected total fruit and vegetable consumption is higher among Italian, Ukrainian, Dutch and Polish ethnic groups. Between the French and Chinese, the difference in log of expected monthly total and fruit and vegetable consumption is lowest for Chinese (0.098 times lower than

Canadians). Compared to Canadian citizens (by birth), the difference of log of expected frequency of monthly fruit consumption is 0.084 times higher for immigrants. And the difference of log of expected frequency monthly other vegetable consumption is lower by 0.07 times for immigrants compared with non-immigrants. However, there is no difference in the frequency of total fruits and vegetable consumption in between immigrants and non-immigrants.

Table 5.4: Results of Negative Binomial Regression of Ontarians

	Fruits		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Ethnicity						
Canadian (base)						
French	**-0.097*** **	0.033	-0.013	0.041	**-0.041***	0.023
English	-0.031	0.029	**0.068*** **	0.025	0.029	0.018
German	0.035	0.029	**0.104*** **	0.030	0.050	0.020
Scottish	-0.019	0.031	0.019	0.027	0.009	0.018
Irish	-0.037	0.032	0.017	0.027	-0.013	0.018
Italian	**0.097** **	0.038	**0.117*** **	0.044	**0.056***	0.029
Ukrainian	0.072	0.058	0.063	0.060	**0.080** **	0.039
Dutch	0.022	0.042	**0.146*** **	0.039	**0.082*** **	0.024
Chinese	**-0.103***	0.062	**0.328*** **	0.061	**-0.098*** **	0.036
Jewish	-0.070	0.069	0.051	0.119	0.002	0.061
Polish	**0.108** **	0.050	**0.122** **	0.053	**0.104*** **	0.034
Portuguese	0.032	0.074	0.010	0.077	0.006	0.049
South Asian	-0.052	0.051	**0.126** **	0.055	0.027	0.037
Norwegian	0.148	0.123	0.017	0.116	0.020	0.068
Welsh	-0.065	0.073	-0.006	0.080	-0.017	0.048
Swedish	**0.198** **	0.089	0.070	0.078	0.066	0.053
Other	-0.025	0.034	-0.011	0.033	0.008	0.024
Language usage						
English Only (base)						
French Only	**0.358*** **	0.134	0.132	0.122	**0.285***	0.153
Both English and French	**0.169*** **	0.031	**0.140*** **	0.034	**0.129*** **	0.022
Neither English nor French	-0.124	0.147	**0.285***	0.168	0.031	0.083

	Fruits		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Immigrants status	**0.084*** **	0.028	**-0.070** **	0.030	0.022	0.018
Household Characteristics						
Number of kids under the age 12	**0.036** **	0.016	0.018	0.019	0.010	0.011
Household size	**-0.021***	0.011	-0.009	0.013	0.005	0.007
Demographic characteristics						
Income						
Income <=30,000 (base)						
Income (<=50,000 &>30,000)	**0.128*** **	0.033	**0.139*** **	0.043	**0.068*** **	0.025
Income (<=100,000 &> 50,000)	**0.191*** **	0.033	**0.120*** **	0.040	**0.076*** **	0.025
Income > 100,000	**0.215*** **	0.036	**0.170*** **	0.044	**0.099*** **	0.027
Education						
Primary education (base)						
Secondary education	-0.017	0.035	**0.139*** **	0.039	-0.008	0.024
Diploma	0.028	0.031	**0.152*** **	0.032	0.001	0.021
University	**0.083** **	0.032	**0.303*** **	0.036	**0.084*** **	0.023
Age of respondent	**0.002*** **	0.001	**-0.002*** **	0.001	0.0003	0.0003
Multi ethnicity	**0.052***	0.027	-0.002	0.027	0.014	0.019

	Fruits		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Area of residents						
Toronto(base)						
Guelph	-0.041	0.071	-0.085	0.068	**-0.078***	0.045
Kitchener	0.033	0.059	0.037	0.054	-0.002	0.032
Oshawa	-0.056	0.061	**-0.118****	0.057	-0.055	0.035
Greater Sudbury	0.005	0.064	-0.069	0.065	-0.045	0.041
Hamilton	**0.085***	0.045	-0.055	0.039	-0.011	0.027
Ottawa	-0.031	0.043	0.045	0.061	-0.008	0.031
Kingston	0.079	0.071	0.002	0.065	0.028	0.050
London	0.024	0.047	-0.065	0.047	-0.019	0.028
Thunder Bay	-0.092	0.061	**-0.113****	0.052	**-0.075****	0.038
St. Catharines	**-0.139*****	0.052	0.040	0.051	-0.048	0.038
Windsor	-0.002	0.066	**-0.128***	0.074	**-0.058**	0.039
Barrie	-0.051	0.068	-0.092	0.062	-0.049	0.043
Brantford	-0.056	0.067	0.077	0.062	-0.037	0.043
Peterborough	-0.063	0.075	-0.036	0.084	-0.053	0.055
Not a central metropolitan area	0.027	0.032	0.020	0.030	0.025	0.019
Constant	**3.476*****	0.058	**3.525*****	0.069	**4.774*****	0.041
Log alpha	**-0.369*****	0.019	**-0.464*****	0.028	**-1.328*****	0.021
Alpha	0.692	0.014	0.629	0.016	0.266	0.005
Number of Observations	18,829		18,668		18,275	
F-Statistics	4.68		8.55		4.71	
Deviance R square	0.022		0.043		0.027	
DP R square	0.829		0.838		0.874	

Significance p< 0.01 “***”, p<0.05 “**”, p<0.1”*”

5.4.2.2 Zero Inflated Negative Binomial Regressions Results of Ontarians

Because of the excess zeros in the frequency data, Zero-inflated Negative Binomial (ZINB) model was used for fruit juice, carrot, and salad and potato consumption (Table 5.6). The coefficients for the dispersion parameter (alpha) were 0.933, 0.734, 0.583 and 0.534, respectively, and were significant, thus suggesting the ZINB model is appropriate. The table 5.5 shows the values of log Alpha and values of goodness of fit measures. The preferred measure for the count models, the deviance R- squares take the respective values of 0.014 for fruit juice, 0.018 for carrot, 0.043 for the salad and 0.071 for potato. The joint test of ethnicity significant suggests there is a significant variation of impact of different ethnic groups on fruit juice, carrot, potato and salad consumption. Further, adjusted Wald test for the variables is significant, which means they are statistically different from zero (Table A2, A3, A4 & A5 – Appendix A).

Table 5.5: Statistics of model fit

	Fruit Juice	**Carrot**	**Salad**	**Potato**
Log Alpha	-0.070**	-0.309***	-0.540***	-0.627***
F-statistics	4.81	3.45	7.47	21.22
Deviance R- square	0.014	0.018	0.043	0.071
DP R-square	0.757	0.594	0.677	0.540

Significance p< 0.01 “***”, p<0.05 “**”, p<0.1”*”

In addition to the Negative Binomial model, the ZINB regression includes set of variables as inflated variables. These positive coefficients of inflated variables explain the likelihood that a predictor variable is at a certain zero group. The rest of the coefficients are treated as a standard Negative binomial regression output.

Compared to Canadians, the difference in the log of expected consumption frequency for those of Italian ethnicity is 0.111 times lower for fruit juice, and 0.467 times lower for potato.

However, the difference in the log of expected salad consumption frequency was higher by 0.309 times for Italians. Further, those of Chinese ethnicity consume fruit juice, carrot, salad and potatoes less frequently than Canadians. For instance, compared to Canadians, the difference in the log of expected monthly salad consumption counts was 0.347 times lower for those of Chinese ethnicity. Compared to Canadians, the difference in the log of expected salad consumption count was 0.218 times lower for those of Norwegian ethnicity and 0.135 times lower for those of Welsh ethnicity. Further, the difference in the log of expected frequency of carrot consumption count is 0.239 times lower for those from Norwegian ethnicity: nevertheless, the consumption count is 0.162 times higher for South Asians. Further, those of Jewish consume potatoes less frequency, while the Welsh consume salad and juices less frequently. Moreover, compared to non-immigrants, the difference of the log of expected potato consumption frequency is 0.09 times higher for immigrants. Lastly the multi-ethnicity coefficient is positive and significant for carrots. This suggests that an individual who follows more than one ethnic group has a higher frequency of consuming carrots compare to a person with one ethnicity.

Table 5.6: Results of Zero Inflated Negative Binomial Regression of Ontarians

	Fruit's Juice		Carrots		Salad		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Ethnicity								
Canadian (base)								
French	-0.013	0.058	-0.054	0.043	-0.015	0.040	0.059	0.046
English	0.025	0.039	-0.030	0.034	0.064	0.037	0.026	0.029
German	0.011	0.050	-0.043	0.039	0.055	0.035	0.019	0.036
Scottish	0.017	0.042	0.060	0.038	-0.0004	0.029	0.001	0.033
Irish	-0.026	0.041	**-0.082****	0.038	0.007	0.032	0.043	0.039
Italian	**-0.111***	0.065	-0.079	0.073	**0.309*****	0.055	**-0.467*****	0.047
Ukrainian	0.077	0.073	0.139	0.106	0.117	0.064	0.004	0.094
Dutch	0.106	0.071	-0.025	0.053	0.044	0.046	0.048	0.044
Chinese	**-0.455*****	0.090	**-0.242*****	0.078	**-0.347*****	0.109	**-0.647*****	0.082
Jewish	0.074	0.132	-0.035	0.141	-0.017	0.077	**-0.298****	0.120
Polish	0.107	0.092	0.014	0.071	0.030	0.047	0.063	0.067
Portuguese	-0.035	0.099	-0.003	0.116	0.211	0.103	-0.119	0.073
South Asian	0.050	0.073	**0.162****	0.073	0.114	0.059	-0.116	0.071
Norwegian	-0.109	0.132	**-0.239****	0.111	**-0.218****	0.107	-0.002	0.113
Welsh	**-0.178****	0.086	0.171	0.119	-0.068	0.083	0.079	0.086
Swedish	-0.056	0.116	0.063	0.113	-0.025	0.096	0.038	0.079
Other	0.072	0.262	-0.008	0.047	**0.169*****	0.064	**-0.112****	0.046
Language usage								
English Only (base)								
French Only	0.138	0.262	0.562	0.371	0.075	0.157	**0.422***	0.229
Both English and French	**0.078***	0.046	**0.138*****	0.046	**0.078****	0.038	-0.054	0.040
Neither English	-0.131	0.190	-0.060	0.136	-0.132	0.165	-0.146	0.100

	Fruit's Juice		Carrots		Salad		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
nor French								
Immigrants status	0.048	0.041	0.066	0.045	-0.002	0.034	**0.090****	0.038
Household Characteristics								
Number of kids under the age 12	-0.028	0.024	0.036	0.023	0.021	0.023	-0.016	0.025
Household size	-0.006	0.015	0.0004	0.015	**0.022***	0.012	**0.051*****	0.012
Demographic characteristics								
Education								
Primary education (base)								
Secondary education	**-0.248*****	0.048	**-0.109****	0.054	**0.083****	0.038	**-0.157*****	0.043
Diploma	**-0.281*****	0.045	**-0.127*****	0.044	**0.104*****	0.032	**-0.234*****	0.042
University	**-0.323*****	0.050	**-0.080***	0.047	**0.307*****	0.038	**-0.409*****	0.046
Age of respondent	**-0.002*****	0.001	**0.002*****	0.001	**0.003*****	0.001	**0.008*****	0.001
Multi ethnicity	0.026	0.038	**0.100****	0.041	-0.045	0.047	-0.053	0.032
Constant	**3.457*****	0.074	**2.296*****	0.085	**2.483*****	0.060	**2.045*****	0.075

	Fruit's Juice		Carrots		Salad		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Inflate variables								
Income								
Income <=30,000 (base)								
Income (<=50,000 &>30,000)	-0.036	0.117	**-0.374****	0.180	**-0.461*****	0.164	-0.099	0.193
Income (<=100,000 &> 50,000)	-0.113	0.103	**-0.513*****	0.150	**-0.930*****	0.155	-0.206	0.164
Income > 100,000	-0.076	0.114	**-0.926*****	0.196	**-1.823*****	0.224	-0.111	0.191
Area of residents								
Toronto(base)								
Guelph	-0.281	0.250	**0.595***	0.352	0.338	0.434	-0.211	0.161
Kitchener	0.248	0.212	-0.230	0.297	-0.339	0.276	-0.277	0.372
Oshawa	**-0.351***	0.189	-0.622	0.416	**-0.594***	0.320	**-0.812****	0.333
Greater Sudbury	0.057	0.192	-0.519	0.349	-0.150	0.334	-0.196	0.321
Hamilton	0.188	0.150	-0.307	0.232	-0.129	0.227	**-0.974*****	0.267
Ottawa	-0.038	0.160	-0.035	0.217	-0.321	0.263	**-0.437****	0.216
Kingston	0.023	0.235	-0.371	0.422	-0.152	0.382	-0.517	0.405
London	-0.092	0.149	-0.397	0.283	**-0.509***	0.262	**-0.705****	0.274
Thunder Bay	**-0.360***	0.206	**-0.940****	0.404	0.173	0.396	**-1.002****	0.429
St. Catharines	0.212	0.168	0.206	0.258	-0.204	0.288	**-0.556****	0.277
Windsor	-0.159	0.205	**0.679*****	0.232	-0.364	0.284	**-0.585***	0.315
Barrie	**-0.443***	0.246	-0.789	0.497	-0.098	0.352	-0.263	0.393
Brantford	0.206	0.189	0.098	0.308	-0.172	0.383	**-1.120*****	0.420
Peterborough	0.186	0.244	-0.100	0.474	-0.570	0.352	-0.177	0.399
Not a central metropolitan area	-0.043	0.089	**-0.346****	0.144	**-0.348****	0.139	**-1.007*****	0.161

	Fruit's Juice		Carrots		Salad		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Constant	**-1.233*** **	0.101	**-1.759*** **	0.136	**-1.605*** **	0.133	**-1.852*** **	0.135
Log alpha	**-0.070** **	0.028	**-0.309*** **	0.029	**-0.540*** **	0.033	**-0.627*** **	0.035
Alpha	0.933	0.026	0.734	0.021	0.582	0.019	0.534	0.019
Number of Observations	18,891		18,716		18,804		18,827	
F-Statistics	4.81		3.45		7.47		21.22	
Deviance R square	0.014		0.018		0.043		0.071	
DP R square	0.757		0.594		0.677		0.540	

Significance p< 0.01 "***", p<0.05 "**", p<0.1"*"

5.4.3. Regression results of Fruits and Vegetable consumption for immigrants in Ontario

This section includes the regression results of fruits and vegetable consumption of migrant households in the Ontario province. Section 5.4.3.1 describes results from Negative Binomial regressions while section 5.4.3.2 provides discussion of Zero-inflated Negative Binomial Regressions. One of the main objectives of my study is to understand whether the food consumption pattern of immigrants is different from non-immigrants. To achieve this, I used the same source of data with a sub population of immigrants. Further, the length of residence variable in the model helps to understand changes in immigrants' consumption with number of years in Canada. Acculturation into new culture in the host country might influence food consumption pattern of immigrants. The English ethnic group was chosen as a base for ethnicity since the larger proportion of the sample was from an English ethnic group. Further, the English proportion in Ontario was 23.12 percent based on 2011 Census Canada[35]. As discussed in section 5.4.1, compared to entire sample regression, migrant model includes additional three different ethnic groups: (1) African, (2) South, Central America and Caribbean, and (3) other. Here, the *other* variable captures the ethnic groups who were not included in the listed ethnic groups in the questionnaire as well as the *other* variable excludes ethnic groups from African and South, Central America and Caribbean regions. Simply, this other variable captures the ethnic groups that belong to Middle East Asian, South East Asian (Except Chinese), and Australian region.

5.4.3.1. Negative Binomial Regressions Results of Immigrants in Ontario

As mentioned above, goodness of fit tests suggested the data suffer from over-dispersion, and so a Negative Binomial (NB2) was estimated. Table 5.8 shows the Negative Binomial regression results of fruits, salad, other vegetables, and total food and vegetable consumption. The log of

[35]Next to Canadians, English was the second largest ethnic group in Ontario

dispersion parameter (alpha) is significant for four regressions. Table 5.7 shows the values of the log Alpha and results of goodness of fit measures. The significance of log Alpha parameter suggests that Alpha is significantly different from zero. The deviance R square was 0.048 for fruit, 0.075 for salad and 0.061 for other vegetables and, 0.039 for total fruits and vegetables. The joint test for ethnicity was significant for the regressions which suggest that different ethnicity has a different impact on fruit, salad, other vegetables and, total fruit and vegetable consumption. Further, an Adjusted Wald test was performed for each variable in the regression. The adjusted Wald test results show that variables are statistically different from zero (Table B1, B4, B6 & B7 – Appendix B).

Table 5.7: Statistics of Model Fit

	Fruit	**Salad**	**Other vegetables**	**Total fruits and vegetables**
Log Alpha	-0.578***	-0.059***	-0.572***	-1.481***
F-statistics	2.82	2.68	3.96	3.44
Deviance R- square	0.048	0.075	0.061	0.039
DP R-square	0.816	0.743	0.819	0.861

Significance p< 0.01 “***”, p<0.05 “**”, p<0.1”*”

Compared to those of English ethnicity, the difference in the log of expected fruit consumption frequency is 0.210 times higher for Italians, 0.277 times higher for Ukrainian and 0.727 times higher for those from Norwegian ethnicity. Nevertheless, the difference in the log of expected fruit consumption frequency is lower for those of French ethnicity by 0.220 times and by 0.135 times for Chinese. The difference in the log of expected salad consumption frequency is 0.447 times higher for Italians compared to those of English ethnicity. Further, compared to English, the difference in the log of expected salad consumption frequency is 0.144 times lower for Scottish and 0.640 times lower for Chinese. In contrast, compared to English, the difference in the log of expected other vegetable consumption frequency is higher for German, Dutch,

Chinese, Norwegian, South Asians and Swedish by 0.133, 0.182, 0.386, 0.431, 0.149, and 0.396 times, respectively. Further, compared to English, the difference in the log of expected total fruit and vegetable consumption frequency is higher for German by 0.097 times, Dutch by 0.121 times, Norwegian by 0.262 times, and Swedish by 0.242 times. However, the Chinese' log of expected total fruit and vegetable consumption frequency is 0.16 times lower than English. Altogether, many ethnic groups such as German, South Asian, Dutch, Chinese and etc have higher frequency of consuming other vegetables compared to those from English ethnic group.

The coefficient on the length of residence is positive and significant for salad consumption. This shows that immigrants tend to eat salad at higher frequency the longer they have been in Canada. In addition, the coefficient on multi-ethnicity was positive and significant for fruit consumption, suggesting that respondents characterized by more than one ethnic group have a higher frequency of fruit consumption.

Table 5.8: Results of Negative Binomial Regression of Immigrants in Ontario

	Fruits		Salad		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Ethnicity								
English (base)								
French	**-0.220****	0.104	-0.017	0.140	-0.046	0.125	-0.048	0.087
German	0.124	0.078	0.060	0.079	**0.133***	0.073	**0.097***	0.050
Scottish	-0.114	0.070	**-0.144***	0.082	0.005	0.076	-0.068	0.049
Irish	-0.138	0.086	-0.104	0.103	-0.004	0.084	-0.066	0.056
Italian	**0.210*****	0.071	**0.447*****	0.128	0.130	0.106	0.076	0.063
Ukrainian	**0.277***	0.162	0.024	0.168	0.014	0.164	0.150	0.112
Dutch	0.134	0.106	0.076	0.087	**0.182****	0.086	**0.121****	0.050
Chinese	**-0.135***	0.072	**-0.640*****	0.129	**0.387*****	0.094	**-0.160*****	0.047
Jewish	-0.038	0.136	0.081	0.185	-0.314	0.211	-0.164	0.114
Polish	0.026	0.091	-0.102	0.096	0.064	0.088	0.041	0.064
Portuguese	-0.038	0.098	0.258	0.165	0.022	0.110	-0.065	0.071
South Asian	0.046	0.066	0.073	0.096	**0.149***	0.081	-0.021	0.051
Norwegian	**0.727*****	0.273	-0.527	0.453	**0.431****	0.192	**0.262****	0.108
Welsh	-0.031	0.211	-0.006	0.198	-0.086	0.138	0.076	0.107
Swedish	0.079	0.183	0.103	0.238	**0.396****	0.170	**0.242***	0.125
African	-0.064	0.125	-0.008	0.157	0.155	0.202	0.066	0.114
South, Central America and Caribbean	-0.015	0.084	0.157	0.116	-0.067	0.095	-0.005	0.114
Other	-0.092	0.071	0.152	0.106	-0.017	0.083	-0.047	0.049

	Fruits		Salad		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Language usage								
English Only (base)								
French Only	0.234	0.260	0.126	0.199	-0.074	0.240	0.303	0.245
Both English and French	0.087	0.069	0.080	0.096	0.019	0.089	0.047	0.058
Neither English nor French	-0.186	0.152	-0.185	0.167	0.216	0.167	0.001	0.085
Length of Residence	-0.001	0.002	**0.005****	0.002	0.002	0.002	-0.00001	0.011
Household Characteristics								
Number of kids under the age 12	**0.051***	0.030	0.062	0.040	0.023	0.036	0.024	0.022
Household size	**-0.052*****	0.018	0.035	0.026	-0.023	0.019	-0.007	0.012
Demographic characteristics								
<u>Income</u>								
Income <=30,000 (base)								
Income	**0.162*****	0.060	-0.062	0.089	**0.232*****	0.071	**0.085****	0.042

	Fruits		Salad		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
(<=50,000 &>30,000) Income	**0.171*** **	0.064	-0.073	0.080	**0.140** **	0.068	0.067	0.044
(<=100,000 &> 50,000) Income	**0.138** **	0.068	-0.096	0.089	**0.208** **	0.073	0.036	0.047
Education								
Primary education (base)								
Secondary education	-0.053	0.067	**0.264*** **	0.091	0.092	0.076	-0.0001	0.047
Diploma	0.009	0.062	**0.195** **	0.089	0.074	0.068	-0.021	0.047
University	-0.004	0.062	**0.461*** **	0.095	**0.201*** **	0.068	0.046	0.044
Age of respondent	**0.004** **	0.002	0.001	0.002	-0.001	0.001	0.001	0.001
Multi ethnicity	**0.118***	0.067	-0.029	0.090	0.016	0.072	-0.009	0.049
Area of residents								
Toronto(base)								
Guelph	0.187	0.119	**-0.411** **	0.204	-0.097	0.084	-0.041	0.083
Kitchener	**0.210** **	0.105	-0.133	0.096	-0.058	0.099	0.017	0.061
Oshawa	-0.043	0.087	0.132	0.115	0.109	0.087	0.045	0.072
Greater Sudbury	-0.081	0.237	-0.047	0.148	0.071	0.198	0.054	0.132

	Fruits		Salad		Other Vegetables		Total Fruits and Vegetables	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Hamilton	0.094	0.073	**0.116***	0.070	-0.123	0.075	-0.011	0.047
Ottawa	-0.029	0.079	-0.033	0.127	0.146	0.116	0.017	0.063
Kingston	**0.511*****	0.188	-0.008	0.275	0.077	0.181	**0.299***	0.160
London	**0.165***	0.088	**0.187****	0.090	0.020	0.078	**0.088***	0.053
Thunder Bay	**-0.322*****	0.107	0.041	0.168	**-0.365*****	0.112	**-0.194****	0.082
St. Catharines	-0.184	0.139	-0.017	0.133	0.030	0.110	-0.089	0.098
Windsor	0.051	0.134	0.139	0.112	0.060	0.137	0.094	0.081
Barrie	-0.007	0.141	0.302	0.249	**-0.259***	0.156	-0.004	0.068
Brantford	-0.069	0.194	-0.128	0.167	-0.110	0.152	-0.083	0.113
Peterborough	-0.042	0.150	0.048	0.216	0.221	0.187	0.081	0.094
Not a central metropolitan area	-0.064	0.060	-0.008	0.064	**0.092***	0.056	-0.020	0.039
Constant	**3.599*****	0.115	**2.315*****	0.163	**3.410*****	0.155	**4.852*****	0.085
Log alpha	**-0.578*****	0.043	**-0.059*****	0.051	**-0.571*****	0.068	**-1.480*****	0.045
Alpha	0.561	0.024	0.943	0.048	0.564	0.038	0.227	0.010
Number of Observations	3,917		3,906		3,876		3,784	
F-Statistics	2.82		2.68		3.96		3.44	
Deviance R square	0.047		0.075		0.061		0.039	
DP R square	0.816		0.743		0.819		0.861	

Significance p< 0.01 “***”, p<0.05 “**”, p<0.1”*”

5.4.3.2. Zero Inflated Negative Binomial Regressions Results for Immigrants in Ontario

Because of the excess zeros in the frequency data, Zero-inflated Negative Binomial (ZINB) model was used for fruit juice, carrot and potato consumption (Table 5.10). The coefficients for dispersion parameter (alpha) were 0.871, 0.714, and 0.530 respectively and were significant (P<0.05), thus suggest that ZINB model is appropriate. The table 5.9 shows the respective value for log Alpha and F-statistics, Deviance R-square and DP R-square. The deviance R- squares were 0.026 for fruit juice, 0.033 for carrot, and 0.088 for potato. The joint test for ethnicity was significant for the regressions which suggest that there is a significant variation of impact of different ethnic groups on fruit juice, carrot and potato consumption among immigrants in Ontario. Further, the results of the adjusted Wald test for each variable are significant (Table B2, B3 & B5 – Appendix B).

Table 5.9: Statistics of Model Fit

	Fruit Juice	**Carrot**	**Potato**
Log Alpha	-0.138**	-0.337***	-0.637***
F-statistics	2.95	2.33	6.09
Deviance R- square	0.026	0.033	0.088
DP R-square	0.745	0.605	0.548

Significance p< 0.01 “***”, p<0.05 “**”, p<0.1”*”

Compared to English, the difference in the log of expected fruit juice consumption frequency is 0.406 times higher for French, 0.194 times higher for those of German ethnicity, but 0.661 times lower for Chinese. Moreover, the difference in the log of expected carrot consumption frequency is 0.298 times lower for French and 0.293 times lower for Chinese. Further, the difference in the log of expected potato consumption frequency is higher for French by 0.186 times, Dutch by 0.0.219 times and Welsh by 0.400 times. However, compared to English, the log of expected

potato consumption frequency is lower for Italian by 0.482 times, Chinese by 0.847 times, Jewish by 0.567 times and South Asian by 0.292 times and other ethnic groups by 0.187 times.

The coefficient on the length of residence is negative and significant for potato consumption. This shows that immigrants tend to eat potato at less frequency the longer they have been in Canada. The coefficient on the multi-ethnicity variable has a negative and significant correlation with potato consumption. This suggests that respondents characterized by more than one ethnic group have a lower frequency of potato consumption.

Table 5.10: Results of Zero Inflated Negative Binomial Regression of Immigrants in Ontario

	Fruit's Juice		Carrots		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Ethnicity						
English (base)						
French	**0.406****	0.185	**-0.298***	0.159	**0.186***	0.109
German	**0.194****	0.097	-0.132	0.093	-0.132	0.092
Scottish	-0.147	0.101	-0.090	0.091	0.153	0.149
Irish	-0.073	0.112	-0.132	0.107	0.237	0.150
Italian	-0.117	0.124	-0.033	0.135	**-0.482*****	0.116
Ukrainian	0.161	0.168	0.302	0.234	0.224	0.195
Dutch	-0.002	0.118	-0.020	0.095	**0.219****	0.109
Chinese	**-0.661*****	0.119	**-0.292*****	0.100	**-0.847*****	0.109
Jewish	-0.188	0.141	-0.254	0.294	**-0.566*****	0.186
Polish	0.161	0.172	0.071	0.127	0.072	0.118
Portuguese	-0.201	0.156	-0.115	0.141	-0.111	0.094
South Asian	-0.064	0.105	0.153	0.096	**-0.291*****	0.095
Norwegian	-0.420	0.290	-0.316	0.339	0.107	0.215
Welsh	0.262	0.196	0.210	0.168	**0.400***	0.214
Swedish	0.002	0.286	0.105	0.225	-0.050	0.221
African	0.280	0.197	0.267	0.227	-0.301	0.189
South, Central America and Caribbean	0.141	0.136	0.060	0.126	-0.162	0.124
Other	0.021	0.128	0.055	0.093	**-0.187***	0.102
Language usage						
English Only (base)						
French Only	0.309	0.281	**0.788***	0.470	**0.693***	0.419
Both English and	0.069	0.105	0.096	0.135	-0.127	0.093

	Fruit's Juice		Carrots		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
French						
Neither English nor French	-0.130	0.189	-0.089	0.155	-0.089	0.109
Length of Residence	-0.001	0.003	-0.0006	0.002	**-0.005****	0.002
Household Characteristics						
Number of kids under the age 12	-0.015	0.044	**0.104****	0.044	0.058	0.048
Household size	0.021	0.023	-0.018	0.026	0.005	0.020
Demographic characteristics						
Education						
Primary education (base)						
Secondary education	**-0.194****	0.099	-0.095	0.100	-0.074	0.077
Diploma	**-0.191****	0.087	**-0.170****	0.083	**-0.153****	0.072
University	**-0.204****	0.088	**-0.205****	0.085	**-0.284*****	0.074
Age of respondent	-0.0001	0.002	0.002	0.002	**0.007*****	0.002
Multi ethnicity	-0.144	0.096	-0.059	0.086	**-0.176*****	0.094
Constant	**3.381*****	0.153	**2.508*****	0.175	**2.472*****	0.139

	Fruit's Juice		Carrots		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Inflate variables						
Income						
Income <=30,000 (base)						
Income (<=50,000 &>30,000)	0.095	0.222	-0.296	0.360	0.173	0.355
Income (<=100,000 &>50,000)	0.029	0.209	-0.382	0.311	0.467	0.320
Income > 100,000	0.040	0.234	-0.178	0.370	**0.669***	0.368
Area of residents						
Toronto(base)						
Guelph	-0.129	0.576	0.392	0.799	0.662	0.625
Kitchener	-0.203	0.317	0.469	0.433	**-1.499****	0.717
Oshawa	-0.152	0.441	-1.501	1.231	-0.444	0.645
Greater Sudbury	0.503	0.649	0.236	0.829	-0.869	1.202
Hamilton	0.061	0.266	-0.546	0.472	**-0.780***	0.416
Ottawa	-0.227	0.381	-0.116	0.412	-0.739	0.450
Kingston	0.451	0.623	**-28.408*****	0.533	**-47.639*****	3.259
London	-0.458	0.310	**-19.983*****	4.938	-0.390	0.488
Thunder Bay	0.306	0.524	-1.650	1.472	**-32.862*****	0.248
St. Catharines	0.338	0.379	-0.122	0.788	-3.211	3.727
Windsor	-0.591	0.367	0.562	0.435	-0.050	0.499
Barrie	0.124	0.483	-0.333	0.819	-1.350	0.979
Brantford	**-0.999****	0.500	-0.152	0.659	-1.281	0.853
Peterborough	-1.433	0.891	**-28.246*****	0.776	-2.262	1.796
Not a central metropolitan area	0.142	0.192	-0.334	0.389	**-0.718***	0.371

	Fruit's Juice		Carrots		Potatoes	
Independent Variables	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**	**Coefficients**	**Linearized Standard Error**
Constant	**-1.279*** **	0.181	**-1.928*** **	0.242	**-2.218*** **	0.274
Log alpha	**-0.138** **	0.055	**-0.337*** **	0.054	**-0.637*** **	0.065
Alpha	0.871	0.048	0.714	0.039	0.529	0.035
Number of Observations	3,929		3,888		3,911	
F-Statistics	2.95		2.33		6.09	
Deviance R square	0.026		0.033		0.088	
DP R square	0.745		0.605		0.548	

Significance p< 0.01 "***", p<0.05 "**", p<0.1"*"

5.5 Discussion of factors influencing on fruits and vegetable consumption

Previous research has shown that lower fruit and vegetable consumption is associated with higher rates of obesity and chronic diseases (Leone et al., 2012; Perez, 2002). Further, Canadian residents have been shown to consume a lower level of fruit and vegetable compared to Health Canada recommendations (Perez, 2002). Based on Canada's food guide, an adult should have to consume at least 7-8 fruit and vegetable servings per day. However, based on the total fruit and vegetable consumption histogram in the section 5.3, more than 50 percent respondents consume less than 3.04 servings per day. Further, more than 40 percent of households consume carrots 0.08 times per day and around one fourth of households consume salad around 0.08 times per day. This helps to show a large proportion of Ontario residents consume less than the recommended servings of fruit and vegetables. Thus, it is important to understand the reasons for the lower consumption among Ontario residents.

The regression results explain the role of ethnicity and other socio-demographic variables in shaping fruit and vegetable consumption. Compare to Canadians, those of Chinese ethnicity were identified as consuming fruits and vegetables less frequency. However, their frequency of consuming other vegetables is higher than those of Canadian ethnicity. This suggests that those of Chinese ethnicity consume more vegetables such as cabbages, leafy greens, gourds, bamboo shoots, etc, rather than consuming carrots or salad. The frequency of fruit and vegetable consumption is lower for Chinese compare to Canadian. Further, in the other vegetable regression, the estimates for South Asians are positive and significant. This shows that South Asians have a higher likelihood of consuming traditional South Asian cuisine including okra, brinjal, pumpkin, luffa and gourds (snake gourds, bitter gourds) (Ansari, 2005). Moreover, those of French ethnicity have a lower frequency of overall fruit and vegetable consumption. For

instance, the French migrants consume lower frequency of fruits and carrots; however, their frequency of potato and fruit juice consumption was higher. Roux et al. (2000) identified that the lower income group amongst French ethnicity consumes a lower amount of fruits and vegetable and a higher amount of starchy and sweet products.

There is no significant difference in potato consumption between most ethnicities from European region (except those from Italian ethnicity) and those of Canadian ethnicity. This means that potato is a major starch plant in European diet (such as French fries, smash potato) as well as one of major ingredient of Canadian diet is potato (e.g. poutine). Even though salads are an integral part of a European cuisine, there is no difference between salad consumption between Canadian and most of Europeans (such as respondents from English, German, Irish ethnicities). However, this might be because larger proportion of respondents, who identified themselves as Canadian, might be descendents[36] of ethnic groups from European countries. In contrast, those from the Italian ethnic group consume a higher frequency of fruits, salad, other vegetables, but a lower frequency of potatoes. Their diet practices align better with Health Canada recommendations. The reason for better dietary practices amongst the Italian ethnic group might be because the Mediterranean diet is rich in fruit and vegetables and poor in saturated fatty acids (Tavani & Vecchia, 1995). Overall, lower fruit juice consumption among Italians, Chinese, Jewish and Other ethnic groups reflected that might be because of caloric content of fruit juices.

In contrast to my expectation, in the migrant model, there is no significant difference between fruit and vegetable consumption between (1) African and Canadian, and (2) South, Central American and Caribbean and Canadian. There are might be two different reasons: (1) the residents from Africa and South, Central American and Caribbean might have already exposed

[36]As discussed in section 4.4, they should be third generation or greater than that.

these types of fruit and vegetable consumption, and (2) the broader composition of ethnicity. Because of the nature of the data, I couldn't able to further decompose these broader ethnic groups into more refined ethnic groups that might be more reflective of the diversified ethnicity in these regions.

Further, immigrants' consumes higher frequency of potatoes and lower frequency of other vegetables compared to non-immigrants. In addition, the probability of consuming potato decreases with length of residence in Canada and the probability of consuming salad increases with length of residence in Canada. However, there is no significant difference in total fruit and vegetable consumption between immigrant and non-immigrants. This contradicts the previous literature that immigrants were generally healthy at the time of arrival; however, their health status starts to converge toward the Canadian average with the length of stay in Canada (Lou & Beaujot, 2005; Dunn & Dyck, 2000; Frisbie &Hummer, 2001). Because, when residents are at immigrant status, there is a higher probability that: (1) they have lower income, (2) be unemployed, and (3) available vegetables might not be a part of their traditional cuisine. However, with longer residence in Canada, their income will increase and they have higher chances to consume healthy foods or acculturate to new customs might yield worse diet practices. Further, the negative correlation for immigrant's status and other vegetable consumption explains that there might be: (1) unavailability of information regarding other vegetables in the market among immigrants, (2) inaccessibility of these vegetables due to higher prices, and (3) these vegetables are not available at nearby grocery stores.

Apart from ethnicity, household socio-demographic and economic characteristics were used as control variables. The impact of these control variables varies between migrant model and entire Ontario model. In the Ontario model, compared to only English speakers, residents

who able to speak both English and French languages have a higher frequency of consuming fruits, fruit juices, carrots, salad, other vegetables, total fruits and vegetables. This suggests that the ability to communicate the host country language increase the accessibility of higher fruits and vegetable consumption (Hrboticky & Krondl, 1984). Perez (2002) shows that education becomes significant and positively associated with frequency of fruits and vegetable consumption. Further, there are number studies showed that nutritional education will improve the consumption of fruit and vegetables (Heim et al., 2009; McAleese & Rankin, 2007; Parmer et al., 2009), while Shohaimi et al. (2004) identified that lower education qualification individuals consume lower amount of fruit and vegetable consumption. My results show a mixture of negative and positive estimates for fruits and vegetable consumption. In the Ontario and immigrant models, education is significant for consumption of fruit juice, carrot, salad, potato and other vegetables. With a higher level of education, respondents consume less frequency of potatoes, fruit juices and carrots; however, the frequency of salad and other vegetables consumption increases with level of education. It shows that educated people have lower likelihood to consume energy dense foods (e.g. potatoes) and beverages (e.g. fruit juices due to the addition of sugar value) (Drewnowski & Spector, 2004; Kant, 2004).

Further, respondents with a higher income, have a higher likelihood of consuming fruits, other vegetables, total fruits and vegetables. In addition, in the Ontario model, the negative and significant coefficients for income for carrots and salad regression shows that if residents have higher income, there is a higher likelihood of moving away from zero consumption[37].Many studies argued that immigrants are vulnerable in terms of income compared to Canadians. In the immigrant's consumption models, income becomes significant for fruits, potato and other

[37] Zero consumption means residents do not consume a particular good at all

vegetable and total fruit and vegetables. With increasing income, immigrants have a higher frequency of consuming fruits and other vegetables while immigrants with higher income group (>= $100,000 annual income) less prefer consuming potatoes. This helps to illustrate that people with lower socio-economic status have a low frequency of fruits and vegetable consumption than people of higher socio-economic status (Perez, 2004; Serdula et al., 2004; Subar et al., 1995).

Food unavailability is identified as one of the factors for food insecurity in Canada. For instance, compare to rural households, the prevalence of food insecure percentage is higher amongst urban households by 8.1 percent (Health Canada, 2008)[38]. Based on Statistic Canada (2015), around nine percent households in Ontario were food insecure between 2011 and 2012. In the study, Toronto was used as a base for analysis since it has the highest number of food outlets compared to other census metropolitan areas. The results show that there are no differences of availability of fruit and vegetables between rural area and Toronto (except availability of potato is higher in rural areas). In addition, compared to Toronto, some census metropolitan areas have higher availability fruits and vegetables (e.g. residents who lives in Kingston have a higher frequency of consuming fruits, carrots, total fruit and vegetables) while some places are having less accessibility (e.g. frequency of consumption of other vegetables is lower in Oshawa and Thunder bay).Further, compared to Toronto, the residents who live in Thunder Bay have a higher likelihood to have an insufficient supply of other vegetables and total fruits and vegetables in the market compared to Toronto. In addition, compared to Toronto, residents who live in Guelph have lower frequency of consuming total fruits and vegetables.

[38]Retrieved from http://www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/insecurit/key-stats-cles-2007-2008-eng.php

5.6 Bi-Variate Probit Regression Analysis for Convenience Food Consumption

The Bi-variate probit model was used to estimate the impact of ethnicity on convenience food consumption. As described in the Chapter 4, convenience food was classified into two different categories: (1) frozen food, and (2) fast-food. However, due to the limited sample size, it was not possible to estimate the model amongst migrants only, so the focus instead is on the all-Ontario sample (i.e. migrants and non-grants). Table 5.11 shows the results of bi-variate probit regression for fast-food and frozen food. The correlation (ρ)between the disturbance terms of fast-food and frozen food was -0.773 and was significant (p-value<0.1). This shows that the unobserved factors affecting fast-food and frozen food consumption are negatively correlated. This result confirms that the fast-food and frozen food consumption are linked (i.e. a random shock to frozen food consumption has an effect on the probability of consuming fast-food) and support the appropriateness of the estimation of the bivariate model. Further, F-statistics of the regression is 180.10. The significant value for F-statistics suggests that there is a significant joint effect of all the variables on fast-food and frozen food consumption.

Compared to Canadians, the probability of consuming fast-food increases for German, English, South Asian, Polish, Welsh and other ethnic groups by 0.601, 0.322, 0.900, 0.911, 1.097 and 0.714. However, compared to Canadians, the probability of consuming fast-food decreases for Ukrainian by 0.642, Dutch by 0.725, Chinese by 5.851, Jewish by 4.907, those of Portuguese ethnicity by 5.472 and those of Norwegian ethnicity by 6.463. Further, compared to Canadians, the probability of consuming frozen food for Jewish increases by 0.926and the probability of consuming frozen food for those of Portuguese ethnicity decreases by 5.813. In addition, there is no significant difference between immigrants and non-immigrants for fast-food and frozen food consumption. This could suggest that immigrants might be exposed to westernized foods in their

home country. This is supported by income growth and urbanization process in Asian countries that led to a shift in demand for foods from staples towards more westernized diet including fast-food (Pingali, 2007). Education is significant and positive for fast food consumption. This suggests that residents with secondary school and post secondary diploma/ certificates consume a higher frequency of fast-food consumption compared with those with less than secondary school education. In contrast to that, lower income groups consume a higher amount of energy dense foods (Drewnowski & Specter, 2004; Hemphill et al., 2008). Lastly, the regression estimates shows that residents who have income between $30,000 and $50,000 have higher probability of consuming fast-food than residents who with income less than $30,000.

Table 5.11: Results of Bi-variate Probit analysis of Frozen and Fast-food Consumption of Ontarians

Independent Variables	**Coefficients and Linearized Std.errors**	
	Fast-food	Frozen food
Ethnicity		
Canadian (base)		
French	-0.004 (0.211)	-0.117(0.154)
English	**0.322 (0.152)****	0.012 (0.123)
German	**0.601 (0.219)*****	-0.073(0.176)
Scottish	0.193 (0.182)	-0.125(0.196)
Irish	0.296 (0.244)	-0.0137 (0.168)
Italian	0.279 (0.347)	0.294 (0.188)
Ukrainian	**-6.342 (0.358)*****	0.250(0.458)
Dutch	**-0.724 (0.395)***	0.185 (0.207)
Chinese	**-5.851 (0.336)*****	-0.347 (0.435)
Jewish	**-4.907 (0.206)*****	**0.926 (0.544)***
Polish	**0.911 (0.328)*****	0.098 (0.248)
Portuguese	**-5.472 (0.410)*****	**-5.813(0.218)*****
South Asian	**0.900 (0.393)****	-0.023 (0.360)
Norwegian	**-6.463 (0.580)*****	0.323 (0.523)
Welsh	**1.097 (0.492)****	-0.162 (0.459)
Swedish	0.389 (0.467)	-0.620 (0.410)
Other	**0.714(0.213)*****	-0.013(0.161)
Language usage		
English Only (base)		
French Only	**-4.549 (0.360)*****	**-5.824 (0.345)*****

Both English and French	0.282 (0.195)	0.138 (0.145)
Immigrant status	-0.203(0.185)	-0.031(0.172)
Household Characteristics		
Number of kids under the age 12	0.152 (0.115)	-0.042 (0.091)
Household size	**-0.170 (0.084)****	-0.028 (0.069)
Demographic characteristics		
Income		
Income <=30,000 (base)		
Income (<=50,000 &>30,000)	**0.436 (0.250)***	0.234 (0.214)
Income (<=100,000 &> 50,000)	0.127 (0.275)	0.063 (0.142)
Income > 100,000	0.425 (0.287)	0.065 (0.178)
Education		
Primary education (base)		
Secondary education	**0.571 (0.231)****	-0.223 (0.176)
Diploma	**0.425 (0.192)****	**-0.320 (0.167)***
University	0.248 (0.263)	-0.223 (0.172)
Age of respondent	-0.0004 (0.007)	-0.003 (0.004)
Multi ethnicity	-0.136(0.203)	-0.022(0.158)
Constant	**-3.014 (0.532)*****	**-1.433 (0.357)*****
Log rho	**-1.028 (0.597)***	
rho	-0.773	

Significance 0.01"***", 0.05 "**", 0.1"*"
Number of Observation = 3,250
Population Size = 10,778,104
F statistics = 180.10

5.7 Summary

This chapter presented results from count data and choice models that sought to account for the role of ethnicity in shaping fruit and vegetable and convenience food consumption. The fruit and vegetable consumption data were analyzed using negative binomial and the Zero-inflated negative binomial models while convenience food consumption was analyzed using bivariate probit model. Key findings including the following: (1) ethnicity generally has a significant influence on fruit and vegetable consumption and convenience food consumption,(2) however, the role of ethnicity is idiosyncratic, with little in the way of systematic evidence regarding a

particular ethnic group or a particular food or food group, (3) immigrant status has a significant influence on fruits and vegetable consumption, and (4) length of residence influence salad and potatoes consumption.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

In an effort to combat rising rates of overweight and obesity, Health Canada recommends a diet that includes at least seven to eight servings of fruits and vegetables daily. However, Canadian households, on average, fail to meet this serving recommendation (Perez, 2002). Further, increased consumption of high fat and energy dense foods have been identified as contributors to rising rates of obesity and overweight (Drewnowski & Specter, 2004). Moreover, the burden of obesity falls disproportionately on people with limited resources, racial-ethnic minorities, and the poor (Drewnowski & Specter, 2004; McDonald & Kennedy, 2004). These previous findings led to the questions investigated in this thesis, namely whether consumption of fruits and vegetables, and convenience foods (which are often energy dense), varies across different ethnicities.

Ethnicity is hypothesized to have an influence on food consumption in Ontario. Fruits and vegetable and convenience foods are of interest because of the association between consumption of these food groups and overall health status. There are five specific research questions investigated: (1) Does fruit and vegetable consumption vary across different ethnic groups amongst Ontario residents (including migrants and non-migrants), (2) Does fruit and vegetable consumption vary across different ethnic groups amongst migrants in Ontario, (3) Does convenience food consumption vary across different ethnic groups amongst residents of Ontario, (4) what is the role of migrants' residence status in Canada on fruit and vegetable consumption in Ontario, and (5) does length of residence in Canada have a significant influence on migrant food consumption. In order to explore these questions, I first reviewed the past literature to understand the factors (other than ethnicity) that influence of food choices. This

review led to development of a framework characterizing food choice that explicitly accounts for ethnicity (see Figure 6.1). This framework was used to aid in identifying factors to account for when developing empirical models that help to answer the above five research questions.

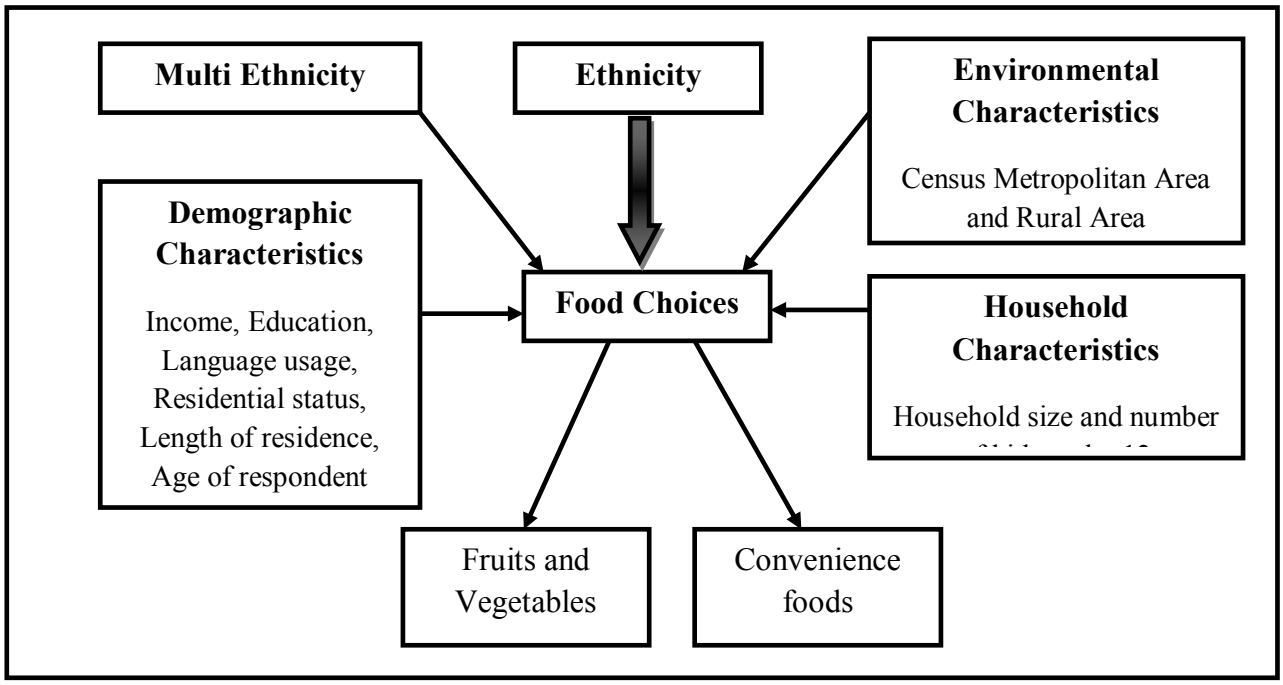


Figure 6.1: Framework of determinants of Food Choices

I used two different models for fruit and vegetable consumption. The first model mainly focused to understand the effect of ethnicity and migrant status on fruit and vegetable consumption in Ontario. In the second model, the role of ethnicity and length of migrant residence in Canada on fruit and vegetable consumption is explored, since I believed that there is a difference in food consumption between first generation and the following generations within an ethnic group. For example, the consumption pattern of first generation Chinese is different from their descendants in Canada (Hrboticky & Krondl, 1984; Sutton-Brady, Davis & Jung, 2010). Data from the Canadian Consumer Health Survey (2013) was used for the analysis. The data for fruit and vegetable consumption was captured as count data showing the monthly frequency of

consumption of fruits and vegetables. Since these data were over-dispersed, and there were a large number of observations with zero consumption events, a Zero-Inflated Negative Binomial model was used to model the frequency of fruits and vegetable consumption. Convenience food consumption was captured in the 2013 CCHS through a question about whether the respondent used convenience foods (either frozen foods or fast-foods) as the main ingredients of a main meal. Responses to this question were treated as binary output and models using a bi-variate probit model applied to convenience food options (either fast food or frozen food).

6.2 Conclusions

Results show that there is heterogeneity of fruit and vegetable consumption across different ethnic groups in Ontario. Further, immigrant status and length of residence in Ontario were also found to influence frequency of consumption of some fruit and vegetable. These findings lend to support the existing differences in obesity issues amongst different ethnic groups due to the differences in food consumption pattern. Respondents of Chinese and Norwegian ethnicity have lower frequency of consumption of carrots and salad compared to those identifying as having Canadian ethnicity. Further, compared with Canadians, the frequency of fruit consumption is low amongst Chinese and French ethnic groups. Despite the specific ethnic differences in the study, the frequency of consuming other vegetables is high among many ethnic groups compared to Canadians. This could reflect the variety of other vegetables available to residents of Ontario, or it could reflect a higher frequency of consumption of ethno-cultural vegetables not explicitly captured by the CCHS. Altogether, those of French and Chinese ethnicity were identified as ethnic groups who consume less frequency of fruit and vegetable compared to Canadians. Even though the frequency of fruit and vegetable consumption is lower amongst those for those from the Chinese ethnic group, the percentage of Chinese who are overweight is comparatively lower

than Caucasians in Canada (McDonald and Kennedy, 2005). The lower rate of obesity amongst Chinese can be explained by either: (1) higher frequencies of other vegetable consumption reduce prevalence of obesity; or (2) lifestyle of Chinese reduces the chances of getting obesity. McDonald and Kennedy (2005) showed that more than 45 percent of South Asian men were overweight. This can be explained by the higher probability of fast-food consumption amongst South Asians compared to Canadians. Further, immigrants have a higher frequency of consumption of potatoes, but a lower frequency of consumption for other vegetables compared to non-immigrants. Migrants' frequency of potato consumption declines with length of residence in Canada, while their frequency of salad consumption increases with number of years in Canada. This can be explained by several reasons: (1) price of other vegetable might be too high so as to render them unaffordable, (2)other vegetables might not be available in grocery stores near or in migrant communities (i.e. a food desert effect), (3) acculturation effect – the results showed that immigrants consume a higher frequency of salad with increased length of residence in Canada. Compared to Canadians, the probability of consuming fast-food is high among those of English, German, Polish, South Asian and Welsh ethnicity. Compared to Canadian, frozen food is highly used as a main meal among Jewish ethnicity. The results of this study provide insights for program planners in Ministry of Health and CIHI & PHAC planners.

6.3 Limitations

This study presents evidence that different ethnic groups have significant different food consumption pattern in Ontario. However, the study was able to incorporate only 17 ethnic groups, even though Canada has more than 200 ethnic groups. Unfortunately, there is no data about ethnic groups in Africa and South America regions coupled with food choices. Even though I created a dummy to represent the ethnic groups from these regions, these dummies

capture the broader ethnic groups. Even within a region, there is a number of different food practices associated with different ethnic groups. One of the major limitations in my study is lack of price information for fruit and vegetables, and convenience food. Omission of a price variable in the demand function can causes bias in calculated estimates. However, I assumed that location of respondents in the cross sectional survey was used as a proxy for prices in the demand equation. Further, the coefficient of the fruit and vegetable explains the direction and magnitude of the frequency of consumption. Frequency measurements are subjective to the respondents. This will be more accurate if we had information related quantity of consumption. Further, the convenience food data were collected as a part of a main meal question. This limited the number of observations in the study. Further, the observations are not sufficient to understand the true nature of convenience food consumption among different ethnic groups. This research is limited to fruits and vegetable consumption. If the CCHS can collect information about meat, dairy, bakery product consumption, it will give a broader picture.

6.4 Recommendations for Further Research

This study establishes that the ethnicity has an impact on food choices. However, a number of research questions remain unanswered. Overall, the length of residence is identified as a significant impact on fruit and vegetable consumption. After isolating the ethnicity and immigrant effects in the model, the role of length of residence on food consumption can be identified for each ethnic group separately. This can provide a deeper understand of role of the length of residence for each ethnic group. Since the regression results show that some ethnic groups have lower frequency of consumption than those of Canadian ethnicity, exploring the interaction effect between ethnic groups and income will provide a deeper understanding of poor diet practices. As the location of the households available in F1 survey, mapping ethnic groups

with their location will provide a clear idea about dwellings of these ethnic groups. This information will be more useful for current policy makers to target the health food programs towards these vulnerable groups.

Appendices

Appendix A: Adjusted Wald test for fruit and vegetable consumption of entire Ontario sample

Table A1: Results of adjusted Wald test estimates of monthly fruit consumption of Ontarians

Independent Variables	P value
Ethnicity	
French	0.003
Italian	0.010
Chinese	0.099
Polish	0.033
Swedish	0.027
Language usage	
French Only	0.008
Both English and French	0.000
Immigrants status	0.002
Household Characteristics	
Number of kids under the age 12	0.027
Household size	0.060
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.000
Income (<=100,000 &> 50,000)	0.000
Income > 100,000	0.000
Education	
University	0.011
Age of respondent	0.007
Multi ethnicity	0.052
Area of residents	
Hamilton	0.061
St. Catharines	0.007
Log alpha	0.000

Table A2: Results of adjusted Wald test estimates of monthly fruit juice consumption of Ontarians

Independent Variables	P value
Ethnicity	
Italian	0.089
Chinese	0.000
Welsh	0.038
Language usage	
Both English and French	0.092
Education	
Secondary education	0.000
Diploma	0.000
University	0.000
Age of respondent	0.010
Multi ethnicity	0.076
Inflate variables	
Oshawa	0.073
Thunder Bay	0.081
Barrie	0.073
Log alpha	0.000

Table A3: Results of adjusted Wald test estimates of monthly carrot consumption of Ontarians

Independent Variables	P Value
Ethnicity	
Irish	0.033
Chinese	0.002
South Asian	0.027
Norwegian	0.031
Language usage	
Both English and French	0.003
Demographic characteristics	
Education	
Secondary education	0.045
Diploma	0.004
University	0.092
Age of respondent	0.007
Multi ethnicity	0.014

Inflate variables	
Income	
Income (<=50,000 &>30,000)	0.038
Income (<=100,000 &> 50,000)	0.000
Income > 100,000	0.000
Area of residents	
Guelph	0.091
Thunder Bay	0.020
Windsor	0.004
Not a central metropolitan area	0.016
Log alpha	0.000

Table A4: Results of adjusted Wald test estimates of monthly salad consumption of Ontarians

Independent Variables	P Value
Ethnicity	
Italian	0.000
Ukrainian	0.067
Chinese	0.001
Portuguese	0.040
South Asian	0.056
Norwegian	0.043
Other	0.009
Language usage	
Both English and French	0.039
Household Characteristics	
Household size	0.066
Demographic characteristics	
Education	
Secondary education	0.033
Diploma	0.002
University	0.000
Age of respondent	0.000
Inflate variables	
Income	
Income (<=50,000 &>30,000)	0.005
Income (<=100,000 &> 50,000)	0.000
Income > 100,000	0.000
Area of residents	
Oshawa	0.063

London	0.052
Not a central metropolitan area	0.012
Log alpha	0.000

Table A5: Results of adjusted Wald test estimates of monthly potato consumption of Ontarians

Independent Variables	P Value
Ethnicity	
Italian	0.000
Chinese	0.000
Jewish	0.013
Other	0.015
Language usage	
French	0.065
Household Characteristics	
Household size	0.000
Demographic characteristics	
Education	
Secondary education	0.000
Diploma	0.000
University	0.000
Age of respondent	0.000
Multi ethnicity	0.008
Inflate variables	
Area of residents	
Oshawa	0.015
Hamilton	0.000
Windsor	0.064
Ottawa	0.043
London	0.010
Thunder Bay	0.020
St.Catherines	0.045
Brantford	0.008
Not a central metropolitan area	0.000
Log alpha	0.000

Table A6: Results of adjusted weld test estimates of monthly other vegetable consumption of Ontarians

Independent Variables	P value
Ethnicity	
English	0.008
German	0.001
Italian	0.008
Dutch	0.000
Chinese	0.000
Polish	0.021
South Asian	0.021
Language usage	
Both English and French	0.000
Neither English nor French	0.089
Immigrants status	0.019
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.001
Income (<=100,000 &> 50,000)	0.003
Income > 100,000	0.000
Education	
Secondary education	0.004
Diploma	0.000
University	0.000
Area of residents	
Oshawa	0.038
Thunder Bay	0.028
Windsor	0.083
Age of respondent	0.001
Log Alpha	0.000

Table A7: Results of adjusted Wald test estimates of monthly total fruit and vegetable consumption of Ontarians

Independent Variables	P value
Ethnicity	
French	0.078
German	0.012
Italian	0.057
Ukrainian	0.039
Dutch	0.001
Chinese	0.006
Polish	0.003
Language usage	
French Only	0.062
Both English and French	0.000
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.006
Income (<=100,000 &> 50,000)	0.002
Income > 100,000	0.000
Education	
University	0.000
Area of residents	
Guelph	0.084
Thunder Bay	0.046
Log Alpha	0.000

Appendix B: Adjusted Wald test for migrant's fruit and vegetable consumption

Table B1: Results of adjusted Wald test estimates of monthly fruit consumption of immigrants

Independent Variables	P value
Ethnicity	
French	0.034
Ukrainian	0.089
Italian	0.003
Chinese	0.062
Norwegian	0.008
Household Characteristics	
Household size	0.004
Number of kids under the age 12	0.095
Education	
Secondary education	0.068
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.007
Income (<=100,000 &> 50,000)	0.008
Income > 100,000	0.043
Age of respondent	0.010
Multi ethnicity	0.075
Area of residents	
Kitchener	0.047
Kingston	0.007
London	0.062
Thunder Bay	0.003
Log alpha	0.000

Table B2: Results of adjusted Wald test estimates of monthly fruit juice consumption of immigrants

Independent Variables	P Value
Ethnicity	
French	0.028
German	0.046
Chinese	0.000
Demographic characteristics	
Education	
Secondary education	0.050
Diploma	0.027
University	0.020
Inflated Variables	
Area of residents	
Brantford	0.046
Log alpha	0.000

Table B3: Results of adjusted Wald test estimates of monthly carrot consumption of immigrants

Independent Variables	P -value
Ethnicity	
French	0.061
Chinese	0.003
Language usage	
French Only	0.093
Household Characteristics	
Number of kids under the age 12	0.017
Education	
Diploma	0.040
University	0.016
Inflated Variables	
Area of residents	
Kingston	0.000
London	0.000
Peterborough	0.000
Log alpha	0.000

Table B4: Results of adjusted Wald test estimates of monthly salad consumption of immigrants

Independent Variables	P Value
Ethnicity	
Scottish	0.078
Italian	0.001
Chinese	0.000
Length of Residence	0.043
Demographic characteristics	
Education	
Secondary education	0.003
Diploma	0.028
University	0.000
Area of residents	
Guelph	0.044
London	0.038
Hamilton	0.098
Log alpha	0.000

Table B5: Results of adjusted Wald test estimates of monthly potato consumption of immigrants

Independent Variables	P Value
Ethnicity	
French	0.087
Italian	0.000
Dutch	0.044
Chinese	0.000
Jewish	0.002
South Asian	0.002
Welsh	0.061
Others	0.068
Length of Residence	0.020
Language usage	
French Only	0.098
Demographic characteristics	
Education	
Diploma	0.034
University	0.000
Age of respondent	0.002

Multi ethnicity	0.060
Inflated Variables	
Income > 100,000	0.069
Area of residents	
Kitchener	0.037
Kingston	0.000
Hamilton	0.061
Thunder Bay	0.000
Not a central metropolitan area	0.053
Log alpha	0.000

Table B6: Results of adjusted Wald test estimates of monthly other vegetables consumption of immigrants

Independent Variables	P-value
Ethnicity	
German	0.069
Dutch	0.035
Chinese	0.000
South Asian	0.065
Norwegian	0.025
Swedish	0.020
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.001
Income (<=100,000 &> 50,000)	0.039
Income > 100,000	0.004
Education	
University	0.003
Area of residents	
Thunder Bay	0.001
Barrie	0.097
Not a central metropolitan area	0.098
Log alpha	0.000

Table B7: Results of adjusted Wald test estimates of monthly total fruit and vegetable consumption of immigrants

Independent Variables	P Value
Ethnicity	
German	0.051
Dutch	0.016
Chinese	0.001
Swedish	0.053
Norwegian	0.015
Demographic characteristics	
Income	
Income (<=50,000 &>30,000)	0.045
Area of residents	
Kingston	0.062
Thunder Bay	0.099
Log alpha	0.000

Appendix C: Adjusted Wald test for convenience foods consumption

Table C: Results of adjusted Wald test estimates of convenience food consumption of entire sample

Independent Variables	P values	
	Fast-food	Frozen food
Ethnicity		
Canadian (base)		
English	0.034	
German	0.006	
Ukrainian	0.000	
Dutch	0.067	
Chinese	0.000	
Jewish	0.000	0.088
Polish	0.006	
Portuguese	0.000	0.000
South Asian	0.022	
Norwegian	0.000	
Welsh	0.026	
Other	0.001	
Language usage		
English Only (base)		
French Only	0.000	0.000
Household Characteristics		
Household size	0.044	
Demographic characteristics		
Education		
Primary education (base)		
Secondary education	0.014	
Diploma	0.027	0.056
Income		
Income (<=50,000 &>30,000)	0.081	
Log rho	0.085	

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