AN ECONOMIC ANALYSIS OF OBESITY, HEALTH CLAIMS, AND REGULATIONS

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Bachelor of Arts, University of Ghana, 2010

A Thesis
Submitted to the School of Graduate Studies
of the University of Lethbridge
in Partial Fulfillment of the
Requirements for the Degree

MASTER OF ARTS IN ECONOMICS

Department of Economics
University of Lethbridge
LETHBRIDGE, ALBERTA, CANADA

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Date of Defense: August 20, 2015

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Dedication

I dedicate this this thesis to my mother Mrs. Dorcas Owusu and my two siblings, Akwasi and Queenster.

Abstract

Obesity is becoming an increasing cause of concern worldwide. This thesis examines the determinants and prevalence of obesity, and evaluates the potential health-related cost savings associated with the implementation and promotion of the health claim on low-calorie diets and obesity in Canada. Using data from 2004 Canadian community health survey and reviews of medical/nutritional literature, a Multilevel Multinomial Logistic Regression Model and a variation of Cost of illness approach reveal the following. We found that almost two-thirds of Canadians are overweight/obese. We also found that the aged, males, married, people born in America, less educated, physically inactive, and inadequate fruits/vegetable consumers have increased risk of becoming obese. A 5%-10% reduction in caloric intake due to health-information/health-claims results in nontrivial health-related base savings of CAD$2.09 billion with range of CAD$360 million to CAD$4.18 billion. Stronger economic policies such as subsidies/taxes on low-calorie/high-calorie diets could potentially lead to social optimal calorie consumption.

Acknowledgement

First and foremost, I am thankful to the Almighty God for the gift of life, strength and knowledge to pursue this graduate degree. I wish to express my profound gratitude to my supervisor, Dr. Stavroula Malla for her support and unreserved mentorship throughout my graduate studies. I am thankful for the unfailing patience, encouragement and enormous time she dedicated to the success of this thesis and my entire graduate degree.

A special thanks to my co-supervisor, Dr. Kien Tran for his guidance, support and invaluable suggestions to make this thesis a success. I would like to express my sincere gratitude to my committee members, Dr. Alexander Darku and Dr. Duane Rockerbie for their invaluable contribution to the completion of the thesis. I am most grateful to Dr. Darku for his encouragement, constructive criticism and time dedication throughout my entire graduate program. A special thanks to the faculty and staff of the Economics Department especially Dr. Richard Mueller, Dr. Kurt Klein, Dr. Pascal Ghanzalian, Jeff Davidson and Merle Christie. I would like to express a special word of thanks to my colleagues and friends, Eric Agyemang, Adriana Appau, Eric Sogah, Comfort Kwarteng, Thomas Atta-Fosu, Akwasi Owusu, Cosmas Dery, Richard Yeboah, Kwaku Adoo, Prince Obeng, Jessie Acquah, Frederick Amponsem, Emmanuel Obeng-Mireku and last but not the least Ekow Botwe for their encouragement and support during my graduate studies.

Without the love, encouragement and unfailing support of my mother, Mrs. Dorcas Owusu, I would not have been where I am today. Mom, I say thank you for being very instrumental in my life. I also thank my two siblings Akwasi and Queenster for their love and support. Thank you.

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List of Abbreviations

BMI	Body Mass Index
CCHS	Canadian Community Health Survey
CHD	Coronary Heart Diseases
CIHI	Canadian Institute of Health Information
CLA	Conjugated Linoleic Acid
COI	Cost of Illness
CR	Calorie Restriction
CVD	Cardiovascular disease
DALY	Disability- Adjusted Life Years
FDA	Food and Drug Administration
FFN	Functional Foods and Nutraceuticals
FSP	Food Stamp Programs
GLLAMM	Generalized Linear Latent And Mixed Models
HYLG	Healthy Years of Life Gained
LCD	Low-Calorie Diets
MB	Marginal Benefit
MC	Marginal Cost
ML	Maximum Likelihood
MMLRM	Multilevel Multinomial Logistic Regression Models
NBJ	Nutrition Business Journal
NHED	National Health Expenditure Database
O.R	Odds Ratio
OTC	Over-the-Counter
PHAC	Public Health Agency of Canada
PHS	Personal Health Supplies
QALYs	Quality-Adjusted Life Years
R&D	Research and Development
SPAR	Ministers of Sport, Physical Activity and Recreation
U.K	United Kingdom
U.S	United States
VAT	Value Added Tax
VLCD	Very Low-Calorie Diets
WHO	World Health Organization
WHO/FAO	World Health Organisation/ Food and Agriculture Organisation

CHAPTER ONE

1. Introduction

The increasing health care cost burden, increasing morbidity rates, and increasing mortality rates in Canada and other developed countries as a result of some preventable diseases are a cause for great concern (Canadian Institute for Health Information 2013, and World Health Organization 1996). A significant number of these preventable health risk diseases are diet related. Expert consultation of joint WHO and FAO in 2002 recognized that as a result of changing dietary and lifestyle patterns, certain diseases like obesity, hypertension, diabetes mellitus, cardiovascular disease (CVD), and many others have become increasing causes of disability and premature deaths. Mounting evidence on awareness of the strong correlation between diet and health, coupled with the increasing health care cost in Canada have kindled interest in functional foods (Malla et al. 2013)[1]. Governments, policy makers and interest groups are now focusing attention on the promotion of functional foods (Health Canada 2009a). As a result, Health Canada has approved the use of a total of thirteen health claims on functional foods and food products since the year 2000 (detailed discussion on functional foods and health claims are presented in chapter two)[2]. For example, Health Canada approved the health claim on Ground Whole Flaxseed and Blood Cholesterol Lowering in 2014.

It has been shown that excess consumption or absence of certain vital nutrients in our daily diets is the main cause of most of the preventable diseases (Health Canada

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[1] Health Canada defines functional foods as "a food similar in appearance to, or may be a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions" (Health Canada 1998).

[2] The generally accepted definition of health claims in Canada is "any representation in labelling or advertising that states, suggests, or implies that a relationship exists between consumption of a food or an ingredient in the food and a person's health" (Health Canada 2012b).

2012a). Obesity, which is a preventable health risk disease, has been shown to be a health concern in Canada (Katzmarzyk et al. 2001). The causes of obesity are multi-faceted. Prominent among them is the decline in physical activities of Canadians and the changing food environment. The causes of obesity also includes the consumption of food in large quantities and the availability of unhealthy foods with overblown calories. Increased calorie consumption is positively associated with obesity (Fontana et al. 2007, and Redman et al. 2007). Cutler et al. (2003) suggested that a greater proportion of the problem of increasing obesity incidence in the U.S. could be attributed to increase in caloric intake. Obesity is increasingly becoming a major health risk issue in North America and the world at large. The statistics shows that not only is obesity an issue in developed countries, it is also a major health concern in developing countries due to the prevalence rates in some of these countries being even higher than that of the U.S. and other developed countries (Popkin and Doak, 1998). Obesity has been shown to be the risk factor to quality of life in terms of morbidity and mortality (Katzmarzyk et al. 2001 and Edwards 2007). Studies have also shown that obesity is the major risk factor for diseases such as heart disease and diseases of pulmonary circulation, cancer, cerebrovascular diseases (such as hypertension and stroke) and diabetes (Birmingham 1999, Tan 2011 and Alter et al. 2012). The number of deaths due to obesity in Canada was 8,414 in 2004 as compared to 4,321 deaths in 2000, a figure which is almost twice the estimated obesity related deaths in the year 2000 (Luo et al. 2007). Moreover, it is estimated that, 13.5% of the deaths recorded in Canada in the year 2001 could have been avoided in the absence of obesity (Katzarzyk 2001).

The increasing health care expenditure and the negative obesity externalities are seen as a burden to the health care system in most countries, especially countries with a publicly funded health care system like Canada. The negative obesity externalities arise when all or portions of the health care cost of obese individuals is borne by the entire population because of the publicly funded health care system in place. It is estimated that the direct cost of obesity in Canada for the year 1997 was $1.8 billion, a figure representing 2.4% of the total health care expenditure in 1997 (Birmingham 1999). In 2005, the total cost of obesity was $4.3 billion (Heart and Stroke Foundation 2011, PHAC 2009). In 2008, the cost of obesity was estimated to be $4.6 billion (Public Health Agency of Canada 2011). This figure is regarded as a very conservative estimate since only eight of the diseases closely linked to obesity were taken into consideration. In 2006, a similar study that assessed the cost of obesity taking into consideration 18 chronic diseases closely linked to obesity found the total cost of obesity to be about $7.1 billion (Public Health Agency of Canada 2011). The rate of increase in health care expenditure in Canada has been 7% per year between 2000 to 2010 with an expected all-time high expenditure of $211 billion in 2013 (Canadian Institute of for Health Information 2013). With the continuous increase in health care cost, morbidity and mortality, it is necessary that measures are put in place to minimize—if not eliminate—the incidence of obesity in Canada.

Combating the incidence of obesity and its consequences will involve the reduction of calorie content in our foods. There have been a lot of efforts from the government to reduce the incidence of obesity in the country. However, based on the current statistics on the incidence and cost of obesity in Canada, it seems the efforts are

neither sufficient nor effective. In 2008, the Ministers of Sport, Physical Activity and Recreation (SPAR) in Canada (with the exception of Quebec) established physical activity targets for children and youth (PHAC 2011). In addition, there have been measures to facilitate healthier eating, like the introduction of mandatory nutrition labelling on pre-packaged foods in Canada in 2005, and the requirement to label the presence of trans-fats in these foods. However, more work needs to be done in the form of stringent policies to curtail the ever-increasing incidence of obesity in Canada. The U.S. and Europe are beginning to take firmer approach to the problem of obesity by considering disease risk reduction health claims on diets with low calories (European Food Safety Authority 2011)[3]. This approach, however, is not under consideration in Canada even though the statistics discussed above clearly show that obesity is a significant health concern in Canada. Other countries are also considering other policies aimed at caloric intake reduction. A good example is the attempted introduction of a "fat tax" by the Danish government in 2011. Although it was well intentioned, the tax was repealed a year later due to some implementation challenges (Stafford 2012).

The issue of obesity has not been adequately addressed in the literature, especially in Canada. In attempt to address the issue of obesity, numerous scientific studies have been conducted to assess the effects of calorie restriction on human body composition and weight (e.g. Fontana et al. 2004, Guarente and Picard 2005, Kok et al. 2005, Heilbronn et al. 2006, Larson-Meyer et al. 2006, Racette et al. 2006, Villareal et al. 2006, Weiss et al. 2007, Civitarese et al. 2007, Fontana et al. 2007, Redman et al. 2007, Colman et al. 2009, Redman et al. 2009). Other studies have also assessed the effects of measures

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[3] Disease risk reduction claims specify the relationship that exists between the consumption of a nutrient and its impact on disease risk.

like investments in research and development (R&D), subsidies and taxes on obesity incidence (e.g. Tiffin and Arnoult 2011, Alston et al. 2013, Rickard et al. 2013, Leicester and Windmeijer 2004, Mytton et al. 2007, Cash et al. 2005). However, to the best of our knowledge, no work has been done to empirically examine (using actual nationwide Body mass index data), the effects of calorie restriction on obesity incidence. In addition, though studies have been conducted to assess the effects of health claims on other diseases (e.g. Malla et al. 2015), no work has been done to critically assess the direct impact of health claims on obesity incidence in Canada.

1.1 Thesis Objective

The main goal of this study is to identify the determinants of obesity in Canada and assess the potential economic benefits of successful implementation and promotion of health claims in Canada. Hence, the objectives of this thesis are to give an updated evaluation of the socioeconomic and sociodemographic characteristics of obesity in Canada (i.e. analysis of the risk factors or determinants of obesity) and to estimate the prevalence of overweight individuals and obesity in Canada. In addition, the study examines how implementation of government policies and regulations could help reduce obesity incidence, thereby resulting in a reduction of health care expenditure in Canada. The allowance of the health claim on low calorie diets and obesity is explicitly assessed while other policies and their implications are discussed.

1.2 Thesis Contribution

This thesis makes two main contributions to the existing literature on obesity. To begin with, this is the first study to use the disease risk reduction health claim on low calorie

diets and obesity as an intervention policy to comprehensively analyse the potential reductions in obesity prevalence and health-related expenditure on the disease. Although previous studies have attempted to analyse the various aspects of health claims in North America, little work has been done to critically assess the efficacy of health claims in Canada. A lot of the work done on health claims have placed more emphasis on the U.S. In addition, most of the studies that attempted to analyse health claims focused on specific aspects of the claim. For example, they focused on the impact of the health claims on consumer behaviour, demand and willingness to pay (e.g. Levy and Stokes 1987, Moon et al. 2011, Brown and Schrader 1990, and Wansink and Cheney 2005). Others also tried to estimate the potential cost savings to the health sector as a result of increasing the consumption of functional foods or reducing the intake of certain food constituents, but did not specifically reference a particular health claim (e.g. Joffres et al. 2007, and Malla et al. 2007). The studies did not explicitly account for the implication of the health claims on health care expenditure. Few studies that attempted to assess the impact of health claims on health-related expenditure also focused on other diseases (e.g. Malla et al. 2015). Though some work has been done on obesity, to the best of our knowledge, no study has comprehensively and explicitly analysed the health claim on low calorie diets and obesity as an intervention policy to address the problem of obesity in Canada and elsewhere.

Secondly, to the best of our knowledge, this is the first study that analyzes the effects of calorie restriction on obesity prevalence by performing weight loss simulations on actual data which was based on measured height and weights. This thesis performs weight loss simulation on confidential micro-level data from Statistics Canada to estimate

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the potential reduction of obesity prevalence in Canada resulting from the introduction of a policy (in this case, the implementation and promotion of the health claim on low calorie diets and obesity) that will encourage people to reduce their caloric intake. In addition, this thesis analyzes the effects of the reduction in obesity prevalence on health care expenditure to estimate the potential health care savings. In order to address the obesity problem, various studies have used different intervention measures like agricultural R&D investment, taxes, and subsidies to assess the impact of these policies on calorie consumption and obesity incidence (e.g. Tiffin and Arnoult 2011, Alston et al. 2013, Rickard et al. 2013, Leicester and Windmeijer 2004, Mytton et al. 2007, Cash et al. 2005). However, none of these studies empirically examined the effects of the resultant decrease in calorie consumption on obesity prevalence. By using the introduction and promotion of the health claim on low calorie diets and obesity as an intervention policy, the study systematically examines the impact of such policy on calorie consumption, obesity prevalence and health care expenditure through simulation of actual data on Canadians.

1.3 Organisation of the study

The remainder of this thesis is organised as follows. Chapter 2 provides the background information on health claims and obesity. Chapter 3 provides review of relevant literature on the determinants of obesity, policies relating to obesity, functional foods and health claims in general. Chapter 4 outlines the methodological approach, model specification, the data used and some measurement issues. The chapter also discusses in details, the various methods used to perform the analyses. The methods include descriptive statistics,

Multilevel Multinomial Logistic Regression Models (MMLRM) and a variation of Cost of Illness (COI) approach. Chapter 5 presents and discusses the econometric results and the estimations from the COI approach. Specifically, it discusses the major findings from the study and explain their relevance. In addition, it compares and contrast the results from the study to previous findings in the literature. Chapter 6 discusses policy implications and makes recommendations based on the findings of this thesis. Chapter 7 provides the summary, conclusions and limitations of the thesis.

CHAPTER TWO

2. Background

This chapter provides a detailed explanation of the key terms and concepts used in this thesis. First, definition of key terms such as functional foods, natural health products, health claims, therapeutic claims, disease risk reduction claims, functional claims, and general health claims are discussed. Second, we briefly provide information on the different types of health claims, regulation process and issues surrounding health claims, as well as industry, market and research trends of functional foods. Finally, relevant obesity background information such as the prevalence, trend, health risk and socioeconomic burden of obesity are discussed.

2.1 Functional foods, Natural health products (NHPs) and health claims

Health Canada acknowledges that diets can alter one's risk of developing or aggravating certain chronic health conditions (Health Canada 1998). The increasing economic burden of some diet related preventable diseases and the mounting evidence of strong correlation between diet and health have attracted a number of policy responses from the government and other stakeholders (Health Canada 1998). Such responses include mandatory nutrition labelling and the promotion of functional foods and health claims. Functional food consumption has the potential to improve well-being and reduce health care cost. There is no generally accepted definition for functional foods and NHP around the world[4]. However, Health Canada (1998) defines functional food as "*a food similar in*

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[4] In Canada, NHPs were formerly referred to as nutraceuticals.

appearance to, or may be a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions". An example of a functional food is food high in fibre, which is noted for reducing one's rick of developing certain types of cancer. Nutraceuticals is defined by health Canada as "*a product isolated or purified from foods that is generally sold in medicinal forms not usually associated with food and is demonstrated to have a physiological benefit or provide protection against chronic disease*" (Health Canada 1998). Agriculture and Agri-Food Canada defines NHPs as products that "*are made from natural sources, sold in dosage form, and designed to maintain or promote health; to restore or correct human health function; or to diagnose, treat or prevent disease. They come in a wide variety of forms like tablets, capsules, tinctures, solutions, creams, ointments and drops*" (Agriculture and Agri-Food Canada 2014a). Some examples of NHPs are vitamin and mineral supplements. NHPs therefore include nutraceuticals, homeopathic and traditional medicines.

Great efforts are currently being made to create awareness of the benefits of the nutrient content of foods such as the use of health claims. The main aim of these measures is to facilitate healthy eating choices which will in the long run translate into a healthier population. This will also lead to a reduction in the upsurging health care cost (Malla et al. 2013). Health claim on foods refers to any claim that links the consumption of a food or any food product to health. The generally accepted definition of health claim in Canada is "*any representation in labelling and advertising that states, suggests, or implies that a relation exist between the consumption of food or food constituent and health*" (Health Canada 2012). According to Health Canada, health claims could take

two main forms: the generic claims and product specific claims. Generic claims could be used on any food item given—that the item meet the criteria set out for the use of that claim—while product specific claims cannot be used for any food unless that specific food carrying the claim has undergone registration and enough supporting evidence has been provided. An example of generic claim is a claim stating that "*a healthy diet rich in a variety of vegetables and fruit may help reduce the risk of some types of cancer*" (Health Canada 2007).

Health Canada categorizes health claims into four main groups. These groups include therapeutic, disease risk reduction, functional claims, and general health claims[5]. Therapeutic claims refers to claims suggesting that the consumption of a food constituent can lead to the cure, mitigation or the prevention of a disease condition. An example of therapeutic claim is *"Psyllium and Blood Cholesterol Lowering"*. Disease risk reduction claims, on the other hand, establish a link between the intake of a nutrient and the reduction of major disease risk factor(s). An example of disease risk reduction claim is *"Vegetables and Fruit and Heart Disease"*. Functional claims are claims suggesting that the intake of a food or food constituent is associated with normal growth and development, or maintenance of normal functioning of the human body. An example of functional claim is *"promotes regularity" and "improves nutrient absorption and aids in digestion"* (Health Canada 2009b). Functional claims can also be subcategorized into two claims: nutrient function claims and probiotic claims. According to Agriculture and Agri-Food Canada (2013), *"nutrient function claims are function claims that describe the well-established roles of energy or known nutrients that are essential for the maintenance of*

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[5] Functional claims were formerly known as structural/functional claims

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good health or for normal growth and development". Probiotic claims also refer to claims suggesting that the food or food product contains microorganisms that are essential to human health. Lastly, general health claims *"are broad claims that promote health through healthy eating or that provide dietary guidance. These claims can be made on any product provided no linkage is made to a specific product or to a health effect, disease or health condition"* (Agriculture and Agri-Food Canada 2013). An example of a general health claim is *"Canada's Food Guide recommends eating at least one dark green and one orange vegetable each day"* (Agriculture and Agri-Food Canada 2014b).

There are currently thirteen acceptable Disease Risk Reduction or Therapeutic Claims in Canada (Health Canada 2015a). The acceptable Disease Risk Reduction or Therapeutic Claims are[6]:

- Vegetables and Fruit and Hearth Disease (2015)
- Soy Protein and Cholesterol Lowering (2015)
- Ground Whole Flaxseed and Blood Cholesterol Lowering (2014)
- Sugar-Free Chewing Gum and Dental Caries Risk Reduction (2014)
- Barley Products and Blood Cholesterol Lowering (2012)
- Unsaturated Fat and Blood Cholesterol Lowering (2012)
- Psyllium Products and Blood Cholesterol Lowering (2011)
- Oat Products and Blood Cholesterol Lowering (2010)
- Plant Sterols (Phytosterols) and Blood Cholesterol Lowering (2010)
- Calcium and Osteoporosis (2000)
- Fruits, Vegetables and Cancer (2000)
- Dietary Fat, Saturated Fat, Cholesterol, Trans Fatty Acids and Coronary Heart Disease (2000)
- Sodium and Hypertension (2000)

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[6] Acceptable Disease Risk Reduction or Therapeutic Claims as at August 2015

In Canada, the Food and Drug Act governs health claim usage on food and food products. Before a new health claim is approved and allowed to be used, a petitioner needs to apply to health Canada providing scientific evidence backing the claim. Before the claim is accepted or authorized, the evidence submitted by the petitioner is evaluated using three main criteria: causality, generalizability, and quality assurance (Health Canada 2009a). The causality criterion requires applicants to provide evidence establishing the fact that the consumption of the food has effect on health outcomes. This is mostly done by providing human-based studies establishing a clear link between the consumption of the food and health. The generalizability criterion requires that the claim must be meaningfully generalizable to the broader population or a segment of the population. Lastly, the food on which the claim is used must conform to quality standards. If the claim is on a novel food, then a separate application for the novel food must either be submitted with the health claim application or submitted prior to the health claim application (Health Canada 2009a)[7]. It is important to note that health claims that place the food under the definition of drug need pre-market approval and regulation amendment (Health Canada 2009a).

Health claims and functional foods continue to receive increased recognition and acceptance worldwide. Globally, the market for functional food has grown tremendously over time with most of the growth dominated by the developed countries. It is estimated that, from 2000 to 2006, the market for functional foods grew by 68% (Blandon et al. 2007). In 2000, the market for functional foods was estimated to be US$50.63 billion. By

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[7] Health Canada defines novel foods as "foods that have been produced through new processes, that do not have a history of safe use as a food, or that have been modified by genetic manipulation" (Health Canada 2002)

2006, the functional foods market had grown to US$85.01 billion (NBJ 2004; 2007)[8]. The lack of uniformity in the definition of functional food has made it difficult to identify which country has the largest market for functional foods. However, irrespective of the definition used, the U.S., Japan, and Europe remain the leading markets for functional foods (Bandon et al. 2007, and Malla et al. 2013).

Focusing on Canada, the market for functional foods in the perspective of the global market can be considered as small. Canada's market for functional foods represents 1% of the global market (NBJ 2007). However, it is important to note that, the market for functional foods in Canada has witnessed significant growth over time. In 1997, the market for functional foods was US$0.4 billion. However, by 2005, it had grown to US$1.0 billion (NBJ 2007a). According to the results from the 2005 Functional Foods and Nutraceuticals survey, 389 firms were involved in the production of functional foods and nutraceuticals (FFN) in 2005. Out of this number, 118 firms were engaged in functional foods while 174 firms were engaged in nutraceutical products. The remaining 97 firms were engaged in both. According to health Canada, 73% of Canadians regularly take natural health products (Health Canada 2015b). In 2004, the total revenue from the FFN industry was $2.9 billion. The functional food industry contributed $823 million, the nutraceuticals $1.6 billion and the remaining $442 million by firms producing both products. In addition, the total value of exports of FFN products in 2004 was $545 million. Considering employment, the results from the FFN survey suggested that, the sector employed a total of 12,872 people in 2004. Lastly, out of a total of $162.8 million spent on R&D by all firms, $74.5 million was incurred on FFN products (Palinic 2005).

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[8] NBJ- Nutrition Business Journal

2.2 Prevalence and trend of obesity

The statistics indicates that the prevalence rate of obesity in Canada is alarming (Statistics Canada 2013). Two out of every three Canadian adults are said to be overweight or obese. Considering the prevalence of obesity alone, 23.1% of Canadian adults were found to be obese in 2004 (Tjepkema 2006). Canadian adults of Aboriginal origin had the highest obesity prevalence among the ethnic groups with a prevalence rate of 37.8% in 2004 (Tjepkema, 2006). The percentage of Canadian children aged 2 to 17 years who were overweight or obese in 2004 was 26%. Considering obesity alone, 8% of the children were obese (Shields 2006). About 41% of Canadian young people of Aboriginal origin were recorded as overweight or obese in 2004 (Shields 2006).

In Canada, the number of people who are overweight or obese has increased significantly over the past two decades (Tjepkema 2006 and Shields 2006). The statistics shows that not only are the obesity and overweight prevalence rates very high but they also show a worrying trend of increase over time. While the prevalence of overweight individuals and obesity combined among children and adolescents have doubled over the past two decades (i.e. from 14% in 1978/79 to 29% in 2004), considering obesity alone, the prevalence has almost tripled over the same time period. The prevalence of obesity increased from 3% in 1978/79 to 9% in 2004 (Shields 2006). Adult obesity prevalence rate in Canada has quadrupled from 5.6% in 1985 (Flegal *et al*. 2002 and Katzmarzyk 2002a, b) to 23.1% in 2004 (Tjepkema 2006).

Findings from other studies also showed a disturbing trend of increase in the prevalence of overweight individuals and obesity. About 32% of Canadian adults who were of normal weight in 1994/95 had turn overweight by 2002/03. At the same time, 2%

of Canadian adults who were of normal weight in 1994/95 had turned obese by 2002/03 (Le Petit and Berthelot, 2005). According to Statistics Canada, "*in 2009, 17.9% of Canadians aged 18 and older, roughly 4.4 million adults, reported height and weight that classified them as obese, virtually unchanged from 2008. However, from 2003 to 2009, obesity among men rose from 16.0% to 19.0%, and among women, from 14.5% to 16.7%*" (Statistics Canada 2009).

2.3 Health risks and burden of obesity to the health sector

Obesity has been shown to be a risk factor in most chronic diseases. Combining both the overweight and obesity prevalence shows that 59.2% of Canadian men and 43.9% of women were at increased health risk because of excess weight (Statistics Canada 2010-Canadian Community Health Survey 2009). According to Health Canada, being overweight or obese increases the risk of a wide range of serious diseases and conditions such as: "Hypertension or high blood pressure; Coronary heart disease; Type 2 diabetes; Stroke; Gallbladder disease; Osteoarthritis; Sleep apnea and other breathing problems; Some cancers such as breast, colon and endometrial cancer; Mental health problems, such as low self-esteem and depression" (Health Canada 2006a, page 2).

Obesity undoubtedly is a major health concern in Canada, considering the cost and the trend of mortality rates of obesity in the country. In 1997, the estimated direct cost of obesity in Canada was $1.8 billion (Birmingham 1999). This represented 2.4% of the total health care expenditure in 1997 (Birmingham 1999). In estimating this cost, Birmingham (1999) focused on the diseases that had a well-established association with obesity. In addition, emphasis was given to the comorbidities (obesity related diseases)

whose monetary cost could be estimated from the National Health Expenditure Database (NHED) of the Canadian Institute of Health Information (CIHI). The comorbidities selected included postmenopausal breast cancer, colorectal cancer, coronary artery disease, endometrial cancer, gallbladder disease, hyperlipidemia, hypertension, pulmonary embolism, stroke and type II diabetes. The top three contributors to the total cost of obesity were Hypertension at $656.6 million, Type 2 diabetes mellitus at $423.2 million, and coronary artery disease at $346.0 million (Birmingham 1999). According to the Heart and Stroke Foundation, in 2005 the total cost of obesity was estimated to be $4.3 billion [direct cost $1.8 billion, and indirect cost $2.5 billion] which according to the Heart and Stroke Foundation may be an underestimation (Heart and Stroke Foundation 2011, PHAC 2009)[9]. It was also estimated that the total direct cost of the overweight and obese in Canada was $6.0 billion in 2006 with 66% attributed to obesity. This corresponds to 4.1% of the total health expenditures in Canada (Anis et al 2009). The total cost of obesity alone (both direct and indirect) based on 18 diseases closely linked to obesity was about $7.1 billion (Public Health Agency of Canada 2011).

Moreover, deaths due to obesity and being overweight from 1985 to 2000 were 57,000 in Canada (Heart and Stroke Foundation 2011, Tjepkema and Shields 2005). Katzmarzyk and Arden (2004) also estimated the total number of deaths which could be attributable to overweight and obesity to be 57,181 within the same time period (1985-2000). In 2004, deaths due to obesity in Canada were 8,414 (Luo et al 2007). Not only are the deaths due to obesity very high but they also show a disturbing trend of increase with time. In 1985, the deaths dues to obesity were 2,514. By the year 2000, the total

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[9] Direct cost includes hospital care expenditure, physician services, drug cost, health research cost, cost of services of other health professionals and other health care cost. Indirect cost is mainly the cost incurred due to productivity loss resulting from mortality and morbidity.

number of deaths attributed to being overweight and obesity had increased to 4,321 (Katzmarzyk and Arden, 2004). However, by the year 2004, the total number of deaths dues to obesity had increased by almost a double of the year 2000 figure to 8,418 (Luo et al 2007). Furthermore, it is estimated that, the elimination of overweight and obesity could have theoretically reduced premature deaths by 13.5% (Katzmarzyk 2001).

CHAPTER 3

3. Literature review

Extensive literature exists on different areas under health claims and obesity. By mainly focusing on studies that were based on North America, this chapter reviews relevant literature on health claims and obesity. The first part of the chapter reviews previous studies on health claims, consumer attitude, and the acceptance and willingness to pay for functional foods. The second part of the chapter reviews studies that analysed the various factors that significantly contribute to obesity incidence. This section reviews studies on the determinants of obesity by comparing and contrasting the major findings of those studies. Finally, we reviewed studies that focused on price intervention policies as an important measure to reduce obesity. Included in the review are studies on intervention measures like agricultural R&D investment, subsidies on healthy food products, and "fat taxes" on unhealthy foods.

3.1 Health claims, consumer attitude, acceptance and willingness to pay

A number of studies have attempted to analyse different aspects of the various health claims on functional foods. These studies used different approaches to assess the impact of the health claims on the consumption of the various functional foods. Studies have shown that consumers value functional foods and the health information they carry, which links the consumption of those foods to health (e.g. Brown and Schrader 1990, Moon et al. 2005). It has been shown that the health information can influence the behavioural intentions of consumers (e.g. Moon et al. 2011). Furthermore, health claims

or health information have been identified to affect demand patterns (e.g. Levy and Stokes 1987, and Ippolito and Mathios 1991). A significant number of the studies in this section focus on factors that affect acceptance and the willingness to pay by consumers (e.g. West et al. 2002, Tuorila and Cardello 2002, Maynard and Franklin 2003, West and Larue 2004, Teratanavat and Hooker 2006, Peng et al. 2006, Herath et al. 2008, Markosyan et al. 2009, Henson et al. 2010, Milligan et al. 2010, Lawless et al. 2015). Highlights of the major findings of these studies are discussed below.

Evidence from the literature has revealed that consumers are increasingly becoming aware of the health implications of their diet choices and as such now place importance on the link between diet and health. The awareness of health benefits derived from the consumption of functional foods and food products has been shown to be positively associated with the consumption of those foods. Brown and Schrader (1990) used cholesterol information index to examine the impact of cholesterol information on the demand for shell eggs in the U.S. The cholesterol information is the relationship between the presence of cholesterol in the diet and the development of arterial diseases (diseases associated with high blood cholesterol). The study suggested that per capita shell egg consumption was reduced by 16% to 25% as a result of the cholesterol information. Moreover, a positive interaction was observed between egg price and cholesterol, which suggested a reduction in price elasticity of shell eggs as a result of availability of cholesterol information. Although the price of eggs fell, the associated increase in consumption of shell egg was less as a result of the presence of cholesterol information. Moreover, there was a negative interaction between income and cholesterol, suggesting a reduction of income elasticity of shell eggs as a result of cholesterol

information. Although income increased, the resultant increase in the consumption of shell eggs was less than proportionate, as a result of the cholesterol information. According to the author, the study could be extended to examine the relationship between cholesterol information and the consumption patterns of other food products like red meat, poultry, and dairy products.

It has been shown that consciousness of the health benefits of foods greatly affects both the decision and frequency of consumption of those foods. Moon et al. (2005) used a sample of 1400 households from an online survey of the Ipsos-NPD Marketing Research Panel data to examine whether the perceived health benefit of soy protein had impact on the consumption pattern of soy foods. The authors claimed that clinical research had established a close link between soy consumption and reduction of chronic diseases like osteoporosis, heart disease and cancer. A two stage model was used to examine the effect of perceived health benefits from soy foods on consumer decision. While the first stage examined the decision to consume or not to consume soy foods, the second stage examined the frequency of consumption of soy foods. Findings from the study suggested that the perception of health benefits significantly affected both the decision to consume soy foods and the frequency of consumption. Moreover, it was revealed that the impact of negative perception regarding soy foods (e.g. unappetising taste and inconvenience) far exceeded the impact of health benefit perception. The consumers who participate in the soy food market as a result of high perception of health benefits consume soy foods more frequently than those with low perception of health benefits. The study recommended that consumer motivation and knowledge of nutrition should be improved.

Making health information available to consumers in the form of health claims has been identified as a significant factor that influences the behavioural intentions of consumers. Moon et al. (2011) used data collected by Ipsos-Observer in 2007 to assess the influence of health claims on the behavioural intention of consumers in relation to soy-based foods. The author adopted the theory of planned behaviour by Ajzen and Fishbein (1977, 2005) to examine the impact of health claims on consumer behavioural intention in relation to soy-based foods. Findings from the study indicated that non-users of soy-based foods who already have insight in nutrients are more inclined to trying soy-based foods. Sporadic consumers were also seen to be more likely to include soy-based foods in their regular diet, while the regular consumers of soy-based foods were also seen to be more likely to increase their consumption. A strong positive relationship was observed between respondent's perception of health benefit and taste, and their behavioural intention towards soy-based foods. The study also revealed that consumers were indifferent about whether a food product had an "FDA" health claim or it had a general health claim. This implied that, the name "FDA" added little or no information to consumers. Comparing users to non-users of soy-based food products (i.e. both regular and sporadic), users were seen to be more willing to increase their consumption of soy-based foods. The author recommended that awareness programs should be targeted at both non-user and sporadic users of soy-based food products.

It has been shown that health claims usage has an important effect on consumer demand for functional foods. Evidence from the literature suggests that health claims usage can alter the demand patterns of consumers. Levy and Stokes (1987) used data from 209 Giant Food, Inc., and supermarkets in certain areas of the U.S. within a sixty-

four week period to examine the impact of health claims (or health message advertising campaigns) on purchase of high fibre and non-high fibre ready-to-eat cereals. Specifically, the paper looked at the impact of the promotion of high fibre cereal products (e.g. All-Bran) of Kellogg Company after the company embarked on an intensive campaign to create the awareness of the link between consuming foods rich in fibre and the prevention of certain types of cancer. The findings from the study suggested that the campaign led to a shift in market share from non-high fibre cereals to high-fibre cereals. There was a progressive increase in the market share of high-fibre cereals during the entire 48 weeks of assessment. There was also a sharp increase in the market share of All-Bran product (which is very rich in fibre), 24 weeks into the campaign. An increase of market share from 0.99% to 1.46% was recorded (i.e. representing a relative increase of 47%). The sales of other high-fibre products of Kellogg Company rose 0.3%, which represented a relative increase of about 14%.

The use of health claims on cereal products began in 1984. Ippolito and Mathios (1991) used data from various sources to examine the market of ready-to-eat cereals in the U.S during the time that there was a ban on using health claims on the cereal products and also after the ban had lifted. Findings from the study revealed that consumer knowledge of fibre-cancer relationship was significantly improved as a result of the lift of the ban on health claims. In addition, the health claim also led to an increase in fibre cereal consumption and also an increase in product innovation. Although market share data on the periods prior to the beginning of health claim usage (i.e. 1978-1984) showed no significant shift in cereal consumption towards high-fibre cereals, there was a significant shift of market share towards high-fibre cereals after the use of health claims

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began. There was about a 7% increase in weighted fibre content after the health claim was allowed. That is, an increase from 1.64 grams per ounce in 1978 and 1984 to 1.75 grams per ounce in 1985-1987. It was recommended that health claims policy should be designed in such a way that producers will be motivated to make truthful claims.

Health claims, health information and education of health benefits of functional foods have been identified as significant factors that affects acceptance and the willingness to pay for functional foods by consumers (e.g. West et al. 2002, Tuorila and Cardello 2002, Maynard and Franklin 2003, West and Larue 2004, and Teratanavat and Hooker 2006). Consumer acceptance and usage of the health claims on functional foods has been analysed by a number of studies. The major findings from these studies have been highlighted below. West et al. (2002) used data from a telephone interview of 1008 Canadian household food shoppers to examine the Canadian consumer's attitudes, beliefs, knowledge and willingness-to-pay for functional foods. The study indicated that so far as credible information is provided about the safety and efficiency of the health claim on functional foods, the consumer would be willing buy and even go to the extent of paying price premium for the healthy foods. The findings suggested that a greater number of Canadians are more likely to pay a price premium for functional foods and nutraceuticals with the belief that it could reduce their likelihood of developing diseases such as cancer and heart disease.

Tuorila and Cardello (2002) used data from 78 adult U.S. respondents to examine the degree to which consumers would compromise on taste for the health benefits of functional food products. According to evidence from the study, the consumer's liking and decision to consume a product is significantly influence by the taste of that product.

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The magnitude of the impact of taste on consumption and liking is not dependent on the type of health benefits of the product. In addition, the study found that information about the expected health benefits of a food played important role in influencing consumers to consume functional foods. Information of the health benefits of food was also observed to be a determining factor as to whether a consumer would like a food product or not. The likelihood to consume functional juice was observed to be more dependent on the improvement in physical or cognitive performance derived from the food than the improvement in emotional well-being.

Maynard and Franklin (2003) examined the commercial feasibility of cancer-fighting functional dairy foods. The study assessed the willingness to pay for a selected dairy products that had been enhanced with conjugated linoleic acid (CLA) known to fight certain types of cancer. Findings from the study suggested that consumers were willing to pay premiums for the foods enriched with CLA. On average, consumers were willing to pay additional $0.41 per gallon for milk enriched with high-CLA, $0.38 per pound for butter enrich with high-CLA and $0.15 per eight-ounce cup of high-CLA yogurt. Based on the cancer fighting abilities of CLA, about 80% of the respondents were willing to pay a minimum of $0.20 per gallon of milk enriched with CLA.

Lawless et al. (2015) examined the factors that affect the willingness to pay for a nutraceutical-rich juice blend (a novel product). The factors included consumer characteristics, attitudinal factors, and product sensory attributes. Findings from the study indicated a general acceptance of nutraceutical-rich juice. On a 9-point scale, respondents indicated a 7.42 overall liking for nutraceutical-rich juice. On average, consumers were willing to pay $3.45 per bottle for nutraceutical-rich juice blend.

West and Larue (2004) used data from a 2001 telephone survey of 1008 Canadian household food shoppers to identify the factors that affect the desire of consumers to be among the initial people to try innovative functional foods. Findings from the study suggested that the desire of consumers to try new functional foods is significantly influenced by the belief of link between diet and health and also the belief of the nutrition content claim on the product by consumers. Consumers who were already at risk of developing diseases like cancer or heart disease and consumers who were already embarking on measures to reduce their likelihood of developing health risk diseases were seen to be more inclined to trying new functional foods. In addition, the willingness of consumers to be among the first to try new functional foods was affected by the production process of the new functional food. Among consumers who were not willing to be the first to try new functional foods were consumers with dislike for genetically modified foods and also older consumers. Lastly, the study found that a compromise of the credibility of health claims on functional foods and the belief of the diet-health relationship could discourage potential active consumers of functional foods.

Teratanavat and Hooker (2006) used data from about 1704 households from Ohio to examine the variations in consumers' preferences and consumer valuation of novel foods with functional properties. Findings from the study suggested that more than 50% of the respondents had positive valuation for functional tomato juice and they were willing to pay price premium for the health benefits of the natural functional tomatoes. In addition, it was found that consumers preferred functional foods with single health benefits capable of fighting cancer to functional foods with multiple health benefits (i.e. ability to jointly fight heart-disease and cancer). Consumer familiarity with the functional

food was also observed to play significant role in food choices by the consumers. Females were observed to have more heterogeneous preferences for functional foods than males. Finally, the study suggested that consumers acknowledge the importance of the health benefits of functional foods and they are willing to pay price premium for these functional foods.

Peng et al. (2006) used data from a telephone survey of 803 consumers in Canada to examine consumer attitudes and acceptance of CLA-enriched dairy products. The findings indicated that, the success of the CLA-enriched products market could be significantly improved by educating consumers of the health benefits of both conventional and CLA-enriched dairy products. Furthermore, promotion of all dairy products was also seen as helpful measure to improving the CLA-enriched dairy products markets. According to the authors, consumers who were already familiar with products like calcium or vitamin-enriched milk or calcium-enriched orange juice were observed to be more likely to be interested in CLA-enriched cheese. However, there was no relation between consumers' interest in CLA milk products and familiarity with omega-3 or soy products. The study found that consumers were more interested in the ability of CLA-enriched milk products to reduce risk of cancer or diabetes than the ability to reduce risk of heart disease. It was suggested that the target consumers of CLA-enriched products should be middle-aged consumers and people who are health conscious. The authors recommended that future studies should address the issue of consumers' willingness-to-pay price premium for dairy products enriched with CLA since intention is undoubtedly affected by price.

Herath et al. (2008) used a survey data of 1700 Canadians to identify consumer segments associated to functional foods and nutraceuticals in the country. The authors used cluster analysis and analysis of variance (ANOVA) to examine the data. The study revealed that some sociodemographic factors such as age, income, education and location were important determinants of functional foods and natural health product consumption in Canada. In addition, the study found that consumers with characteristics like the elderly, less educated, and low income were more likely to accept functional foods and nutraceuticals. The authors indicated that these types of consumers were more concerned about their health and they also showed a higher willingness to know more about potential health benefits of functional foods and nutraceuticals. On the other hand, consumers with characteristics like the young, highly educated, and high income households were observed to be less likely to accept functional foods and nutraceuticals.

Markosyan et al. (2009) used data from a face-to-face consumer survey of 730 US consumers with contingent valuation survey instrument to assess consumers' responses to a "functional" apple enriched with antioxidant coating noted to fight cancer. The results from the study suggested that consumers place more value in functional foods and they are willing to pay price premium for these foods. Findings from the willingness-to-pay estimation revealed that, on average, consumers are willing to pay a marginal premium for antioxidant-enriched apples. According to the results from the study, consumers who place emphasis on organic products when shopping are less likely to pay price premium for antioxidant-enriched apples. In spite of the general positive attitude of consumers towards functional foods, it was found that the fear of the riskiness of the technology used in functional food production might result in rejection by some consumers.

Consumers in Spokane were observed to be more likely to pay price premium for antioxidant-enriched apple than Seattle consumers (Markosyan et al 2009).

Henson et al. (2010) used data from a mall intercept survey of 446 respondents in Ontario, Canada to examine consumers' willingness to purchase foods and non-prescription pills containing phytosterol, which is noted to reduce the risk of cardiovascular disease (CVD). The study used Protection Motivation Theory (PMT). According to the authors, PMT is a social cognition model rooted in research on fear appeal in determining health-protective behaviours. The findings from the study confirmed that the PMT framework could generally explain the propensity of consumers to embark on health related-dietary changes. Particularly, the framework could explain the propensity of consumers to consume nutraceuticals and functional foods. According to the results, the main determinants of consumers' intention to use non-prescription drugs and/or foods rich in phytosterols to reduce their risk of CVD are response efficacy and self-efficacy.[10] The study found that, perceived threat of CVD was not a significant determinant of consumers' willingness to consume products rich in phytosterols. Therefore, consumers may consume products if they perceive that they are effective irrespective of the degree of their self-perceived threat of CVD. Finally, the study found that, cholesterol as a risk factor of CVD did not have any significant effect on consumers' intention to increase the consumption of products rich in phytosterol.

Milligan et al. (2010) analysed socioeconomic and demographic factors associated with the willingness to pay for cancer prevention. More than half of the

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[10] Response efficacy refers to the belief that products the works effectively whiles self-efficacy means consumers are able to consume the product in the required manner.

respondents were of the view that their chances of developing cancer later in their lives were high. The study found that while age was negatively related to willingness-to-pay to avoid cancer, income and self-assessed likelihood of developing cancer were positively related to willingness-to-pay to avoid cancer. While 72% of the respondents were willing to pay a minimum of $100 to prevent cancer, 10% were willing to pay $1000. Bech-Larsen and Grunert (2003) also analysed consumer's perception of the healthiness of functional foods in relation to health claims, processing methods, functional enrichment, and food-type. The study suggested that, consumer acceptance of healthy functional foods is highly influenced by among other things, their perception of the healthiness of the processing methods, enrichment components and health claims used in the production of such food products. In comparing respondents from the three countries where the research data was sampled from, the study found that people from Finland had more positive attitude towards functional food than people from the U.S. and Denmark. This finding was interesting considering the fact that, the market share of functional foods in the U.S. is bigger than that of Europe. The study indicated that the use of health claims could significantly improve the consumers' health perception of functional foods. In addition, it was found that, the perception of nutritional qualities in the base-product had more effect on consumers' perception of the healthiness of the functional food than the use of health claims.

In spite of all the work done on health claims and functional foods, few studies have attempted to analyse the successes and failures of the health claims. Briefly discussed below is a study that assess the health claims in the U.S. Wansink and Cheney (2005) analysed the existing health claims approved by the Food and Drug

Administration (FDA) to understand the impact of the relationship between diet and health on awareness and usage of the claims. The study claimed that the primary source of information on diet-health relationships continues to be the product nutritional labels. Since consumers are increasingly becoming concerned about the authenticity of these claims, it is necessary that these claims come from credible sources (like government entities, academia, etc.). The study argued that the awareness of the presence of nutrients in food can be translated into consumption if consumers are motivated. According to the authors, the two fundamental knowledge that consumers can have about a healthy (nutritional) food are the attributes and benefits of the food. The study suggested that there was a positive relation between the awareness of the two fundamental knowledge and the consumption of functional foods. The author argued that health claims that target particular populations are mostly successful in establishing a clear link between diet-health and the health benefits of consuming such foods among the targeted population. It was further argued that in addition to targeting specific segments of the population, prior nutrition knowledge is also very vital for the success of the health claims. Another factor that can contribute to the success of a health claim is media attention and also promotion of health claim by companies. Health claims can also be successful if it clearly quantifies the health benefits. It was recommended that in order to make health claims acceptable, more salient health-related belief should be added to the claim. An example of such addition is "the ability to reduce the risk of heart disease" (Wansink and Cheney 2005). Such additions can overshadow some of the reservations that consumers have about a food product.

3.2 Determinants of obesity

The discussion here focuses on obesity and its major risk factors. The emphasis is on North American studies. The severity of the obesity epidemic has attracted a number of empirical studies into the causes and determinants of obesity. Numerous studies have attempted to establish a relationship between obesity and certain sociodemographic/ socioeconomic and lifestyle factors by employing different analytical techniques. Moreover, such studies have also attempted to identify groups of people who are more or less at risk of being obese as compared to the normal.

Gender has been shown to be a significant determinant of overweight and obesity in Canada and the rest of the world at large. Generally, most studies suggest males are more likely to obese as compared to females (Katzmarzyk 2002, Kaplan et al 2003, Huoto et al 2004, Bélanger-Ducharme and Tremblay 2005, Mandal and Chern 2006, and Edwards 2007). However, other studies rather found females to be more likely to be obese than males (Tan et al 2011, and Le Petit and Berthelot 2005). Moreover, it has been found that, generally, males are more likely to be overweight than females (Kaplan et al 2003, Oliver and Hayes 2005, Ward et al. 2007, and Le Petit and Berthelot 2005). As a result of the significant relationship between gender and overweight/obesity, some authors recommend that gender should be taken into consideration when formulating and implementing obesity intervention policies (Huoto et al 2004, and Tan et al. 2011).

Beside the general relationship between gender and overweight /obesity discussed above, the relationship between gender and overweight/obesity varies significantly when other sociodemographic and socioeconomic variables such as age, income, education, marital status, smoking status, alcohol use, comorbidity and physical activities are taken

into consideration. Generally considering age, some studies observed that people became overweight/obese as they aged (Bélanger-Ducharme and Tremblay 2005, Mandal and Chern 2006, Ogden et al. 2006, Shields 2006, and Alter et al. 2012). This relationship was however not universal across studies on overweight/obesity. Some studies also found the relation to be negative, implying people were rather getting overweight/obese at younger ages (Kaplan et al 2003, Oliver and Hayes 2005, Cook and Daponte 2008, Constăngioară et al 2009, and Shields and Tjepkema 2006). Considering age by gender, studies have suggested that, generally, age is negatively associated with overweight/obesity among males. In other words, men put on weight at younger ages. Younger men were more likely to be overweight/obese as compared to their older counterparts (Shields and Tjepkema 2006, and Le Petit and Berthelot 2005). Results from other studies also suggested that overweight/obesity among females increased with age (Huoto et al 2004).

Considering income, there is growing evidence to support the claim that a negative relationship exists between income and overweight/obesity. As income (or household income) increases, the likelihood of getting overweight/obese reduces (Bélanger-Ducharme and Tremblay 2005, Oliver and Hayes 2005, Shields 2006, Le Petit and Berthelot 2005, and Shields and Tjepkema 2006). In contrast, few studies also found the relationship to be positive. As income increased, the likelihood of getting overweight/obese rather increased (Edwards 2007, and Ward et al. 2007). Other studies also did not find any significant relationship between income and obesity (Huoto et al. 2004, and Tan et al. 2011). There were some significant variations in the relationship between income and overweight/obesity when the analysis was decomposed into sex.

Analysing the relationship by sex, it was observed that, as income levels increased, the proportion of men obese rather increased (Ward et al. 2007). Specifically looking at Canada, while there was a negative relationship between income and weight among women (i.e. low income significantly related to high weight and the opposite for high income), there was a positive correlation between income and weight among Canadian men (Auld and Powell 2006).

Education has also been shown to be an important determinant of obesity. A significant number of studies have suggested a negative relationship between education and overweight/obesity. It has been found that generally as people completed higher levels of education, their likelihood of getting overweight or obese reduced (Ward et al. 2007, Kaplan et al 2003, Huoto et al 2004, Oliver and Hayes 2005, Mandal and Chern 2006, Edwards 2007, and Tan et al 2011). Taking sex into consideration, it was observed that the proportion of men obese reduced as education levels increased (Ward et al. 2007, and Torrance et al 2002). Generally, education was also seen to be negatively associated with obesity among women although the relationship was not perfectly linear (Ward et al. 2007, and Torrance et al 2002).

Smoking status was seen to be a significant predictor of overweight/obesity. Most studies found smokers to be less likely to be obese as compared to individuals who had never smoked (Kaplan et al 2003, Huoto et al 2004, Mandal and Chern 2006, Edwards 2007, Ward et al. 2007, and Tan et al 2011). Contrary to the above, few studies found the opposite. For example, it was observed that frequent male smokers were seen to be 50% more likely to be obese when compared with males who had never smoked (Le Petit and Berthelot 2005). Former smokers, on the other hand, were found to be more likely to be

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obese as compared to non-smokers (Mandal and Chern 2006, Edwards 2007, and Shields and Tjepkema 2006). No significant variation was observed in the analysis when sex taken into consideration as both men and women recorded increase in obesity prevalence over time irrespective of their smoking status (Shields and Tjepkema 2006).

Considering alcohol, diet and physical activities, alcohol consumption was seen to be significantly associated with reduced prevalence of overweight/obesity. Most studies found that the likelihood of getting overweight/obese was negatively related to the moderate consumption of alcohol (Smothers and Bertolucci 2001, and Kaplan et al 2003). Fruit and vegetable consumption was generally seen to be negatively associated with overweight/obesity. As people increased their consumption of fruits and vegetables, their likelihood of getting overweight/obese reduced (Mandal and Chern 2006, Shields 2006, Tjepkema 2006, Edwards 2007, Ward et al. 2007, and Auld and Powell 2006). Skipping breakfast increased the chances of the risk of obesity and overweight. In addition, there was a positive relationship between the rate of snack intake and the risk of obesity and overweight (Constăngioară et al 2009). Social intervention programs such as the Food Stamp Programs (FSP) were also seen to be positively related with overweight and obesity[11]. This relation was mostly found among low income women. Among men, the relationship was insignificant (Gibson 2003). Considering physical activities, physically active people were found to be less likely to be overweight/obese as compared to less active people. In other words, growing evidence suggested that sedentary lifestyle was positively associated with overweight/obesity (Kaplan et al 2003, Huoto et al 2004,

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[11] Now referred to as Supplemental Nutrition Assistance Program (SNAP) provides nutritional assistance to the eligible individuals in the U.S. Those eligible includes the elderly, children, disabled, unemployed, etc.

Mandal and Chern 2006, Tjepkema 2006, Edwards 2007, Ward et al. 2007, Constăngioară et al 2009, Le Petit and Berthelot 2005).

Marital status was seen to be a significant predictor of obesity. While it was found that single (unmarried) people were less likely to be obese (e.g. Kaplan et al 2003), evidence was found to support the opposite that singles were rather more likely to be obese (e.g. Edwards 2007). Divorced and widowed individuals were seen to be more likely to be obese (Edwards 2007).

Evidence from the literature suggests the existence of a significant relationship between the risk of becoming overweight/obese and the presence of comorbidities. A number of studies found a positive relationship between obesity and the presence of comorbidities such as postmenopausal breast cancer, colorectal cancer, coronary artery disease, endometrial cancer, gallbladder disease, hyperlipidemia, hypertension, pulmonary embolism, stroke and type 2 diabetes. People who had obesity related diseases (comorbidities) and those who had family history of obesity related diseases were more likely to be obese (Tjepkema 2006, Tan et al 2011, Mokdad et al 2003, Kaplan et al 2003, Huoto et al 2004, and Tan et al 2011). Obesity was seen to be significantly associated with mortality. It was observed that there were increasing levels of mortality risk across almost all the BMI levels. There is growing evidence that the number of deaths attributable to overweight and obesity is on the increase (Katzmarzyk et al. 2001, Katzmarzyk and Ardern 2004, Edwards 2007).

Considering race, there is growing evidence to support the fact that people of Aboriginal origin were more likely to be obese as compared to other races (Bélanger-

Ducharme and Tremblay 2005, and Tjepkema 2006). Generally, black non-Hispanics, multiracial non-Hispanics, and Hispanic females were seen to have increased risk of overweight/obesity (Mandal and Chern 2006, and Cook and Daponte 2008). Mexican-American, Black and Hispanic children and adolescents had increased risk of being obese as compared to other races (Shields 2006). People of Chinese origin were on the other hand seen to be less likely to be obese (Tan et al 2011). People born outside Canada were seen to be less likely to be obese as compared to those born in Canada (Edwards 2007). Comparing the prevalence of overweight/obesity between Canada and the U.S. revealed that, Canadians had a lower prevalence rate as compared to their U.S. counterparts (Shields 2006, and Tjepkema 2006) The average U.S. individual was heavier than the average Canadian individual by 1.7 BMI units in the case of men and 3 BMI units in the case of women. Relevant sociodemographic characteristics such as income, education, race, and living arrangements could not explain the difference in obesity between Canada and the U.S. An average American will still be heavier than an identical Canadian even if the variables above followed the same distribution in both countries. (Auld and Powell 2006).

Place of residence was seen to be another important determinant of overweight/obesity. A significant number of studies found that people who resided in rural areas were more likely to be obese as compared to those who resided in urban areas (Huoto et al 2004, Bélanger-Ducharme and Tremblay 2005, and Mandal and Chern 2006). Evidence from some few studies also suggested that there was no significant relationship between being obese and region or place of residence (Le Petit and Berthelot 2005). Studies now place significant emphasis on contextual factors (environment

characteristics) as an important predictor of obesity (Lakdawalla and Philipson 2002, Chou et al. 2004, and Auld and Powell 2006). Some of these contextual factors include restaurant outlet density, supermarket availability, food prices and access to physical activity-related facilities[12]. Food prices were observed to be significant determinants of obesity (Goldman et al 2011, Auld and Powell 2006). Increase in the prices of high calorie foods resulted in the reduction of obesity in the long run (Goldman et al 2011). Availability of supermarkets was also seen to be positively related to the consumption of healthy foods like fruits and vegetables (Horowitz et al. 2004). Easy access to supermarkets and retail shops provide consumers with the necessary variety of healthy food at affordable prices (Chung and Myers 1999). Prices of food tend to be cheaper in these large chain stores.

Being overweight was seen as a significant determinant/predictor of obesity. The likelihood of an overweight person transitioning into an obese person was seen to be significantly high (Le Petit and Berthelot 2005). Lastly, in considering whether health insurance could be considered as a significant determinant of obesity externalities, it was observed that health insurance itself was not the cause of obesity externalities. However, failure to risk-adjust premiums to take weight into consideration rather causes obesity externality to rise (Bhattacharya and Sood 2007).

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[12] The difficulty in getting data on contextual factors has made it difficult to analyse the effects of these factors on overweight/obesity in Canada. Therefore most of the studies that focus on contextual factors relied on data from the US.

3.3 Obesity intervention policies

Due to the high social and economic cost associated with obesity and its closely related diseases, a number of studies have proposed diverse measures to reduce obesity incidence and subsequently lead to the reduction in its associated cost. Significant among those measures include investment in agricultural R&D, introduction of subsidies on healthy food products, and the implementation of "fat taxes". These studies emphasise the importance of food prices as a tool to tackle the obesity menace (Tiffin and Arnoult 2011, Alston et al. 2013, Rickard et al. 2013, Leicester and Windmeijer 2004, Mytton et al. 2007, Cash et al. 2005). The main findings of the studies are discussed below. Alston et al. (2013) examined the impact of public agricultural investment on obesity and social welfare in the U.S. Findings from the study confirmed the already existing claim that public investment in agricultural R&D had contributed to the problem of obesity through its resultant cheaper food prices. However, the study found that although public investment in agricultural R&D had contributed to the incidence of obesity, the influence was very modest and as such, any intervention policy based on agricultural R&D was less likely to be effective. In addition, the study found that policy based on agricultural R&D was unlikely to be effective given the fact that, it takes relatively longer time for such investment to affect food prices. Rickard et al. (2013) examined the impact of farm policies affecting food prices on obesity incidence in the U.S. Findings from the study indicated that the abolishment of subsidies on grains and oilseeds would only result in a modest reduction in caloric intake. In addition, the study found that although the abolishment of all farm subsidies would result in the reduction of the intake of certain

unhealthy foods, such action could also trigger the increase in consumption of other unhealthy foods. This may result in an overall increase in caloric intake.

Leicester and Windmeijer (2004) examined the possibility of a "fat tax" as an intervention policy to tackle the increasing incidence of obesity in the U.K. The study claimed that, considering the external cost of obesity to the society, there is economic justification for government intervention. Two main forms of implementation of such a tax were suggested by the study. These are either taxing the percentage fat content of foods, or taxing certain types of foods considered as having high fats or unhealthy nutritional content. The study argued that "fat tax" is necessary since the revenue generated from it could be used to fund other policies aimed at reducing obesity incidence such as funding subsidies on healthy foods, funding healthy eating education campaigns, and subsidising exercise equipment. Mytton et al. (2007) analysed the impact of value added tax (VAT) on diets and health by extending VAT to cover additional food categories. The study argued that a carefully implemented "fat tax" could have a modest but significant effect on food consumption and health. According to the study, taxes that target principal dietary sources may be counterproductive. For example, a policy that is successful in reducing saturated fat consumption may lead to an increase in salt consumption. However, taxes that cover wider food categories could lead to significant health improvements.

Cash et al. (2005) examined the effect of subsidies on healthy foods like fruits and vegetables in the U.S. According to the study, a sustained modest subsidy on fruits and vegetables could lead to increases in their consumption, thereby resulting in significant reduction of a number of diseases incidence. It is indicated that, as subsidies on fruits and

vegetables increases, the number of diseases prevented also increases significantly. However, it is important to note that this increase comes with a little increase in the cost per statistical life saved. The study attributes this increase in cost to diminishing marginal health benefits of fruits and vegetables.

Even though a number of studies are in favour of government interventions such as the usage of taxes and subsidies—as discussed above in solving obesity related problems—other studies argue that such interventions could do more harm than the intended good (Taylor 2013, and Chouinard et al. 2007). Taylor (2013) analysed the effectiveness of food taxes as a tool to minimize obesity incidence. The author argued that food taxes are ineffective intervention measures to minimize obesity incidence. The study indicated that individual food products that may be targeted for tax may not necessarily be a cause of increase in weight since obesity is a multifaceted problem. It was argued that taxing certain foods may lead to the substitution for more unhealthy foods which will further lead to an increase the total calorie consumption. According to the study, such taxes only serve as new revenue generating sources for the government. Chouinard et al. 2007 examined the impact of a "fat tax" on the consumption pattern of dairy products. It was argued that a tax on the fat content of a food product may yield ineffective results. To achieve a significant reduction of fat consumption, the tax will have to be extended to cover all food items and the tax rate will have to be high enough. In addition, it is argued that although such taxes could generate substantial revenues for the government, a greater proportion of the tax burden is paid by the poor.

3.4 Summary

In summary, evidence from the literature suggests that health claims have a significantly positive impact on the consumption of functional foods. The behavioural intensions of consumers towards functional foods could be influenced by proper promotion of the awareness of the health claim and functional foods. The perception of health benefits of the functional foods significantly affects both the decision to consume and frequency of consumption. So far as credible information is provided about the safety and efficiency of the health claim on functional foods, consumers will be willing to go to the extent of paying premiums for such foods. However, for the health claims to be successful, it must come from credible sources like government entities. In addition, the success of health claims also depends on prior nutritional knowledge of consumers and how best the claims define its target groups.

Additionally, it was suggested that the reduction/increment of certain nutrition intake could result in a significant reduction of certain disease incidence like hypertension and thereby increase cost savings on the management and treatment of such diseases. A number of socioeconomic and sociodemographic factors have been identified as significant determinants of overweight and obesity. Some of these determinants are age, gender, race, marital status, income, education, smoking status, alcohol use, fruits and vegetables consumption, comorbidity, physical activity, current BMI status, etc.

Diverse policy interventions based on the price of foods have been proposed to tackle the increasing incidence of obesity. Significant among these interventions are investment in agricultural R&D, introduction of subsidies on healthy food products, and the implementation of "fat taxes". Investment in agricultural R&D was seen to result in

cheaper food prices, thereby contributing to the incidence of obesity. It was found that, a sustained modest subsidy on foods could lead to healthy eating. Moreover, it has been suggested that there is economic justification for "fat taxes". A carefully implemented "fat tax" could have a modest but significant effect on food consumption and health. The revenue generated from such taxes could be used to finance other obesity reduction policies. However, in spite of the above mentioned potential benefits, other studies are of the view that such intervention policies could cause more harm than the intended good. For instance, taxes that target principal dietary sources may be counterproductive because of the substitution effect. Taxing certain foods may lead to the substitution for more unhealthy foods which will further lead to an increase in the total calorie consumption. A policy that is successful in reducing saturated fat consumption may lead to an increase in salt consumption. Finally, it has been shown that although such taxes could generate more revenue for the government, a greater proportion of the tax burden would be paid by the poor.

CHAPTER 4

4. Methodology and Data description

In this chapter, we describe the data used for the study and provide a detailed discussion of the methods used for the analyses. To thoroughly analyse the obesity issue in Canada and evaluate the efficacy of public policies to address the issue, we use a multi-method approach. This includes the use of both econometrics and a variation of cost of illness approach. First, we discuss the derivation of the econometric model used (the Multilevel Multinomial Logistic regression), and justify its choice. Second, a step-by-step discussion of the cost of illness approach used to estimate the potential health-related cost savings in Canada is presented. Finally, the chapter presents the variables of the econometric model and describes the data used at each stage of the analyses. Confidential micro-level data from Statistics Canada on individuals nested into provinces is used for the analyses. Measurement issues concerning data on Body Mass Index (BMI) are also discussed.

4.1 Multilevel Multinomial Logistic Regression

 Due to the categorical or ordinal nature of the dataset, including the main variable of interest– BMI, the Discrete Choice types of models are often the most appropriate tool for the current analysis. The two most often used models in the literature are the Multinomial Probit regression and the Multinomial Logistic regression. Although both models produce similar results, considering the ease of computation and the frequent usage of the Multinomial Logistic model in the empirical literature, the latter is used to perform the analysis. In order to incorporate the heterogeneity among the provinces into

the analysis, we use Multilevel Multinomial Logistic Regression Model (MMLRM). The province-level information is incorporated into the individual-level through a random intercept hierarchical model. Specifically, the thesis follows the hierarchical or multilevel modeling used by Raudenbush and Bryk (2002). The following two-level model is considered for the response variable R, which takes on the value of m with probability $P(R=m) = \varphi_m$, for $m = 1, \ldots, M$.

$$P(R_{ij} = 1) = \varphi_{1ij}$$

$$P(R_{ij} = 2) = \varphi_{2ij}$$

$$P(R_{ij} = 3) = \varphi_{3ij}$$

$$P(R_{ij} = 4) = \varphi_{4ij} = 1 - \varphi_{1ij} - \varphi_{2ij} - \varphi_{3ij} \qquad (1)$$

where, $R_{ij} = 1$ implies i^{th} individual from j^{th} province is underweight, $R_{ij} = 2$ implies i^{th} individual from j^{th} province is healthy, $R_{ij} = 3$ implies i^{th} individual from j^{th} province is overweight, and $R_{ij} = 4$ implies i^{th} individual from j^{th} state is obese.

The MMLRM can then be written as:

Level 1 model (individual): $\qquad \theta_{mil} = \beta_{0j(m)} + X_{ij}{}'\beta \qquad\qquad (2)$

Level 2 model (province): $\qquad \beta_{0j(m)} = \alpha_{00(m)} + Z_{0j(m)}{}'\alpha + \mu_{0j(m)} \qquad (3)$

where $\theta_{mil} = \log\left(\frac{\varphi_{mij}}{\varphi_{Mij}}\right) = \log\left(\frac{P(R_{ij}=m)}{P(R_{ij}=M)}\right),$ $\qquad\qquad\qquad (4)$

$for\ m = 1,2,3.$

The error term is not included in the level one model since θ_{mil} is already expressed as an expected value of the indicator variables for the various classifications of Body Mass Index (Mandal and Chern, 2006). $\beta_{0j(m)}$ is the individual level intercept and β is the vector of coefficients corresponding to a vector of individual level predictor variables X_{ij};

$\alpha_{00(m)}$ is the intercept at the province level; and α is the vector of coefficients corresponding to a vector of province level predictor variables $Z_{0j(m)}$. The random component term $\mu_{0j(m)}$ has multivariate normal distribution with component means of 0 and variance-covariance matrix τ;

$$\mu_{0j(m)} \sim MN(0, \tau) \tag{5}$$

From (2) and (3), the combined model can be written as:

$$\theta_{mij} = \left[\alpha_{00(m)} + X_{ij}'\beta + Z_{0j(m)}'\alpha\right] + \left[\mu_{0j(m)}\right] \tag{6}$$

where the terms in the first parenthesis is the fixed part of the model and the term in the second parenthesis is the random part of the model showing the variation among provinces. Alternatively, the slope parameters at the individual level could have been allowed to vary but for simplicity, the slopes are assumed to be constant at all levels.

The conditional likelihood contribution of the jth cluster can be written as a multivariate integral over the correlated error terms (Rabe-Hesketh et al. 2005). The likelihood contribution for a given cluster j can be written as;

$$f_{ij}^{(2)}(\Omega) = \int g(\mu_{0j(m)}; 0, \tau) \prod_{i=1}^{n_j} f_{ij}^{(1)}(\Omega|\mu_{0j(m)}) d\mu_{0j(m)}, \tag{7}$$

where $i = 1, ..., n_j$; Ω is a vector of all the model parameters; $g(.; \mu, \tau)$ represents the normal density with mean μ and covariance matrix τ, and $f_{ij}^{(1)}$ is the conditional likelihood contribution of unit i in cluster j which can be written as;

$$f_{ij}^{(1)}(\Omega|\mu_{0j(m)}) = R_{ij}\Phi(\theta_{mij}) + (1 - R_{ij})\Phi(-\theta_{mij}) \tag{8}$$

where $\Phi(.)$ is the standard normal cumulative distribution function and R_{ij} is the response vector given in (1).

In order to estimate the MMLRM, there is the need to evaluate and maximize the likelihood in (7) and (8). However, because of the complexity of the likelihood function due to the integral term in (7), it becomes very difficult to evaluate the likelihood contribution analytically. Therefore, it is necessary to approximate the maximum likelihood solution. One basic way to estimate the parameters is to evaluate the marginal likelihood numerically by applying Gauss-Hermite quatrature (Rabe-Hesketh et al. 2005).

To estimate the parameters of the MMLRM, the Generalized Linear Latent and Mixed Models (GLLAMM) command in STATA is used. GLLAMMs perform the estimation by Maximum Likelihood (ML) approach using 8-point ordinary Cartesian (Gauss-Hermite) quadrature. However STATA is specified to use adaptive quadrature instead of the ordinary quadrature to evaluate and maximize the marginal log likelihood during the parameter estimation process. Although the ordinary quadrature generally works well, there are instances where it performs poorly. A typical instance where the ordinary quadrature approximation performs poorly is when the function being integrated has sharp peaks (Rabe-Hesketh et al. 2002). Sharp peaks occur when the number of units within each cluster is very large (i.e. larger number of level one units nested within level two units). Moreover, the issue of sharper peaks may also arise if there is a high intraclass correlation. Adaptive quadrature, on the other hand has been proven to accurately and efficiently estimate parameters. Even in circumstances where the ordinary quadrature works well, in terms of computational efficiency, adaptive quadrature is much more desirable because it requires less quadrature points to attain the same precision as the ordinary quadrature (Rabe-Hesketh et al. 2002, and Grilli and Rampichini 2006).

In addition, the number of integration on points is specified to 12 points. Increasing the number of integration on points improves the approximation. For detailed information on this procedure, refer to the GLLAMM manual by Rabe-Hesketh et al. (2004). The results from the MMLRM can be presented in terms of odds ratios by taking the exponential of equation (6). The MMLRM can be expressed in terms of odds ratios as:

$$\exp(\theta_{mij}) = \exp([\alpha_{00(m)} + X_{ij}\beta + Z_{0j(m)}\alpha] + [\mu_{0j(m)}]) \tag{9}$$

4.2 Cost of Illness approach

In addition to the econometric analysis, a variation of the Cost of Illness (COI) approach is used to estimate the health-related cost savings of obesity in Canada. Health economists use a wide range of approaches and methodologies to estimate the potential economic benefits of improved health resulting from policy interventions. Some of the methods are: Cost of Illness (COI), Willingness to Pay (WTP), Disability-Adjusted Life Years approach (DALY), Quality-Adjusted Life Years (QALYs), Cost Benefit Analysis, Healthy Years of Life Gained (HYLG), and Cost-Utility (cost effectiveness). This thesis uses a variation of the Cost of Illness approach (COI) to estimate the potential cost savings to the public health sector in Canada as a result of the approval and promotion of the health claim on low calorie diets and obesity. The COI approach is considered an effective analytical tool to estimate health-related cost savings resulting from the usage of disease risk reduction health claims (Gray et al. 1998, Malla et al. 2007 and Gyles et al. 2010, Malla et al. 2015).

A number of studies have adopted various variations of the COI approach to estimate the potential cost savings associated with improved health resulting from dietary improvements. For instance, Gray et al. (1998) used a prevalence-based, cost-of-illness approach to estimate the influence of a change in dietary fat intake on coronary heart disease (CHD) costs in Canada. In addition, Malla et al. (2007) also estimated the potential health cost savings associated with the substitution of the existing oils in the market with trans-fat free canola oil. The study suggested that, the consumption of trans-fat free canola oil will lead to a reduction in the incidence of CHD, which will also lead to a reduction in the health care expenditure on the disease. In a separate study, Gyles et al. (2010) used a variation of the COI approach to estimate the health cost savings associated with reduced CHD incidence resulting from the consumption of foods rich in plant sterols. Malla et al. (2015) also used a variation of COI approach to estimate that health-related cost savings associated with a potential health claim linking consumption of soluble fiber and soy protein to reduced risk of coronary heart disease in Canada.

While this thesis acknowledges that other methodologies could be used to estimate health cost savings, considering the nature of analysis to be conducted and the data available, the suitable method is a variation of the COI approach. The analysis involves four main steps. First, we establish the link between health claim usage and healthy diet choices. Second, we estimate the potential weight loss that will result from the restriction of calories in diets. Third, we evaluate the potential reduction in obesity prevalence resulting from the restriction of calories intake by conducting weight loss simulation of real data on measured heights and weights of Canadians. Fourth, we estimate the potential health-related cost savings attainable through a successful reduction

of caloric intake resulting from the approval and promotion of the health claim on low calorie diets and obesity.

4.2.1 Step one: Health claims increases consumption of low calorie diets

The analysis begins by establishing a link between health claims and consumption of healthy diets. Specifically, this thesis asserts that the introduction of the health claim on low calorie diets and obesity will significantly encourage people to reduce their consumption of foods high in calories and substitute it for low calorie diets. This assertion is based on the findings from numerous scientific/nutrition studies that suggest strong correlation between the consumption of healthy (i.e. low calorie) foods and improved health, and also the findings from a comprehensive review of studies on health claims and consumer demand. The link between the introduction of health claims on healthy foods and the consumption of such foods is discussed below.

4.2.1.1 Diet, health claims and consumption

Stakeholders are increasingly becoming aware of and recognising the significant link between diet and health (Malla et al., 2013). In 2002, a joint WHO and FAO expert consultation on Diet, Nutrition and the Prevention of Chronic Diseases identified diet and lifestyle changes to be significantly related to the increasing epidemic of chronic diseases in the world (WHO 2003). Nutrition is now considered an alterable determinant of chronic diseases, as mounting scientific evidence suggests that the changing of one's diet can have both positive and negative effects on the health of that person (WHO 2003). According to the consultation, not only will the changes in one's diet affect the present

health conditions, but it will also affect that person's future chances of developing any of the chronic diseases (like cancer, diabetes, etc.). Findings from recent studies suggest that consumers value health claims and health information that links the consumption of healthier foods or food constituents to reduced health risk of certain diseases (Levy and Stokes 1987, Brown and Schrader 1990, Williams 2005, and Moon et al 2011). A consumer's perception of the healthiness of a particular food is improved by the health information (health claim) that the food carries. Using health claims on foods helps consumers in their diet choices and improves their understanding of the relationship that exists between diet and diseases (Williams 2005, and Barreiro-Hurlé et al. 2010). Evidence from studies also suggests that consumers are willing to pay premiums for the benefits they derive from healthy or health-enhancing food products (West et al. 2002, Maynard and Franklin 2003, Larue et al. 2004, Teratanavat and Hooker 2006, Barreiro-Hurlé et al. 2008, Maratte et al. 2010, and Milligan et al. 2010).

A number of studies have attempted to assess the impact of health claims on the consumption pattern of consumers. Below is a discussion of the studies that established a significant relationship between the usage of health claims on food products and consumption pattern. Moon et al (2011) in their work on the influence of health claims on the behavioural intention of consumers found that the higher consumers perceive that a relationship exists between diet and health, the more likely they are to try the food product for the first time, use more often, or increase their consumption if they are already using it. Similarly, after an intensive campaign to create awareness of the link between the consumption of foods rich in fibre and the prevention of certain types of cancer, there was a 47% increase in relative market share of Kellogg company's rich in

fibre All-Bran product (Levy and Stokes 1987). Calfee and Pappalardo (1991) also argued that, the Kellogg campaign caused a significant turning point in food marketing. According to the authors, the decision to revise regulations on health claims by the US Food and Drug Administration was influenced by the Kellogg campaign which was based on the advice from the National Cancer Institute that dietary fibre had the potential to prevent certain types of cancer. Brown and Schrader (1990) found that per capita shell egg consumption was reduced by 16%-25% as a result of the cholesterol information made available to consumers. Barreiro-Hurlé et al. (2008) argued that consumers' selection of a particular type of wine is significantly affected by its functional attributes. They found that consumers were willing to pay additional money for wines made from resveratrol enriched grapes. However, having the health claims alone may not necessarily yield the required results. It is necessary that the claims get the endorsement of a trusted authority like the government (Wansink and Cheney 2005). Further discussion on the link between diets, health claims, and consumption pattern can been seen at the literature review section of the thesis.

Based on the above discussion, it can be inferred that if the necessary attention is given to the health claim on low calorie diets and obesity, the intake of calories could be significantly reduced. As a result, the problem of obesity and its related diseases could be considerably reduced since there is mounting evidence in support of calorie restriction and weight loss (Fontana et al. 2007, Redman et al. 2007, Weiss et al. 2007, and Redman et al. 2009). Figure 1 graphically depicts the impact of health claims on the consumption of unhealthy diets, in this case the consumption of high calorie diets. The publicly funded nature of the health care system in Canada leads to a moral hazard problem whereby

individuals may not make private optimal diet choices equal to social optimal as the consequences of such poor diet choices are borne by others. This implies that people tend to under-consume healthy foods and over-consume unhealthy foods. Additionally, since the health benefits from functional foods is a credence attribute and cannot be easily evaluated by consumers without labelling, in the absence of health information on food products informing consumers of the benefits or dangers of the nutritional contents of such foods, individuals have even less incentive to make the right diet decisions. The consumer may not even know the benefits/cost of the food. The individual may only consider the immediate satisfaction ($MB_{private\ 1}$) derived from making such diet choices (consumption of high calorie diets) without taking into consideration the full cost borne by the society. In taking such private decision, since the individual may not take the full cost to the society into consideration, the social benefit (MB_{social}) to the society will be much lesser than the private benefit as shown in Figure 1

Figure 1. Impact of health claims on the intake of high calorie diets.
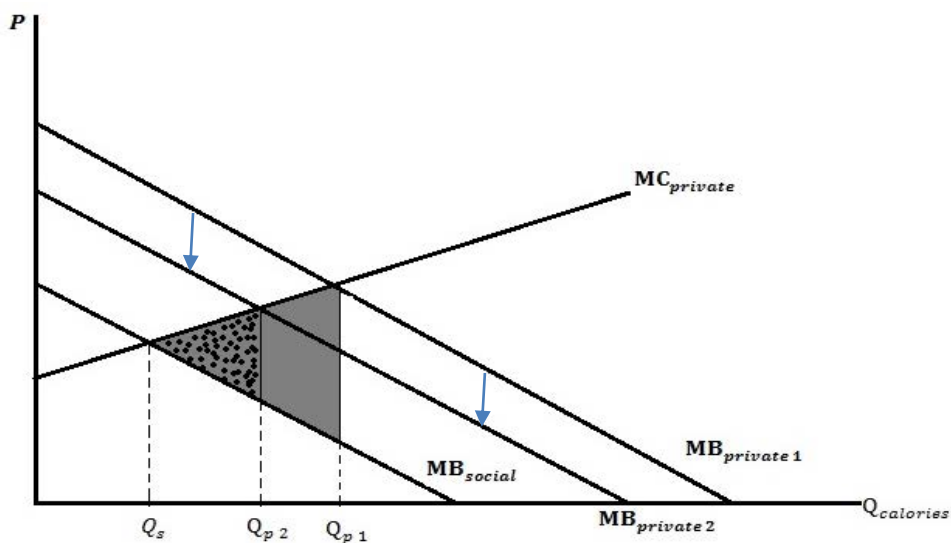
Source: Author's calculation

However, if the government approves and promotes the use of the health claim on low calorie diets and obesity, it is expected that some consumers will revise their preference for high calorie diets and switch to a much low calorie one. Although the consumers are not made to pay directly for the full cost of their poor diet choices, their utility for high calorie diets reduces since they become increasingly aware of the health risks of high calorie diets and the benefits of low calorie diets. In addition, the approval of the health claim by a credible source like the government will boost consumer confidence in the message that the health claim carries. As a result, the marginal private benefit curve will shift from $MB_{private\ 1}$ to $MB_{private\ 2}$ corresponding to a reduction in caloric intake from $Q_{p\ 1}$ to $Q_{p\ 2}$. This will also lead to a reduction in the loss to the society (DWL) from the gray shaded area to the dotted area.

4.2.2 Step two: Calorie restriction and weight loss

With the base assertion that a possible introduction and promotion of the health claim on low calorie diets and obesity will lead to a reduction in caloric intake, this step estimates the potential weight loss that will result from the reduced caloric intake. This was done through a meta-analysis of medical/nutrition literature that was based on clinical trials. Clinical trials on the influence of calorie restriction (CR) on the human body composition have suggested that the reduction of caloric intake has a non-trivial influence on the weight of people who practice it (e.g. Tsai and Wadden 2006, Villareal et al. 2006, Fontana et al. 2007, Redman et al. 2007, Weiss et al. 2007, and Redman et al. 2009). Aside from the influence of CR on the human body composition, numerous studies on a wide range of living organisms including insects and mammals suggest that life span is

significantly increased as a result of the restriction of calories in diets (e.g. Lin et al.

2000, Guarente and Picard 2005, Civitarese et al. 2007, and Colman et al. 2009).

However, it must be noted that the mechanism through which it slows down aging is not

yet clear and it is still unknown whether CR will result in an increase in life span among

humans (e.g. Lin et al. 2000, and Heilbronn and Ravussin, 2003). The restriction of

calories in one's diet may take two main forms. These are low-calorie diets (LCD) and

very low-calorie diets (VLCD). LCD is the restriction of caloric intake to about 800-1500

kcal/day whiles VLCD is the restriction of caloric intake to about 250-800 kcal/day

(Initiative 1998). Findings from studies suggest that the effect of both interventions on

weight loss after a year are not significantly different from each other (Wadden et al.

1994).

To estimate the optimal weight loss resulting from restricting one's caloric intake,

a meta-analysis of a number of human clinical studies assessing the impact of CR on

weight was conducted. A computer search of *Medline (via OVID)* was conducted with the

key words "calorie restriction" and "weight loss" or "weight reduction". Moreover, an

extensive search of the references of relevant studies was also performed. The main

criteria used for accepting and including studies into the meta-analysis was that the

weight intervention should include at least one form of calorie restriction in diets. The

reason for using this criteria was to exclude studies in which weight loss was achieved as

a result of other interventions rather than the restriction of calories or the substitution of

high calorie diets for low calorie ones. This reduces the possibility of including studies

where weight loss was achieved accidentally or CR was not the intended intervention.

Table A.1 in the appendix gives a detailed presentation of the findings from the meta-

analysis. The current results suggest that on average, CR will result in 10.61% $\pm$ 1.42% loss in weight within a period of one year.

4.2.3 Step three: Reduction in obesity prevalence resulting from weight loss

In this step, the study estimates the reduction in obesity prevalence resulting from the restriction of calories in the daily diets of individuals. A weight reduction simulation was performed on the CCHS 2.2 dataset to observe the effect of the estimated weight loss in step two on obesity prevalence in Canada. In other words, the study ran a simulation of the CCHS 2.2 dataset to observe the changes to obesity prevalence in Canada if overweight or obese people were to reduce their weight by 10.61% $\pm$ 1.42%. To simplify the analysis, the estimated weight loss was rounded to 10%.

To evaluate the corresponding reduction in obesity prevalence resulting from the reduced intake of high calorie diets, the weight loss estimate in step two was deducted from the actual weights of Canadians who are either overweight or obese. The BMI of everyone in the dataset was then recalculated to evaluate the "new" prevalence of obesity in Canada as a result of the estimated weight reduction. The new obesity prevalence estimate was then compared to the obesity prevalence prior to the imposition of the weight reduction restriction to evaluate the reduction in obesity prevalence associated with the reduction of caloric intake. To ensure the robustness of the estimate, the analysis was repeated by considering another scenario. A modest weight loss of 5% was used to re-run the simulation. According to the U.S Food and Drug Administration (FDA), a weight loss of even 5% is considered as clinically significant (Moyer 2012).

4.2.4 Step four: Health-related cost savings resulting from reduction in obesity

prevalence

Finally in this step, we estimate the potential health-related cost savings to Canada resulting from calorie restriction. In 2006, obesity was estimated to cost Canada a total of $7.1 billion (Public Health Agency of Canada 2011). Out of this amount, $3.2 billion was in direct cost, while the remaining $3.9 billion was indirect. In order to estimate the potential health-related cost savings, the 2006 obesity cost estimate was adjusted to reflect the current monetary terms. The consumer price index for health and personal care data from Statistics Canada was used to adjust the 2006 estimate of $7.1 billion to a 2014 level of $7.98 billion (Statistic Canada 2015). A similar adjustment of disease cost was done by Gyles et al. (2010) and Malla et al. (2015).

In order to estimate the potential health-related cost savings, we established the relationship between reduction in obesity prevalence and reduction in health care expenditure on the disease. It is of no doubt that the reduction in the prevalence of overweight and obesity will result in the reduction of the health care expenditure for the treatment and management of overweight and obesity in Canada. However, what is unclear is the exact relationship between the reduction in prevalence of overweight and obesity and the reduction in health care expenditure on overweight and obesity. To estimate the health-related cost savings, different scenarios were considered. The first scenario, 'ideal', assumes an optimistic relationship between reduction in prevalence and health-related cost savings. It is assumed that there is a 1:1 relationship between reduction in the incidence of a disease and health-related cost savings (i.e. a 1% reduction in the prevalence of obesity will result in a 1% reduction in cost). Although this

assumption is exaggerative of the potential health benefits of the health claim on low calorie diets and obesity and may not be achievable in the short-run, it provides a useful analysis of the long term benefits of the health claim. In the long run, all cost is variable and therefore the fixed components of cost which may not spontaneously respond to the reduction in overweight and obesity prevalence in the short term will eventually respond to the changes in prevalence with time. Table 7 provides a summary of the calculations.

Since the first scenario oversimplifies the relationship between the reduction in prevalence and health cost savings, a second scenario, 'base', was considered where the various cost components of the disease were taken into consideration in establishing the relationship between changes in prevalence and changes in health cost savings. Instead of assuming a linear (i.e. 1:1) relationship, a detailed examination of the various components of disease cost was considered. Cost of obesity can be grouped into direct and indirect. The direct cost component includes hospital care expenditure, physician services, drug cost, health research cost, cost of services of other health professionals, and other health care cost. The indirect cost is mainly the cost incurred due to productivity loss resulting from mortality and morbidity (Public Health Agency of Canada, 2014). Since less incidence of obesity will result in fewer cases of obesity related mortalities and morbidities, it is assumed that, a reduction in obesity prevalence will result in a proportionate reduction in the indirect cost of obesity.

Hospital care expenditure represents the highest component of the direct cost of obesity[13]. Generally, irrespective of the level of disease incidence, there will still be some amount of cost incurred in the running of the hospital (Gyles et al. 2010). It has been estimated that, more than three fourths of hospital expenditure is fixed. Approximately

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[13] See Table A.2 in the appendix for details on the various cost components.

84% of hospital expenditure has been estimated to be fixed with the remaining 16% being variable (Roberts et al. 1999, Gyles et al., 2010). Since the fixed cost component of the hospital expenditure may not immediately respond to the reduction in the prevalence of obesity in the short run, it is assumed that, only the variable component of the cost will change proportionally to the change in obesity prevalence. That is, a 1% reduction in obesity prevalence will lead to a 0.16% reduction in hospital cost.

Drug cost of obesity is the second highest component of obesity cost. Taking total drug cost into consideration, approximately 84.9% is prescribed and the remaining 15.1% non-prescribed (Canadian Institute for Health Information, 2014). Logically, since lower cases of obesity will results in lower prescription of obesity drugs, a linear relationship (i.e. 1:1) is therefore assumed between changes in obesity prevalence and changes in the prescription of drugs. Non-prescription drugs, which are mainly over-the-counter (OTC) drugs and personal health supplies (PHS), were not included in the analysis because it may not immediately respond to a reduction in obesity prevalence. Therefore, the relationship between obesity prevalence reduction and reduction in drug cost becomes 1:0.85.

Physician services may not be required if one is not sick or ill. As such, it is expected that fewer cases of obesity and its related comorbidities will result in fewer physician visits. Fewer physician visits will also imply a reduction in physician service expenditure. It is therefore assumed that a reduction in the prevalence of obesity will lead to a proportionate reduction in the cost incurred on the services of physicians (i.e. 1:1 relationship).

The expenditure incurred for the services of other health professionals can be grouped into three main categories; namely dental care cost, vision care, and others. The 'others' category comprises expenditure on massage therapists, chiropractors, physiotherapists, podiatrists, and psychologists (Canadian Institute for Health Information, 2014). It is expected that a reduction in the prevalence of obesity will not necessarily result in a reduction in the expenditure incurred on dental care and vision care. As such, they are excluded from the analysis. The proportion of expenditure on the services of other health professionals that go to dental care and vision care are 61.1% and 19.2% respectively. Therefore, the relationship between the reduction in obesity prevalence and reduction in expenditure on other health professionals becomes 1:0.20.

Expenditure on health research is considered largely fixed and as such, a reduction in the prevalence of obesity may not affect it in the short term. Finally, expenditure on other health care includes mostly expenses on home care and medical transportation (Canadian Institute for Health Information, 2014). The majority of this expenditure is also considered fixed and as such was excluded from the analysis. Table A.2 in the appendix provides a summary of the percentage reduction in the various components of health care cost resulting from a 1% reduction in obesity prevalence. To make the analysis comparable to the 'ideal' case scenario, a weighted average of the percentage reductions in the various components of obesity cost resulting from a 1% reduction in the prevalence of obesity is evaluated. This gives a 1:0.83 relationship between reduction in disease prevalence and reduction in health care expenditure. That is, a 1% reduction in the prevalence of obesity will result in a 0.83% reduction in health care expenditure on the disease. In evaluating the weighted average, we used the total cost of

each obesity cost component as its respective weight. The evaluated weighted average was then used to estimate the total health-related cost savings corresponding to the total percentage reduction in obesity prevalence.

Finally a third scenario, 'low' which assumes a more conservative relationship between reduction in disease prevalence and health-related cost savings was examined. The 'low' scenario assumes that there is a 1:0.5 relationship between reduction in the incidence of a disease and health-related cost savings (i.e. a 1% reduction in the prevalence of obesity will result in a 0.5% reduction in health-related cost). Figure 2 below provides a pictorial description of the systematic steps used to estimate the potential health-related cost savings.

Figure 2. Framework of the health-related cost savings estimation procedure
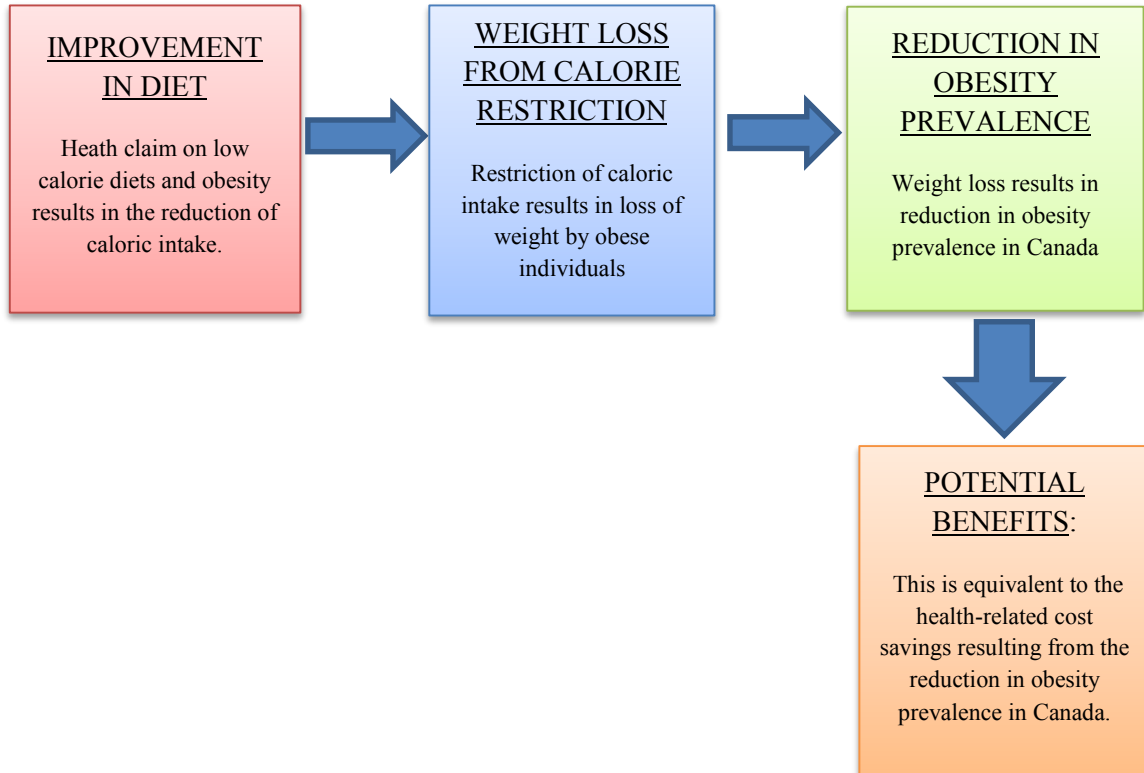
Source: By author

4.3 Data

This thesis used different sources of data for different stages of the analyses. For the econometric analysis, confidential micro-level data from the 2004 Canadian Community Health survey (CCHS 2.2) provided by Statistics Canada was used. For the COI approach, a combination of data from the 2004 CCHS 2.2 and data obtained through reviews of medical and nutritional literature that is based on human clinical trials was used. The review was done by conducting a computer search of Medline (via OVID). Extensive search of the references of relevant studies was also performed. The CCHS 2.2 micro-level data was chosen because it provides the opportunity to incorporate the effects of heterogeneity among provinces on obesity in the analysis. In addition, the CCHS 2.2 data was based on measured heights and weights.

It has been shown that data based on self-reported heights and weights tends to underestimate the prevalence of obesity (Torrance et al. 2002, Bélanger-Ducharme and Tremblay 2005, Le Petit and Berthelot 2005, Tjepkema 2006 and Goldman et al. 2011). A possible explanation of this problem is that, people are more inclined to increase their height estimates and reduce their weights (Tjepkema 2006). The comparison of the 1978-1979 Canada Health Survey (measured data) to the 1981 Canada Fitness Survey (self-reported data) by Torrance et al. (2002) indicated that, while the latter reported the percentage obese to be 9%, the former reported the percentage of people obese to be 13%. Moreover, comparing the 1988 Campbell Survey on Well-Being (self-reported data) with the 1986-1992 Heart Health Survey (measured data) also revealed that, the percentage of people obese was 10% and 14% respectively. In addition, the estimated percentage of Canadians obese in 2003 (estimate based on self-reported heights and

weights) was 15.2%, which is significantly below the 2004 estimate of 23.1% which was based on measured heights and weights (Tjepkema 2006). Hence it is necessary to use data based on measured heights and weights.

The CCHS is a cross-sectional survey which gathers information annually at the sub-provincial levels. The CCHS 2.2 is the first survey to collect nationwide nutrition data since Nutrition Canada survey was conducted about 35 years earlier (Health Canada 2006b). Prior to 2007, data for the CCHS was gathered every two years. However, the CCHS data is now collected annually. Although other current versions of the dataset like the annual CCHS exist, the 2004 CCHS 2.2 was chosen because most of the annual versions are based on self-reported BMI. Furthermore, they do not focus on nutrition. The 2004 CCHS 2.2 collected data on the consumption of foods and dietary supplements on a representative sample of Canadians. It provides information on the nutrition intake of Canadians and also data on measured heights and weights. Data on some selected health conditions and sociodemographic or socioeconomic characteristics of respondents were also collected by the survey. The CCHS 2.2 collected information on persons aged 0 and above in all the 10 provinces in Canada. The groups of people excluded from the survey include: full-time members of the Canadian Forces, people living in the Territories, First Nation Reserves or Crown Lands, in prisons or care facilities and some remote areas.

The overall sample size of the CCHS 2.2 was 70,214. For the purpose of this thesis, people aged below 18 years were excluded from the analyses because the emphasis of this thesis was on adult obesity in Canada. By excluding people younger than 18 years from the analyses, the sample size was reduced to 42,320. Non-responses and missing information were also deleted from the final dataset used for the analyses,

thereby further reducing the sample size to 16,878. Although the CCHS 2.2 collected data on measured heights and weights, a significant number of the respondents did not have information on measured heights and weights. About 32.32% of the remaining sample (after deleting missing and non-responses) did not have information on either measured heights or measured weights. Since our dependent variable (BMI) is a derived variable from both measured heights and weights, this means that, a significant amount of the respondents did not have information on measured BMI. One cannot overemphasise the importance of using data based on measured BMI, however, using measured BMI alone also meant losing about 32.32% of the potential sample size. To address this problem, the study imputes the expected missing information on the measured BMI by using the relationship that exists between the measured BMI and self-reported BMI. One way of adjusting self-reported data on heights and weights is to use the existing relationship between the two (Cawley 1999, and Goldman et al. 2011). Cawley (1999) proposed the use of the relationship that exists between measured and self-reported external data to adjust the self-reported values. Fortunately, in this case, the CCHS 2.2 provided data on both the measured and self-reported BMI for a significant number of respondents. This thesis therefore performed the adjustment based on the existing relationship between the measured and the self-reported BMI for the respondents who have records on both. After the adjustment, the final sample size became 24,938.

Among the variables considered in the study were health care records and socio-economic or socio-demographic variables like age, gender, marital status, education, household income, physical activity, chronic condition, self-rated health status, geographic location (i.e. province of residence), country of birth, fruit and vegetable

consumption, smoking status, and alcohol consumption. The dependent variable is Body Mass Index (BMI), which is derived from the ratio of a person's weight to height. The World Health Organisation (2014) defines BMI as the weight in kilograms divided by the square of the height in metres (kg/m^2). Although BMI is a continuous variable, it can be categorized into groups. The World Health Organisation (WHO) classifies BMI into six major classifications. The classifications are underweight, normal weight, overweight, obese class I, obese class II and obese class III. However, this study merges the three sub-classifications of obesity into one (i.e. obese) since our focus is not on the various sub-classifications of obesity. BMI is calculated by the following methods[14]:

Metric: BMI=weight (kg)/height (metres)^2

Non-metric: BMI=weight (pounds)/height (inches)^2 x 703

The table below shows how BMI is classified into the various categories:

Table 1. BMI classification

BMI classification		BMI cut-off points
Underweight		< 18.5
Normal weight		18.5 - 24.9
Overweight		25.0 - 29.9
Obese	Obese Class I	30.0 - 34.9
	Obese Class II	35.0 - 39.9
	Obese Class III	≥ 40.0

Source: WHO (2014)

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[14] Tjepkema (2006)

Table 2 provides information on the percentage of people underweight, normal weight, overweight, and obese when the various sub-groups of the variables of interest are taken into consideration. In other words, Table 2 provides information on the distribution in percentages of the people in the various sub-populations (variables of interest) who are in the various sub-classifications of BMI. For example, considering sex, it can be observed from the table that out of the total people in the sampled dataset, 51.07% are males and 48.93% are females. Focusing on males, it can be observed that 0.4%, 15.56%, 22.94%, and 12.17% out of the total proportion of men are underweight, normal weight, overweight and obese respectively.

Table 2. Percentage of people within the various sub-groups who are underweight, normal weight, overweight and obese

VARIABLES	BMI CATEGORIES				
	Underweight	Normal weight	Overweight	Obese	Total
Age Groupings:					
18-24	0.45	7.12	3.72	1.58	12.87
25-34	0.41	7.7	5.62	4.37	18.11
35-44	0.27	8.24	8.06	5.21	21.79
45-54	0.14	7.08	7.78	5.94	20.94
55-64	0.1	3.89	5.7	4.05	13.74
65-74	0.1	2	3.41	1.76	7.28
75+	0.1	1.73	2.3	1.15	5.28
Sex:					
Male	0.4	15.56	22.94	12.17	51.07
Female	1.18	22.2	13.65	11.9	48.93
Marital Status:					
Married	0.62	16.48	20.58	13.69	51.36
common Law	0.2	5.52	4.28	2.84	12.84
Widowed	0.09	1.32	1.72	1.07	4.2
Separated/Divorced	0.13	3.21	3.03	2.2	8.56
Single, never married	0.54	11.24	6.98	4.27	23.04

Self-Rated Health:					
Poor	0.06	0.41	0.59	0.83	1.89
Fair	0.23	2.26	2.62	2.99	8.11
Good	0.44	9.85	10.96	8.93	30.18
Very good	0.52	14.17	14.47	7.82	36.98
Excellent	0.33	11.08	7.94	3.48	22.84
Physical Activity:					
Active	0.23	8.26	7.51	3.41	19.42
Moderately Active	0.28	10.2	10.17	5.17	25.82
Inactive	1.07	19.3	18.91	15.49	54.76
Fruit and Veg. Consumption:					
Less than 5 Times/Servings per Day	1.11	25.19	25.34	17.09	68.74
More than 5 Times/Servings per day	0.47	12.58	11.25	6.97	31.26
Has Chronic Condition:					
Yes	0.48	13.12	14.89	12.72	41.21
No	1.1	24.65	21.69	11.35	58.79
Type of Smoker:					
Daily Smoker	0.55	8.7	8.04	4.78	22.07
Occasional Smoker	0.03	2.07	1.63	0.98	4.71
Former Smoker	0.15	9.5	11.63	8.6	29.88
Never Smoked	0.85	17.49	15.29	9.7	43.33
Alcohol Consumption:					
Less Than Once a Month	0.33	7.22	6.71	6.72	20.99
Once a Month	0.27	4.24	3.66	2.09	10.26
2 to 3 Times a Month	0.29	5.2	4.13	3.9	13.53
Once a Week	0.25	7.23	5.75	3.52	16.75
2 to 3 Times a Week	0.23	8.32	9.25	4.43	22.23
4 to 6 Times a Week	0.07	2.22	3.19	1.37	6.86
Everyday	0.12	3.34	3.89	2.04	9.4
Country of Birth:					
Canada	1.4	32.08	31.25	21.49	86.21
Other America	0	0.6	0.94	0.32	1.87

Europe	0.12	2.5	3.06	2.04	7.71
Asia	0.06	2.59	1.34	0.22	4.2
Education:					
Less than Sec Sch. Grad	0.34	4.97	6.07	5.2	16.58
Sec Sch. Grad	0.31	6.35	6.01	4.53	17.2
Some Post-Sec	0.21	4.19	3.63	2.13	10.16
Post-Sec Grad	0.72	22.25	20.88	12.2	56.06
Household Income Grouping:					
Lowest Income	0.23	2.95	2.42	1.59	7.19
Lower Middle Income	0.4	6.42	6.03	4.34	17.19
Upper Middle Income	0.53	14.04	12.9	9.34	36.82
Highest Income	0.42	14.35	15.24	8.79	38.8

Source: Author's calculation

CHAPTER 5

5. Empirical results

The previous chapter discussed the two main analytical methods used, and also described the data used for the analyses. In this chapter, we present and discuss the results from both analytical methods. The discussion is done in two parts. The first part presents and discusses the results from the descriptive statistics and the econometric models (MMLRM). The results are compared to the findings of previous studies to assess its validity. The second part of the chapter presents and discusses the findings of the COI approach. The results include estimates of obesity prevalence reductions and its corresponding potential health-related cost savings resulting from the implementation and promotion of the health claim on low calorie diets and obesity. To ensure the robustness of the results, different cases and scenarios are considered during the estimation process.

5.1 Results from the econometric approach

This section presents the results from the Multilevel Multinomial Regression Model (MMLRM) for the various categories of BMI. Normal weight was selected as the reference BMI category. Preliminary analysis of the CCHS 2.2 data suggests that the prevalence of overweight and obesity among Canadian adults was 36.59% and 24.07% respectively[15]. We find about 37.77% of Canadian adults to be of normal weight, while 1.58% are classified as underweight. Details of the distribution of the BMI categories (underweight, normal weight, overweight and obese) with respect to the variables of interest was presented in Table 2 in the previous chapter. To test whether the use of the

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[15] Canadian adults refers to Canadians aged 18 years and above.

hierarchical modeling (i.e. MMLRM) was appropriate for the dataset, the study estimated the variance of the random component of the model. We find the variance of the random component at the province level to be significantly different from zero. That is, a variance of 0.028 with a standard error of 0.010. In addition, the results from a likelihood ratio test indicated that the MMLRM fits considerably better than the simple multinomial logistic regression model (LR chi2(1) = 76.26 and Prob > chi2 = 0.000).

Table 3 below presents the results from the MMLRM. The first column under each BMI classification reports the odds ratios from the MMLRM[16]. The second and third columns report the standard errors and the p-values respectively associated with the model estimation. For the purpose of all the analysis in the study, unless otherwise stated, significance is assumed to refer to a 5% level. The analysis and discussions of results is limited to overweight and obesity since the focus of this thesis is not on the underweight category of BMI. Although being underweight is also associated with a number of health risks such as Osteoporosis and low muscle mass, considering its small prevalence, it can be said that underweight is not a serious health concern in Canada. Due to the complexity of the interpretation of coefficients from a logistic regression, all discussions will be based on the odds ratios (O.R). The odds ratios are the exponentiated coefficients of the MMLRM regression. The presentation and discussion of the results is done by considering the various variables as presented in Table 3 below.

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[16] Odds ratios above one indicate increased odds of overweight/obesity while odds ratios below one indicate reduced odds of overweight/obesity. The interpretation could be done using percentages by subtracting one from the odds ratio and multiplying the results by 100. For example, an odds ratio of 1.23 for overweight could be interpreted as 23% increased odds of becoming overweight.

Table 3. Multilevel Multinomial Logistic regression results

Variables	Underweight			Overweight			Obese		
	O.R	S.E	P>z	O.R	S.E	P>z	O.R	S.E	P>z
Age Groupings:									
18-24 (reference)									
25-34	0.778	0.132	0.138	1.725	0.105	0.000	2.722	0.189	0.000
35-44	0.368	0.086	0.000	2.188	0.141	0.000	2.803	0.209	0.000
45-54	0.345	0.084	0.000	2.345	0.155	0.000	3.011	0.227	0.000
55-64	0.590	0.143	0.030	2.889	0.209	0.000	3.090	0.254	0.000
65-74	0.557	0.155	0.036	2.855	0.233	0.000	2.288	0.212	0.000
75+	0.540	0.152	0.029	2.136	0.182	0.000	1.076	0.107	0.461
Sex:									
Male (reference)									
Female	1.611	0.197	0.000	0.511	0.017	0.000	0.638	0.024	0.000
Marital Status:									
Married (reference)									
Common Law	0.936	0.208	0.766	0.891	0.054	0.058	0.914	0.060	0.173
Widowed	1.083	0.242	0.721	0.990	0.064	0.876	1.017	0.074	0.818
Separated/Divorced	0.964	0.207	0.863	0.911	0.050	0.087	0.888	0.053	0.046
Single, never married	0.964	0.171	0.836	0.693	0.034	0.000	0.719	0.038	0.000
Country of Birth:									
Canada (reference)									
Other America	1.329	0.573	0.51	1.609	0.205	0.000	1.025	0.157	0.872
Europe	1.257	0.270	0.287	0.987	0.063	0.834	0.960	0.070	0.574
Asia	1.034	0.350	0.922	0.413	0.047	0.000	0.173	0.029	0.000
Education:									
Less than Sec Sch. Grad (reference)									
Sec. Sch Grad	1.002	0.154	0.991	0.992	0.051	0.879	0.816	0.046	0.000
Some Post-Sec	0.928	0.166	0.676	1.003	0.062	0.964	0.876	0.060	0.055
Post-Sec Grad	0.629	0.095	0.002	0.883	0.040	0.005	0.745	0.036	0.000
Household Income: Grouping									
Lowest Income (reference)									

Lower Middle Income	1.123	0.182	0.475	1.083	0.064	0.18	1.060	0.068	0.362
Upper Middle Income	0.868	0.145	0.396	1.094	0.063	0.118	1.182	0.074	0.008
Highest Income	0.765	0.148	0.165	1.199	0.075	0.004	1.204	0.083	0.007
Physical Activity:									
Active (reference)									
Moderately Active	1.161	0.230	0.453	1.009	0.046	0.843	1.242	0.068	0.000
Inactive	2.314	0.390	0.000	1.022	0.043	0.609	1.591	0.079	0.000
Self-Rated Health:									
Poor (reference)									
Fair	0.678	0.171	0.122	1.060	0.131	0.635	1.062	0.126	0.61
Good	0.300	0.073	0.000	1.170	0.135	0.175	0.818	0.091	0.072
Very Good	0.202	0.051	0.000	1.063	0.123	0.598	0.548	0.062	0.000
Excellent	0.305	0.081	0.000	0.799	0.095	0.061	0.346	0.041	0.000
Has Chronic Condition:									
Yes (reference)									
No	1.309	0.172	0.04	0.907	0.033	0.008	0.653	0.026	0.000
Type of Smoker:									
Daily Smoker (reference)									
Occasional Smoker	0.646	0.176	0.108	1.162	0.092	0.059	1.453	0.129	0.000
Former Smoker	0.622	0.105	0.005	1.402	0.064	0.000	2.078	0.106	0.000
Never Smoked	0.816	0.107	0.121	1.260	0.054	0.000	1.669	0.080	0.000
Alcohol Consumption:									
Less than Once a Month (reference)									
Once a Month	1.102	0.198	0.588	0.808	0.048	0.000	0.672	0.042	0.000
2 to 3 Times a Month	0.782	0.139	0.167	0.870	0.046	0.009	0.769	0.043	0.000
Once a Week	1.128	0.186	0.467	0.889	0.046	0.022	0.612	0.034	0.000
2 to 3 Times a Week	0.802	0.150	0.237	0.873	0.044	0.007	0.522	0.029	0.000
4 to 6 Times a Week	0.899	0.268	0.72	0.882	0.065	0.088	0.525	0.045	0.000
Everyday	1.787	0.362	0.004	0.761	0.048	0.000	0.483	0.035	0.000

Fruit and Veg. Consumption:									
Less than 5 Times/Servings per Day (reference)									
More than 5 Times/Servings per Day	0.986	0.126	0.911	0.886	0.032	0.001	0.928	0.037	0.059
Unemployment:	0.987	0.036	0.713	0.994	0.023	0.807	0.998	0.024	0.919
Inequality:	2.797	12.843	0.823	0.184	0.563	0.58	0.129	0.397	0.506
Cons:	0.095	0.197	0.255	1.693	2.279	0.696	1.776	2.416	0.673

(Number of level 1 units = 24938, number of level 2 units = 10, Condition Number = 4371.3613, log likelihood = -26699.278)
Source: Author's calculation

Considering age groups, we observe that with the exception of people aged 75 and above, all the age groups are significantly associated with an increased risk of becoming overweight or obese when compared to the reference age group of 18 to 24. For instance, the 35-44 age group have odds ratios 2.188 and 2.803 of becoming overweight and obese respectively. The odds ratios suggest that the 35-44 age group have increased risk of becoming overweight or obese when compared to the youngest adult age group of 18-24. Although people aged 75 and above are associated with an increased risk of becoming overweight and obese, only the overweight category is significant. The obese category is not statistically significant. Generally, a progressive positive relationship is observed between age and the likelihood of becoming overweight or obese when all other age groups are compared to the 18 to 24 age group. However, this relationship breaks down after the age of 64 years. After the age of 64, although the relationship is still positive, the risk level begins to fall. We observe that the 55 to 64 age group has the highest likelihood of becoming overweight or obese when compared to the youngest adult group with an

odds ratio of 2.889 for overweight and 3.090 for obesity. In contrast, the age group that is observed to have the least risk of becoming overweight or obese when compared to the youngest adult group is the 25 to 35 age category with an odds ratios of 1.725 for overweight and 2.722 for obesity.

Comparing females to males, females are seen to be significantly less likely to be overweight or obese as compared to males with odds ratios of 0.511 for overweight and 0.638 for obesity. Females are approximately 48.9% and 36.2% less likely to be overweight and obese respectively when compared to males. Considering marital status, people who are single (never married) are seen to be significantly less likely to be overweight or obese with odds ratios 0.693 for overweight and 0.719 for obesity when compared to married people. Single, never married people are 30.8% and 28.1% less likely to be overweight and obese respectively when compared to the married group. Although being separated or divorced significantly reduces the likelihood of being obese, it reduces the likelihood of becoming overweight only at 10% level of significance. Compared to married people, being in a common law relationship reduces the likelihood of becoming overweight at 10% level of significance and approaches significance for the obese category with a P-value of 0.17. Being a widow does not significantly predict the risk of becoming overweight or obese.

Taking Canada as the reference country, people who are born in Asia are observed to have reduced risk of becoming overweight or obese with odds ratios 0.413 for overweight and 0.173 for obesity. We find that people born in Asia are 58.7% and 82.7% less likely to be overweight and obese respectively when compared to their Canadian counterparts. We also find that people born on other parts of the American

continent (excluding Canada) are 60.1% more likely to be overweight than people born in Canada. Although people born in other areas of the American continent have increased risk of becoming obese when compared to Canadian born individuals, the result is not significant at any of the standard levels of significance. Moreover, people born in Europe record reduced risk of becoming overweight or obese. However, the result is also not statistically significant at any of the standard level of significance.

The results show that post-secondary school graduates are significantly less likely to become overweight or obese when compared to people with less than secondary school graduation. Post-secondary school graduates have 11.7% and 25.5% reduced odds of becoming overweight and obese respectively with odds ratios of 0.883 for overweight and 0.745 for obesity. Having some post-secondary school education reduces the likelihood of becoming obese at 10% level of significance. However, having some post-secondary education does not significantly predict the likelihood of becoming overweight. Similarly, compared to people with less than secondary school education, secondary school graduates are seen to be less likely to be obese. Secondary school graduates are 18.5% less likely to be obese as compared to those who did not graduate from secondary school. The results for the overweight category is, however, not statistically significant even though being a secondary school graduate results in a reduced risk of becoming overweight.

Generally, household income is positively associated with the likelihood of becoming overweight or obese. People from the highest household income groups are observed to be more likely to become overweight or obese relative to people from the lowest income household group. Individuals from the highest household income category

have 19.9% and 20.4% increased odds of becoming overweight and obese respectively (with odds ratios of 1.199 for overweight and 1.204 for obesity). Compared to people from the lowest income households, people from the upper middle income households are seen to be significantly more likely to be obese. However, the overweight category approaches significance at a P-value of 0.12. While the variable for the lower middle income group is not significant in predicting the likelihood of being obese, it approaches significance for the overweight category with a P-value of 0.18.

Relative to active people, people who are considered inactive are 59.9% more likely to be obese and 2.2% more likely to be overweight (with odds ratios of 1.022 and 1.591 for overweight and obesity respectively). However, the estimate for the overweight category is not statistically significant. Moderately active people are also seen to be about 24.2% more likely to be obese when compared to the active people. However, the moderately active and inactive variables do not significantly predict the likelihood of being overweight.

Considering self-rated health, we find that people who consider their health to be excellent are 20.1% less likely to be overweight and 65.4% less likely to be obese when compared to people with poor self-rated health. Individuals with excellent self-rated health have reduced odds of overweight and obesity with odds ratios of 0.799 and 0.346 for overweight and obesity respectively. People with self-rated health of good and very good are observed to be less likely to be obese. The variable for people with fair self-rated health is not a significant predictor for both overweight and obese categories. The results for both the good and very good self-rated health variables are not statistically significant in predicting the likelihood of being overweight. People with no chronic

diseases are 9.3% less likely to be overweight and 34.7% less likely to be obese when compared to people with at least one chronic disease. The odds ratios for overweight and obesity are 0.907 and 0.653 respectively.

The results show that smoking status is a significant predictor of both overweight and obesity. People who have never smoked before are more likely to be overweight or obese than daily smokers. Never smoked individuals have 26.0% and 66.9% increased odds of becoming overweight and obese respectively (with odds ratios of 1.26 for overweight and 1.669 for obesity) when compared to daily smokers. People who have quit smoking and occasional smokers are also more likely to be overweight or obese than daily smokers. We find that the type of smokers who have the highest likelihood of being overweight or obese are the former smokers. Relative to daily smokers, those who have quit smoking are 40.2% and 107.8% more likely to be overweight and obese respectively when compared to daily smokers.

With respect to alcohol consumption, frequent alcohol consumers are seen to be less likely to be overweight or obese. Those who drink alcohol everyday are 23.9% less likely to be overweight and 51.7% less likely to be obese when compared to those who consumed alcohol less than once a month. Frequent consumers have reduced risk of overweight and obesity with odds ratios of 0.761 and 0.483 respectively. Those who consume alcohol four to six times a week are 11.8% and 47.5% less likely to be overweight and obese respectively when compared to those who drink less than once a month. Moreover, compared to those who drink less than once a month, people who consume alcohol once a month are 19.2% and 32.8% less likely to be overweight and obese respectively.

Finally, frequency of fruit and vegetable consumption is seen to be a significant predictor of both overweight and obesity. People who consume more fruits and vegetables are less likely to be overweight or obese than those who consume less fruits and vegetables. People who consume fruits and vegetables more than five times/servings per day are 11.4% less likely to be overweight and 7.3% less likely to be obese (with odds ratios of 0.886 and 0.928 for overweight and obesity respectively) when compared to those who consume less than five times/servings per day. The odds ratios indicate that those who consume fruits and vegetables more frequently have reduced risk of overweight/obesity. State level variables like unemployment rate and level of inequality within provinces are not statistically significant predictors of overweight and obesity.

5.1.1 Discussion

Most of the results from the econometric analysis of this thesis met our expectations, as they were consistent with previous findings from other studies. Age was seen to be generally positively related to overweight and obesity although the relationship breaks down after a certain later age. These results are consistent with most of the findings of other studies (Bélanger-Ducharme and Tremblay 2005, Mandal and Chern 2006, Ogden et al. 2006, Shields 2006, and Alter et al. 2012). Mandal and Chern (2006) found the relationship between age and obesity to be generally positive until a certain later age in life. Results from this thesis suggest that the likelihood of becoming overweight or obese when compared to the youngest age group increases until about sixty-four years and begins to fall thereafter. This is shown in Figure 3 and Figure 4 below. A possible explanation of this relationship is that, generally people put on weight as they age until

they reach the later years of their life where sickness and other mortality factors set in to offset this relationship. Few studies, however, found the relationship between age and overweight/obesity to be negative (e.g. Kaplan et al 2003, Oliver and Hayes 2005, Cook and Daponte 2008, Constăngioară et al 2009, and Shields and Tjepkema 2006).

Figure 3. Relationship between age group and odds of becoming overweight
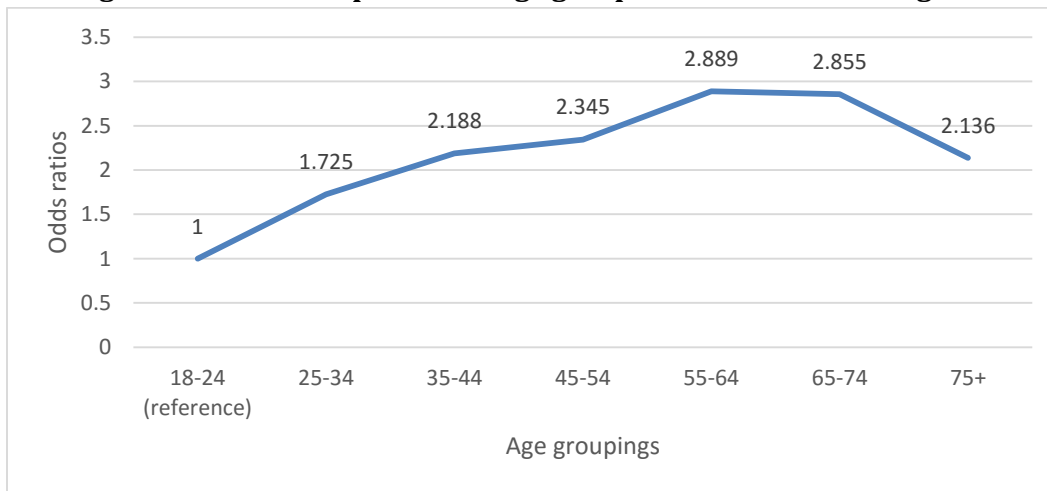
Source: Author's calculation

Figure 4. Relationship between age group and odds of becoming obese
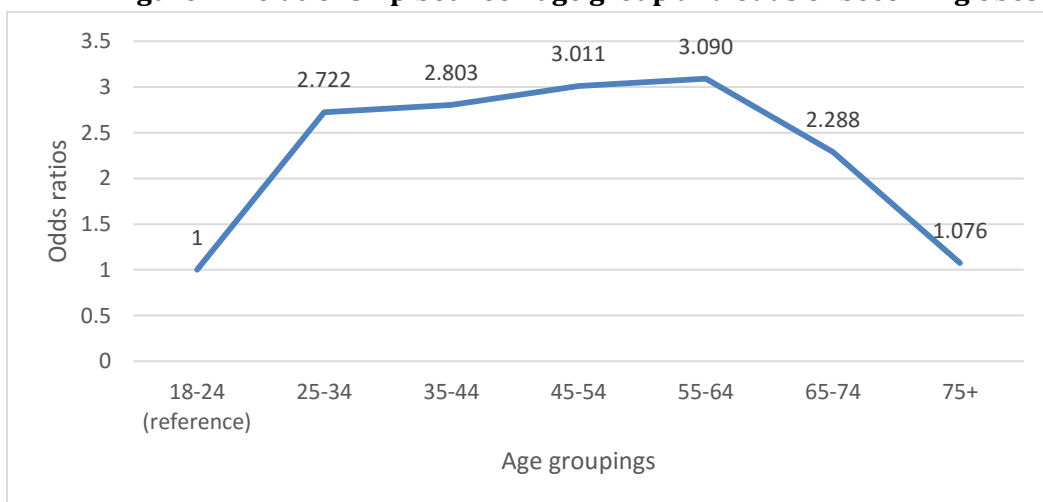
Source: Author's calculation

People born in Europe and Asia are observed to be less likely to be obese than people born in Canada, although the results for Europe were not statistically significant. However people born in other parts of the American continent (but not Canada) are seen to be more likely to be overweight when compared to Canadian born. This result is consistent with the results of most similar studies (e.g. Edwards 2007 and Shields 2006). Shields (2006) found young Canadians of South Asian or East Asian origin to have the least percentage of overweight or obesity relative to other races. Tjepkema (2006) also found Canadians to have a relatively lower prevalence rate of overweight and obesity as compared to their U.S counterparts.

The results for the sex variable are also consistent with previous studies. We found females to be generally less likely to be overweight or obese when compared to their male counterparts. A significant number of studies have also reported similar findings (Edwards 2007, Kaplan et al 2003, Bélanger-Ducharme and Tremblay 2005, Huoto et al. 2004, Mandal and Chern 2006, and Katzmarzyk 2002). This result is not surprising as relatively females are concerned with their appearance and a lot of cosmetic and weight loss programs and commercials target women. Similarly, we find that singles (never-married) have the least likelihood of being overweight or obese when compared to the married. Almost all the variables under marital status except for the widowed are less likely to be overweight or obese than those who are married. A possible reason for such results is that, singles may want to stay in good shape to be able to attract a marriage partner (Edwards, 2007). Depending on the age at which one is widowed or circumstances surrounding the death of their partner, one may not be willing to marry again. In this case such a person may not worry as much about their weight.

People with higher education are seen to be less likely to be obese when compared with people less education (i.e. less than secondary school graduation). This result is consistent with the findings of most previous studies. Generally, evidence from most studies suggests that the likelihood of becoming overweight or obese reduces as the education level increases (Ward et al. 2007, Kaplan et al. 2003, Huoto et al. 2004, Oliver and Hayes 2005, Mandal and Chern 2006, Edwards 2007, and Tan et al. 2011). Presumably this result could be explained by the fact that, as people acquire more knowledge they tend to read and learn more about healthy lifestyle and this may affect their eating and lifestyle choices.

Surprisingly, people from the highest household income category are seen to be more likely to be overweight or obese in comparison to the people from the lowest household income category. A possible explanation of this results is that, in the quest to amass wealth, people may spend too much time at their work places to the extent that they are unable to find time to exercise. Furthermore, increased wealth may increase sedentary activities, as the rich may prefer more driving to walking. Ward et al. (2007) and Edwards (2007) also found similar results in their respective studies. These results, however, contradict the findings of a number of other studies that observed a negative relationship between income and BMI (Bélanger-Ducharme and Tremblay 2005, Oliver and Hayes 2005, Shields 2006, Le Petit and Berthelot 2005, and Shields and Tjepkema 2006). Generally, it is expected that as income increases, people are able to afford expensive weight loss equipment and also afford to go to the gym regularly. It is also expected that the rich can afford healthy foods. In addition, other studies found the

relationship between income and overweight/obesity to be inconclusive (Huot et al. 2004 and Tan et al. 2011).

As was expected, physical activeness was observed to be negatively related to obesity, although the results are not statistically significant for the overweight category. This result was in agreement with most of the findings from previous studies (Kaplan et al 2003, Huoto et al 2004, Mandal and Chern 2006, Tjepkema 2006, Edwards 2007, Ward et al. 2007, Constăngioară et al 2009, and Le Petit and Berthelot 2005). The fruit and vegetables consumption variable also gave expected results, as the increase in consumption of fruits and vegetables is associated with a lower likelihood of overweight and obesity. These results are also consistent with literature on the subject (Mandal and Chern 2006, Shields 2006, Tjepkema 2006, Edwards 2007, Ward et al. 2007, and Auld and Powell 2006).

People who rate their health to be excellent are less likely to be overweight or obese when compared with those who rate their health to be poor. As self-rated health improves, the likelihood of becoming obese reduces. These results are not surprising as obesity has been identified to be associated with ill-health. Furthermore, these results are boosted by the findings from the chronic condition variable. Those who responded "no" to having any chronic condition are found to be significantly less likely to be overweight or obese when compared to those who responded 'yes' to having at least one chronic condition. This is in agreement with the findings from most studies that observed a relationship between the presence or health history of comorbidities and overweight/obesity (Tjepkema 2006, Tan et al 2011, Mokdad et al 2003, Kaplan et al 2003, Huoto et al 2004, and Tan et al 2011).

The smoking status variable also returned expected results. Frequent smokers were observed to be significantly associated with reduced odds of overweight/obesity, which is consistent with most previous studies' findings (Kaplan et al 2003, Huoto et al 2004, Mandal and Chern 2006, Edwards 2007, Ward et al. 2007, and Tan et al 2011). However, the findings from a few studies suggested that frequent smoking was associated with an increased risk of obesity, rather than the inverse (e.g. Le Petit and Berthelot 2005). Although occasional smokers, former smokers, and never smoked people are all at increased risk of becoming overweight or obese when compared to daily smokers, we find that former smokers have the highest likelihood of becoming overweight or obese.

Interestingly, increased alcohol consumption is significantly associated with reduced likelihood of overweight and obesity. These results are also consistent with the findings from most studies. In view of this finding, most studies recommend moderated drinking as a measure to tackle obesity (e.g. Kaplan et al. 2003, and Smothers and Bertolucci 2001). Kaplan et al. (2003) found moderate drinking to be protective among both men and women. However, it is important to note that considering the other health risks associated with smoking and alcohol consumption, caution must be taken when proposing any overweight or obesity intervention programs based on these findings.

5.2 Potential reduction in obesity prevalence and its corresponding health-related cost savings

This section presents the results of the COI approach discussed in detail in the second part of chapter 4. Two main results are presented in this section. The first set of results presents the findings from the weight loss simulations discussed in step three of the COI

procedure. Various cases were considered in evaluating the potential reduction in obesity prevalence resulting from a weight loss simulation of the 2004 CCHS 2.2 dataset. The cases considered include a 10% and 5% weight loss simulation performed on 100%, 60%, and 30% of overweight and obese individuals in the 2004 CCHS 2.2 to estimate the potential reductions in obesity prevalence in Canada. The second set of results present the corresponding potential health-related cost savings on total obesity expenditure resulting from the estimated reductions in obesity prevalence given the cases considered. The potential health-related cost savings are based on the established relationship between disease incidence and health care expenditure discussed in step four of the COI procedure.

5.2.1 Reduction in obesity prevalence resulting from weight loss

The results from the weight loss simulation are presented below. Table 4 gives the details of a 10% and 5% weight loss simulation on all persons overweight and obese. As additional information, this thesis also provides the results of the effect of weight loss on overweight prevalence in Canada, although the main focus is on obesity.

Table 4. Simulation results after weight loss estimate is applied to all overweight and obese persons

Prevalence of overweight and obesity after weight loss is applied to all persons overweight or obese						
Percentage Weight loss	Prevalence before weight loss		Prevalence after weight loss		Percentage change in prevalence	
	Overweight %	Obesity %	Overweight %	Obesity %	Overweight %	Obesity %
5%	36.59	24.07	34.20	17.38	-7	**-28**
10%	36.59	24.07	27.38	11.46	-25	**-52**

Source: Author's calculation

From Table 4 it can be observed that by imposing a 10% weight loss restriction on the data, overweight and obesity prevalence reduces from 36.59% to 27.38% and 24.07% to 11.46% respectively. This results in a reduction of the overweight and obesity prevalence by 25% and 52% respectively. Similarly, after imposing a 5% weight loss restriction on the data, overweight and obesity prevalence reduces from 36.59% to 34.2% and 24.07% to 17.38% respectively. That is, overweight and obesity prevalence reduces by 7% and 28% respectively.

As sensitivity analysis, the study relaxes the assumption that the health claims will be successful in persuading all overweight and obese persons to reduce their weight (i.e. 100% success rate). In other words, the assumption that everyone overweight or obese will reduce their weight by 5% or 10% is relaxed. Therefore, assuming a 60% success rate of the health claim, we repeatedly and randomly select 60% of the people overweight and obese to apply 5% and 10% weight loss restriction on them. That is, the implementation and promotion of the health claim on low calorie diet and obesity will encourage 60% of overweight and 60% of obese individuals to restrict their caloric intake. The 'new' BMI estimates and their corresponding reduction in overweight and obesity prevalence was then re-calculated. Table 5 below provides detailed information of these weight loss simulations.

Table 5. Simulation results after weight loss is randomly and repeated applied to 60% of overweight and obese samples

Percentage Weight loss	Prevalence before weight loss		Prevalence after weight loss		Percentage change in prevalence	
	Overweight %	Obesity %	Overweight %	Obesity %	Overweight %	Obesity %
5%	36.59	24.07	35.44	20.00	-3	**-17**
10%	36.59	24.07	31.37	16.46	-14	**-32**

Source: Author's calculation

From Table 5, after a weight loss of 10% is randomly and repeatedly applied to 60% of the people overweight and obese, overweight and obesity prevalence reduces from 36.59% to 31.37% and 24.07% to 16.47% respectively (representing reduction in overweight and obesity prevalence by 14% and 32% respectively). Similarly, by imposing 5% weight loss on 60% of the overweight and obese sample selected randomly and repeatedly, we observe a reduction in overweight and obesity prevalence from 36.59% to 35.55% and 24.07% to 20.00% respectively. This corresponds to a reduction in overweight and obesity prevalence by 3% and 17% respectively.

Furthermore, the analysis was repeated for a 10% and 5% weight loss by assuming a more conservative success rate of the health claim. This time we assumed that the implementation of the health claim on low calorie diets and obesity would encourage 30% of overweight and obese individuals to reduce their caloric intake by either 10% or 5%. Table 6 presents the 'new' obesity prevalence figures and its corresponding percentage changes in the prevalence.

Table 6. Simulation results after weight loss is randomly and repeated applied to 30% of overweight and obese samples

Prevalence of overweight and obesity after weight loss is applied to 30% randomly selected individuals who are overweight or obese						
Percentage Weight loss	Prevalence before weight loss		Prevalence after weight loss		Percentage change in prevalence	
	Overweight %	Obesity %	Overweight %	Obesity %	Overweight %	Obesity %
5%	36.59	24.07	36.51	21.90	-0.2	**-9**
10%	36.59	24.07	34.50	20.16	-6	**-16**

Source: Author's calculation

From Table 6, after a weight loss of 10% is randomly and repeatedly applied to 30% of the people overweight and obese, the overweight and obesity prevalence reduces from 36.59% to 34.5% and 24.07% to 20.16% respectively. This corresponds to a reduction in overweight and obesity prevalence by 6% and 16% respectively. Similarly, by imposing 5% weight loss on 30% randomly and repeatedly selected overweight and obese individuals, we observe a reduction in overweight and obesity prevalence from 36.59% to 36.51% and 24.07% to 21.9% respectively. This corresponds to a reduction in overweight and obesity prevalence by 0.2% and 9% respectively.

5.2.2 Potential health-related cost savings resulting from the reduction in obesity prevalence

This section presents the results of the potential health-related cost savings estimations corresponding to the evaluated reductions in obesity prevalence. Table 7 presents the results of the cost savings resulting from the scenario where the weight loss simulation is conducted on all persons overweight or obese. Table 8 and Table 9 presents the results of

the scenarios where the weight loss simulations are performed on 60% and 30% randomly and repeatedly selected overweight and obese individuals respectively.

Table 7. Health-related cost savings estimation after weight loss is applied to all obese persons

Reduction in health-related cost after weight loss is applied to all persons obese							
Scenario	Percentage reduction in obesity prevalence as a result of:		Total health care cost of obesity in Canada (billion CAD $)	Relationship between change in prevalence and cost	Percentage reduction in health care cost as a result of:		Total reduction in health expenditure on obesity as a result of: (billion CAD $)	
	5% weight loss	10% weight loss			5% weight loss	10% weight loss	5% weight loss	10% weight loss
Low	28	52	7.98	1: 0.5	14	26	1.11	2.09
Base	28	52	7.98	1: 0.83	23	43	1.84	3.47
Ideal	28	52	7.98	1: 1	28	52	2.22	4.18

Source: Author's calculation

Table 8. Health care cost savings estimation after weight loss is applied 60% randomly and repeatedly selected obese individuals

Reduction in health-related cost after weight loss is applied to 60% randomly selected individual who are obese							
Scenario	Percentage reduction in obesity prevalence as a result of:		Total health care cost of obesity in Canada (billion CAD $)	Relationship between change in prevalence and cost	Percentage reduction in health care cost as a result of:		Total reduction in health expenditure on obesity as a result of: (billion CAD $)	
	5% weight loss	10% weight loss			5% weight loss	10% weight loss	5% weight loss	10% weight loss
Low	17	32	7.98	1: 0.5	8	16	0.68	1.26
Base	17	32	7.98	1: 0.83	14	26	1.12	2.09
Ideal	17	32	7.98	1: 1	17	32	1.35	2.52

Source: Author's calculation

Table 9. Health care cost savings estimation after weight loss is applied 30% randomly and repeatedly selected obese individuals

Scenario	Percentage reduction in obesity prevalence as a result of:		Total health care cost of obesity in Canada (billion CAD $)	Relationship between change in prevalence and cost	Percentage reduction in health care cost as a result of:		Total reduction in health expenditure on obesity as a result of: (billion CAD $)	
Reduction in health-related cost after weight loss is applied to 30% randomly selected individual who are obese								
	5% weight loss	10% weight loss			5% weight loss	10% weight loss	5% weight loss	10% weight loss
Low	9	16	7.98	1: 0.5	5	8	0.36	0.65
Base	9	16	7.98	1: 0.83	7	13	0.60	1.08
Ideal	9	16	7.98	1: 1	9	16	0.72	1.30

Source: Author's calculation

From Table 7, the results indicate that when a 10% weight loss simulation is performed on all persons overweight and obese, the potential health-related cost savings for the ideal, base, and low scenarios are $ 4.18 billion, $3.47 billion, and $2.09 billion respectively[17]. Similarly, when a 5% weight loss simulation is performed on all persons overweight and obese, the potential health-related cost savings for the ideal, base, and low scenarios are $2.22 billion, $1.84 billion, and $1.11 billion respectively.

Moreover, when a 10% weight loss simulation is performed on 60% randomly and repeatedly selected overweight and obese individuals from the dataset, the potential health-related cost savings for the ideal, base, and low scenarios are $2.52 billion, $2.09 billion, and $1.26 billion respectively. Likewise, when a 5% weight loss simulation is performed on 60% randomly and repeatedly selected overweight and obese individuals,

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[17] For instance, considering the base estimation, a 10% weight loss simulation on all overweight/obese individuals results in 52% reduction in obesity prevalence. Based on the 1:0.83 relationship between reduction in prevalence and reduction in cost, the estimated percentage reduction in cost becomes 43%. Therefore 43% of the total obesity cost of $7.98 becomes $3.47. Similar analysis is conducted for all cases/scenarios.

the potential health-related cost savings for the ideal, base, and low scenarios are $1.35 billion, $1.12 billion, and $680 million respectively. This is shown in Table 8. Finally, the analysis reveals that, the potential health-related cost savings for the ideal, base, and low scenarios resulting from a 10% weight loss simulation performed on 30% randomly and repeatedly selected overweight and obese individuals are $1.30 billion, $1.08 billion, and $650 million respectively. Performing the same simulation for a 5% weight loss shows that the potential health-related cost savings for the ideal, base, and low scenarios are $720 million, $600 million, and $360 million respectively.

In summary, the potential health-related cost savings could be put into three main groups. These groups are the optimistic, expected, and pessimistic. The optimistic considers the ideal scenario (i.e. a 1:1 relationship between reduction in obesity prevalence and reduction in health-related cost) where a 10% weight loss simulation is performed on all individuals overweight and obese. This results in a potential health-related cost savings of $4.18 billion dollars. The expected considers the base scenario (i.e. a 1:0.83 relationship between reduction in obesity prevalence and reduction in health-related cost) where a 10% weight loss simulation is performed on 60% randomly and repeatedly selected overweight and obese individuals. This results in a potential health-related cost savings of $2.09 billion. Lastly, the pessimistic looks at the low scenario (i.e. a 1:0.5 relationship between reduction in obesity prevalence and reduction in health-related cost) where a 5% weight loss simulation is performed on 30% randomly and repeatedly selected overweight and obese individuals. This results in a potential health-related cost savings of $360 million. The summary of the three main scenarios discussed above is presented in Table 10 below.

Table 10. Summary of cases/scenarios of health-related cost savings

Groups	Cases/Scenarios	Health care savings
Optimistic	All individuals overweight/obese + 10% weight loss simulation + 1:1	$4.18 billion
Expected	60% randomly and repeatedly selected overweight/obese individuals + 10% weight loss simulation + 1:0.83	$2.09 billion
Pessimistic	30% randomly and repeatedly selected overweight/obese individuals + 5% weight loss simulation + 1:0.05	$360 million

Source: Author's calculation

CHAPTER 6

6. Policy implication and recommendation

The findings from this thesis confirm that, obesity is a significant health concern in Canada. By critically analysing the socioeconomic and sociodemographic determinants of obesity, we observed that, certain groups of people are more vulnerable to the disease than others. For example, age is observed to be significantly positively related to obesity. Older people are at increased risk of becoming obese when compared to the younger generation. In addition, other groups that are observed to have increased odds of becoming obese include males, the married, people born in other parts of the American continent (excluding Canada), less educated individuals, physically inactive individuals, and people who consume less fruits and vegetables. Such vital information will aid policy makers and interest groups to direct specific policies to target specific groups of people who are at increased risk of becoming obese. Particularly, the study recommends that much of the awareness creation of the dangers of high caloric intake and obesity management education programs should be directed towards highly vulnerable groups like the elderly. At the same time, preventive education programs should be directed towards less vulnerable groups like the younger generation to help them minimise their likelihood of developing the disease. Such programs may include activities that encourage people to increase their physical activities and also pay proper attention to the nutrition contents of their foods.

Evidence from the literature suggests that being overweight is a significant predictor of obesity. The likelihood of an overweight person transitioning into an obese person is seen to be significantly high (Le Petit and Berthelot 2005). This thesis provides

important information on both the incidence and determinants of overweight and obesity in Canada. The incidence of overweight and obesity is 36.59% and 24.07% respectively. That is, almost two thirds of Canadian are either overweight or obese. Such information on the incidence and determinants of overweight and obesity in Canada has the potential to enlighten consumers on the dangers of the disease and boost awareness creation efforts. This will help people make informed decisions concerning their health and diet choices.

This thesis has shown that the implementation and promotion of the health claim on low calorie diets and obesity as an intervention policy to tackle the obesity menace would have nontrivial implications on the consumption of calories, obesity incidence, and health care expenditure in Canada. We estimate that as a result of a 5% to 10% reduction in caloric intake by obese individuals, the health care expenditure on obesity alone in Canada could be reduced by a base amount of $2.09 billion, ranging between $360 million and $4.18 billion. We therefore recommend that the necessary attention should be given to the health claim and, if possible, it should be implemented and promoted within the shortest possible time.

The information on the potential health-related cost savings could encourage the government to further introduce specific policies like taxes on high calorie foods and subsidies on low calorie foods. Such policies could significantly reduce the incidence of obesity in the country since it could discourage excess consumption of calories and encourage the consumption of low calorie diets. Studies suggest that price reductions of healthy foods significantly encourage the consumption of such foods (French 2003, and Epstein et al. 2006). Goldman et al. (2011) found that increasing the prices of high calorie

foods resulted in the reduction of obesity in the long run in the U.S. Such intervention policies are necessary because the individual will take private optimal diet choices which are not equal to the social optimal level. Even in the presence of perfect information and health claims, consumers will consume more than the socially optimal amount due to health care externality. Consumers over-consume unhealthy products if they don't bear the full cost of their poor diet choices. This results from the nature of the health care system in Canada (i.e. publicly funded health care system). Hence, the private optimal level may be significantly higher than the social optimal level as depicted in Figure 5. Two main types of market failure could be associated with the problem of obesity: information asymmetry and health care externalities. While education of the general populace and the introduction and promotion of health claims on low calorie diets and obesity are expected to address the problem of information asymmetry, policies such as subsidies and taxes are expected to address the problem of the health care externalities.

The approval and promotion of the health claim on low calorie diets and obesity is expected to significantly reduce the incidence of obesity in Canada as discussed in an earlier section of this thesis but will not lead to the social optimal consumption. The introduction of specific policies like subsidies on low calorie diets could further discourage the intake of high calorie diets and could result in a social optimal outcome. Figure 5 shows how a subsidy on low calorie diets could result in further reduction of caloric intake following the reduction due to the health claim. All other things being equal, the introduction of subsidies on foods that are low in calories but are close substitutes to those that are high in calories may entice consumers to substitute the low calorie choices for the high calorie ones. This will result in the further downward shift of

the marginal private benefit curve from $MB_{private\,2}$ to MB_{social} (where the marginal

private benefit curve coincides with the marginal social benefit curve), corresponding to a

reduction in caloric intake from $Q_{p\,2}$ to Q_s. From Figure 5 it can be observed that with

the right amount of subsidies, people will consume at the social optimal level Q_s where

there is no loss to the society. However, it is important to note that, in practice, the impact

of subsidies on low/high calorie diet consumption is dependent on the elasticity of

demand and supply of the food in question. The success of such a policy will depend on

how responsive the product is to changes in prices.

Figure 5. Impact of low calorie diet subsidies on caloric intake
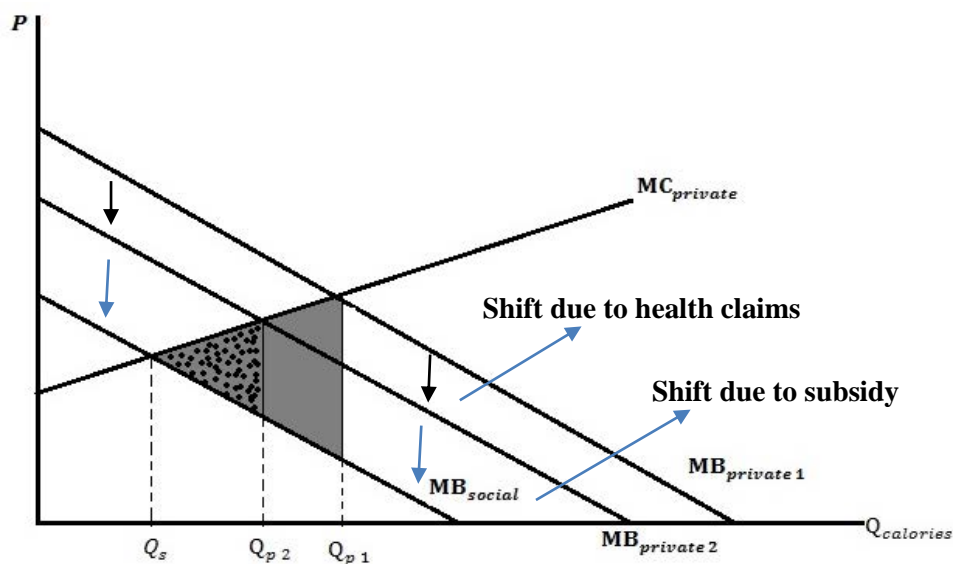
Source: Author's calculation

As an alternative policy to the subsidy on low calorie foods, the government could

introduce a Pigovian tax on high calorie diets. An example of such taxes is the "fat tax".

Fat taxes are intended to discourage the consumption of unhealthy foods that likely lead

to obesity and its related health problems (Leicester and Windmeijer 2004, Cash et al.

2005, and Mytton et al. 2007). Similar to such a policy is the tax on tobacco products

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which has led to a significant reduction of tobacco consumption and improved health in the UK (Mytton et al. 2007). Figure 6 below shows the impact of the fat tax on the price and quantity of unhealthy foods consumed, such as high calorie diets.

Figure 6. Impact of fat taxes on caloric intake.
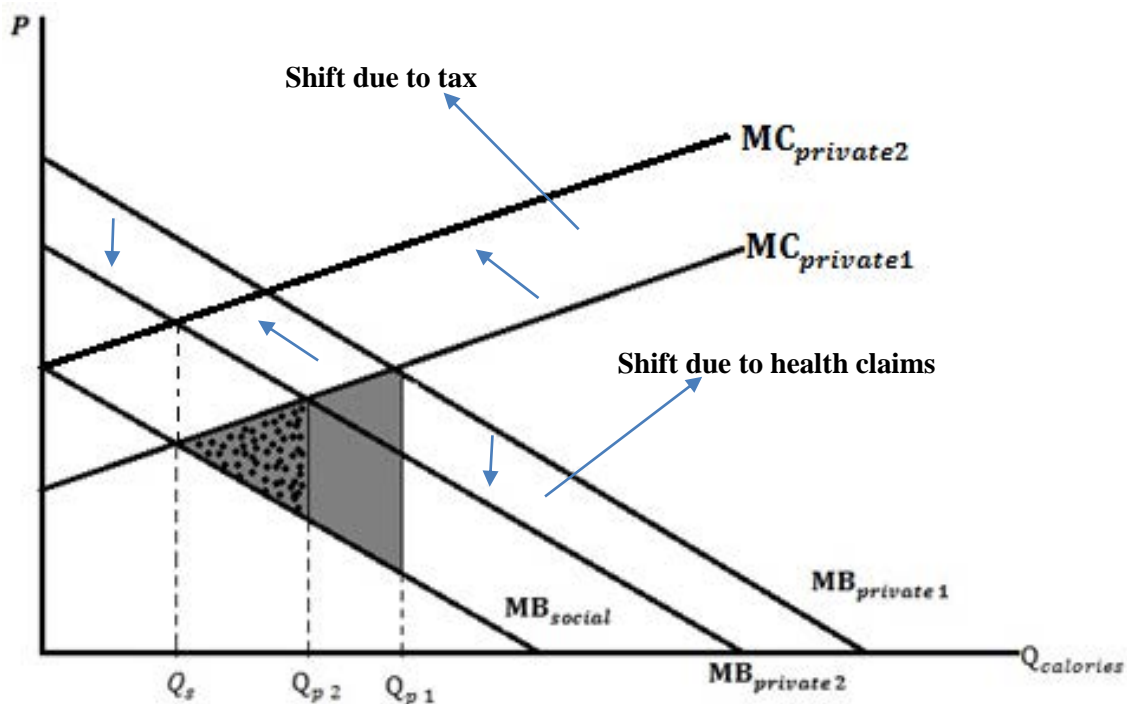
Source: Author's calculations

As a result of the imposition of the right amount of tax on high calorie diets (or foods high in fats), the price of high calorie foods increases. All things being equal, the increase in price will cause the marginal cost private curve to shift upwards to the left from $MC_{private1}$ to $MC_{private2}$ as depicted in Figure 6. Therefore, the quantity demanded of high calorie foods will reduce from Q_{p2} to Q_s. At Q_s, there is no loss to the society. In

practice, though the introduction of tax may cause a reduction in caloric intake towards the social optimal level, such reduction may not necessarily coincide with the social optimal level.

Theoretically, the right magnitude of tax on high calorie diets could shift the $MC_{private1}$ curve upwards to the point where the quantity of high calorie diets consumed would coincide with the social optimal quantity. It can therefore be inferred that a proper implementation of fat taxes on high calorie foods could discourage the consumption of such unhealthy foods. However, as discussed earlier, numerous studies have shown that, if such taxes are not properly implemented, it could cause more harm than the intended good, as in the case of Denmark. Among the challenges of using taxes as an intervention measure to address obesity problems is the substitution effect and the elasticity of demand of the food product on which the tax is imposed. As discussed earlier, imposing taxes on certain food products may lead to the substitution for more unhealthy foods which may further worsen the obesity problem. Moreover, depending on how responsive the product is to changes in price, an intervention policy based on tax may or may not be successful. For example, a tax on food products with fairly elastic demand may be successful in reducing the quantity demanded of such products. However, irrespective of how high a tax on an unhealthy food may be, if the product is highly inelastic, the impact of the tax may be minimal or totally ineffective. The difficulty for policy makers is how to accurately measure the responsiveness of the demand for the unhealthy diets. As a result, a tax intervention policy may be successful or not depending on factors like the nature of the product (i.e. necessity, luxury, etc.), availability/proximity of close substitutes, time period, etc.

In summary, the following policy recommendations are made based on the findings of this thesis. First, specific policies such as obesity education programs should be introduced to target specific groups of people who are at increased risk of becoming obese. Second, the government should implement and promote the health claim on low calorie diets and obesity. Third, given the publicly funded nature of the Canadian Health Care system, other stronger economic intervention policies such as the introduction of subsidies on low calorie diets and the introduction of taxes on high calorie diets should be introduced by the government. By significantly reducing the incidence of obesity in the country, funds that would have otherwise been used for the treatment and management of the disease could be channelled to other productive sectors of the economy. The results from this thesis are likely to serve as a great resource for interest groups like the government, health sector, regulatory bodies, manufacturers, consumers, and academic circles.

CHAPTER 7

7. Summary and conclusion

The increasing mortality and morbidity rates in addition to the continuous rise in the health care costs have become significant health and policy concerns in North America and the world at large. Obesity, which is strongly associated with a number of diseases, is increasingly becoming a health care concern. As part of the measures to address these issues, a number of policies have been proposed or initiated by governments and interest groups. Prominent among these is the approval of health claims on functional foods and food constituents. The main goal of this thesis was to identify the socioeconomic and sociodemographic determinants of obesity in Canada and assess the potential economic benefits of the successful implementation and promotion of the health claim on low calorie diets and obesity in Canada. This thesis also estimated the current prevalence of obesity in Canada by using data based on measured heights and weights. Based on the findings from this thesis, policy implications were discussed.

To achieve this goal, the study used a multi-method approach. A combination of both econometrics and variation of cost of illness approach were used for the analyses. The analysis was conducted in two parts. Considering the categorical or ordinal nature of the available data, the first part used the Multilevel Multinomial Logistic Regression to analyse the socioeconomic and sociodemographic determinants of obesity in Canada. In addition, descriptive statistics were used to evaluate the prevalence of obesity in Canada. The second part of the analysis which involved the estimation of the health-related cost savings used a variation of the cost of illness approach. The estimation was accomplished by following four main steps. Firstly, by examining the findings from numerous scientific

and nutrition studies on healthy eating and good health, and also health claim demand studies, this thesis established that, the approval and promotion of the health claim on low calorie diets and obesity will lead to a significant reduction in caloric intake. Secondly, through a meta-analysis of medical/nutrition literature, the potential weight loss resulting from the restriction of calories was estimated. Thirdly, the estimated potential weight loss was deducted from the actual weights of overweight and obese Canadians to perform a simulation of the data to estimate the reduction of overweight/obesity prevalence resulting from calorie restriction. Finally, the cost savings resulting from the reduction in obesity prevalence was estimated.

This thesis used different sources of data for different stages of the analyses. While confidential micro-level data from the 2004 CCHS 2.2 was used for the econometric analysis, a combination of the 2004 CCHS 2.2 and data obtained through reviews of medical and nutrition literature that was based on human clinical trials was used for the COI approach. The CCHS 2.2 surveyed about 70,214 respondents and was based on measured heights and weight. The survey reports consumption information of individuals nested into provinces. After excluding respondents below the age of 18 and respondents with missing information in variables of interest, the final sample size used for the analyses was reduced to 24,938.

Findings from this thesis suggest that, the prevalence of underweight, normal weight, overweight, and obesity among Canadian adults are 1.58%, 37.77%, 36.59% and 24.07% respectively. Most of the findings from the econometric analysis gave expected results. However, other interesting results were discovered. With the exception of people aged 70 and above, age group was seen to have a progressive positive relationship with

the likelihood of becoming overweight or obese when all other age groups were compared to the youngest age group of 18-24. Females were seen to be significantly less likely to be overweight or obese when compared to males. Comparing the married to all other groups, we observed that, the married were more likely to be overweight or obese.

Moreover, people born in other areas of the American continent (excluding Canada) were found to be more likely to be overweight or obese when compared to other groups. Considering education, people with higher education were less likely to be overweight or obese in comparison to the less educated. Fruits and vegetables consumption and physical activity levels were both found to be negatively associated with the likelihood of becoming overweight or obesity. Compared to all other groups, daily smokers were observed to have the lowest likelihood of becoming overweight or obese. People with at least one known chronic condition and those who perceived their health to be poor were also seen to be more likely to become overweight or obese. Interestingly, compared to people from the lower income groups, higher income group individuals were seen to have a higher likelihood of becoming overweight or obese. This finding deviates from the general *a priori* expectation. Frequent alcohol consumers were also seen to be less likely to be overweight or obese.

Findings from the COI approach suggest that a successful implementation and promotion of the health claim on low calorie diets and obesity could result in a significant reduction in caloric intake. By embarking on calorie restriction, one could reduce weight by approximately 10% within a year. An optimistic calculation of the potential benefits of the implementation and promotion of the health claim on low calorie diets and obesity resulted in a health-related cost savings of $4.18 billion. A base (expected) estimation

indicated a potential health-related cost savings of $2.09 billion. A pessimistic estimation resulted in a potential health-related cost savings of $360 million.

Based on the findings from this thesis, a number of policy recommendations were discussed. We observed that certain groups of people are more vulnerable to the disease (obesity and its closely related comorbidities) than others. For example older people, physically inactive, and the married have an increased risk of becoming obese. This thesis, therefore, recommends that specific policies such as obesity awareness and education programs should be directed towards these at risk groups of people. In addition, this thesis confirmed that even a modest reduction in caloric intake (i.e. 5% reduction in caloric intake) due to the health claim could significantly reduce the incidence of obesity in Canada, and thereby leading to a reduction in the health care expenditure on the disease. Thus, this thesis recommends four main intervention measures to tackle the obesity problem in the country. These are: the implementation and promotion of the health claim on low calorie diets and obesity, nationwide introduction of obesity education campaigns, the introduction of subsidies on healthy foods with low calorie contents, and the introduction of taxes on unhealthy foods with overblown calorie contents.

In conclusion, obesity has been identified to be an increasing health issue in North America and beyond. Almost two-thirds of Canadians are overweight or obese. Socioeconomic and sociodemographic factors have been proven to have significant implications on the disease. Although the causes of the obesity are multifaceted, it has been shown that excessive calorie consumption plays an important role in the problem of obesity. In order to reduce the intake of calories, this thesis proposed and examined the

effects of the implementation and promotion of the health claim on low calorie diets and obesity on calorie consumption, obesity incidence, and health care expenditure. We found that, the health claim has a nontrivial impact on obesity incidence and health care expenditure. We found that a 5% to 10% reduction in caloric intake by obese individuals due to the health claim could lead to a base health-related cost savings of $2.09 billion, a high savings of $4.18 billion, and a low savings of $360 million. Based on the findings from this thesis, we recommend other obesity intervention policies like obesity education campaigns, introduction of subsidies on low calorie diets, and the introduction of "fat taxes" on high calorie food products.

7.1 Limitations

Although this thesis achieved its goals and made significant contributions to the literature, we acknowledge some unavoidable limitations. First, this thesis used the 2004 CCHS nutrition dataset from Statistics Canada which is about a decade old. We acknowledge the fact that a more recent dataset would have given more up to date findings on the issue of obesity in Canada. However, the CCHS nutrition data is collected periodically and according to Statistics Canada, the next CCHS nutrition dataset is planned to be released in the fall of 2016. Other current datasets available are also either based on self-reported information on BMI or did not contain all the variables of interest.

A second limitation is the lack of adequate data on health claim usage in Canada, which made it difficult to examine the exact impact of health claims on consumer demand. As a result, different scenarios were analysed to assess the possible impact of the health claim on low calorie diets and obesity in Canada. With adequate and updated

information, a more robust estimation could be made in future research. However, it is expected that the core findings may not be significantly different from the findings of this thesis.

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Appendix

Table A.1. Results of the meta-analysis to determine the average weight loss resulting from CR

Authors(S)	Year	CR intervention period (months)	Type of CR	Reduction in weight (%)	Deviation ± (%)	Range	
						LOW (%)	HIGH (%)
Hagan, R. Donald, et al.	1986	3	LCD	8.5***	0.7	7.8	9.2
Franssila-Kallunki, A., et al.	1992	2	VLCD	10.5	0.1	10.4	10.6
Puddey, I. B., et al.	1992	4.5	LCD	10.8*	1	9.8	11.8
Wing, Rena R., et al.	1994	12	LCD	9.7	0	9.7	9.7
Miller, Wayne C., et al.	1997	3.8	LCD	11.1	0.4	10.7	11.5
Wadden, Thomas A., et al.	1998	5	LCD	13.2*	5.7	7.5	18.9
Ross, Robert, et al.	2000	3	LCD	8	0	8	8
Kok, Petra, et al.	2005	4	VLCD	14.6*	0.4	14.2	15
Villareal, Dennis T., et al.	2006	12	LCD	10.7	6.3	4.4	17
Heilbronn, Leonie K., et al.	2006	6	LCD	10.4	0.9	9.5	11.3
Racette, Susan B., et al.	2006	12	LCD	10.7	0	10.7	10.7
Larson-Meyer, D. Enette, et al.	2006	6	LCD	10.1	1	9.1	11.1
Tsai, Adam Gilden, and Thomas A. Wadden.	2006	1	LCD	9.7	2.4	7.3	12.1
Redman, Leanne M., et al.	2007	6	LCD	10.4	0.9	9.5	11.3
Weiss, Edward P., et al.	2007	9	LCD	10.7	1.4	9.3	12.1
Fontana, Luigi, et al.	2007	12	LCD	10.9**	2.1	8.8	13
Redman, Leanne M., et al.	2009	6	LCD	10.4	0.9	9.5	11.3

AVERAGE WEIGHT LOSS = 10.61% ± 1.42%

NB: * calculated by author

      **calculated by author from BMI changes

      *** calculated by finding the average weight loss between men and women

Source: Author's calculation

Table A.2. Percentage reduction in health-related cost components resulting from a 1% reduction in disease incidence.

Obesity cost components	Percentage reduction in cost	Cost (million $)
Hospital care	0.16	9757.9
Physician	1.00	2480.0
Drug	0.85	4960.5
All other health cost*	0.20	4462.4
Indirect cost	1.00	52600.0

Weighted average = 0.83

* 'All other health cost' represents the expenditure on services of other health professionals, other health care and research[18].

Source: Anis et al. (2010) and author's calculation

Table A.3. Summary of literature on obesity, overweight health claims, consumer attitude, acceptance and willingness to pay

Summary of literature on obesity and overweight							
Author	Year	Location	Area	Title	Objective	Method/Data	Citation/ Prepare for
Birmingham, C. Laird, Jennifer L. Muller, Anita Palepu, John J. Spinelli, and	1999	Canada	Costing of illness of obesity	The cost of obesity in Canada	To estimate the direct cost involved in both the treatment and research into obesity in Canada	Cost of Illness approach Data from 1994- 1995 National Population Health Survey and National Health Expenditure	*Canadian Medical Association Journal* 160, no. 4 (1999): 483-488.

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[18]Below are the cost components of the various subcomponents of "all other health cost" category. All amounts are in millions of dollars: other health professionals- $396.9, other health care- $3729.7 and research- $335.8.

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Aslam H. Anis						Database (NHED) from the Canadian Institute of Health Information	

Results/ Implications

- The total direct cost of obesity in Canada in 1997 was $1.8 billion representing 2.4% of the total health care cost.
- The range of the total cost of obesity ranges between $829.4 million and $3.5 billion.
- This represents 1.1% and 4.6% of total health care cost.
- In estimating the contributions of the top 3 comorbidities that significantly contributed to the obesity cost were;
  - hypertension ($656.6 million),
  - type 2 diabetes mellitus ($423.2 million) and,
  - coronary artery disease ($346.0 million).
- Further research into the therapeutic benefits and cost effectiveness of management strategies for obesity is recommended.

Katzmar zyk, Peter T., Cora L. Craig, and Claude Bouchar d.	2001	Canada	Trends of overwe ight and obesity	Original article underweight, overweight and obesity: relationships with mortality in the 13-year follow-up of the Canada Fitness Survey.	To analyse the relationship between Body Mass Index (BMI) and mortality in Canada.	Cox Proportional Hazard Models. Data from the 1981Canada Fitness Survey (13- year Follow-up) N=10,725	*Journal of Clinical Epidemio logy* 54.9 : 916- 920.

Results/ Implications

- 3% of the total people considered in the study were underweight, 58% were of normal weight and 39% were overweight or obese.
- There are increasing levels of mortality risk across almost all the BMI levels.
- The underweight category reported an increased risk of mortality with HR of 1.63, and 95% confidence interval (C.I) of 0.93- 2.85
- Overweight recorded an increasing level of risk with HR of 1.16 and 95% C.I of 0.96- 1.39.
- The various sub-classifications of obesity also recorded increasing levels of risk. Obese class I recorded HR of 1.25 with 95% C.I of 0.96- 1.65, obese class II and obese class III recorded HR of 2.96 with 95% C.I of 1.39- 6.29.
- 13.5% of premature deaths could be theoretically avoided if overweight and obesity is eliminated.
- 1.2% of premature deaths could also be avoided if issues of underweight are curbed.

Katzmar zyk, Peter T.	2002	Canada	Trends of overwe ight	The Canadian obesity epidemic: an	To examine the temporal trends in stature, body	Descriptive analysis, Tukey mean- difference	*Obesity Research* 10.7: 666-674.

| | | | and obesity | historical perspective. | mass, weight-for-height, and overweight and obesity prevalence in Canadian adults over the last 45 years. | plots

Data from: the 1953 Canadian weight-height survey (N= 22,000), 1971-1972 Nutrition Canada Survey (N=2,687 men and 3,428 women), 1978-1979 Canadian Health Survey (N= 1,508 men and 1,867 women), 1981 Canadian Fitness Survey (N=4,831 men and 5,448 women), and the 1986-1992 Canadian Heart Health Surveys (N=7,565 men and 7,813 women).

1994National population health survey (N= of 5,857 men and 6,461 women), 1996 National Population Health Survery (N=23,059 man and 26,138 women), and the 1998 National Population Health Survey (N= 4670 men and 5,133 women). | |
|---|---|---|---|---|---|---|---|

Results/ Implications

- There was a 1.4 cm/ decade increase in median stature of Canadian men.
- Women reported a 1.1 cm/ decade increase in median stature.
- Median body mass increased by 1.9kg/decade among men whiles the increase among women was 0.8kg/decade.
- Over the past 45 years, the average weight-for-height of adult Canadians increased by 5.1% in men whiles that of women increased by 4.9%.
- Whiles overweight prevalence increased from 40% in 1970-1972 to 50% in 1998, obesity on the other hand increased from 9.7% to 14.9% over the same time period.
- While the prevalence of overweight increased from 46.1% and 7.6% to 60.1% and 15.6% respectively among men, that of women increased from 31.7% and 11.7% to 38.0% and 14.4% respectively.

Torrance, G. M., M. D. Hooper, and B. A. Reeder.	2002	Canada	Trends of overweight and obesity	Trends in overweight and obesity among adults in Canada (1970-1992): evidence from national surveys using measured height and weight.	To analyze the secular trends in obesity and overweight for the years 1970 to1992 among Canadian adults.	Comparative analysis Data from 1970 and 1972 Nutritional Canada Survey, 1978-1979 Canada Health Survey, 1986 and 1992 Canadian Heart Health Surveys N=27,284	*International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity* 26.6: 797-804.

Results/ Implications

- The rates of obesity and overweight increased significantly within the years of 1970s to 1990s.
- There was a steady increase in the proportion of men overweight or obese between the years of 1970-1972 to 1986-1992.
- There was a significant increase of overweight and obesity between the years of 1970-1972 and 1978-1979 among women.
- While there was no significant increase in the proportion of women overweight from 1978 to 1979 and 1986 to 1992, the proportion of women obese increased significantly within this same time period.
- Men in the primary education category and women in the secondary and post-secondary category reported the highest relative increase in obesity rates within the period 1970 -1972 to 1986-1992.
- Smokers and former smokers showed the highest increase in obesity prevalence.

Fontaine, Kevin R., David T.	2003	U.S	Measure of Economic	Years of Life Lost due to	To estimate the number of years of life lost	Years of Life Lost Data from the	*Jama* 289, no. 2: 187-193.

Redden, Chenxi Wang, Andrew O. Westfall, and David B. Allison.			burden	Obesity	(YLL) which can be attributed to overweight and obesity.	1999 U.S. Life Tables, the Third National Health and Nutrition Examination Survey (NHANES III; 1988-1994); and the First National Health and Nutrition Epidemiologic Follow-up Study (NHANES I and II; 1971-1992) and NHANES II Mortality Study (1976-1992).	

Results/ Implications

- The overall pattern of the association between overweight or obesity and YLL was a J or U shaped.
- BMI associated with the least YLL (optimal BMI) for adults was approximately 20 to 25 for whites and 23 to 30 for blacks.
- Younger adults had greater YLL across any level of BMI when compared with older adults.
- White men within the ages of 20 to 30 years with BMI levels greater than 45 had a maximum YLL of 13 whiles white women had YLL of 8.
- No significant relationship was found between YLL and overweight and moderate obesity among blacks older than 60 years.
- Severe obesity (BMI greater than 40) had a positive relationship with YLL.
- Black young adults with severe obesity had maximum YLL of 20 for men whiles that of women was 5.

Mokdad, Ali H., Earl S. Ford, Barbara A. Bowman, William H. Dietz, Frank Vinicor, Virginia S. Bales, and James S.	2003	U.S.	Obesity and related diseases	Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001.	To examine and estimate the prevalence of obesity and other obesity related diseases among U.S adults in 2001.	Logistic regression Data from the 2001 Behavioral Risk Factor Surveillance System (BRFSS) N = 195005	JAMA: the journal of the American Medical Association 289, no. 1: 76-79.

Marks.							

Results/ Implications

- There was an increase of 5.6% in the prevalence of obesity in 2001 (from 19.8% in 2000 to 20.9% in 2001).
- There was an increase of 8.2% in the prevalence of diabetes in 2001 (from 7.3% in 2000 to 7.98% in 2001).
- Prevalence rate of Body Mass Index (BMI) of 40 or greater was 2.3% in 2001
- Overweight and obesity were found to be significantly related to high cholesterol, diabetes, arthritis, high blood pressure, asthma, and poor health status.
- The following Odds Ratios were estimated for adults with BMI of 40 or greater when compared with adults of normal weight:
  -7.37 for diagnosed diabetes, 6.38 for high blood pressure, 1.88 for high cholesterol level, 2.72 for asthma, 4.41 for arthritis and 4.19 for fair or poor health.

Gibson, Diane.	2003	U.S.	Food stamp program and obesity	Food stamp program participation is positively related to obesity in low income women	To analyse the relationship between Food Stamp Program participation and obesity of low income individuals.	Conceptual model of obesity Data from the National Longitudinal Survey of Youth 1979 (NLSY79) N= 22,347 (with 13,390 observations on 3,574 women and 8,957 observations on 3157 men)	The Journal of nutrition, 133(7), 2225-2231.

Results/ Implications

- There is a positive and significant relationship between obesity (among low income women) and Food Stamp Program participation.
- There was a 9.1% increase in the likelihood of obesity among low income women who are currently participating in the Food Stamp Program.
- Comparing participants in the Food Stamp Program over the past five years to non-participants shows a 20.5% increase in the predicted probability of current obesity.
- Gains derived from the Food Stamp Program had a larger positive relationship to obesity per dollar as compared to cash income.

Kaplan, Mark S., Nathalie Huguet, Jason T. Newsom, Bentson H. McFarland, and Joan Lindsay	2003	Canada	Prevalence of overweight and obesity	Prevalence and Correlates of overweight and obesity among older adults: Findings from the Canadian National Population Health Survey.	To analyze the factors associated with overweight and obesity among older men and women.	Multiple logistic regressions Data from the second wave of the 1996-1997 Canadian National Population Health Survey (NPHS) N=12,823	*The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 58, no. 11: M1018-M1030.

Results/ Implications

- The overall percentage of respondent who were classified as underweight, normal weight, overweight and obese were 8.5%, 40.0%, 38.7% and 12.8% respectively
- More men were overweight as compared to women.
- Men were 57% more likely to be overweight than women
- Considering obesity, men were also 37% more likely to be obese when compared to women
- Younger senior adults (65 – 69 years) were seen to be more likely to be obese than older senior adults.
- Men who had higher levels of social support were more likely to be obese than females who also had higher levels of social support.

Huot, I., G. Paradis, and M. Ledoux.	2004	Canada	Prevalence and determinants	Factors associated with overweight and obesity in Quebec adults.	To examine the correlates of overweight and obesity in Quebec. The main source of data for the study was the Quebec Heart Health Demonstration Project (QHHDP).	Bivariate logistic regression Data from the Quebec Heart Health Demonstration Project (QHHDP) N= 10014	*International journal of obesity* 28.6: 766-774.

Results/ Implications

- Male university students were significantly less likely to be overweight or obese.
- Increasing the levels of education among women significantly reduced the risk of overweight
- However lower risk of obesity was only associated with women having university education
- Income was seen to have inconclusive effect on overweight and adiposity
- Men currently in the last quartile of the Global Dietary Index (GDI) were 2.3 times more likely to be obese as compared to men in the first quartile of the GDI.
- Obesity was seen to be positively related to age among women.
- Moreover, reported health problems were also seen to be positively related to overweight and

obesity among all the groups.
- Smoking was negatively associated with excess weight among all groups.
- Exercising was negatively related to overweight and obesity.
- Place of residence had significant effect on overweight and obesity.
- Women rural dwellers were 1.3 times more likely to be overweight as compared to urban dwellers.
- They were also observed to be 2.1 times more likely to be obese.

Katzmar zyk, Peter T., and Christop her I. Ardern.	2004	Canada	Trends of overwe ight and obesity	Overweight and obesity mortality trends in Canada, 1985-2000.	To examine the temporal trends in mortality burden due to overweight and obesity in Canada between the years of 1985 and 2000.	Population Attributable Risk (PAR) Data from the 1985 and 1990 Health Promotion Survey, 1994, 1996, and 1998 National Population Health Surveys, and 2000 Canadian Community Health Survey.	*Canadia n Journal of Public Health* 9 5.1

Results/ Implications

- There has been an increase in the number of deaths attributable to overweight and obesity from 2,514 in 1985 to 4,321in 2000.
- There was an increase in the PAR from 5.1% in 1985 to 9.3% in 2000.
- As year 2000, 9.3% of all deaths among Canadian adults aged 20-64 could be theoretically linked to overweight and obesity.
- The total number of deaths attributable to overweight and obesity from 1985 to 2000 was estimated to be 57,181.
- The province with the highest relative increase in the number of overweight and obesity related deaths was Newfoundland whiles that with the lowest was British Colombia.

Le Petit, Christel, and Jean-Marie Berthelo t.	2005	Canada	Trends of overwe ight and obesity	Obesity: A growing issue	To examine the transition of a sample of people aged 20 to 56 years from one weight category to the other over a period of time (8 years).	Logistic regressions and Cox proportional hazards modelling. Data from the National Population Health Survey (1994/95 through 2002/03).	Statistics Canada.

						N=17,276	

Results/ Implications

- About 32% of the people who were of normal weight in 1994/95 became overweight by 2002/03.
- Only 2% of those who were of normal weight in 1994/95 had transitioned into being obese by 2002/03.
- A quarter of those who were overweight in 1994/95 became obese by 2002/03.
- Only 10% of the people who were overweight in 1994/95 had returned to normal weight by 2002/03.
- Men were more likely to move from normal weight to overweight than women.
- Women were more likely to move from overweight to obese than men.
- Younger men were seen to be more likely to be obese than older men.
- Men in their twenties and thirties were more likely to be obese than men in their fifties.
- Among women, although those in their twenties were more likely to be obese compared to those in their fifties, the results was not statistically significant.
- High income household members were less likely to become obese compared to low income household members.
- Male frequent smokers in 1994/95 were 50% more likely to be obese by 2002/03 when compared with never-smoked males.
- The study also revealed that, people with lower physical activity levels were more likely to be obese.
- There was no significant relationship between being obese and region of residence.

Oliver, Lisa N., and Michael V. Hayes.	2005	Canada	Prevalence and determinants	Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth.	1) To find out whether neighbourhood socio-economic status (SES) was systematically related to overweight prevalence among Canadian children and youth. 2) To find out if factors accounting for the relationship had faced validity. 3) To find out if after controlling for	Hierarchical non-linear modelling Data from the 2000/2001 National Longitudinal Survey of Children and Youth (cycle 4) SES data from: 2001 Statistic Canada's Dissemination Area Databases	*Canadian Journal of Public Health* 96.6

						demographic variables, neighbourhood SES had independent effects.		

Results/ Implications

- The prevalence of overweight and obesity among Canadian children was 33.17% and 13.85% respectively.
- The prevalence of overweight and obesity among the youth was 24.09% and 7.30% respectively.
- Overweight and obesity prevalence increased from 24% and 7% in high SES neighbourhoods to 35% and 16% respectively in low SES neighbourhoods.
- Female youth are less likely to be overweight. (i.e. they have reduced odds of being overweight).
- As family income increased, the odds of being overweight also reduced.
- A child whose person most knowledgeable (PMK) has less schooling is likely to have higher odds of being overweight.

Bélanger- Ducharme, F., and A. Tremblay	2005	Canada	Prevalence	Prevalence of obesity in Canada	To examine the prevalence of obesity in Canada by summarizing survey data on obesity prevalence.	Descriptive Statistics Self-reported data from: Health Promotion Survey in 1985 and 1990, the General Social Survey in 1985 and 1991, the National Population Health Survey (NHS) in 1994, 1996 and 1998, and the 2000-01 and 2003Canadian Community Health Survey (CCHS) Measured data from: 1970-72 Nutrition Canada Survey (NCS),	*Obesity Reviews* 6.3: 183-186.

						1978-79 Canada Health Survey (CHS), 1981 Canada Fitness Survey (CFS), 1988 Campbell Survey on Wellbeing of Canadians (CSWC) and the 1988-92 Canadian Heart Health Survey (CHHS)	

Results/ Implications

- There was a temporal trend in obesity prevalence.
- There was an increase from 8% to 13% of the obesity prevalence estimate from 1970-72 to 1988-92.
- The percentage of men overweight increased from 47% to 58% among men while that of women increased from 34% to 41% with the period of 1970-72 to 1988-92.
- Men were seen to be more likely to be obese relative to women.
- About 33.3% of Canadian adults aged 18years and over were overweight.
- Furthermore, the 2003, CCHS revealed that about 14.9% were obese.
- About 13.9% and 15.9% of women and men respectively were found to be obese.
- Men and women aged55 to 64years showed the highest obesity prevalence of 20.3% and 19.7% percent respectively.
- People residing in rural areas were seen to have overweight and obesity prevalence significantly higher than the national rate.
- The percentage of boys who were obese was 19% as compared to 17% of girls.
- People of Aboriginal origin reported the highest rate of obesity in the country with rate of 26%.

Shields, Margot.	2006	Canada	Prevalence and determinants	Overweight and obesity among children and youth.	To examine the prevalence of overweight and obesity among children and youth within the ages of two to seventeen in Canada.	Descriptive statistics Data from the 2004 Canadian Community Health Survey (CCHS): Nutrition and the 1978/79 Canadian Health Survey. N=8661. Additional data from: 1999-2002 National Health and	*Health Rep* 17.3: 27-42.

						Nutrition Examination Survey (NHANES) N=7297	

Results/ Implications

- In 2004 26% of children and adolescents in Canada were overweight or obese.
- 8% of children and adolescents were obese.
- The prevalence of overweight and obesity combined has more than doubled over the past two decades (i.e. about 70% increase from 1978/79 to 2004).
- The prevalence of obesity alone has almost tripled (i.e. 2.5 times higher).
- The percentage of youth within the ages of 12 and 17 who were obese increased by 3 times (i.e. from 3% to 9% in 1978/79 and 2004 respectively).
- U.S had a slightly higher prevalence of obesity than Canada (i.e. 10% compared to 80%).
- Girls in Canada within the ages of 2 to 5 years, were more likely to be obese than their counterpart in the U.S.
- American girls within the ages of 12 to 17 years were almost twice likely to be obese than their Canadian counterparts (i.e. 13% compared to 7%).
- Overweight/obesity was relatively high (more than 30%) among the Mexican-American, Black and Hispanic children and adolescents.
- About 41% of Canadian young people of aboriginal origin were overweight/obese.
- Young people from Canada consumed fruits and vegetables less than five times in a day.
- Young people from middle income households were more likely to be obese than those from high income households.

Tjepkema, Michael	2006	Canada	Prevalence and determinants	Adult obesity.	To compare the prevalence of obesity among adults (18 years and older) for the periods 1978/79 and 2004.	Logistics regression models Data from the2004 Canadian Health Survey: Nutrition, the 1978/79 Canadian Health Survey and the 1986 to 1992 Canadian Heart Health Surveys. Additional data from: 1999 to 2002 National Health and Nutrition Examination Survey	*HEALTH REPORTS- STATISTICS CANADA17.3: 9.*

						(NHANES) N=9,488	

Results/ Implications

- 23.1 percent of Canadian adults were obese representing an estimate of 5.5 million Canadian adults.
- 36.1% of Canadian adults were overweight in 2004.
- Health risk increases as you move from each sub-classification of obesity to the other (i.e. from obese class I to class II and to class III).
- In 2004 the percentage of Canadian adults in obese class I was 15.2%, obese class II was 5.1% and obese class III was 2.7%.
- In 1978/79, the percentage of adult obesity in Canada was 13.8% which is significantly lower than the 2004 figure of 23.1%.
- The prevalence of obesity rose in every age group with the exception of the 65-74 age groups.
- People below 35 years and those above 75 years reported the greatest increase.
- There was a significant increase in the median BMI of adults from 24.4 in 1978/79 to 26.1 in 2004.
- The percentage of American adults (18 years and older) who were obese in 1999/2002 was 29.7% which is significantly greater than that of Canadian adults (23.1% in 2004).
- 32.7% of American women were obese as compared to 23.2% of Canadian women.
- 26.6% of American men compared to 22.9% of Canadian men were obese.
- White American women were more likely to be obese than white Canadian women (30.3% compared to 24.8%).
- Whiles decrease in the consumption of fruits and vegetables were positively related to obesity, increase in physical activities was negatively related to obesity.
- Whiles 2.8% of men with normal BMI reported heart diseases, more than twice this percentage (6.8%) of men who were overweight reported heart disease.

Shields, Margot, and Michael Tjepkema.	2006	Canada	Trends of overweight and obesity	Trends in adult obesity	To analyse obesity prevalence trend in Canada from 1978/79 to 2004	Descriptive statistics Data from 2004 Canadian Community Health Survey (CCHS): Nutrition, 1978/79 Canada Health Survey (CHS) and the 1986/92 Canadian Heart Health Surveys (CHHS).	*Health reports/Statistics Canada, Canadian Centre for Health Information= Rapports sur la sante/Statistique Canada, Centre canadien d'information sur la sante* 17. 3 : 53-59..

Results/ Implications							

- Although the distribution of Canadian adults' BMI was similar in 1978/79 and 1986-92, by 2004, there was a significant shift of the distribution towards heavier weights.
- Obesity estimates among men moved from 12% in 1978/79 to 23% in 2004. Women also experienced similar pattern (increasing from 16% in 1986-92 to 23% in 2004)
- There was a significant increase in obesity prevalence from 1986-92 to 2004 in all provinces in Canada.
- The likelihood of men being obese had increased throughout the age groups with the highest increase (9% to 24%) in the 25 to 34 age group.
- Women also experience increase in their prevalence rate, however these increases were more uniform across age groups.
- Obesity prevalence increased for both sexes irrespective of their smoking status.
- Former male smokers recorded a sharper increase than never-smokers.
- Both male and female former-smokers had a higher likelihood of being obese.
- People in higher income households are less likely to be obese.

Mandal, Bidisha, and Wen S. Chern.	2006	USA	Prevalence and determinants of Obesity and overweight	Econometric Analysis of Rising Body Mass Index in the US: 1996 versus 2002	To find out what is causing the increasing rates of obesity and overweight.	Uses Multilevel Multinomial Logit Regression Individual level data from Behavioural Risk Factor Surveillance System (BRFSS) augmented with state-level measures from Economic Census (EC), Current Population Survey (CPS), Economic Research Service (ERS), and Bureau of Labour Statistics. For 1996, N=117139 and for 2002, N=190982	*Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California. 2006.*

Results/ Implications

- The higher the urban residency, the lower the rates of obesity and overweight.
- Increased participation of food stamp programs increases the prevalence of obesity.
- There is a positive relationship between excise tax on cigarettes and obesity.
- Current smokers are less likely to be obese as compare to non-smokers.
- Former smokers are more likely to be obese as compared to non-smokers.
- There is a positive relationship between lower-priced foods from fast food restaurants and obesity.
- Higher-priced foods from full-service restaurants have a negative relationship with obesity.
- Sedentary lifestyle of an individual is positively related to the prevalence of obesity and overweight.
- The employment status of an individual is not significantly related to obesity (i.e. whether employed or unemployed).
- The self-employed individuals are healthier.
- A positive relationship exists between the consumption of fruits and vegetables, and the prevalence of obesity and overweight.
- Those with health insurance are more likely to be obese.
- Age is generally positively related to obesity however, the relationship breaks down beyond certain age.
- Men, black non-Hispanics, multiracial non-Hispanics, Hispanics and the less educated have high risk of overweight and obesity.
- Individuals are now aware that, overweight and obesity are hazardous to health.

| Auld, M. C. and L. Powell | 2006 | U.S. and Canada | Prevalence, determinants of Obesity and overweight | The economics of obesity: research and policy implications from a Canada-US comparison | To find out why obesity rates differ across the United States and Canada, for which groups do they differ, and what do these differences suggest for policy and for research? | Switching Regression model

Data on Canada from the 2000-2001 Canadian Community Health Survey (CCHS), N=20545.

Data on US from 2002 National Longitudinal Survey of Youth (NLSY79),N= 7446 , and American Chamber of Commerce

Researchers Association (ACCRA) Cost of Living | Health services restructuring: new evidence and new directions. John Deutsch Institute, Queen's University at Kingston: 305-332. |

						Index reports	

Results/ Implication

- Low income is strongly related to high weight among Canadian women
- Among American women, it is only high but not moderate income that is associated with low weight.
- There is a positive correlation between income and weight among both Canadian and American men.
- Highly educated U.S. women in the middle income groups are heavier and they are lighter at the extremes of the income distribution
- U.S. men with college education have strong positive relationship between income and Body Mass index
- No relationship exist between income and Body Mass Index among less educated U.S. men.
- Key sociodemographic characteristics cannot explain the difference in obesity between Canada and the U.S.
- Fast food prices, fruit and vegetable prices, and local area availability of chain supermarkets have statistically significant relationships with mean Body Mass Index among the American adults sample
- Implementation of preventive non-medical policies such as subsidies to "healthy" foods, taxes on fast food and soda, etc.

Ogden, Cynthia L., Margaret D. Carroll, Lester R. Curtin, Margaret A. McDowell, Carolyn J. Tabak, and Katherine M. Flegal	2006	U.S.	Prevalence, determinants of obesity and overweight	Prevalence of overweight and obesity in the United States, 1999-2004	To estimate current trend and prevalence of overweight among both children and adolescents and also estimate the trend and prevalence of obesity among adults	Logistic regression model Data from National Health and Nutrition Examination Survey (NHANES) N=8,389(4431 adults and 3958 children and adolescents)	*JAMA: the journal of the American Medical Association* 295, no. 13: 1549-1555.

Results/ Implications

- In 2003-2004, 17.1% of children and adolescents were estimated to be overweight whiles 32.2% of adults were obese.
- Prevalence of extreme obesity among adults was estimated to be 4.8%.
- Prevalence of overweight in female children and adolescents increased from 13.8% (1999-2000) to 16% (2003-2004).
- Prevalence of overweight among males also increased from 14.0% (1999-2000) to 18.2% (2003-2004).
- There was a significant increase in prevalence of obesity among men from 27.5% (1999-2000) to 31.1% (2003-2004).

- The prevalence of obesity among women experienced no significant change during the period of the study.
- There was only a change from 33.4% (1999-2000) to 33.2 (2003-2004).
- The prevalence of extreme obesity (Body Mass Index of 40 and over) in 2003-2004 was 6.9% in women and 2.8% in men.
- In 2003-2004 the prevalence of obesity among the various ethnic/racial groups were;
  - Non-Hispanic white adults 30%,
  - Non-Hispanic black adults 45%, and
  - Mexican Americans 36.8%.
- In 2003-2004 the prevalence of obesity among adults aged 20-39 years was 28.5%.
- That of adults aged 40-59 and adults aged 60 and over were 36.8% and 31% respectively.

Edwards, Mike	2007	Canada	Prevalence and determinants of Obesity and overweight	An econometric analysis of overweight and obesity in Canada: Evidence from cycle 2.2 of the Canadian Community Health Survey	To identify the sociodemographic and behavioural factors that will help in determining the groups likely to be affected by obesity and overweight.	Multinomial Logit regression. Data from the 2004 Canadian Community health Survey (CCHS 2.2) N=9,347	University of New Brunswick (Canada), 2007.

Results/ Implications

- Males have higher likelihood of being obese as compared to females
- Singles are less likely to be obese as compared to the married
- The divorced and the widowed are more likely to be obese
- Moderately or more active people are less likely to be obese
- Fruits and vegetables consumption is negatively associated with obesity or overweight.
- Daily smokers are less likely to be overweight and obese as compared to non-smokers.
- Former smokers are also more likely to be obese than people who have never smoked before
- People born outside Canada are less likely to be obese than Canadian born.
- Similar analysis for overweight gave insignificant results.
- Education is negatively associated with obesity.
- People without a job are more likely to be obese
- Low earners are more likely to be obese.

Bhattacharya, Jay, and Neeraj Sood.	2007	U.S.	Health insurance and obesity	Health insurance and the obesity externality	To examine whether health insurance that subsidize medical expenditure for the obese results in obesity.	Two regime model of weight loss and health insurance Data from National Health and Interview Survey and the	Vol. 17. Emerald Group Publishing Limited, 2007.

						Medical Expenditure Panel Survey N= 6,900	

Results/ Implications

- Health insurance itself does not result in obesity externalities.
- Failure to adjust premiums to reflect weight choices of individuals causes obesity externalities to increase.
- The welfare cost associated with obesity externalities induced by health insurance is $150 per capita.
- The categories of people most likely to be affected by obesity induced externalities are women and the elderly.
- The study recommends risk rating of premiums to take into consideration, bodyweight changes.
- Welfare loss is reduced by moderate level of cost sharing.
- Improvement in technologies that helps people to manage or reduce weight can significantly minimise welfare losses.

Ward, Heather, Valerie Tarasuk, and Rena Mendelson.	2007	Canada	Prevalence and determinants	Socioeconomic patterns of obesity in Canada: modeling the role of health behaviour.	To analyze the relationship between obesity and income and education in Canada. To also examine the indirect regulations of obesity as a result of fruit and vegetable intake, leisure-time physical activity (LTPA) and smoking.	Path analysis data from the Canadian Community Health Survey (cycle 2.2)	*Applied Physiology, Nutrition, and Metabolism* 32.2: 206-216.

Results/ Implications

- There was a similar prevalence rate of obesity among both men and women with the prevalence rates of 26% and 25% respectively.
- Men recorded a significantly higher percentage of overweight than women (i.e. 44% compared to 31% respectively).
- The study also revealed that, the proportion of men considered as obese reduced as education levels increased.

- As income levels increased, the proportion of men obese also increased.
- Women with less than secondary education had almost twice the obesity prevalence rate as those who had graduated from post-secondary education.
- Whiles overweight and obesity was related to income positively, it was negatively associated with current smoking.
- There was a negative relationship among obesity in men and education, fruit and vegetable intake and LTPA.
- Men who were overweight or obese were less likely to be current smokers.
- Whiles LTPA was positively related to income and education, it was negatively related to the likelihood of overweight and obesity.
- Among women, the consumption of fruit and vegetables played the role of indirect pathway from income and education to obesity.

Cook, Andrew, and Beth Daponte	2008	U.S	Prevalence and determinants of Obesity and overweight	A Demographic Analysis of the Rise in the Prevalence of the US Population Overweight and/or Obese	To present an age-period-cohort analysis of weight gain throughout the life cycle	Ordered logistic regression analyse Data from National Health Interview Survey for the years 1976-2001 N= 352,760	Population Research and Policy Review 2 7, no. 4 (2008): 403-426.

Results/ Implications

- The BMI of the adult U.S population increases every 5 years between 1976 and 2001.
- Present period Body Mass Index is larger than the previous period's BMI in all age groups and birth cohorts
- The growth in body mass increases with time.
- The age group that shows the greatest increase in BMI is the youngest adult group (18-32 years).
- This age group also displays the highest propensity of being obese.
- The youngest adult group (18-32 years) shows the fastest rate of increase in BMI as compared to the other age groups.
- The probability of an individual's BMI exceeding the normal range has significantly increased between 1976-2001
- The tendency of an American to be overweight or obese has accelerated.
- Non-Hispanic black and Hispanic females are more likely to be obese. Among the men, Non-Hispanic blacks are more likely to be obese.
- It is recommended that, if advertisements of foods that target children are banned, the likelihood of parents purchasing junk foods will be reduced.
- There should be public support for aquacenters to provide water-base exercise throughout the year.

Constăn gioară, Adriana Mirela,	2009	Romania	Measure of obesity prevale	Modern Quantitative Techniques Used In The	To identifying the determinants	Logit regression model	*Romanian Economic*

Monica Caterina Laslău, and Alexandru Constăngioară.			nce and determinants	Management Of Public Health Policy.	of the risk of obesity and overweight through the use of modern econometrical analysis.	Data was collected in 2007-2008 period using a questionnaire inspired by traditional questionnaires for investigating youth risky behaviours (YRBSS 2005, CORT 2004). N=1311	*Business Review* 4 .4 (2009): 125-132.

Results/ Implication

- Girls have a lower estimated risk of overweight and obesity.
- The estimated risk of overweight and obesity of girls decreases with age.
- Weight perception is negatively associated with the risk of obesity and overweight.
- Skipping breakfast increases the chances of the risk of obesity and overweight.
- There is a positive relationship between the rate of snack intake and the risk of obesity and overweight
- A diet without milk increases the chances of the risk of obesity and overweight.
- Low frequency of eggs and white meat consumption increases the risk of obesity and overweight.
- Attitude towards physical activities plays significant role in determining the likelihood of obesity and overweight.
- Nutritional programs should be introduced in schools.
- Families, social care services and local communities should be involved in the nutritional education programs.

Brunello, Giorgio, Pierre-Carl Michaud, and Anna Sanz-de-Galdeano.	2009	Europe	Economic justification of obesity	The rise of obesity in Europe: an economic perspective.	To examine the economic justification of public interventions aimed at controlling the obesity menace.	Review of literature	*Economic Policy* 24 .59: 551-596.

Results/ Implications

- Parent's education and weight background is a significant determinant of obesity among European young adults.
- There is insufficient evidence to prove that, there is lack of information on the issue of obesity among Europeans.
- Therefore, public intervention cannot be justified on the grounds of insufficient information.

- The size of the health insurance externality is not significant enough to merit public intervention.
- Enough evidence was found to prove that, product and labour market imperfections exist.
- Obesity has a significant effect on productivity and wages.
- Wages of the obese employees were less than non-obese employees even though they all perform similar tasks.
- Obesity can affect productivity if it affects either health or education.
- The study proves that obesity affects the health of individuals.
- Obese individuals tend to complete fewer years of education.
- This, therefore, shows that obesity generates production inefficiency.

Tan, Andrew KG, Richard A. Dunn, Mohamed Ismail Abdul Samad, and Mustapha Idzwan Feisul.	2011	Malaysia	Prevalence and determinants of obesity and overweight	Sociodemographic and health-lifestyle determinants of obesity risks in Malaysia.	To analysing the sociodemographic and health-lifestyle factors that affects the possibility of obesity among the Malaysian population.	Logit regression analysis Data from the Malaysian Non-Communicable Disease Surveillance-1 report of the Ministry of Health Malaysia(2006) N=2447	*Asia-Pacific Journal of Public Health* 23, no. 2 (2011): 192-202.

Results/ Implication

- Females are 5.3% more likely to be obese compared to males.
- People with low education are 0.9% more likely to be obese
- People with family history of illnesses associated with obesity are 4.8% more likely to be affected with obesity health risk
- Non-smokers are 6.4% more like to be obese
- Compared to Malays, Chinese (9.3%) and other ethnic groups (5.5%) are less likely to be obese.
- Smoker are also 6.4% less like to be obese as compared to non-smokers
- Factors like age, marital status, location of residence, income levels, length of work hour, and fruit and vegetable diet did not have any statistically significant effect on obesity in the study.
- Based on the estimated logit equation, a "typical" respondent has a 25% likelihood of being obese.
- To ensure effective health outcomes, policy interventions should focus on specific ethnic subgroups and across age-groups.
- Public health authorities should introduce national obesity prevention programs that lay more emphasis on females, particularly housewives and those in their productive years.
- The Malaysian government should introduce programs that will aim at both increasing the awareness of obesity and also encourage more people to pursues further education or schooling.

Goldman, Dana, Darius Lakdawalla, and Yuhui Zheng	2011	U.S	Food prices and weight	Food prices and the dynamics of body weight.	To examine both the short and long- run consequences of body weight on food price changes	Dynamic Panel Model and Probit model Data from 1992-2004 Health and Retirement Study (HRS) and 1992-2003 ACCRA Cost of Living data N= 3111	Universit y of Chicago Press

Results/ Implications

- Reducing price per calorie by 10% will result in an increase in BMI of 0.26 units (0.77%) within 2 years.
- Reducing price per calorie by 10% will result in an increase in BMI of 1.05 units (2.5%) within 10 years.
- The maximum long-run effect of a price reduction of calorie on BMI is 2.2 units (5.1%).
- Although the long term effect of price on Body Mass Index is larger, it is still below the threshold of clinical significance.
- Coefficients of other price variables in the study were found to be insignificant.
- The effect that price of food has on weight increases over time.
- The study suggests that, policies that aim at raising prices of calories may in the short term have little effect on weight.
- Fat tax aimed at reducing body weights may not yield the desired results quickly.

Alter, David A., Harindra C. Wijeysu ndera, Barry Franklin, Peter C. Austin, Alice Chong, Paul I. Oh, Jack V. Tu, and Therese A. Stukel.	2012	Canada	Trends of overwe ight and obesity	Obesity, lifestyle risk-factors, and health service outcomes among healthy middle-aged adults in Canada.	To examine the cumulative longitudinal health system expenditures and outcomes relative to obesity among a cohort of middle-age adults in Ontario Canada.	Propensity-matching Data from the 1996/1997 Ontario Health Survey (OHS)	*BMC health services research* 12, no. 1: 238.

Results/ Implications

- Among the three classifications of BMI (obese, overweight and normal weight), the obese cohort was significantly older and at the same time the prevalence of diabetes and hypertension was significantly higher in the obese cohort.
- More than 30% of the patients had multiple risk factors independent of BMI.
- Comparing obesity (as an isolated risk-factor) with propensity-matched normal weight controls, it was revealed that obesity was not associated with significant higher cumulative health care cost.
- When obesity was combined with other risk factors such as psychological distress, physical inactivity and/or smoking, it became significantly associated with increased cumulative health care cost as compared to normal weight propensity-matched health controls.
- In the presence of multiple lifestyle risk factors, an overweight or obese individual had a significantly increased health care expenditure as compared with normal weight healthy controls.
- There was a positive relationship between risk of developing diabetes and hypertension and multiple life style factors. They were all associated with higher expenditure.

Summary of Literature on *health claims, consumer attitude, acceptance and willingness to pay*							
Author	Year	Location	Area	Title	Objective	Method/Data	Citation/ Prepare for
Levy, Alan S., and Raymond C. Stokes.	1987	U.S.	Health claims and functional foods	Effects of a health promotion advertising campaign on sales of ready-to-eat cereals	To examine the impact of health claims (or health message advertising campaigns) on purchase of high fibre and non-high fibre ready-to-eat cereals.	Data from 209 Giant Food, Inc., and supermarkets	*Public Health Reports*102, no. 4 (1987): 398.

Results/ Implications

- There was a shift in market share from non-high fibre cereals to high-fibre cereals.
- The market share of high-fibre cereals increased continuously during the entire 48 weeks of assessment.
- There was also a sharp increase in the market share of the All-Bran product 24 weeks into the campaign.
- A relative increase of 47% of the market share of All-Bran product was recorded.
- Sales of other high fibre products of Kellogg also rose by 0.3%, representing relative increase of 14%.

Brown, Deborah J., and Lee F. Schrader	1990	U.S.	Health claims and functional foods	Cholesterol information and shell egg consumption	To examine the impact of cholesterol information on the demand for shell eggs in the U.S	Fixed and variable coefficient models Data: 1955-1987 articles in Medline data base	*American Journal of Agricultural Economics* 72, no. 3 (1990): 548-555.

Results/ Implications

- Per capita shell egg consumption was reduced by 16% -25% as a result of the cholesterol information.
- A positive interaction was observed between egg price and cholesterol.
- As a result of cholesterol information, a reduction in the price of eggs was accompanied by a less than proportionate increase in shell eggs consumption.
- A negative interaction was observed between income and cholesterol information.
- Cholesterol information led to a less than proportionate increase in shell egg consumption when income was increased.

Ippolito, Pauline M., and Alan D. Mathios	1991	U.S.	Health claims and functional foods	Health claims in food marketing: Evidence on knowledge and behavior in the cereal market	To examine the market of ready- to eat cereals during the time that there was a ban on using health claims on the cereal products and when the ban was lifted in the U.S.	Data from Maxwell in *Advertising Age*, U. S. Department of Agriculture's 1985 Continuing Survey of Food Intakes by Individuals (CSFII) for women aged 19 to 50, and Health and Diet Survey.	*Journal of Public Policy & Marketing* (1991): 15-32.

Results/ Implications

- The lift of the ban on health claims led to a significant increase in consumer knowledge of the fibre-cancer relationship.
- Health claim led to an increase in fiber cereal consumption and also an increase in product innovation.
- There was a significant shift of market share towards high-fiber cereals after the ban on health claims was lifted.
- Health claim usage led to about 7% increase in weighted fiber content.
- The author recommended that, the design of health claims policy should be made in such a way that producers would be motivated to make truthful claims.

Tuorila, Hely, and Armand V. Cardello	2002	U.S.	Functional foods	Consumer responses to an off-flavor in juice in the presence of specific health claims.	To examine the degree to which consumers would compromise on taste for the health benefits of functional food products.	Analysis of variance Data: Survey N=78	*Food Quality and Preference13, no. 7 (2002): 561-569.*

Results/ Implications

- Taste significantly influences consumer's liking and decision to consume a product.
- Health benefits of a product does not determine the magnitude of the impact of taste on consumption and liking of the product.
- Information of the health benefits of food is a determining factor as to whether a consumer would like a food product or not.
- The likelihood to consume functional juice is more dependent on the improvement in physical or cognitive performance derived from the food than the improvement in emotional well-being.

West, Gale E., Carole Gendron, Bruno Larue, and Rémy Lambert	2002	Canada	Acceptance and willingness to pay for functional foods	Consumers' Valuation of Functional Properties of Foods: Results from a Canada-wide Survey	To examine the Canadian consumer's attitudes, beliefs, knowledge and willingness-to-pay for functional foods	Stated-choice experiments Data from a telephone interview of Canadians household food shoppers N=1008	*Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 50, no. 4 (2002): 541-558.*

Results/ Implications

- Credible and efficient information on health claims would lead consumers to buy and even pay price premium for healthy foods.
- Greater number of Canadians are more likely to pay a price premium for functional foods and nutraceuticals with the belief that, it could reduce their likelihood of developing diseases such as cancer and heart disease.
- Consumers were less interested in functional meat.

Maynard, Leigh J., and Sharon T. Franklin	2003	U.S.	Acceptance and willingness to pay for functio	Functional foods as a value-added strategy: The commercial potential of "cancer-	To examine the commercial feasibility of cancer-fighting functional	Prototype development, Contingent valuation method	*Review of Agricultural Economics 25, no. 2 (2003):*

			nal foods	fighting" dairy products	dairy foods.		316-331.

Results/ Implications

- Consumers were willing to pay premiums for the foods enriched with CLA.
- On average, consumers were willing to pay additional:
  -$0.41 per gallon for milk enriched with high –CLA
  -$0.38 per pound for butter enrich with high-CLA
  -$0.15 per eight-ounce cup of high-CLA yogurt
- About 80% of the respondents were willing to pay a minimum of $0.20 per gallon of milk enriched with CLA.

Bech-Larsen, Tino, and Klaus G. Grunert.	2003	Denmark, Finland and the USA	Accept ance and willing ness to pay for functio nal foods	The perceived healthiness of functional foods: A conjoint study of Danish, Finnish and American consumers	To analyse consumer's perception of the healthiness of functional foods in relation to health claims, processing methods, functional enrichment, and food-type.	Conjoint task Data: 500 randomly selected households from each of the countries.	*Appetite* 40, no. 1 (2003): 9-14.

Results/ Implications

- Consumer acceptance of healthy functional foods is highly influenced by:
  - processing methods
  - enrichment components
  -health claims used.
- Finnish people had more positive attitude towards functional foods than that of Americans and the Danes.
- Health claims were found to have a significant effect on the perception of the healthiness of functional foods by consumers.
- The perception of healthiness of functional foods is more affected by the nutritional qualities in the base-product than the use of health claims.

West, Gale E., and Bruno Larue	2004	Canada	Functio nal foods and Health claims	Profiling consumer trend-setters in the Canadian healthy-foods market.	To identify the factors that affect the desire of consumers to be among the initial people to try innovative functional	Ordered probit estimation technique Data: Telephone survey N= 1,008	*CAFRI: Current Agricultu re, Food and Resource Issues* 05 (2004).

					foods.		

Results/ Implications

- Desire to try new functional foods is significantly influenced by:
  - belief of link between diet and health
  - belief of the nutrition content claim on the product by consumers.
- Consumers already at risk of getting diseases were more inclined to try new functional foods.
- Production process of the new functional food affects consumer willingness to try new functional foods
- Compromise of the credibility of health claims and the belief of the diet-health relationship could discourage potential active consumers of functional foods.

Leicester, Andrew, and Frank Windmeijer	2004	United Kingdom	Obesity intervention	The 'fat tax': economic incentives to reduce obesity.	To examine the possibility of a "fat tax" as an intervention policy to tackle the increasing incidence of obesity in the U.K.		http://eprints.ucl.ac.uk/14931/1/14931.pdf (accessed May 31, 2015)

Results/ Implications

- As a result of the external cost of obesity to the society, there is economic justification for government intervention.
- "Fat tax" may be implemented by:
  - taxing the percentage fat content of foods
  - taxing certain types of foods considered to have high fats or unhealthy nutritional content.
- The money generated from fat taxes could be used to fund other obesity intervention programs such as:
  - subsidies on healthy foods
  - funding healthy eating education campaigns, and
  - subsidising exercise equipment.

Wansink, Brian, and Matthew M. Cheney	2005	U.S.	Health claims and functional foods	Leverage FDA Health Claim	To analyse the existing health claims approved by the Food and Drug Administration (FDA) to understand the impact of the relationship	Discussion	*Journal of Consumer Affairs* 39, no. 2 (2005): 386-398.

					between diet and health on awareness and usage of the claims.		

Results/ Implications

- The primary source of information on diet-health relationships continues to be the product nutritional labels.
- Health claims should come from credible sources such as government entities, academia, etc.
- Prior nutrition knowledge is very vital for the success of health claims.
- The awareness of the presence of nutrients in food can be translated into consumption if consumers are motivated.
- The two fundamental areas of knowledge that consumers can have about a healthy (nutritional) food are the attributes and benefits of the food.
- There is a positive relation between the awareness of the two fundamental areas of knowledge and the consumption of functional foods.
- Health claims that target particular areas of the population are mostly successful.
- Media attention and promotion of health claims by companies can significantly affect the success of health claims.
- Health claims can also be successful if they clearly quantify the health benefits.
- In order to make health claims acceptable, it was recommended that more salient health-related belief should be added to the claim.

Cash, Sean B., David L. Sunding, and David Zilberman.	2005	U.S.	Obesity intervention	Fat taxes and thin subsidies: prices, diet, and health outcomes.	To examine the effect of subsidies on healthy foods like fruits and vegetables in the U.S.	Empirical simulation model Data: 1994-1996 and 1998 Continuing Study of Food Intake by Individuals (CSFII) N= 18,081	*Acta Agriculturae Scand Section C* 2, no. 3-4 (2005): 167-174.

Results/ Implications

- A sustained, modest subsidy on fruits and vegetables could lead to increases in their consumption
- The increase in fruits and vegetable consumption could also result in a significant reduction in the incidences of a number of diseases.
- As subsidies on fruits and vegetables increase, the number of diseases prevented also increases significantly.
- The reduction in disease comes with a little increase in the cost per statistical life saved.
- This increase in cost could be attributed to diminishing marginal health benefits of fruits and vegetables.

Moon, Wanki, Siva K. Balasubramanian, and Arbindra Rimal	2005	U.S.	Health claims and functional foods	Perceived health benefits and soy consumption behavior: two-stage decision model approach	To examine whether the perceived health benefit of soy protein had impact on the consumption pattern of soy foods.	Two-stage decision model Data from online survey of the Ipsos-NPD Marketing Research Panel. N=1400	*Journal of Agricultural and Resource Economics* (2005): 315-332.

Results/ Implications

- Perception of health benefit significantly affects both the decision to consume soy foods and the frequency of consumption.
- Negative perceptions like unappetising taste and inconvenience for soy foods outweighs the impact of health benefit perception.
- Consumers with high perception of health benefits of soy products consumes soy products more frequently than those with low perception.

Teratanavat, Ratapol, and Neal H. Hooker	2006	U.S.	Functional foods	Consumer valuations and preference heterogeneity for a novel functional food.	To examine the variations in consumers' preferences and consumer valuation of novel foods with functional properties.	Discreet choice experiment Data: Survey of 1704 households N=1704	*Journal of Food Science* 71, no. 7 (2006): S533-S541.

Results/ Implications

- More than half of the respondents had positive valuation for functional tomato juice
- More than half of the respondents were willing to pay premium price for the health benefits of the natural functional tomatoes.
- Consumers preferred functional foods with single health benefits to functional foods with multiple health benefits.
- Consumer food choices was influenced by their familiarity with functional foods.
- Females had more heterogeneous preferences for functional foods than males.

Peng, Yanning, Gale E. West, and Cindy Wang	2006	Canada	Consumer attitude and acceptance of functional	Consumer Attitudes and Acceptance of CLA-Enriched Dairy	To examine consumer attitudes and acceptance of CLA-enriched dairy	Maximum likelihood ordered probit model Data: Telephone	*Canadian Journal of Agricultural Economics/Revue canadien*

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| | | | | foods | Products. | products. | survey N=803 | *ne d'agroec onomie* 5 4, no. 4 (2006): 663-684. |

Results/ Implications

- CLA-enriched products consumption could be improved by:
  - educating consumers of the health benefits of both conventional and CLA-enriched dairy products.
  - promotion of all dairy products.
- Consumers already familiar with products like calcium or vitamin-enriched milk or calcium-enriched orange juice are more likely to be interested in CLA-enriched cheese.
- Consumers are more interested in the ability of CLA-enriched milk products to reduce risk of cancer or diabetes than the ability to reduce risk of heart disease.

| Chouina rd, Hayley H., David E. Davis, Jeffrey T. LaFranc e, and Jeffrey M. Perloff. | 2007 | U.S. | Obesity interve ntion | Fat taxes: big money for small change. | To examine the impact of a "fat tax" on the consumption pattern of dairy products. | Generalized Almost Ideal Demand System

Data: Information Resources Incorporated's (IRI) Infoscan™ scanner data | In *Forum for Health Economi cs & Policy*, vol. 10, no. 2. 2007. |

Results/ Implications

- A tax on the fat content of a food product may yield ineffective results.
- For taxes to be effective in reducing calorie consumption:
  - all food items should be taxed, and
  - tax rate should also be high enough.
- A greater proportion of the tax burden is paid by the poor.

| Mytton, Oliver, Alastair Gray, Mike Rayner, and Harry Rutter | 2007 | United kingdom | Obesity interve ntion | Could targeted food taxes improve health? | To analyse the impact of value added tax (VAT) on diets and health by extending VAT to cover additional food categories. | Model based on consumption data and elasticity values

Data: 2000 National Food Survey of Great Britain | *Journal of epidemio logy and communi ty health* 61 , no. 8 (2007): 689-694. |

Results/ Implications							
• A carefully implemented "fat tax" could have a modest but significant effect on food consumption and health. • Taxes that targets principal dietary sources may be counterproductive. • Taxes that cover wider food categories could lead to significant health improvements.							
Herath, Deepananda, John Cranfield, and Spencer Henson	2008	Canada	Functional foods and nutraceuticals	Who consumes functional foods and nutraceuticals in Canada?: results of cluster analysis of the 2006 survey of Canadians' Demand for Food Products Supporting Health and Wellness.	To identify consumer segments associated to functional foods and nutraceuticals in the country.	Cluster analysis and analysis of variance Data: Survey N= 1700	*Appetite 51, no. 2 (2008): 256-265.*

Results/ Implications							
• Sociodemographic factors such as age, income, education and location are important determinants of functional foods and natural health product consumption in Canada. • Consumers more likely to accept functional foods and nutraceuticals have characteristics such as elderly, less educated, and low income households. • Consumers less likely to accept functional foods and nutraceuticals are the young, highly educated, and high income households.							
Markosyan, Armenak, Jill J. McCluskey, and Thomas I. Wahl.	2009	U.S.	Functional foods	Consumer response to information about a functional food product: apples enriched with antioxidants.	To assess consumers' responses to a "functional" apple enriched with antioxidant coating noted to fight cancer.	Dichotomous choice model Data: Survey N=730	*Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 57, no. 3 (2009): 325-341.*

Results/ Implications

- Consumers place more value in functional foods and they are willing to pay price premium for these foods.
- On average, consumers are willing to pay a marginal premium for antioxidant-enriched apples.
- Consumers who place emphasis on organic products are less likely to pay price premium for antioxidant-enriched apples.
- Fear of the riskiness of the technology used in functional food production might result in rejection by some consumers.

| Henson, Spencer, John Cranfield, and Deepananda Herath | 2010 | Canada | Functional foods | Understanding consumer receptivity towards foods and non-prescription pills containing phytosterols as a means to offset the risk of cardiovascular disease: an application of protection motivation theory. | To examine consumers' willingness to purchase foods and non-prescription pills containing phytosterol, which is noted to reduce the risk of cardiovascular disease (CVD). | Protection Motivation Theory (PMT) Data: survey N=446 | *International Journal of Consumer Studies 34, no. 1 (2010): 28-37.* |

Results/ Implications

- Response efficacy and self-efficacy are the main determinants of consumers' intention to use non-prescription drugs and/or foods rich in phytosterols.
- Perceived threat of CVD is not a significant determinant of consumers' willingness to consume products rich in phytosterols.
- Cholesterol as a risk factor of CVD does not have any significant effect on consumers' intention to increase the consumption of products rich in phytosterol.

| Milligan, Michael A., Alok K. Bohara, and José A. Pagán | 2010 | U.S. | Acceptance and willingness to pay for functional foods | Assessing willingness to pay for cancer prevention. | To analyse socioeconomic and demographic factors associated with the willingness to pay for cancer prevention. | Regression analysis-threshold modeling approach Data from 2002 Health and Retirement Study (HRS) N=18, 171 | *International journal of health care finance and economics 10, no. 4 (2010): 301-314.* |

Results/ Implications

- More than half of the respondents believed that their chances of developing cancer later in their lives was high.
- Age was negatively related to willingness-to-pay to avoid cancer.
- Income was positively related to willingness-to-pay to avoid cancer.
- Self-assessed likelihood of developing cancer positively related to willingness-to-pay to avoid cancer.
- About 72% of the respondents were willing to pay a minimum of $100 to prevent cancer.
- About 10% of the respondents were willing to pay $1000 to prevent cancer.

Moon, Wanki, Siva K. Balasubramanian, and Arbindra Rimal.	2011	U.S.	Health claims and functional foods	Health claims and consumers' behavioral intentions: The case of soy-based food	To assess the influence of health claims on the behavioural intention of consumers in relation to soy-based foods.	Ajzen and Fishbein's (1977, 2005) theory of planned behavior Online survey was conducted by Ipsos-Observer in 2007	*Food Policy* 36, no. 4 (2011): 480-489.

Results/ Implications

- Non-users of soy-based foods who already have insight in nutrients are more inclined to try soy-based foods.
- A strong positive relationship was observed between respondent's perception of health benefit and taste, and their behavioural intention towards soy-based foods.
- While sporadic users were seen to be more likely to include soy-based products in their daily diets, regular consumers were also seen to be more likely to increase their consumption of it.
- Consumers were indifferent about whether a food product had an "FDA" health claim or a general health claim.
- Existing users of soy-based foods were more willing to increase their consumption when compared to non-users.
- It was recommended that, awareness programs target both non-user and sporadic users of soy-based food products.

Rickard, Bradley J., Abigail M. Okrent, and Julian M. Alston.	2013	U.S.	Obesity intervention	How have agricultural policies influenced caloric consumption in the United States?	To examine the impact of farm policies affecting food prices on obesity incidence in the U.S.	Equilibrium displacement model Data: Continuing Survey of Food Intakes by Individuals (CSFII) 1989–1991 (USDA-ARS, 1993), the CSFII 1994–1996, 1998 (USDA-	*Health economics* 22, no. 3 (2013): 316-339.

							ARS, 2000), and the 2001–2002 National Health and Nutrition Examination Survey (CDC, NCHS, 2003).	

Results/ Implications

- The abolishment of subsidies on grains and oilseeds would only result in a modest reduction in caloric intake.
- The abolishment of all farm subsidies may trigger the increase in consumption of other unhealthy foods.
- Therefore, the abolishment of all farm subsidies may result in the overall increase in caloric intake.

Taylor, Peter Shawn	2013	Canada	Obesity intervention	Tax on the Menu: Why food taxes won't make Canadians thinner, but will make their governments much, much fatter. Canadian Taxpayers Federation report	To analyse the effectiveness of food taxes as a tool to minimize obesity incidence.	Literature review	http://www.taxpayer.com/media/Tax%20on%20the%20Menu%20-%20English%20(final).pdf (Accessed June 1, 2015)

Results/ Implications

- Individual food products targeted for tax may not necessarily be a cause of increase in weight since obesity is a multifaceted problem.
- Taxing certain foods may lead to the substitution for more unhealthy diets.
- "Fat taxes" only serve as new revenue generating sources for the government.

Alston, Julian M., Abigail M. Okrent, and Joanna Parks	2013	U.S.	Obesity intervention	Effects of US Public Agricultural R&D on US Obesity and its Social Costs.	To examine the impact of public agricultural investment on obesity and social welfare in the U.S.	Models of Real Farm Commodity Prices and Public Agricultural Knowledge Stocks, Equilibrium Displacement Model	*Robert Mondavi Institute Center for Wine Economics Working Paper* 13 05 (2013).

						Data: commodity-specific public research spending data from the United States Department of Agriculture (USDA) Current Research Information System (CRIS)	

Results/ Implications

- Public investment in agricultural R&D has contributed to the problem of obesity through its resultant cheaper food prices.
- The negative impact of public investment in agricultural R&D is very modest and as such, any intervention policy based on agricultural R&D is less likely to be effective.
- Because it takes a relatively longer time for policies based on agricultural R&D investment to affect food prices, such policies may be ineffective.

Lawless, Lydia JR, A. C. Drichoutis, Rodolfo M. Nayga, Renee T. Threlfall, and Jean-François Meullenet	2015	U.S.	Acceptance and willingness to pay for functional foods	Identifying Product Attributes and Consumer Attitudes that Impact Willingness to pay for a Nutraceutical-Rich Juice Product.	To examine the factors that affects the willingness to pay for nutraceutical-rich juice blend (a novel product).	Non-hypothetical auction-like mechanism Data: survey of 228 participants	*Journal of Sensory Studies* 30, no. 2 (2015): 156-168.

Results/ Implications

- There was a general acceptance of nutraceutical-rich juice.
- On a 9-point scale, respondents indicated a 7.42 overall liking for nutraceutical-rich juice.
- On average, consumers were willing to pay $3.45 per bottle for nutraceutical-rich juice blend.