Pulse Consumption in Canada: Analysis of Pulse Consumption in the Canadian Community Health Survey.

by

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A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in fulfilment of the requirements of the degree of

MASTER OF SCIENCE

Department of Human Nutritional Sciences

University of Manitoba

Winnipeg

Author's Declaration

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

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Abstract

Pulses are nutrient dense foods that possess many beneficial effects. The purpose of this project was to examine the prevalence and effect of pulse consumption on nutrient intake in Canadian adults (≥ 19 y). Analysis was performed on data (N = 20,156) from the 2004 Canadian Community Health Survey (Cycle 2.2). Respondents were divided into groups based on pulse consumption and levels of intake and the association between nutrient intakes and pulse consumption was examined. Analysis revealed that thirteen percent of Canadians consumed pulses on any given day, and individuals with higher pulse intakes had higher intakes of macronutrients as well as enhanced micronutrient intake. Although pulses are generally low in sodium, its intake also was higher in pulse consumers. These data indicate that pulse consumption supports dietary advice that pulses be included in healthful diets. Further studies will be necessary so that dietary advice to increase consumption of pulses will maximize their nutritional benefits.

Acknowledgements

I would like to thank my advisor Dr. Harold Aukema for his guidance, help and valued feedback on all aspects of this project as well as to my committee members, Dr. Gustaaf Sevenhuysen and Dr. Nancy Yu in particular who helped me greatly with her methodological advice.

Thanks to the Manitoba Research Data Centre for providing access to the CCHS 2.2 “master files” and a very special thanks to Dr. Ian Clara for his (seemingly unending) statistical support. Many thanks to Dr. Terryl Hartman and Diane Mitchell from Pennsylvania State University for all of their knowledge, experience and assistance along the way, as well as Dr. Frank Lawrence for his statistical insight.

I would like to thank my parents, George and Debra Mudryj, as well as my extended family and friends for all of their support and encouragement.

The research was funded by Pulse Canada and Saskatchewan Pulse Growers.

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List of Abbreviations

AI	Adequate Intake
AICR	American Institute for Cancer Research
AMPM	Automated Multiple Pass Method
BMI	Body Mass Index
C	Celsius
CCHS	Canadian Community Health Survey
CCHS 2.2	Canadian Community Health Survey, Cycle 2.2 (2004)
CFG	Canada's Food Guide
CHD	Coronary Heart Disease
CI	95% Confidence Interval
CIHI	Canadian Institute for Health Information
CNF	Canadian Nutrient File, version 2007b
CSFII	Continuing Survey of Food Intakes by Individuals
CVD	Cardiovascular Disease
d	Day
DFE	Dietary Folate Equivalent(s)
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EER	Estimated energy Expenditure
EU	European Union
FAO	Food and Agricultural Organization
g	Gram
GFD	Gluten-Free Diet
GI	Glycemic Index
GO	Galactooligosaccharides
HbA1c	Glycosylated Hemoglobin
HDL	High-density lipoprotein
HIV	Human Immunodeficiency Virus
hr	Hour
IDF	Insoluble Dietary Fibre
kcal	Kilocalorie
kg	Kilogram
LDL	Low-density lipoprotein
m	Metre (s)
µg	Microgram(s)
mg	Milligram(s)
min	Minute
mL	Millilitre
mm	Millimetre
MUFA	Monounsaturated Fatty Acid
NCNS	Nutrition Canada National Survey
NHANES	National Health and Nutrition Examination Survey
NHEFS	National Health and Nutrition Examination Survey Epidemiologic Follow-up Study

NS	Not Statistically Significant
OR	Odds Ratio (from a logistic regression analysis)
PAD	Peripheral Artery Disease
PAL	Physical Activity Level (or Physical Activity Index)
psi	Pound per square inch
PSU	Primary Sampling Unit
PUFA	Polyunsaturated Fatty Acid
RDA	Recommended Dietary Allowance
RS	Resistant Starch
SCFA	Short chain fatty acid
SPSS®	Statistical Analysis Software
SD	Standard Deviation
SDF	Soluble Dietary Fibre
TDF	Total Dietary Fibre
UL	Tolerable Upper Intake Levels
US	United States
USDA	United States Department of Agriculture
WHO	World Health Organization
wt	Weight

Chapter 1: Introduction

1.1 Background and Terminology

Pulses are the edible seeds of members of the *Fabaceae* (*Leguminosae*) family, and according to the Food and Agricultural Organization of the United Nations (FAO), pulse crops refer to crops harvested exclusively for their grain, including dry beans, peas and lentils. As defined further by the FAO, the definition excludes crops used for oil extraction, such as soybeans and peanuts or those harvested green for food, such as green beans and green peas (FAO, 1994; FAO, 2010; Michaels, 2004). For the purpose of this study, the FAO definition is used and the term “pulses” will refer to the dry, edible variety of beans, peas and lentils, and will not include soybeans, fresh beans or fresh peas.

Beans, peas and lentils have been consumed for at least 10,000 years and are among the most extensively used foods in the world (Leterme & Munõz, 2002). Historically, the use of pulses is widespread and records of their use have been discovered many places: from the Egyptian pyramids to small villages in Hungary and Switzerland. It is believed that the pea originated in the East, the lentil in the Middle East and the dry bean in areas of Central and South America. More locally, dishes such as pea soup and baked beans have played roles in North America’s national cuisine (Saskatchewan Pulse Growers, 2010).

Globally, beans are produced in various countries of the world, while lentils are harvested mainly in India, Turkey and Canada. Peas are largely grown in Australia, Canada and the United States while the chickpea is predominantly grown in India. The modern pulse industry in Canada began in the 1960s, with the production and subsequent export of field peas and lentils but did not play a significant economic role until nearly a decade later. During the 1970s, work by Dr. Al Slinkard and his colleagues at the Crop Development Centre at the University of Saskatchewan were instrumental in helping previously “unknown” crops such as lentils gain acceptance. The registration of herbicides allowed for a new way to control weeds and the overproduction of wheat led farmers to begin diversifying their crops to include pulses (Saskatchewan Pulse Growers, 2010). In the 1980s the industry expanded dramatically in response to international market demand, and in 2009 total production in Canada was a record 4.1 million tones worth nearly $2.2 billion. Over the past two decades, Canada has become known as the world’s largest exporter of pulses, exporting nearly 75 percent of its production to over 150 countries around the world (Pulse Canada, 2010a). An overview of Canada’s Pulse Industry is shown in **Appendix A.**

A diverse assortment of pulse crops can be grown in a variety of climate and soil conditions. For example, in a semi-arid subtropical climate such as the Mediterranean basin, the cowpea (*Vigna unguiculata*) can be harvested, while colder climates support beans such as *Phaseolus vulgaris* and *P. coccineus*. In locations which incur precipitations below 400 mm, chickpeas thrive while lentils flourish at even lower temperatures and precipitation levels below 300 mm (Vandenburg, 2006). Due to Canada’s diverse agricultural land, a large variety of pulses can be grown. While the provinces of Ontario and Quebec are primary growers of beans, Manitoba is able to grow white and coloured beans, peas and lentils. Meanwhile Alberta harvests peas, lentils and chickpeas as well as beans under irrigation. Currently, the province of Saskatchewan produces 99 per cent of Canada's lentil crop, 88 per cent of Canada's chickpea crop, and 80 per cent of Canada's pea crop, truly earning it its nickname of "the heart of Canada's pulse industry" (Pulse Canada, 2010a; Saskatchewan Pulse Growers, 2010).

Pulses are primarily used for food and feed around the world, but are also emerging as an ethanol alternative fuel (Pulse Canada, 2010a). Although the consumption of legumes and diets low in animal protein and high in grains and cereals have long been credited for their nutritional values and for their preventative role in disease, their consumption in the Western world remains quite low at less than 3.5 kg/capita per year. In other parts of the world, annual pulse consumption can range from 10 kg/capita (South America and India) to 40 kg/ capita (Burundi) (Leterme & Munõz, 2002). Surveys that have been carried out in Central America and the Andes have shown that pulses are seen as nutritionally optimal and are considered a staple food. Ancient civilizations such as the Aztecs and Mayans relied heavily on beans as did the rural Indian tribes of Central America. Their modern day ancestors seem to mimic their food habits as pulse consumption has remained quite stable for the past 35 years in rural communities of different Central American countries. Moreover, in these areas bean consumption is remarkably constant throughout the seasons, in opposition to foods such as fruits which are unavailable through the whole year (Broughton *et al.*, 2003; Leterme & Munõz, 2002).

1.2 Study Rationale

Over the past 25 years, Canadian adults have become heavier and increasingly inactive, leading to a multitude of diet related illness. Health Canada estimates from 1978/1979 showed that 14 percent of Canadian adults aged 18 and over were considered obese (Tjepkema, 2006). Fast forwarding to 2007 and 2009, Statistics Canada showed that 37 percent of Canadian adults were considered overweight, and 24 percent were considered obese, a staggering increase from over 30 years ago (Statistics Canada, 2010b). Globally, the World Health Organization (WHO) projects that by the year 2015, 2.5 billion adults will be considered overweight and over 700 million will be obese (Baier *et al.*, 2010).

In addition to the growing obesity epidemic, it is estimated that Canada will continue to see an increase in the number of diagnoses as well as mortalities of individuals with cancer, cardiovascular disease (CVD) and diabetes. The cost of these ailments is staggering: according to Canadian Cancer Statistics 2010, the total direct and indirect costs of cancer totals over $159 billion dollars per annum (Public Health Agency of Canada, 2010). Even though the rates of CVD have been in a decline over the past 40 years, the Heart and Stroke Foundation of Canada estimates that in 2006, heart disease and stroke cost the Canadian economy $22.2 billion (Heart & Stroke Foundation of

Canada, 2010). As well, the detrimental effects of diabetes have been well established and the cost in Canada is estimated to rise to $16.9 billion by the year 2020 (Diabetes and Society, 2010).

Modifiable risk factors which may contribute to these diseases include poor quality diets and a sedentary lifestyle (Cannon, 2007). A 2009 report published by Health Canada found 5 in 10 Canadian women and 7 in 10 Canadian men had energy intakes which exceeded their energy requirements. In addition, there is concern that intakes of nutrients such as vitamin A, magnesium, potassium, fibre and vitamin D do not meet the recommended requirements, while sodium and fat intakes are higher than the acceptable ranges (Health Canada, 2009).

Although there are limited studies which look at the influence pulse consumption has on dietary intakes, recently a study undertaken by Mitchell and colleagues using data from the National Health and Nutrition Examination Survey (NHANES) was published showing that nutrient intakes were influenced positively based on consumption of a ½ cup of pulses per day (Mitchell *et al.*, 2009).

This report presents results obtained using data from the “master file” of the Canadian Community Health Survey Cycle 2.2 (CCHS 2.2), examines the demographics of the average Canadian pulse consumer, and looks at the relationship between pulse consumption and diet quality. Results gathered from this project may help gain insight into the dietary patterns of Canadian adults and allow for the possibility of future recommendations to be made in regards to pulse intake. We begin with a brief literature review on the nutritional components of pulses and their hypothesized health benefits as well as an overview of the CCHS 2.2. The methodology used in examining the data will be outlined followed by our statistical results, discussion of key findings and future implications of this project.

Chapter 2: Literature Review

2.1 Nutritional Overview of Pulses

Pulses are a significant source of many vitamins and minerals (**Table 2.1**), and epidemiological evidence as well as animal studies supports the protective link between pulse consumption and many diseases. Although a variety of pulses exist, nutritionally they are remarkably similar. Pulses are relatively low in energy density, providing 1.3 kcal/g (based on cooked and unsalted serving). They are characterized by a high carbohydrate content (~50-65%) and generally have a higher amylose content than other cereals, which may be credited with the fact that their carbohydrates are slowly digested, placing them lower on the Glycemic Index (GI) scale than other carbohydrate rich foods like rice, white bread or potatoes (**Table 2.2**) (Ofuya & Akhidue, 2005; McCrory *et al*., 2010; Winham *et al.*, 2008). Pulses are also considered fairly good sources of protein (7.7 g per ½ cup) and are rich in the amino acid lysine, which is often low in cereal grains. Conversely, pulses are low in the essential amino acids methionine and tryptophan which are found in grain-based products (**Table 2.3**). Thus when eaten with a cereal, pulses and grain-based products balance each other to provide a “complete” protein (Mitchell *et al.*, 2009; Patterson *et al.*, 2009; Winham *et al.*, 2008).

Pulses are an excellent source of dietary fibre, providing roughly 7 g of fibre per ½ cup serving (Tosh & Yada, 2010). They contain both a mixture of soluble fibre (which has been shown to lower total serum and low-density lipoprotein (LDL) cholesterol) as well as insoluble fibre (which aids in gastrointestinal function). The fibre-rich components of pulses have also been incorporated into processed food to increase their dietary fibre content. Another healthy component of pulses is that they are low in fat (ranging from 2-6 percent of total content depending on the variety), the majority of this being mono- and polyunsaturated fat. As well, because they are plant foods, pulses do not contain cholesterol, but instead contain plant sterols, whose cholesterol lowering benefits will be discussed later in section 2.4.2 (Iqbal *et al.*, 2006; Patterson *et al.*, 2009; Ratz, 2010; US Dry Bean Council, 2011; Winham *et al.*, 2008).

Table 2.1. Nutritional value of 100 grams of black beans *(Phaseolus vulgaris)*, boiled.

Calories (kcal)	132
Protein (g)	8.86
Carbohydrate (g)	23.71
Dietary Fibre (g)	7
Fat (g)	<1
Saturated Fat (g)	0.1
Cholesterol (mg)	0
Calcium (mg)	27
Iron (mg)	2.10
Magnesium (mg)	70
Phosphorus (mg)	140
Potassium (mg)	355
Sodium (mg)	1
Zinc (mg)	1.12
Dietary Folate Equivalent (DFE) (μg)	149
Copper (mg)	0.209
Selenium(μg)	1.2

Referenced from: Canadian Nutrient File, version 2010. Available at: http://webprod.hc-sc.gc.ca/cnf-fce/index-eng.jsp

Other nutrients that are abundant in pulses include copper, manganese, phosphorus and magnesium. They are also an excellent source of thiamin, niacin and folate as well as a good source of riboflavin and vitamin B5 (pantothenic acid) and B6 (pyridoxine). Pulses contain vitamin E and A, and while dried pulses do not contain vitamin C, their sprouted forms do (1 cup of bean sprouts contains approximately 11 grams of vitamin C). Pulses are also a rich source of iron and zinc; although their iron content varies greatly depending on the variety (e.g. white beans contain almost twice as much iron as black beans) (Bennink & Rondini, 2008; Patterson *et al.*, 2009; Raatz, 2010). It is to be noted that most of the iron contained in pulses is largely bound to phytates which may reduce absorption (Sandberg, 2002). Pulses also contain chemical compounds found naturally in plants called phytochemicals. Lignins, isolflavones and phenolic acid are just a few of these phytochemicals which have been shown in the literature to possess antioxidant and anti-carcinogenic effects. These will be discussed in greater detail in section 2.4.1 *"Pulse Consumption and Cancer"* (Bennink & Rondini, 2008; Madar & Stark, 2002; Messina, 2009; Patterson *et al.*, 2009).

Table 2.2. Glycemic Index of Selected Foods*.

Food	**Glycemic Index**
Chickpeas	39
Lentils	42
Navy Beans	43
Split Peas	45
White Rice	80
White Bread**	100
Potatoes	121

* Per 150 grams cooked except for white bread
**White bread was used as the reference food in an amount equal to the carbohydrate available in the test food
Referenced from: http://www.ontariobeans.on.ca/health.php

Table 2.3. Essential amino acid profile for ½ cup black beans, cooked.

Amino acid	Amount (g)
Isoleucine	0.34
Leucine	0.61
Lysine	0.53
Methionine	0.12
Phenylalanine	0.41
Threonine	0.32
Tryptophan	0.09
Valine	0.40
Histidine	0.21

Derived from Food Processor for Windows, Version 7.60, by ESHA Research in Salem, Oregon, USA

Pulses do not contain gluten and are recommended in the Gluten-Free Diet (GFD), making them ideal for people who suffer from Celiac disease (Kupper, 2005). As well, research has also examined their protective effects as prebiotics (Winham *et al.,* 2008). Prebiotics are compounds that escape digestion and can stimulate the growth of healthy bacteria in the gut. Most prebiotics are oligosaccharides, including raffinose and stachyose which are carbohydrates that are present in pulses. Hypothesized physiological effects that may stem from the use of prebiotics include increased absorption of calcium and magnesium, modulation of carcinogen metabolism and stimulation of immune function (Macfarlane & Cummings, 1999)

Although they are advocated for their nutritional qualities, the raw seeds of pulses also contain “antinutritional” factors such enzyme inhibitors, lectins, galactooligosaccharides (GO) and tannins. Enzyme inhibitors are substances that bind to enzymes and alter their activity by preventing the way it would usually behave. Most pulses contain substances such as enzyme inhibitors which prevent early germination. A substance called phytic acid (which binds phosphorus) is also present to deter early germination, but may reduce absorption of calcium, iron, magnesium and zinc (Santos-Buelga & Scalbert, 1999; Gupta, 1987; Sandberg, 2002).

Lectins (carbohydrate binding proteins) are said to possess anti-fungal, immunomodulatory and anti-tumour properties, but have also come under criticism for their toxic effects. Although lectins are present in most pulses, they are found in the highest amounts in red kidney beans (Bender & Reaidi, 1982; Ye *et al.,* 2001). Because lectins are able to survive digestion by the gastrointestinal tract, they are able to bind to membrane glycosyl groups of the cells lining the digestive tract. This mode of action is described by Vasconcelos and Oliveira in their article entitled "*Antinutritional properties of plant lectins"* (2004). Negative effects of lectins are illustrated in several articles, ranging from interference with nutrient metabolism and loss of gut epithelial cells to the modification of the immune state of the digestive tract. Although lectins are destroyed by cooking, food poisoning incidents involving the ingestion of partially cooked or raw red kidney beans have been reported (Lajolo & Genovese, 2002; Pusztai & Bardocz, 1996; Radberg *et al*., 2001; Wilson *et al*., 1980). However research has also shown some benefits of lectins which will be discussed in section 2.4, "*Pulse Consumption and Diet Related Illnesses*".

GOs (mainly raffinose, stachyose and verbascose) act by inducing gastrointestinal disorders leading to decreased nutrient intake (Burbano *et al*., 1999; Champ, 2002). Due to these factors, the digestibility of pulses is 15-20 percent less than that of the protein casein due to compounds found in their seed coat. Tannins, which are plentiful in legume seeds, also interact with protein digestibility (Rockland & Radke, 1981). A review of the negative effects of tannins by Reddy et al. showed that even one subcutaneous injection of tannic acid at 700 mg/kg body weight caused a significant breakdown of polyribosomes (units of ribosomes important in protein synthesis) in mouse liver, inhibiting the incorporation of amino acids into hepatic cellular proteins (1970).

To reduce the instances of these anti-nutritional factors, pulses are often processed pre-consumption. Methods include milling, soaking, germination and fermentation (Deshpande et al., 1982). Rehman and Shah investigated the effects of thermal heat processing on the anti-nutrient factors of legumes, finding that simple boiling reduced tannins by 20.8–26.8% and phytic acid by 24.0–35.1%. Even greater reductions of tannins and phytic acid were observed after cooking the legumes in an autoclave at 121°C (33.1-45.7% and 28.0-51.6%, respectively) (2005).

Emerging research has shown that the uncomfortable gastrointestinal effects associated with pulse intake experienced by some is perhaps more negligible than first thought. A recent study was performed by the University of Guelph to study the gastrointestinal effects of pulse consumption. Twenty one healthy males were assigned to diets of 4 different soups; control potato, chickpea, lentil and pea. After four 28 day treatment periods, it was observed through questionnaires that although the incidence of flatulence was high across all treatments, severity was reported as low. Bloating and overall gastrointestinal function was also reported as low across the 4 treatments (Duncan, 2008). In addition to these positive results, there are also numerous things that consumers can do to reduce the digestive discomfort of consuming pulses. These include starting off with eating small amounts and gradually working your way up to larger quantities, drinking plenty of water, soaking pulses thoroughly before cooking and taking oral digestive enzymes to prevent these effects (Patterson et al., 1999).

2.2 Nutritional Discrepancies between Dry, Canned and Processed Pulses

Canned pulses are a time effective replacement for dry pulses. However the high sodium “brine” that accompanies most pulses in their canned form may dilute their nutrient density. Recently an article published by Zanovec et al looked at the differences in nutrient density in several varieties of canned and cooked beans. Results showed that dry cooked beans were more energy dense, providing more protein, fibre, iron, potassium and magnesium and less sodium than their canned alternatives ($P < 0.05$). However, the authors also point out that, when drained and rinsed, canned beans also serve a healthier purpose (2011). In their investigation on the reduction in sodium levels of canned beans, Jones and Mount found that draining beans removed 36% of the sodium (from 503 mg/serving to 321 mg/serving), while both draining and rinsing removed, on average, 41% of the sodium (503 mg/serving to 295mg/serving, respectively). It is interesting to note that the investigators found variations in sodium reduction depending on the variety of bean. In drained treatments, the highest reduction occurred in red kidney, garbanzo and pinto beans with the lowest decrease being present in great northern and black beans. The addition of rinsing showed the most favourable effect in great northern beans, black beans and garbonzo beans with a lesser effect in red kidney and pinto beans (2009).

A recent document published by Pulse Canada reported that many consumers rinse their canned pulses prior to using them. Using an online survey (n=921) of American adult canned bean purchasers, a total of 32% of the respondents reported that they drain and rinse canned beans before preparing them and 33% reporting that they drain the brine before use. It is recommended that consumers drain their canned pulses for two minutes, rinse them with water for 10 seconds, and allow the pulses to drain for two more minutes to enjoy the favourable effects of canned pulses (Pulse Canada, 2010b).

Other effects of processing on the nutrient profile of pulses was examined by Kuto and colleagues, who found that thermal processing decreased the insoluble dietary fibre (IDF) content of pinto beans while soaking and cooking increased the amount of resistant starch ($p<0.05$). The effects of processing on field peas was investigated by Wang and colleagues who found that soaking peas resulted in an increase in their protein content (2.6% to 5.0%) while cooking altered protein as well causing an increase from 3.0% to 6.7%. Wang et al also found that IDF in field peas was increased after both soaking and cooking, while the soluble dietary fibre (SDF) content was only affected by cooking (2003).

2.3 Economical Value of Pulses

Due to their inexpensive nature, pulses are often called the 'poor man's meat.' This phrase is dissected by Aykroyd et al in the paper "Legumes in Human Nutrition" as primarily implying that pulses are a meat substitute (even recommended in medieval times by the church as a substitute for meat during the Lenten fasting period). Secondly, it implies an association with poverty as far back as Ancient Greece (Aykroyd quotes a line from the ancient Greek play *Plutus* by Aristophenes in which a character remarks on a recent member of the "nouveau riche" *"Now he doesn't like lentils anymore"* (1964). Though this may have been uttered in jest thousands of years ago, even today there remains a positive association between meat consumption and ones income, with pulses remaining the prime source of protein primarily in countries where animal protein is far too expensive (Leterme & Munõz, 2002).

2.4 The Role of Pulses in Diet-Related Illnesses

2.4.1 Pulse Consumption and Cancer

Many epidemiological studies put little emphasis on the relationship between pulse consumption and cancer, instead focusing on fat consumption, protein source, and intake of vitamins and fibre. As pointed out by Benninck and Rondini, even when pulse intake is assessed, most researchers fail to distinguish between various pulses, making it nearly impossible to determine the effect of different varieties of pulses on cancer (2008). However dietary data from 41 countries reveals that countries with the greatest consumption of pulses had the lowest death rates due to breast, colon and prostate cancer (Correa, 1981).

In 2007, the American Institute for Cancer Research (AICR) published a review based on more than 4500 research studies that examined the relationship between dietary factors and 18 specific cancers. The full report, entitled '*Food, Nutrition and the Prevention of Cancer: a Global Perspective'* brought forth a number of recommendations which may help in reducing ones risk of cancer. Public health goals included a recommendation that "Relatively unprocessed cereals (grains) and/or pulses (legumes), and other foods that are a natural source of dietary fibre, to contribute to a population average of at least 25 g non-starch polysaccharide daily." Personal recommendations encouraged people who consume starchy vegetables also to "ensure intake of sufficient non-starchy vegetables, fruits, and pulses (legumes)." The fact that pulses have been mentioned twice is highly significant (World Cancer Research Fund, 2007).

A recent study published by the *Journal of Nutrition* found a link between breast cancer and dry-bean consumption. This study, which was based on a hypothesis from the Nurses' Health Study, was performed on 150 female rats that were given a diet of small red beans which were incorporated as cooked, freeze dried and milled powder. The results showed that the carcinogenic response in mammary glands was reduced by dry-bean consumption at all concentrations. However at the highest dietary concentration (60 percent wt: wt) there was a 41 percent decreased incidence of cancer, reduced cancer multiplicity of 52.7 percent and decreased tumour mass by 63.7 percent. As well, the rats at the highest dietary concentration had a body weight that was 8.5 percent lower than the control group (Thomson *et al*., 2008).

A number of animal studies have been performed to further investigate the role of pulse consumption on cancer development. One cancer that has a significant link to dietary patterns in colon cancer, as it is estimated that 70 percent of deaths associated with this cancer can be prevented by altering ones dietary intake. In addition, the intake of common beans (*Phaseolus vulgaris*) may appear to reduce mortality as well. A study published by *Nutrition and Cancer* sought to determine whether black and/or navy bean consumption would have an inverse effect on azoxymethane-induced colon carcinogenesis in rats. The rats were divided into groups that were fed either a control diet or diets containing 75% black or navy bean for four weeks. (To be noted: the beans were soaked overnight and cooked until softened. After drying they were ground and incorporated with other diet ingredients). After colon cancer was initiated, the incidence of colon carcinomas was investigated after 31 weeks. Results showed that the incidence of colon adenocarcinomas was significantly lower (at $p > 0.05$) in rats fed the black bean (9%) and navy bean (14%) diets than in rats fed the control diet (36%). The reduction in carcinogenesis was accredited to better controlled appetites and greater levels of butyrate in the colon (which has been shown to induce growth arrest and apoptosis in several colon cancer cell lines) (Bennink, 2002). Similarly, Singh and Fraser examined the relationship between dietary habits and colon cancer, noting that individuals who consumed pulses more than twice a week were 47 percent less likely to develop cancer compared to those who consumed pulses at a rate of less than once a week (1998).

Although the exact mechanism in which pulse consumption may help prevent cancer growth is unknown, scientists believe that the phytochemicals that pulses contain may play a part. As mentioned previously, saponins, protease inhibitors, and phytic acid are just a few of these phytochemicals which occur naturally in plants and appear to have anticarcinogenic effects. Laboratory studies have shown that saponins seem to inhibit the reproduction cancer cells and also play a role in suppressing tumour growth. Protease inhibitors have been shown to slow the division of cancer cells and prevent tumours from releases proteases which destroy cells in close proximity. Phytic acid has also been hypothesized to play a role in the progression of tumour growth (Bennink & Rondini, 2008; Geil & Anderson, 1994; Kerem *et al*., 2005). Several other nutritional components of pulses may be associated with their hypothesized anti-cancer benefits. Selenium has been suggested to play a role in the prevention of breast, esophageal and stomach cancers, possibly due to its function in the deterrence of tumour development (Greeder & Milner, 1980). As well pulses contain zinc which has been associated with decreased oxidative stress and improved immune function (Mocchegiani *et al*., 2006; Mathers, 2002).

The phenolic compounds present in pulses were assessed for their antimutagenic properties by González de Mejía and colleagues. Phenolic compounds are said to possess antioxidant, anti-inflammatory and anti-clotting properties and the results from various studies have shown that bean extracts do inhibit mutagenicity, although these effects were shown to be dose-dependent (1999). In addition, saponins have been touted as having anti-carcinogenic qualities and have been hypothesized to lower blood glucose response. However it is to be noted that most studies regarding the anticancer activity of saponins are limited to the fact that the number of animal studies are low and the effects on humans are found to be inconclusive (Khalil & El-Adawy, 1994).

Another aspect of pulses which may be linked to cancer prevention is their fibre content. The disease prevention effects of a high fibre diet was introduced by Burkitt and Trowell, whose pioneer studies highlighted the “virtual absence” of diseases such as colorectal cancer in native Africans whose diet was rich in fibre (1977). Indeed, many studies have shown high fibre intakes linked with reduced blood pressure, enhanced weight control, improved gastrointestinal function and reduced risk of heart disease which will be discussed next (Anderson *et al*., 1994; Kendall *et al*., 2010).

2.4.2 Pulse Consumption and Cardiovascular Disease

As mentioned, CVD remains the number one cause of death in Western society and is a disease that can be modified via lifestyle changes. Four decades of research has shown that regular consumption of pulses reduces serum cholesterol and triglycerides (the two leading factors in cardiovascular diseases). Anderson and Major suggested that this may be due to the fact that the minerals contained in pulses have been shown to exhibit favourable effects on blood pressure. As well their levels of folate reduce elevated blood homocysteine, which is another risk factor in heart disease. Pulses also contain flavonoids which exert a multitude of heart healthy effects and formononetin, an isoflavone which can be found in peas, beans and chickpeas and has been shown to improve arterial stiffness (2002).

In 1998 the American Heart Association published an article which examined the association of nutrient intake and stroke in U.S. men between the ages of 40 and 75. After completing food frequency questionnaires and following an 8 year period, it was found that higher levels of potassium intake was inversely related to risk of hemorrhagic stroke. As mentioned previously, pulses are a good source of potassium, with one ½ cup containing roughly 480 mg of the daily 3,500 mg daily requirement (Ascherio *et al*., 1998). Using data from the first National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study (NHEFS), Bazzano et al found an inverse relationship between pulse consumption and risk of coronary heart disease (CHD) in American adults. Frequency of pulse consumption was estimated using a 3 month food frequency questionnaire and after a 19 year follow-up period, consumption of pulses four times a week or more resulted in a 22 percent lower risk of CHD when compared with adults who consumed them at a rate of less than once per week (2001).

Pulse Consumption and Lipid Levels

As mentioned previously, the high fibre content of pulses has been shown to exert favourable effects on blood lipid levels. Over the course of eleven clinical trials, Anderson and Major found that intake of non-soya pulses caused decreases in fasting serum cholesterol and triacylglycerol levels as well as LDL cholesterol. In addition, consuming pulses also led to an increase in patient's high-density lipoprotein (HDL) cholesterol levels (2002).

A study published by the *American Journal of Clinical Nutrition* studied the effect of canned bean consumption on hyperlipidemic men. The 24 participants were randomly assigned to a 3 day diet consisting of A) 227 grams of beans B) 227 grams of beans in a divided dose or C) 182 grams of beans. At the study's conclusion there was a decrease in body weight across all 3 diet groups, but it was found that the serum LDL levels of those in diet groups B and C were equally effective and in comparison to diet A had greater results. Compared with studies conducted under similar protocol, canned beans had a less significant effect on serum lipid concentrations than did unprocessed dried beans. When compared on a dry-weight basis, it was shown that the reduction in serum cholesterol concentration was roughly proportional to the amount of beans consumed (Anderson *et al*., 1990).

Another reason that pulses may have hypercholesterolemic attributes may be due to the fact that pulses contain chemical compounds called saponins. These compounds are found in more than 100 plant species, although the main dietary forms are legumes such as chickpeas, navy beans and kidney beans (Güçlü-Üstündağ *et al*., 2007). Some saponins form insoluble complexes with cholesterol thus preventing its absorption from the small intestine while some interfere with cholesterol metabolism by working with bile acids to enhance fecal excretion of these acids, leading to lower plasma cholesterol concentrations (Sidhu & Oakenfull, 1986).

A study undertaken by Finely et al examined the effect of pinto bean consumption on lipid levels, colonic bacterial populations and formation of short chain fatty acids (SCFA). The subjects (40 adults diagnosed with pre-metabolic syndrome and 40 control subjects) were assigned to a 12 week program in which they either consumed ½ cup of a bean entrée (consisting of 130 g of dried, cooked pinto beans) or an isocaloric chicken noodle soup. It was hypothesized that the resistant starch (RS) content of the beans (the portion of starch that evades digestion in the small intestine) would alter blood lipids and produce SCFA which in turn, would reduce serum cholesterol by the production of propionate (a cholesterol synthesis inhibitor). The results yielded from this study showed that the consumption of pinto beans lowered serum total cholesterol ($P < 0.014$) by ~8% in the controls and ~4% in the pre-metabolic syndrome group. It also showed that pinto bean intake decreased serum HDL-cholesterol ($P < 0.05$) and LDL-cholesterol ($P < 0.05$) in both groups. However, no changes were seen in gut fermentations or on the production of SCFA (2007).

Pulses and Blood Vessel Function

According to recent research daily consumption of pulses may actually improve blood vessel function in individuals with peripheral artery disease (PAD) in which blood flow to the limbs is reduced. Pulses contain pterocarpans which prevent proliferation of vascular smooth muscle cells, as well as formononetin, which improves arterial stiffness and reduces hypercholesterolemia (Zahradka, 2008). Anthocyanins, an isoflavone which is present in pulses at high amounts, stimulate adipocytes to secrete adiponectin, a cardioprotective hormone that exhibits anti-inflammatory properties in blood vessel cells and is linked to decreased risk of a heart attack when present in high levels (Pischon *et al*, 2008; Teede *et al*., 2003). Another role that pulse intake plays in CVD prevention is its association with weight management, which will be discussed next.

2.4.3 Pulse Consumption and Weight Management

Favourable effects regarding pulse intake and weight management may be attributed to the high fibre component of these foods. Numerous experiments have assessed high intakes of soluble fibre and their associations with weight loss. Heaton suggests a few reasons as to how fibre interferes with energy intake; by displacing available nutrients from the diet, by increasing mastication, thus taking longer to consume, and increase one’s feeling of fullness, and by reducing the absorptive efficiency of the small intestine (Heaton 1973; Mccrory *et al*., 2010). In a review article on fibre’s role in weight loss, Slavin summarized several intervention studies that sought to examine the role of fibre on weight loss. While they remain inconclusive, several studies have shown that pulse consumers had lower body weights and reduced waist circumferences compared with non-consumers (Slavin, 2005).

Further investigation into the results of the *Nutrition and Cancer* study discussed previously showed that not only was body fat significantly lower in the bean groups versus the control groups, weight gain was also found to be lower in the rats fed the bean diet (with navy bean fed rats having the lowest weight gain and lowest body fat percentage, followed by black bean fed rats) (Bennink, 2002). Secondary analysis of the NHANES data by Papanikolaou and colleagues examined adults (≥ 20 y) who consumed baked beans, variety beans or variety beans as well as baked beans in their one day dietary recall. They found that adults who consumed beans had an overall 23 % reduced risk of increased waist size (p=0.018) as well as a 22% reduced risk of being obese (p=0.026) (2008). Similarly, a recently published randomized controlled trial by Venn et al examined the effect of consumption of pulses in conjunction with whole grains in a sample of obese adults. The intervention group was directed to consume 2 servings of pulses and 4 serves of wholegrain foods per day (as substitutions for more refined carbohydrates). Results showed that the intervention groups had higher intakes of fibre, as well as a greater reduction in waist circumference (-2.8 cm after 18 months) than the control group (2010).

As Bennink and Rondini point out, consuming pulses will not "magically" make one thinner or cause weight loss. However, by substituting pulses for foods with a high GI will help control excessive energy intake and may help maintain a healthier physique (2008).

2.4.4 Pulse Consumption and Diabetes Management

Several dietary factors influence glucose and insulin responses, such as carbohydrate intake and gastric emptying rate (Araya et al., 2002). Currently, the Canadian Diabetes Association recommends eating greater amounts of high fibre foods such as whole grain breads and cereals, lentils, dried beans and peas, brown rice, vegetables and fruits. Similarly, the American Diabetes Association also suggests that people with diabetes include dried beans (like kidney or pinto beans) and lentils into meals (Pulse Canada, 2007).

Pulses and the Glycemic Index Scale

Also recommended to diabetes patients are foods with a low GI, meaning foods that do not cause a sharp rise in blood sugar after their ingestion. The idea of the glycemic index was conceptualized to characterize the differences in glycemic and insulin responses to different carbohydrate sources (Jenkins *et al*., 1981). Pulses are particularly ideal for diabetics for whom it is recommended consume foods that have values less than 55 on the Glycemic Index Scale. The fact that pulses also contain complex carbohydrates makes them suitable for diabetic patients as this leads to reduced rates of digestion (Jenkins *et al*., 2000; Rizkalla *et al*., 2002; Winham *et al*., 2008). It is known that high GI foods cause a rapid increase in blood glucose as well as insulin after a meal and it is hypothesized that a steady diet of high GI foods may lead to desensitization of insulin receptors and insulin resistance (Benninck & Rondini, 2008).

According to Pulse Canada's document entitled "*Peas, Beans, Lentils and Diabetes Control*", eighteen published research studies have reported on the various GI values of a variety of pulses, coming to the same conclusion that pulses had significantly lower GI than the controls (which included white bread, glucose and dextrose) (2007).

Pulses and Postprandial Response

In their "*Diabetes Control*" document, Pulse Canada also published a statement based on several postprandial studies. More than 30 published postprandial studies have compared dry beans or other pulse products (dose ranging from 30 to 762 g) to controls (e.g. potatoes, rice, white bread, pasta, grains, glucose, isolated fibers, etc. The majority of these studies (~83%) found significant reductions in postprandial peak glucose or area under the curve (AUC) compared to the control (2007).

In a study performed by Dilawari et al., subjects who consumed 50 grams of *rajmah* (a kidney bean curry) or *Bengal gram dal* (a chickpea dish) had a reduced blood glucose response compared to subjects who consumed the same amount of rice, potatoes or wheat. The subjects were 6 healthy males whose postprandial glucose levels were measured at intervals between 0 and 120 minutes. The results showed that the peak rise in glucose was decreased by 82.1% with the Bengal gram dal and 67% with the rajmah, compared with 25% and 16% in the wheat and rice treatments, respectively (when compared to dextrose) (1981). Another study undertaken by Dilawari examined the effects on high fibre legumes on the blood glucose profile of 25 test subjects with adult onset diabetes mellitus. After being divided into 5 groups at random, each group was given an oral glucose tolerance test (with 75 g of glucose) followed by 75 g of rajmah, green gram (mung bean), channa (a chickpea dish), rice or wheat. Postprandial blood samples were taken every half hour (from 0 to 120 minutes) and plasma glucose levels were estimated. The results showed that the reduction of plasma glucose levels with the rajmah, green gram and channa were significantly lower compared with the glucose meals, while the rice and wheat groups were not. Dilawari and colleagues also found that the reduction showed a direct relationship with the dietary fibre content of each food (1981).

A recent meta-analysis compiled by Pulse Canada of randomized controlled long term experimental trials found that when eaten on their own, pulses "significantly lowered fasting blood glucose and insulin levels". In studies where treatments were comprised of high-fibre pulse or low GI diets, glycosylated hemoglobin (HbA1c) was significantly lowered. In fact, the reduction in HbA1c seen in people with Type 2 diabetes (~0.48%) was comparable to that achieved by oral medications (2007).

Pulses and Renal Health

It has been hypothesized that limiting ones protein intake appears to slow the onset of diabetic nephropathy, which is characterized by renal disease and failure, in diabetic individuals. However Anderson et al also found that in patients suffering from nephromegaly (hypertrophy of one or both kidneys) or hyperfiltration, the substitution of vegetable for animal protein elicits a positive response. However further research is required in this area (1999).

In terms of their renal benefits on diabetic patients, there have been a small number of studies which have sought to suggest that the protein that occurs in dry beans may have renal protective effects. A study undertaken by Knight and colleagues focused on the impact of protein intake on renal decline in female patients with normal renal function or mild renal insufficiency. Over the course of 11 years, protein intake was measured via a semi-quantitative food questionnaire and creatinine clearance and glomerular filtration rate was used to measure renal function. The authors concluded that although high *total* protein intake was not significantly associated with renal decline in females, high intakes of nondairy animal protein seemed to be correlated with a decline in renal function in women with a history of slight renal insufficiency (2003).

2.4.5 Pulse Consumption and Human Immunodeficiency Virus

As mentioned previously, the lectins found in pulses (specifically red kidney beans) are often associated with toxic symptoms. However, some studies have been published examining the anti-Human Immunodeficiency Virus (HIV) effect of lectins. In 2001, Ye et al published a study suggesting that the bioactive compounds of lectins from raw or canned red kidney beans may actually inhibit HIV-1 reverse transcriptase (which is responsible for generating the DNA copy of the viral RNA genome that will be integrated into the human DNA). In vitro studies from the University of Guelph also supported this finding. It is interesting to note that Ye et al found that the red kidney bean lectin was also able to inhibit α-glucosidase (an enzyme that catalyzes the breakdown of maltose into glucose). This phenomenon may be useful in diabetes research, as α-glucosidase inhibitors are often used in the treatment of type 2 diabetes (Shi *et al.*, 2007; Ye *et al.,* 2001). Antifungal properties of cowpeas (black-eyed peas) and pinto beans have also been discussed in scientific literature. Ye et al examined the effects of antifungal peptides present in pinto beans, finding that they also acted by inhibiting HIV-1 reverse transcriptase (2001).

2.4.6 Overall Health Benefits of Pulse Crops in the Diet

In terms of overall health benefits, a study done by the *Asia Pacific Journal of Clinical Nutrition* studied 5 cohorts of older adults to identify protective dietary predictors of long-lived elderly people. Using a validated Food Frequency Questionnaire the results showed that only for legumes intake were the results plausible, consistent and statistically significant from collective cohorts data. In addition to this, the legume food groups showed a 7-8 percent reduction in mortality hazard ratio for every 20 gram increase in daily intake with or without controlling for ethnicity (Darmadi-Blackberry *et al*., 2004).

2.5 Current Recommendations for Pulse Consumption

Pulses are ideally suited to meet many of the dietary recommendations for good health such as increased intake of complex carbohydrates and decreased intake of fat.

With respect to cancer, the US Food and Drug Administration, Canadian Cancer Society and the World Cancer Research Fund also recommend the consumption of pulses to reduce cancer risk (Guenther et al., 2006; Venter *et al.*, 2001;Winham et al., 2008). High consumption of legumes is also one of the 8 components of the Mediterranean Diet (Willet *et al*., 1995). Canada's Food Guide (CFG) recommends the consumption of pulses as good choices and considers a ½ cup serving of pulses equal to one serving of vegetables, and a ¾ cup serving equal to one meat or alternative serving (CFG, 2010). The advisory committee on the Dietary Guidelines for Americans in 2010 suggested shifting food intake patterns to include cooked dry beans and peas, while the United States Department of Agriculture (USDA) recommends that Americans consume between 2.5 to 3.5 cups of pulses per week (Putnam *et al*., 2000; United States Department of Health and Human Services, 2010).

In his article describing the reasoning behind these recommendations, Leterme outlined the top motives that health-promoting associations have for including pulses in the diet as follows: 1) a low-fat, cholesterol free source of protein for vegetarians, 2) reduction of risk of diet-related diseases such as cancer, diabetes, and obesity, and 3) source of soluble and insoluble fibre (Leterme, 2002).

Data from NHANES (1999-2000) showed that American adults consume one third or less than the recommended serving of pulses and Mitchell et al. found that the average consumption of pulses was less than 1 cup per week (2009). Schneider summarized the state of human consumption of pulses in the European Union (EU) as lower when compared to other regions in the world, varying greatly depending on regional food habits and traditions (2002).

Although literature is lacking on the reasons why intake of pulses is low (particularly in Western societies), there appear to be a few key causes. These include unpleasant gastrointestinal side effects, constraints on cooking, and taste levels. In their article examining pulse consumption in Latin America, Leterme and Muňoz cite length of cooking as a top influence in abstaining from pulses (particularly in areas where pressure cookers are not commonplace), followed by taste aversion and flatulence (2002). Eihusen and Albrecht examined pulse intake in American females ages 19-45, and listed various reasons as to why the women studied did not consume beans. These included taste (21.8%), lengthy cooking time (20%), uncomfortable gastrointestinal side effects (14.6%) and availability (5.5%) as well as combinations of these factors. It is interesting to note that when these authors examined reasons why women include dry beans in their diet, taste was also a factor (30.3%), followed by nutritional value (15.9%) and tradition (8.3%). As mentioned earlier, many precautions can be made to alleviate the unpleasant gastrointestinal effects. In regards to cooking time, pressure cookers can speed the time it takes to cook pulses, and in terms of availability, pulses can be placed in the freezer and stored for up to 6 months (2007).

2.6 Methodological Review

This study used data available from the CCHS 2.2, in which food intake was collected via 24 hr recall. Although this particular method has been shown to provide accurate information on recent intake, it does not usually represent one's usual intake. According to Barrett-Connor, the main advantages of this food collection method are the fact that short term memory is required and the quantitative estimates of food intake it provides (1991). However, many investigators question its worth in epidemiological studies as well as studies which look at a particular food item which is not typically consumed on a daily basis, and warn that the degree of reproducibility vary with the subject's monotony of diet (Barrett-Connor, 1991;Block, 1982).

Beaton et al outlined the variation between 60 subjects who completed multiple 24 hr recalls, finding that in female subjects, the day of the week had significant effect for several nutrients, although this was diminished when intake was adjusted in relation to total energy intake (1979). Although there is no one "ideal" method for collecting food intake, researchers must be familiar with the limitations of each technique and use caution when interpreting results.

2.7 Study Objective and Hypothesis

The purpose of this thesis is obtain a better understanding of the patterns of pulse intake in Canada, as well as to determine the demographic makeup of the average Canadian pulse consumer. It also aims to evaluate the effects of pulse consumption on the diet of the average Canadian adult and to see how pulse intake influences dietary patterns as well as nutrient and food group intake. Based on similar population studies, it is hypothesized that the overall diet quality of pulse consumers will be healthier than non-consumers and that nutrient intake will be enhanced among pulse consumers, particularly nutrients such as fibre, folate, protein, iron and zinc. It is also expected that the quality of food intake will further increase along the quartile of pulse consumption. Regarding already published scientific research, it is also hypothesized that a higher level of pulses in the diet may also be linked with lower incidence of obesity and a healthier body mass index (BMI).

Chapter 3: Methodology

3.1Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2)

Objectives of the CCHS 2.2

The following chapter describes the methods and procedures used by Statistics Canada and Health Canada in creating the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2). Complete detailed information is available on the Statistics Canada website.

Data from the CCHS 2.2 conducted by Statistics Canada was used for this analysis. Prior to its release (which occurred in three stages July 2005, May 2006 and April 2008) the last population based dataset that examined national food consumption and nutrition assessment was the Nutrition Canada National Survey (NCNS) which took place between 1970 and 1972. Although various provincial nutrition surveys were undertaken by Health Canada in the 1990s, national food consumption data was lacking. Development for the CCHS 2.2 began in 2002 and data collection began in January 2004, continuing for 12 months (Health Canada, 2010a; Health Canada, 2010b).

The CCHS surveys are based on collaborative efforts from Health Canada, Statistics Canada and the Canadian Institute for Health Information (CIHI). The main objectives of the CCHS 2.2 were to gather “reliable, detailed and timely” information on the dietary intake and nutritional well-being of Canadians and to inform and guide future policies and guidelines of both government and local health agencies. The CCHS 2.2

consisted of both a nutritional as well as general health component. According to Health Canada, the nutrition constituent estimated the distribution of usual dietary intake in terms of foods, food groups, dietary supplements, nutrients and eating patterns among a representative sample of Canadians at national and provincial levels using a 24-hour dietary recall. It also measured the prevalence of household food insecurity among a variety of Canadian population groups, collected anthropometric measurements (body height and weight) as well as information on physical activity, selected health conditions and socio-demographic characteristics. What follows is a brief overview of the CCHS 2.2. Further details on any of the methods used in the CCHS 2.2 are available on the Statistics Canada Website (Garriguet, 2010; Health Canada, 2010a; Health Canada 2010c; Statistics Canada, 2010a).

3.2 Sampling Processes in the CCHS 2.2

Household Sampling

This cross-sectional sample survey targeted respondents from all age groups living in private occupied dwellings in the ten provinces. Indian reserve occupants, residents of the three territories (Nunavut, Yukon and the Northwest Territories), persons residing in institutions, members of the Canadian Forces and residents of some remote areas were excluded. A desired sample of 29,000 sampling units was chosen for the survey. In order to achieve this, a two-step strategy was put in place: in order to estimate usual distributions, 80 sample units were allocated to each domain of interest (14 age/sex groups) per province resulting in 1,120 units per each province (yielding a grand total of

11,200). The residual units (totaling 17,800) were distributed using a power-allocation scheme of q=0.7[14]. (To be noted, the province of Prince Edward Island was not assigned sampling units until the second step). Prior to data collection, the provinces of Manitoba, Ontario and Prince Edward Island provided extra funding in order to obtain a larger sample, and more funding was provided to obtain a greater sample of off-reserve aboriginals. According to Health Canada, the purpose of these “buy-ins” was to achieve sufficient sample sizes in order to “provide reliable estimates for sub-provincial areas for key domains of interest for Manitoba and Ontario.” Prince Edward Island’s rationale for their “buy-ins” was to increase the targeted number of respondents for various age/sex categories. In total, the province of Prince Edward Island added 300 sample units, Manitoba added 1,500 sample units, and Ontario added 4,360 sample units (Health Canada, 2010c; Health Canada, 2010c; Statistics Canada, 2010a).

Subsequently, each sample was then proportionally allocated to two sections: urban and rural using the number of dwellings in each section. To take into account vacant and out-of-scope dwellings as well as non-response, sample sizes were enlarged prior to data collection. Household samples were selected using a variety of sampling frames, including an area frame, a list frame from the CCHS cycle 2.1 as well as a list frame of addresses from the Manitoba and Prince Edward Island Healthcare registries. The sampling plan designed for the Canadian Labour Force Survey (LFS) was used which involved a multistage stratified cluster design. According to Statistics Canada this plan involved each province being divided into three types of regions: major urban centre, cities and rural then subsequently divided into clusters based on geographic and socio-economic characteristics. Six clusters are then randomly selected for each stratum with a probability proportional to size (PPS), meaning that the probability of selecting a sampling unit is proportional to the size of its population (Health Canada, 2010a; Health Canada, 2010c; Statistics Canada, 2010a). The number of individuals sampled from each province can be viewed in **Appendix E.**

Some revisions were made to this technique to tailor it to the needs of the CCHS 2.2. For example, to account for both vacant and non-responding dwellings, adjustment factors were put in place ranging from 0.25 to 3. For areas with an adjustment factor ≤ 1 the number of primary sampling units (PSU) was reduced. Statistics Canada gives this example "if the factor was 0.5 then only 3 PSUs were selected in each stratum instead of the usual number of 6 PSUs". Alternately, for regions with an adjustment factor ≥ 1, the sampling process was repeated for a subset of selected PSUs (Health Canada, 2010a; Health Canada, 2010c; Statistics Canada, 2010a).

Using the household information gathered from the CCHS 2.1, a secondary frame was created for each province (except for Prince Edward Island and Manitoba) to ensure a sufficient amount of respondents in each age and sex group (particularly for younger age groups). The list of dwelling addressed assembled from this frame was added to the household samples from the altered LFS frame sample to increase the probability of finding dwellings with individuals aged < 18 y. This list was then split by province and urban/rural zone (with the exception of the province of Ontario which was grouped by region). Again a PPS strategy was used to obtain a sample (Health Canada, 2010a; Health Canada, 2010c; Statistics Canada, 2010a).

As mentioned, Manitoba and Prince Edward Island were excluded from the previous process due to their “buy-ins”. Instead, their samples were supplemented with a list generated by their respective Ministries of Health which gathered household information of health insurance cardholders and received by Statistics Canada (Health Canada, 2010c, Statistics Canada, 2010a).

Sampling of Individual Respondents

Individual respondents were selected based on the goal of obtaining the target number of respondents in each area of interest per province as well as region. To obtain the minimum 80 respondents per domain of interest, Statistics Canada selected one person per household based on parameters that would “guarantee the minimum number of individuals in each domain of interest in each province and/or region without generating extreme sampling weights at the end.” An example provided for a three person household (containing 2 adults aged 31 + and a 15 year old) makes the teenager 3 times more likely to be selected than the two adults. The selected dwellings were randomly assigned to four collection periods based on their PSU (Quarter 1: January to March 2004, Quarter 2: April and May 2004, Quarter 3: June to August 2004 and Quarter 4:

September to November 2004), with data collection continuing into January 2005 to improve response rates (Health Canada, 2010c; Statistics Canada, 2010a).

Collection personnel

Interviewers administering the CCHS 2.2 questionnaires were given 3.5 days of training by a senior interviewer or collection manager. Test questions and mock interviews were conducted and the Instructor's Manual was reviewed to ensure familiarity with survey concepts and procedures (Health Canada, 2010c; Statistics Canada, 2010a).

Questionnaire Design

The questionnaires used in the CCHS 2.2 were administered using a computer-assisted interviewing application (CAI). During June and July 2003, the draft questionnaire was tested in the provinces of Quebec, British Columbia and the Atlantic provinces using a sample of 700 units to test survey length, assess respondents reaction, willingness and participation, evaluate procedures related to height and weight collection and gauge the efficacy of the interviewer's training and procedures (Health Canada, 2010c; Statistics Canada, 2010a).

Data Collection

As mentioned, data collection took place between January 2004 and January 2005 to lessen workload as well as to remove seasonal effects attributed to food choice variability and health-related characteristics such as physical-activity. Prior to data collection, a letter and brochure was delivered to all dwellings providing potential respondents with information about the survey. Interviewers visited each household on the primary visit and collected information on household members (including a listing of all members residing in the dwelling, their relationship to each other and demographic information including gender, age and marital status). Following this data collection, one member of the respective household was selected to participate in the CCHS 2.2. The first interview was comprised of two parts: the "24 hour dietary recall" and the "general health questionnaire" and took place in the respondent's home. "Proxy interviews" were required for respondents aged l1 years or younger wherein parents or guardians assisted with the interview. For respondents under 6 years of age, the parent or guardian provided the responses. Whether or not a proxy interview had taken place was indicated by the variable ADMD_PRX (Health Canada, 2010c; Statistics Canada, 2010a).

To ensure respondent privacy, interviews were conducted in private unless the respondent allowed another individual to be present. Variables and flags were set up to indicate whether or not another person was present during the interview, and whether the interviewer felt that this presence influenced the respondent in any way. According to their User Guide Statistics Canada also ensures protection of respondents through *suppression of individual values, variable grouping, and variable capping*. Further confidentiality is guaranteed by limited access to Statistics Canada's "master file" which is only available through custom tabulations, remote access service or Research Data Centres (Health Canada, 2010c; Statistics Canada, 2010a).

24-Hour Dietary Recall

A grand total of 35,107 adults and children completed the initial 24-hour dietary recall. Following this, a subsample of 10,786 (or approximately 30 percent of respondents) completed a secondary recall three to ten days later to account for intra-individual variability which may increase the variance of distribution of intakes, potentially impairing the estimation of “at-risk” individuals. The recall constituent used computer assisted personal interviewing methodology (CAPI) originally put in place by the United States Department of Agriculture (USDA). This program was updated by Health Canada to account for differences in foods available to Canadians in regards to ethnic foods as well as how the food was prepared, and was set up in both English and French (Health Canada, 2010c). According to Statistics Canada, this application contains approximately 27,000 foods within look-up lists. A major advantage to this system was that a trained nutritionist was not required to perform the interview (Garriguet, 2010; Statistics Canada, 2010a).

Twenty-four hour dietary recalls were collected primarily by face-to-face interviews by trained interviewers (unless the respondent refused to be surveyed in person or travel was prohibited in which case a telephone interview was administered). Reports by Statistics Canada show that 7 percent of first interviews were conducted by telephone, indicated by the variable ADMD_N09 (Health Canada, 2010b; Health Canada, 2010c; Statistics Canada, 2010a).

Interviewers collected information on the respondent's food and beverage consumption during the previous 24 hours (from midnight to midnight) and were comprised of 5 steps:

1. **Quick list:** A listing of all foods and beverages consumed by the respondent in the previous 24 hours.
2. **Forgotten foods:** Respondent is asked a series of questions about forgotten foods from nine categories
3. **Time and Occasion:** Respondent is asked details regarding the time they began consuming the food or beverage as well as the eating occasion (example breakfast, lunch)
4. **Detail Cycle:** The respondent is asked more detailed questions regarding their food and beverage intake including food descriptions, preparation methods, food additions, amounts, and location of preparation. A '*Food Model Booklet*' is used as a measuring guide to assist respondents describes the amount of food or beverage they have consumed.
5. **Final Review:** A final series of questions are asked for anything else that the respondent may have consumed.

The overall length of the first interview (including the dietary recall) was 60 minutes. The second day recall was performed over the phone in an interview (unless no phone was available or preferred an in-person interview) and lasted approximately 30 minutes in length (Garriguet, 2010; Health Canada, 2010c; Statistics Canada, 2010a).

Health Canada used the Canadian Nutrient File, version 2001b (CNF) to report the nutrient content of the foods reported by respondents. The CNF is a continuously updated bilingual database that contains information on 150 nutrients in over 5,807 foods. The CNF also contains data from the USDA Food and Nutrient Databases for Dietary Studies, version 1.0 for corresponding foods (in particular for mixed dishes) as well as modified data which reflects the Canadian food supply and unique Canadian dishes. It is to be noted that the accuracy of these databases are not always perfect and nutrient composition may vary from product to product. This will be further discussed in the section entitled "*Limitations*". Further details on both the CNF database (including information on serving size) and the USDA Food and Nutrient Database are available on their respective websites (Canadian Nutrient File, 2010; USDA Food and Nutrient Database, 2010)

Measuring Height and Weight

For the first time in CCHS history, interviewers were able to measure the respondent's height and weight (for those aged $\geq$ 2 y). For respondents who refused to be measured or weighed, or those with physical limitations (such as wheelchair bound respondents) self-reported height and weight was used. Interviewers followed standard protocol and used high quality scales that did not require calibration and measuring tape.

It is to be noted that the interviewers were not trained health professionals and thus were instructed using a training video (developed by experts) (Health Canada, 2010c). As well, Statistics Canada ensured consistency among interviewers by requiring them to measure the same test subject after each training session. Any discrepancies were then addressed and retraining took place if necessary (Statistics Canada, 2010a).

Data Quality and Survey Response Rates

Overall, a national response rate of 76.5% was achieved. Statistics Canada gives the following breakdown:

"After removing the out-of-scope units, 45,889 households were selected to participate in the CCHS 2.2. Subsequently, responses were obtained for 38,725 households, which resulted in an overall household-level response rate of 84.4%. Among these responding households 38,725 individuals (one per household) were selected to participate in the survey, out of which a response was obtained for 35,107, which results in an overall person-level response rate of 90.7%. At the Canada level, this would yield a combined response rate of 76.5%" (Health Canada, 2010c; Statistics Canada, 2010a).

In some cases, a completed interview was not obtained. To qualify as a "partial interview", Statistics Canada decided that the respondent must have completed the 24 hour dietary recall component as well as a "minimum" part of the general health questionnaire (up until the end of the Food Security module). Anything not meeting these criteria was considered a non-response. More information on the shortcomings of the

CCHS 2.2 will be given in section 5.1 entitled "*Limitations*" (Health Canada, 2010c; Statistics Canada, 2010a).

Non response

To minimize non-response, interviewers were directed to make "all reasonable attempts" to obtain a completed interview. Rescheduling and call-backs were made to ensure participation and respondents who refused to participate were sent letters from Statistics Canada's Regional Offices which "stressed the importance of the survey and the household's collaboration" followed by a second call or visit from a senior interviewer to encourage the respondent to participate. During the final months of data collection, non-responders were again approached and persuaded to take part in the survey. As mentioned, if a special circumstance prevented an interview from taking place, and adequate information was not available the household was treated as a non-response (Health Canada, 2010c).

Statistics Canada recruited interviewers with a vast knowledge of languages to lessen language barriers. In cases where the interviewer could not complete the interviewer in the respondent's language another member of the household (if present) was permitted to translate the interviewer's questions and respondent's answers. To ensure data quality, Statistics Canada set up a monitoring system at the interviewer level and weekly feedback was given. Completed interviews were transferred daily to Statistics Canada's Head Office and verified for accurateness (Statistics Canada, 2010a).

Weighting

The process of weighting allows the data collected from surveys to be considered "representative of the covered population". A survey weight is given to each respondent which corresponds to the number of individuals in the *entire* population represented by that respondent. According to Statistics Canada, the weighting strategy for the CCHS 2.2 was developed by treating the sampling frames (as described in the *Household Sampling* section) independently and then integrating them into a single set of weights (Health Canada, 2010a; Health Canada, 2010c).

Bootstrapping

Because the CCHS 2.2 is a multi-stage survey design, it requires a more complex formula to calculate variance estimates. The approximation recommended when analyzing data from the CCHS 2.2 is called 'bootstrapping'. This variance estimation technique is used to estimate standard errors, coefficients of variation and confidence intervals. Bootstrapping is an approach used to estimate distribution from a sample's statistics. It can also be defined as "sampling within a sample" and involves the selection of random samples known as replicates, and the calculation of the variation in the estimates from replicate to replicate. In the CCHS, PSUs were randomly chosen from each stratum and the original sampling weights were adjusted to reflect the probability of selection into the subsample (Phillips, 2004; Rao *et al.*, 1992; Rust *et al.*, 1996). A macro program "Bootvar" was developed to give users access to the bootstrap method and is available in both SAS and SPSS formats. The bootstrapping method was used in all the data analyses for this study via SUDAAN software. Phillips summarizes how bootstrap weights are incorporated into SUDAAN as follows: the bootstrap is implemented into SUDAAN by specifying DESIGN = BRR and the REPWGT statement is used to indicate the names of the variables which contain the bootstrap weights (Health Canada, 2010a; Phillips, 2004)

SUDAAN Bootstrap Example:

The following example code shows how to produce and analyze the relationship between categorical variables. Using the *PROC Crosstab* command and the file "CCHS" we can compare the proportion of consumers and non-consumers (SUBGROUP PulseCon) that fall below the recommended intake of iron (EAR_Iro) for MALES AGED 19-30 (SUBPOPN DHHDDDRI = 8). To test for significance, a chi-squared test can be performed by adding *TEST CHISQ* to the code.

```
PROC CROSSTAB DATA= "CCHS"
FILETYPE=SPSS DESIGN = BRR;
WEIGHT WTSD_M;
REPWGT BSW1-BSW500;
SUBPOPN (DHHDDDRI = 8);
SUBGROUP PULSECON EAR_Iro;
LEVELS 2 2;
TABLE PULSECON * (EAR_Iro);
```

```
TEST CHISQ;
TITLE "Prevalence of Inadequate Iron Intake among Pulse Consumers and Non-Consumers";
Run;
```

For complete information on SUDAAN, please refer to their User Guide (SUDAAN, 10.0.1, RTI International).

3.3 Experimental Methods:

All analyses were performed using PASW SPSS Statistics, IBM, version 18 and SUDAAN Statistical Analysis Software Package, RTI International, version 10.0.1. Data for the current analysis was limited to adults aged $\geq$19 years (n=20,197) and to one day dietary intakes only. Filters were applied in SPSS to remove respondents who did not fit these criteria as well as respondents who did not consume any food or whose recalls were considered to be unreliable according to Health Canada were removed, bringing the sample size to 20,156. Pregnant and breastfeeding women were included in this study and although vitamin and mineral supplementation was coded for in the CCHS 2.2, these intakes were not accounted for in this study.

To identify all foods and food sources that contained pulses, the following CCHS 2.2 files were used: food and ingredient details (FID.txt), food description (FDC.txt) and Food recipe level (FRL.txt) all of which are available at a Research Data Centre. Soybeans and fresh beans were excluded from the analysis as per the FAO definition of pulses used herein. Food sources included varieties of dry beans (*Phaseolus vulgaris)* such as the pinto bean, navy bean, kidney bean and black bean as well as the mung bean

(Vigna radiata) and peas which included yellow peas *(Lathyrus aphaca)*, split green peas*(Pisum sativum)*, chickpeas *(Cicer arietinum)*, black-eyed peas *(Vigna unguiculata)* and lentils *(Lens culinaris)* (USDA, 2011). Pulse consumers were defined as respondents who consumed at least one pulse food or a pulse containing food product during the one day dietary recall and a new variable was created (PulseCon) to code the respondents into 2 categories: non-consumers (0) or pulse consumers (1). The amount of pulses in each food item was calculated by identifying the quantity of pulse per 100 gram of every pulse-containing food product (e.g. approximately 22 g of lentils are present in 100 g of lentil soup) and can be viewed in **Appendix B**. A new variable was created (PurePulse) which summarized the amount of total pulses (g) that each consumer ate that day. If a respondent consumed two or more pulse containing foods, the total amount of pulses was summed. Pulse consumers were further divided into quartiles based on this level of consumption and another variable was produced to account for this (Rank).

Table 3.1. Mean amount of pulse consumed (g) per quartile of consumption

Rank Level	Mean Amount of pulse consumed (g) per quartile
1	12.9
2	47.2
3	99.1
4	293.9

To identify the amount of pulse product per 100g of food the CNF recipe proportion database was used as well as data from Mitchell and colleagues to find ingredient proportions and process intake data for nutrient components (Health Canada, 2010c; Mitchell *et al.*, 2009).

Data for macro and micro nutrients were expressed as absolute values and percent energy. To account for the amount of nutrient consumed in regards to total amount of energy consumed, a new variable was created for each macro and micro nutrient which expressed the quantity per 1000 kcal. Both the total intake of nutrient as well as the nutrient amount expressed in regard to caloric intake was compared between the groups, as dietary guidelines express most nutrient intakes as a value and not relative to total overall energy intake. However it is to be noted that energy intake does play a role in the amount of nutrients consumed, due to the simple fact that the more calories one consumes, the more nutrients one is likely consuming as well. Using Health Canada's Dietary Reference Guidelines, the percentages of consumers and non-consumers that had intakes of nutrients below the Estimated Average Requirement (EAR) were calculated by creating separate variables for each nutrient which had an EAR value. Food group intake data was obtained from the Canada's Food Guide file which was merged with the master file to obtain total food group servings for each Canadian adult (Health Canada, 2010b; Otten *et al*., 2006).

As mentioned, the CCHS 2.2 also gathered physical measurements of the participants, as well as data on selected health conditions and socio-economic and demographic characteristics of respondents. Key demographic variables were examined to observe the demographic of the average Canadian pulse consumer. Gender was examined as well as age, and a new variable was created, splitting the respondents into one of four age groups: 19-30 y, 31-50 y, 51-70 y, and 70 + y. The education level placed respondents into one of four categories based on their highest level of education attained: Less than Secondary School Graduation, Secondary School Graduation, Some Post-Secondary and Post-Secondary Graduation. Income also was examined, splitting the respondents into four groups based on their income adequacy. The classifications were as follows: *Lowest Income* for 1-2 people with an income of ≤$15,000, 3-4 people with an income of ≤$20,000 or greater than 5 people with an income ≤ $30,000; *Middle Income* for 1-2 people with an income between $15,000-29,999, 3-4 people with an income between $20,000-39,999 or greater than 5 people with an income between $30,000-59,999;*Upper Middle Income* for 1-2 people with an income between $30,000-59,999, 3-4 people with an income between $40,000-79,999 or greater than 5 people with an income between $60,000-79,999; and *Highest Income* for 1-2 people with an income ≥$60,000, or 3-4 people with an income ≥$80,000. The cultural background variable placed respondents into categories based on their cultural or racial origin. A new variable was created (Culture) and summarized the respondent's ethnic backgrounds into 5 groups as follows: 1) Caucasian, 2) African Canadian, Arabic, Latin Canadian or Multiple Origins, 3) Asian Canadian, 4) Aboriginal and 5) Other (Health Canada, 2010b).

After all necessary variables were created and both the SPSS dataset and the weighting file were sorted according to SAMPLEID (respondent ID), both files were merged. Using SUDAAN, general linear models were used to analyze macronutrient and micronutrient intakes and to compare nutrient intakes and other variables between non-consumers and consumers as well as between non-consumers and consumers at each of the four levels of consumption. In addition, similar analyses were conducted for each of the food groups using the data from the CCHS`s Canada Food Guide file. Logistic regression was used to determine whether any demographic variables (gender, age, culture, province of residence, income adequacy and education level) increased the likelihood of being classified as a pulse consumer and odds ratios were calculated. Crosstabulations and chi squared tests were used to compare the proportions of consumers and non-consumers who had intakes of nutrients below their respective EAR values. The significance level was set at $P < 0.05$ for differences and $0.05<P<0.10$ for trends.

Chapter 4.0 Results

4.1 Food sources of pulse products

The main sources of pulses in the adult Canadian diet were mung beans, Mexican or Hispanic mixed dishes, kidney beans, baked beans, bean soups and chili. These seven dishes made up 2/3 of the 22 dishes containing pulses in the Canadian diet mentioned in the 1-day recall data (**Table 4.1**).

Table 4.1. Food sources of pulse products in the adult Canadian diet[a]

Food Source	**% of source reported**
Mung Beans	18.2
Mexican or Other Hispanic Dishes	14.0
Kidney Beans[b]	13.3
Baked Beans	11.4
Bean Soups	10.7
Chili	7.4
Lentils	5.3
Chickpeas	3.2
Split Peas	3.0
White Beans	2.9
Hummus	1.8
Pinto Beans	1.3
Refried Beans	1.3
Black Beans	1.2
Other Bean Sources [c]	<1

[a] According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian adults aged ≥ 19 years

[b] Excluding chili

[c] Includes rice with beans, navy beans, falafel, unspecified beans, bean dip, adzuki beans, winged beans, and noodles with beans, which each represent less than 1% of food sources reported

4.2 Frequency of consumption and demographics

On any given day, 13.1% of Canadian adults in 2004 consumed dry beans, peas or lentils (Table 2). Within pulse consumers, average pulse intake was highest in New Brunswick and lowest in Quebec, with the provinces of Ontario and British Columbia having the highest proportions of pulse consumers as residents. The highest proportion of consumers fell into the 51-70 age bracket (Table 2). Pulse consumption in grams also differed between age groups, but not when expressed relative to caloric intake.

Participants who identified themselves as Asian Canadian compared with Caucasian were 3.6 times more likely to be pulse consumers. As well, participants who identified themselves as being Arabic, Latin, African Canadian or of multiple cultural origins were 1.6 times more likely to be pulse consumers than Caucasians. Gender, income, education level and community type (urban versus rural) were not significant determinants of pulse intake (**Table 4.2, Appendix D**).

Table 4.2. Demographic characteristics of pulse consumers[a] and non-consumers based on 1-day intakes from the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2), 2004.

Characteristic	Proportion of Consumers (%) (n=20,156)	Odds Ratio (Lower and Upper 95% Limit)	Amount of pulse consumed (g/d) Mean± SE
Gender			
Male	13.1	1	120.1±6.1
Female	13.2	1.01 (0.8-1.29)	105.1±10.1
Age (years)			
19-30	11.5	1	131.9±29.5
31-50	13.2	1.17 (0.84-1.63)	114.9±12.3
51-70	14.7	1.32 (1.03-1.69)	105.3±13.7[a]
70 +	12.2	1.06 (0.77-1.47)	86.2±10.0
Provincial Location			
Nova Scotia	8.2	1	124.3±15.0[b]
Newfoundland and Labrador	12.6	1.61 (0.96-2.71)	125.1±20.8
Prince Edward Island	11.3	1.42 (0.78-2.59)	109.7±21.8
New Brunswick	10.9	1.37 (0.74-2.53)	145.8±34.9[b]
Quebec	10.4	1.30 (0.78-2.16)	82.6±7.8
Ontario	14.5	1.89 (1.18-3.05)	128.2±23.4[c]
Manitoba	12.9	1.66 (0.89-3.1)	105.7±12.4
Saskatchewan	11.3	1.43 (0.78-2.63)	98.8±21.4
Alberta	11.3	1.43 (0.75-2.74)	96.0±25.9
British Columbia	17.6	2.39 (1.35-4.25)	111.4±8.7[c]
All of Canada	**13.1**		**112.4±7.2**

Culture			
Caucasian	10.8	1	104.8±5.1
African Canadian, Arab, Latin, Multiple Origins	16.5	1.64 (1.05-2.56)	129.5±34.4
Asian Canadian	30.4	3.62 (2.04-6.42)	135.1±37.4
Aboriginal	11.1	1.04 (0.45-2.38)	90.9±33.1
Other (Not specified)	23.2	2.5 (0.94-6.71)	76.5±44.9
Income			
Lowest	13.7	1	113.3±19.3
Lower Middle	14.1	1.04 (0.52-2.05)	105.6±8.9
Upper Middle	12.6	0.91(0.47-1.78)	139.8±30.7
Highest	13.5	0.98 (0.47-2.03)	94.2±18.1
Education			
< Secondary School	11.0	1	104.3±6.0
Secondary School	12.6	1.16 (0.71-1.9)	120.2±14.2
Post- Secondary School	10.3	0.93 (0.62-1.39)	92.0±13.3
Post-Secondary Degree or Diploma	14.5	1.37 (0.93-1.56)	115.0±10.6

[a] 0.05<*P*<0.10, different in comparison with the 70+ age group
[b] 0.05<*P*<0.10, different in comparison with the province of Quebec
[c] Significant at *P*<0.05, different in comparison with the province of Quebec

4.3 Effects on nutrient intake

When examining differences in dietary intakes across quartiles of consumption and comparing them to non-consumers (**Table 4.3**), consumers in the third (99 g/d) and fourth quartile (294 g/d) of pulse consumption consumed 224 kcal or 11% and 325 kcal or 16% more energy per day, respectively, than the average non-consumer. Pulse consumers in the third and fourth quartiles consumed 13% and 24% more carbohydrate and 12% and 19% more protein, respectively, than non-consumers, while fat intake was only higher in the third quartile of pulse consumers (by 12% more than non-consumers). The higher fat intake in pulse consumers in the third quartile was consistent with the higher monounsaturated, polyunsaturated, linolenic and linoleic fatty acid content in the diets of these individuals. In addition, alpha-linolenic acid intake was 44% higher in the fourth quartile of pulse consumers compared to non-consumers. Fibre intake was increased the most by pulse consumption, being 34% and 85% higher, respectively, in the third and fourth quartile of pulse intake and this increase remained significant when adjusted for total energy intake. Cholesterol intake was 18% higher in the second quartile of pulse intake, but not at the other levels of pulse intake. However, when expressed relative to energy intake, cholesterol levels were lowest in the highest quartile of pulse consumption. A number of micronutrients were higher in the highest pulse consumers compared to non-consumers (**Table 4.3**). These included folate (45%), phosphorus (20%), magnesium (35%), iron (35%) and zinc (28%). When adjusted for total energy intake, levels of folate, iron and zinc remained significantly higher among pulse consumers at the fourth quartile. As a result, the proportion of those consuming these nutrients below the EAR was lower in consumers compared to non-consumers, indicating a reduced level of deficiency in consumers (**Table 4.4**). Potassium intake also was higher among pulse consumers, and although it lacks an EAR, analysis using Adequate Intake (AI) levels showed no significant difference between consumers and non-consumers (data not shown). In contrast, the levels of two vitamins were lower in the fourth quartile of pulse consumers compared to non-consumers: vitamin D (20%), and vitamin B_{12}

(14%). However the proportion of those that were below the EAR for these two nutrients was similar for both consumers and non-consumers. Finally, although sodium intake was 31% higher in pulse consumers versus non-consumers, when expressed relative to energy intake, the significance of this was lessened.

Fruit and vegetable consumption was higher in the higher quartiles of pulse consumption, when compared to non-consumers, resulting in approximately one more serving from this food group. There was no difference in the amount of total grain products or dairy products between pulse consumers and non-consumers. In the two highest quartiles of pulse consumers, intakes from the meat and alternatives food groups were 1-3.5 servings higher when compared to non-consumers, consistent with the inclusion of pulses in this food group by Health Canada in this database (**Figure 5.1**) (Health Canada, 2010d)

Table 4.3. Pulse[a] amount and macronutrient, micronutrient and energy intakes per day for non-consumers and by quartiles of pulse consumption based on 1-day intakes from the Canadian Community Health Survey Cycle 2.2 (CCHS 2.2) 2004.

Quartiles of Consumers	Nonconsumers (n=17,750)	Consumers (n=2406)			
		1	2	3	4
Intake category		**Mean ± SE**			
Pulse intake range (g)	0	0.1 - 28.89	28.90 - 66.29	66.30 -137.19	>137.2
Mean Pulse intake (g)	0	12.9 ±0.7	47.2 ±1.1	99.1 ±2.4	293.9 ±39.8
Pulse (g) per 1000 kcal	0	6.1 ±1.2	22.8 ±1.2	38.5 ±5.3	75.6 ±3.4
Food amount (g)	3219 ±119	3540 ±441	3280 ±174	3315 ±139	3620 ±337
Energy (kcal)	2065 ±134	2279 ±318	2126 ±83	2299 ±133*	2390 ±118**
Carbohydrate (g)	253 ±15.6	280 ±38	256 ±12	286 ±16***	314 ±25***
Carbohydrate per 1000 kcal (g)	125 ±1.0	126 ±2.4	124 ±3.4	127 ±2.3	134 ±4.6†□
Fibre (g)	16.6 ±0.4	18.1 ±1.7	18.7 ±1.1	22.2 ±1.6***	30.7 ±2.2***
Fibre per 1000 kcal (g)	8.5 ±0.4	8.5 ±0.6	9.4 ±0.6	10.5 ±0.4***	13.8 ±0.7***
Sugar (g)	103 ±5.0	105 ±11.2	100 ±4.7	110 ±5.7	107 ±7.1
Sugar per 1000 kcal (g)	51 ±1.0	48 ±2.9	49 ±1.7	48 ±3.6	44 ±4.9
Total Fat (g)	75.6 ±5.1	81.2 ±12.2	77.8 ±3.6	84.5 ±6.4*	78.9 ±6.1
Total Fat per 1000 kcal (g)	35.6 ±0.2	34.6 ±0.8	35.5 ±1.4	35.6 ±1.07	31.8 ±2.8
Saturated Fatty Acid (g)	24.8 ±2.0	24.8 ±3.1	22.8 ±1.6	26.2 ±2.3	23.6 ±2.2
Saturated Fat per 1000 kcal (g)	11.7 ±0.2	10.6 ±0.5†	10.3 ±0.5*	11.0 ±0.4*	9.4 ±1.1†
Monounsaturated Fatty Acid (g)	30.3 ±2.1	32.9 ±5.3	32.1 ±1.5	34.6 ±2.6*	32.9 ±2.9

MUFA per 1000 kcal (g)	14.1 ±0.09	14.0 ±0.39	14.6 ±0.58	14.6 ±0.48	13.2 ±1.29
Polyunsaturated Fatty Acid (g)	13.3 ±0.6	15.9 ±3.0	15.7 ±0.9	16.2 ±1.7*	14.9 ±0.9
PUFA per 1000 kcal (g)	6.3 ±0.2	6.6 ±0.2	7.3 ±0.3	6.8 ±0.4	6.1 ±0.3
Linoleic Fatty Acid	10.6 ±0.4	12.9 ±2.9	12.4 ±0.7	12.8 ±1.4*	11.7 ±0.8
Linoleic Fatty Acid per 1000 kcal	5.0 ±0.2	5.2 ±0.3	5.8 ±0.2	5.3 ±0.3	4.7 ±0.3
Linolenic Fatty Acid	1.8 ±0.09	2.3 ±0.32	2.4 ±0.18	2.5 ±0.34*	2.6 ±0.28**
Linolenic Fatty Acid per 1000 kcal	0.9 ±0.02	1.0 ±0.06	1.1 ±0.09	1.1 ±0.13	1.0 ±0.10
Cholesterol	279 ±19.4	316 ±33.0†	330 ±31.6*	303 ±34.3	239 ±36.0
Cholesterol per 1000 kcal	139 ±2.3	140 ±10.6	150 ±9.1	131 ±10.4	104 ±12.7*
Protein	84.5 ±5.3	94.3 ±12.6	91.9 ±4.5	94.9 ±7.9*	100.7±6.7***
Protein per 1000 kcal	41.8 ±0.2	42.4 ±1.2	43.6 ±1.0†	42.1 ±1.4	43.2 ±1.6
Alcohol	9.9 ±0.9	12.2 ±2.8	9.7 ±1.7	8.4 ±6.4	10.4 ±2.1
Alcohol per 1000 kcal	4.2 ±0.3	4.7 ±0.9	3.8 ±0.6	3.4 ±1.4	4.0 ±0.7
Carbohydrate (% kcal)	49.1 ±0.3	49.4 ±0.9	48.7 ±1.4	49.7 ±0.9	52.4 ±1.9
Fat (% kcal)	31.5 ±0.2	30.6 ±0.7	31.5 ±1.2	31.4 ±0.9*	28.0 ±2.5
Saturated Fatty Acid (% kcal)	10.3 ±0.2	9.4 ±0.4†	9.1 ±0.4*	9.7 ±0.4*	8.3 ±1.0†
Monounsaturated Fatty Acid (% kcal)	12.5 ±0.09	12.4 ±0.35	12.9 ±0.50	12.9 ±0.43	11.6 ±1.13
Polyunsaturated Fatty Acid (% kcal)	5.5 ±0.15	5.8 ±0.21	6.5 ±0.25***	6.0 ±0.33	5.3 ±0.29
Linoleic Fatty Acid (%kcal)	4.4 ±0.12	4.6 ±0.28	5.1 ±0.19**	4.7 ±0.25	4.2 ±0.28

Linolenic Fatty Acid (%kcal)	0.8 ±0.02	0.9 ±0.05*	1.0 ±0.08**	1.0 ±0.11	0.9 ±0.09
Protein (%kcal)	16.5 ±0.09	16.7 ±0.48	17.2 ±0.40†	16.5 ±0.56	16.9 ±0.6
Alcohol (%kcal)	2.9 ±0.2	3.3 ±0.6	2.6 ±0.4	2.3 ±0.9	2.7 ±0.5
Vitamin A	696.4 ±58.9	695.5 ±109.8	750.9 ±73.3	755.8 ±95.6	643.9 ±57.4
Vitamin A per 1000 kcal	359.7 ±10.9	328.4 ±57.2	373.4 ±54.8	339.0 ±30.4	278.8 ±33.5†□
Vitamin D	5.7 ±0.13	6.0 ±0.78	6.0 ±1.00	6.3 ±1.48	4.6 ±0.40*
Vitamin D per 1000 kcal	2.8 ±0.19	2.7 ±0.33	2.9 ±0.37	2.7 ±0.92	2.0 ±0.16***
Vitamin C	126.1 ±7.9	142.5 ±23.9	140.8 ±18.3	135.1 ±9.5	135.2 ±13.6
Vitamin C per 1000 kcal	66.3 ±1.3	68.8 ±14.4	67.8 ±5.6	61.3 ±3.9	58.3 ±9.9
Thiamin	1.7 ±0.06	1.8 ±0.26	1.7 ±0.08	1.9 ±0.15*	1.9 ±0.26
Thiamin per 1000 kcal	0.9 ±0.04	0.8 ±0.03	0.8 ±0.03	0.8 ±0.03	0.8 ±0.10
Riboflavin	1.9 ±0.10	2.1 ±0.25	1.9 ±0.08	2.1 ±0.14†	2.0 ±0.09
Riboflavin per 1000 kcal	0.96 ±0.02	0.94 ±0.03	0.95 ±0.03	0.93 ±0.03	0.87 ±0.02**
Niacin	39.6 ±2.5	43.3 ±5.8	42.7 ±2.0	43.1 ±2.7*	43.9 ±2.3
Niacin per 1000 kcal	19.7 ±0.14	19.7 ±0.55	20.6 ±0.53	19.0 ±0.51	19.0 ±0.49
Vitamin B6	1.9 ±0.09	2.1 ±0.27	2.0 ±0.10	2.1 ±0.09†	2.1 ±0.14**
Vitamin B6 per 1000 kcal	0.94 ±0.02	0.97 ±0.03	0.99 ±0.05	0.95 ±0.06	0.91 ±0.03
Vitamin B12	4.4 ±0.28	5.2 ±0.72	4.9 ±0.68	4.2 ±0.96	3.8 ±0.32*
Vitamin B12 per 1000 kcal	2.2 ±0.04	2.2 ±0.32	2.4 ±0.63	1.9 ±0.60	1.7 ±0.16**
Naturally Occurring Folate	226.9 ±12.5	250.2 ±30.7	250.0 ±10.3†	295.9 ±40.7*	423.6 ±69.1***
Nat. Occurring Folate per 1000 kcal	118.5 ±1.4	116.6 ±6.4	125.3 ±5.3	140.1 ±13.2†	186.70±20.7***
Folic Acid	119.8 ±19.0	157.3 ±43.4	130.2 ±28.0	139.0 ±32.1	133.2 ±20.7

Folic Acid per 1000 kcal	58.5 ±5.8	68.0 ±10.1†	59.7 ±9.8	58.9 ±7.8	56.3 ±8.5
Folate (from food in dietary folate equiv.)	452.9 ±34.1	470.3 ±66.6	450.0 ±16.1	540.9 ±80.3†	655.9 ±59.0***
Folate per 1000 kcal	228.8 ±3.7	216.1 ±6.3	217.7 ±10.0	240.8 ±16.3	289.0 ±17.0***
Folacin	352.3 ±31.1	417.1 ±76.4	384.8 ±31.4**	438.4 ±67.4*	563.2 ±88.5***
Folacin per 1000 kcal	180.0 ±6.6	190 ±9.6†	187.6 ±9.2	200.6 ±17.7†	245.5 ±28.5**
Calcium	865 ±62.3	885 ±93.5	749 ±52.5	937 ±69.8	954 ±92.9†
Calcium per 1000 kcal	432 ±4.1	405 ±18.9	370 ±16.0***	416 ±16.8	402 ±26.1
Phosphorus	1330 ±63.1	1454 ±186.9	1352 ±61.8	1497 ±84.4**	1598 ±107.9***
Phosphorus per 1000 kcal	660 ±11.4	650 ±17.8	657 ±18.9	671 ±19.1	687 ±25.0
Magnesium	323 ±14.2	359 ±45.6	339 ±14.8	374 ±17.1***	438 ±39.5***
Magnesium per 1000 kcal	166 ±4.5	166 ±3.7	171 ±5.5	175 ±4.8†□	192 ±9.7†
Iron	13.9 ±0.7	14.8 ±1.6	14.1 ±0.5	16.0 ±0.7***	18.7 ±0.8***
Iron per 1000 kcal	7.0 ±0.1	6.8 ±0.2	7.0 ±0.2	7.2 ±0.4	8.3 ±0.3***
Zinc	11.2 ±0.6	12.5 ±2.0	11.8 ±0.8	12.7 ±0.7**	14.3 ±0.6***
Zinc per 1000 kcal	5.5 ±0.1	5.6 ±0.3	5.7 ±0.2	5.7 ±0.2	6.2 ±0.2***
Sodium	3050 ±170.0	3320 ±412.0	3369 ±141.2†	3581 ±203.0†	3988 ±250*
Sodium per 1000 kcal	1522 ±32.6	1503 ±39.5	1613 ±57.7†	1584 ±122.4	1720 ±143.2†

Potassium	3074 ±94	3351 ±438	3192 ±160	3476 ±133	3927 ±153
Potassium per 1000 kcal	1588 ±56	1564 ±41	1597 ±87	1608 ±63	1708 ±66**
Caffeine	226 ±15	246 ±34	192 ±55	219 ±15	228 ±27
Caffeine per 1000 kcal	134 ±20	128 ±12	101 ±32	107 ±13*	110 ±15
Moisture	2777 ±92	3053 ±376	2826 ±179	2820 ±131	3091 ±309
Moisture per 1000 kcal	1586 ±91	1524 ±65	1493 ±165	1352 ±64**	1402 ±97
Grain Products	5.7 ±0.5	6.5 ±1.1	5.5 ±0.3	6.6 ±1.4	6.3 ±0.9
Fruit and Vegetables	5.2 ±0.2	5.8 ±0.8	6.1 ±0.5*	5.7 ±0.4†	6.2 ±0.4*
Dairy and Dairy Products	1.7 ±0.1	1.7 ±0.2	1.4 ±0.1*	1.8 ±0.2	1.6 ±0.2
Meat and Alternatives	4.0 ±0.2	4.5 ±0.5	5.0 ±0.4**	6.3 ±0.4***	7.5 ±0.6***

[a] Pulses include all types of dry beans (kidney, navy, mung and black) and peas (yellow and green split peas, chickpeas and blackeyed peas) as well as lentils. Soybeans were excluded.

* p <0.05, statistically significant in comparison with the non-consumer group

** p <0.01, statistically significant in comparison with the non-consumer group

*** p<0.001, statistically significant in comparison with the non-consumer group

† approaching significance (p value between 0.05 and 0.1)

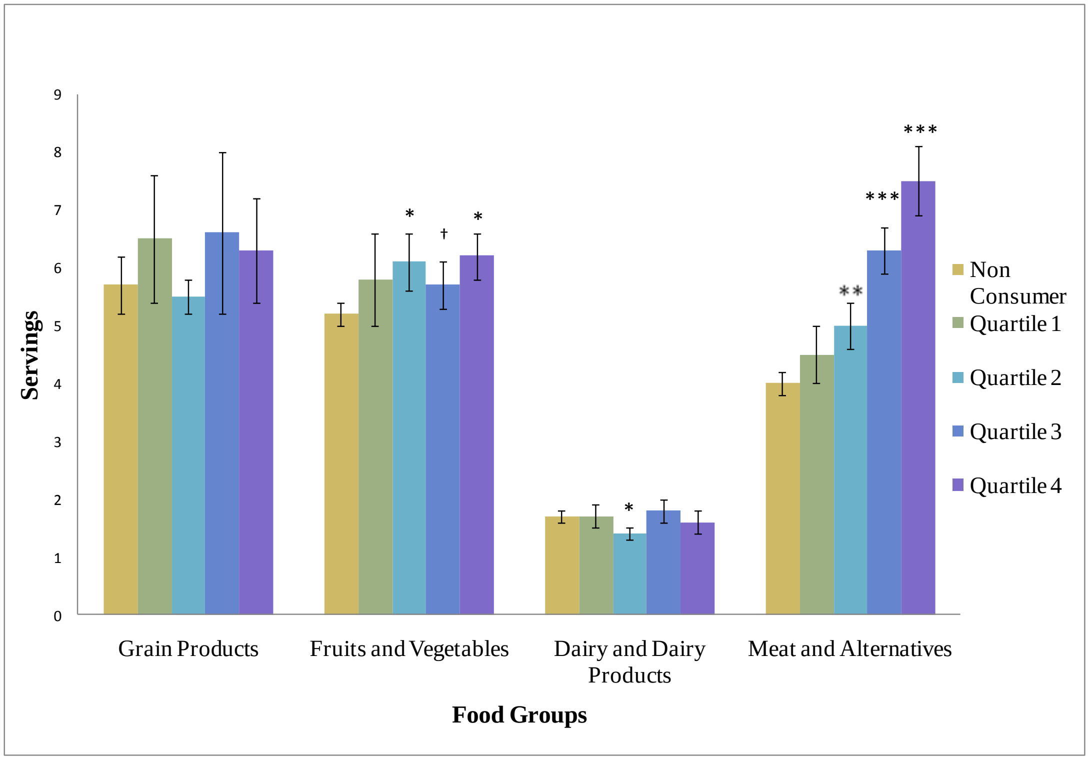

Fig. 5.1. Food group intakes among non-consumers and by quartiles of pulse consumers based on 1-day intakes from the Canadian Community Health Survey Cycle 2.2 (CCHS 2.2) 2004. Food groups and serving sizes are from the Canada Food Guide. Pulses are included in the meat and alternatives group.
* $P < 0.05$, different in comparison with the non-consumer group
** $P < 0.01$, different in comparison with the non-consumer group
*** $P < 0.001$, different in comparison with the non-consumer group
† $0.05 < P < 0.10$, different in comparison with the non-consumer group

Table 4.4. Prevalence of inadequacy for nutrients[a] with an Estimated Average Requirement (EAR) in Canadian adults based on 1-day intakes from the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2), 2004.

	Percentage of intakes less than EAR			
	Male Non-Consumers	**Male Consumers**	**Female[b] Non-Consumers**	**Female Consumers**
Calcium				
19-30	42.7	42.9	55.0	52.0
31-50	50.4	41.9	56.8	62.1
51-70	57.3	56.2	78.4	75.8
> 70	76.9	73.8	82.1	83.1
Vitamin D				
19-30	85.3	84.7	90.0	89.5
31-50	86.9	87.8	90.5	92.4
51-70	85.6	75.6	91.8	93.5
> 70	85.3	88.9	90.7	92.6
Thiamin				
19-30	15.3	7.2	26.2	16.3†
31-50	15.7	13.8	21.9	15.3†
51-70	16.4	9.1**	24.6	23.2
> 70	20.0	17.5	27.5	20.9
Riboflavin				
19-30	11.7	12.2	18.6	10.0
31-50	11.8	11.4	13.3	9.7
51-70	14.0	11.3	15.2	10.3
> 70	19.6	16.7	17.9	12.6

Vitamin B6				
19-30	15.7	6.2	34.9	21.2*
31-50	16.2	16.9	30.4	18.8
51-70	32.4	24.3	41.8	33.9
> 70	39.0	28.0	42.9	36.4
Folate[c]				
19-30	22.2	9.7	44.2	22.7**
31-50	26.8	19.0**	40.6	29.0**
51-70	27.0	20.0**	42.8	30.1†
> 70	39.5	27.3	54.1	39.5
Vitamin B12				
19-30	24.5	27.4	41.1	41.4
31-50	21.7	22.1	36.5	39.2
51-70	24.5	22.6	38.7	32.0
> 70	34.6	32.5	42.8	38.5
Iron				
19-30	5.1	1.1	27.2	15.2*
31-50	4.3	0.8**	26.1	12.7†
51-70	5.0	2***	7.2	3.4
> 70	8.2	3.4	7.0	4.1
Magnesium				
19-30	49.7	31.8	49.1	31.6*
31-50	56.7	40.8	47.3	31.9†
51-70	60.6	45.1***	46.3	32.1†
> 70	66.7	55.2***	53.1	36.4

Phosphorus				
19-30	5.6	1.2	13.7	5.3†
31-50	4.6	4.7	11.1	5.3†
51-70	5.8	4.4***	12.1	6.9
> 70	10.0	10.2	14.9	9.3
Zinc				
19-30	33.3	17.8	36.6	21.7*
31-50	35.1	20.4*	35.1	18.7*
51-70	42.7	28.2***	34.8	23.0
> 70	53.5	39.0*	43.3	28.4

[a] Not including potassium (which lacks an EAR) and niacin (analysis showed no significant difference between groups)
[b] Excluding pregnant or lactating women
[c] Folate intake from food in dietary folate equivalency
* *P* <0.05, different in comparison with non-consumers at corresponding life stage group
** *P*<0.01, different in comparison with non-consumers at corresponding life stage group
*** *P*<0.001, different in comparison with non-consumers at corresponding life stage group
† 0.05<*P*<0.10, different in comparison with non-consumers at corresponding life stage group

Chapter 5.0 General Discussion and Conclusions

The proportion of pulse consumers in Canadian adults appears to be similar to that of the US population, despite important differences in cultural makeup. It has been previously reported that 7.9% of the US populations are pulse consumers, but the NHANES analysis did not include mung beans or other sprouted forms of beans (such as navy bean sprouts) as a source of pulse consumption (Mitchell *et al*., 2009). When these were removed from the CCHS 2.2 pulse database, the proportion of the Canadian adult population classified as pulse consumers dropped from 13.1% to 10.7%. In the Continuing Survey of Food Intakes by Individuals (CSFII) 1994-1996, 14% of US residents consumed at least one pulse containing food over a 2-day period (Lucier *et al*., 2000). Similarly in our analysis, when the smaller subset of 10,786 respondents with both day one and day two recalls were combined, 14.7% were pulse consumers. When the smaller subset of respondents who completed the second day recall was examined alone, the rate of consumption was 12.6%. Other differences between these studies include larger sample size for the CCHS 2.2 data and the inclusion of foods such as lima beans (which we excluded in our analyses), and exclusion of lentils, split peas and yellow peas, which represented approximately 8% of the food sources reported in the CCHS 2.2 survey.

In terms of the most frequently consumed pulse containing foods, in the NHANES study pinto beans and refried beans were predominantly consumed, which mimicked results found in the CSFII study (Lucier *et al*., 2000). Pulse consumption trends in Europe found that dry beans were the most popular form of pulses eaten, but it is difficult to compare these results due to the variation in nomenclature and the fact that the variety of bean was not specified (Schneider, 2006). In Canada, however, pinto and refried beans represented only one percent of the pulse foods reported, while mung beans were the most popular pulse in the CCHS 2.2 data set. This likely can be ascribed to the differences in the cultural mosaic of the US and Canada. The US Hispanic population represents 16% of the US population (US Census Bureau, 2007), while the same group represents approximately 1% of the Canadian population (Statistics Canada, 2006). As Lucier and colleagues mention in the CSFII study, approximately 1/3 of the beans consumed were by Hispanic Americans or consumed in areas such as California, Texas and Florida which have high Hispanic populations (2000). Conversely, the Asian population in Canada is approximately 10%, making up approximately 66% of Canada's visible minority population (Canadian Council on Social Development, 2004), while Asian Americans represent less than 5% of the US population (US Census Bureau, 2010). The provinces with the highest proportion of Asians, Ontario and British Columbia, were also the two provinces found to contain the highest proportion of pulse consumers (Statistics Canada, 2006), fitting in with the finding that Asian Canadians were found to be almost 4 times more likely to be pulse consumers. The prevalence of pulse consumption in the Canadian Asian population is reflected in the predominance of the mung bean in our top consumed pulses list. Mung beans are grown in many Asian countries and are popular in many Asian dishes both as a sprouted form or cooked (Coffman & Garciaj 1977). Examining the geographical influence on pulse consumption in Europe, Schneider examined the countries of Spain, France and the United Kingdom, which accounted for approximately 60 percent of the EU pulse consumption (based on volume) (2006).

In contrast to the US data, neither education level nor income level influenced pulse consumption in Canadians, perhaps reflecting the differing cultural backgrounds of Canadian consumers, or the higher proportion of US citizens (27%) having less than a high school education compared with Canadians (16%) (Lucier *et al*., 2000; Mitchell *et al*., 2009).

Overall, consumption of pulses is associated with improved nutrient intakes, especially in the highest quartile of intake. Similar effects on dietary quality were observed in the previous analysis of the NHANES population (Mitchell et al., 2009). The nutrient intake which improved the most with pulse consumption was fibre. Consumers in the highest quartiles of pulse consumption in both Canada and the US consume almost twice as much fibre as non-consumers. Although this level of intake still does not meet the dietary recommendation for this nutrient, it should be noted that the Canadian Nutrient File lacks data on functional fibre (i.e. isolated, extracted or synthetic fibre) so it is possible that the fibre intakes may be underestimated in this analysis (Health Canada, 2010b).

The higher intakes of carbohydrate, protein and fibre are likely due to these macronutrients being present in large amounts in pulses in addition to the fact that pulse eaters tend to consume more calories in general. This also contributes to the improvement of diet quality observed in pulse consumers, as 32% of males and 21% of females, 19 years and older, have carbohydrate intakes below the Acceptable Macronutrient Distribution Range (Health Canada, 2009). Several micronutrients (folate, magnesium, iron, potassium and zinc) that were consumed by pulse eaters in larger amounts also can be explained by these nutrients being found in higher levels in pulses (Patterson *et al*., 2009; Scarbieri *et al*., 1979). Indeed, there were fewer pulse consumers that had inadequate intakes (below the EAR) of magnesium, zinc, folate and iron. Health Canada recently reported that 34% of adults consume magnesium in quantities below the EAR, with this number being higher than 40% in some life stage groups. There also is a low prevalence of inadequacy for zinc, folate and iron, ranging from 10-41% for specific age and gender groups that consume less than the EAR. Similarly, median potassium intakes of Canadian adults are below the adequate intake (AI) value (Health Canada, 2009). The current analysis using EAR values was consistent with these findings and further demonstrates that fewer pulse consumers had intakes of nutrients below the EAR.

Pulse consumption is associated with higher sodium intake, contributing to the reported 78% of Canadian adults that exceed the tolerable upper intake level (UL) for sodium (Health Canada, 2009). This is likely not due to the composition of the pulses themselves, but may reflect an increased intake of pulse-containing foods traditionally high in sodium, such as Mexican or other Hispanic dishes and bean soups. These dishes account for approximately 25% of all pulse products consumed. As well, the higher energy intake among pulse consumers may partly explain the higher sodium intake among this group, given that the increase in sodium is lessened when the intake values are expressed relative to energy intake (0.05<*P*< 0.10). It is also possible that the increased sodium intake among pulse consumers is due to the sodium that is added to canned beans during processing, but such conclusions cannot be made from this dataset.

Another potential concern associated with pulse consumption was the lower intakes of vitamins B_{12} and D. Health Canada recently reported that 10-35% of Canadian adults have an intake of vitamin B_{12} that is below the EAR (Health Canada, 2009; Health Canada, 2010e). Found in foods such as meat, shellfish and dairy, vitamin B_{12} (cobalamin) plays a vital role in the formation of red blood cells and DNA production (Mayo Clinic, 2011). Absorption from food is usually fifty percent, and although deficiency is rare, the elderly and strict vegetarians can be at risk. An article from the *Annual Review of Nutrition* by Stabler and Allen suggests a potential link between B_{12} deficiency and an increase in the popularity of vegetarian type diets for either health or religious reasons (2004). Unfortunately, dietary restrictions were not accounted for in the CCHS 2.2 which will be discussed in section 5.1. Vitamin D plays a critical role in building healthy bones and helping the body absorb calcium. The median intake of this vitamin in Canada is below the recently revised RDA for this nutrient (Health Canada, 2009; Health Canada, 2010e; Institute of Medicine of the National Academies, 2010) and the proportions of respondents below the EAR for both vitamin D and B_{12} were similar among consumers and non-consumers, suggesting that pulse consumption does not compromise the nutrient status of these individuals in this regard and that the majority of Canadians, regardless of pulse consumption are not consuming sufficient levels of these nutrients (Otten *et al*., 2006).

On the other hand, pulse consumers tended to consume higher levels of calcium, a finding that was significant in the US data analysis. This cannot be explained by altered dairy product intake, as consumption of foods from the milk and milk product group was not increased in pulse consumers. The increase in calcium is perhaps due to the fact that common pulse dishes such as Hispanic foods contain calcium (Mitchell *et al*., 2009). Further detailed analysis on the connection between ethnic background and food choices may shed some light on the relationship between pulse intake and vitamin D status.

Overall energy intake was higher in pulse consumers, a finding consistent with the US population analysis (Mitchell *et al*., 2009). However this increase in the amount of calories consumed did not account for the increase in nutrient intake, as the majority of differences between consumers and non-consumers remained significant even when adjusted for energy intake (with the exception of sodium and protein). It would be expected that this higher energy intake by pulse consumers would be associated with an increased body mass. However, although mean BMI was higher in pulse consumers (28.0 ± 0.75 and 27.3 ± 0.11, respectively), this difference was not statistically significant. This trend is in contrast to other findings which suggest that high fibre foods such as pulses lead to an increased feeling of fullness and may lead to a healthier body weight when eaten at higher amounts (Papanikolaou et al., 2008). The reason for this apparent discrepancy cannot be determined from the survey data, but it may be that other foods consumed along with pulses may counteract the expected satiating effects of high fibre pulses, or that the actual source of pulses may be at large (for example the consumption of high fat, high calorie Mexican food instead of a healthier pulse alternative, such as a bean salad). Whatever the reasoning may be, it is clear that many factors are at play. The effect of pulse consumption on body weight also may be confounded by the fact that a large proportion of Canadians are in the overweight BMI category (Health Canada, 2010f, **Appendix F**).

In the US, the percentages of total energy from total and saturated fat were significantly lower in the diets of consumers at the third and fourth quartiles of pulse consumption (Mitchell *et al*., 2009). This trend also was observed in Canadians in the current analysis, but not as strongly as in the US data. It is interesting to note that while US pulse consumers at the highest quartile of intake consume 20 g more of total fat than non-consumers, Canadians in the third quartile consume 10 g more total fat, but in the fourth quartile, fat consumption is similar to non-consumers. These differences may be due to the differences in the types of foods commonly consumed in the different data sets. Mung bean dishes more commonly consumed in Canada are typically lower in fat compared to pinto and refried bean dishes more commonly consumed in the US (Lucier *et al*., 2000; Mitchell *et al*., 2009). This also may explain why the intake of monounsaturated and polyunsaturated fatty acids in the Canadian pulse consumers were higher than in non-consumers, while this trend was not observed in the US data (Mitchell *et al*., 2009).

In addition to the predominantly positive effect of pulse consumption on nutrient intakes, further evidence of improved dietary quality with pulse consumption is demonstrated by the extra serving of fruits and vegetables eaten by consumers compared to non-consumers, a goal of the Food Guide that most Canadians do not achieve. In contrast, pulse consumers in the NHANES data consumed more grain products, but not other food groups (Mitchell *et al*., 2009). These differences are likely due to the difference in the sources of pulses being eaten by Canadian compared to US consumers.

5.1 Limitations

There are some limitations in this research. As with the NHANES study, the consumption of pulses in the CCHS 2.2 is based on a single reference day, meaning that those who were not identified as a consumer during a single day of intake may still be a pulse consumer. Although second day consumer values were similar to the first day, the frequency of consumption is impossible to determine based on the 24 hour recall method. Information was not collected on specific types of diets, (i.e. low-carbohydrate, vegetarian or vegan diets) which may have been helpful in further examining the demographic of the average consumer or food preparation techniques, which may affect the nutrient content (e.g. added salt) of the dishes consumed. In addition, the CNF may not be completely accurate in its summary on the nutritional breakdown of various foods or food dishes. Due to the fact that the CNF values for many foods represent a general product (for example canned baked beans), subtle differences in nutrient composition between variety and brand (e.g. Heinz™ versus Bush Brothers™) are not necessarily reflected in the CNF. In the same way, nutrient composition may also be influenced by growing conditions (such as soil composition) as well as manufacturing and processing differences (Health Canada, 2010b; Statistics Canada, 2010a).

It is also impossible to determine whether the 24 hour dietary recall was truly representative of the respondent's normal diet, as respondents may over or under report their food consumption, even with trained experts administering the dietary recall. As mentioned previously, 24 hr recalls are often criticized when used to look at intake of foods that are not eaten every day (such as beans or peas). Because the CCHS 2.2 was a cross-sectional look at the dietary habits of Canadians, the results should be interpreted with caution. It is entirely possible that the survey would have provided differing results if another time-frame had been chosen, with either higher or lower amounts of consumers. As well, cause and effect of pulse consumption and diet quality cannot be assumed, as pulse consumption may be a component of an overall lifestyle. The CCHS 2.2 also does not take into account those residing on Indian reserves, residents occupying any of the three territories, those living in Institutions or members of the Canadian Forces (Health Canada, 2010a; Statistics Canada, 2010a).

5.2 Conclusions and Future Implications

Many Canadian adults struggle to meet dietary recommendations, falling below the recommended values of nutrient intakes. As well, the growing expenditure of diet and lifestyle related illnesses are a major burden that costs our economy billions of dollars every year. These results demonstrate that an increased intake of dry beans and peas, especially at increasing intakes is associated with higher intakes of fibre, protein, carbohydrate, folate, magnesium, iron, potassium and zinc in Canadians, leading to improved diet quality. Many research studies have shown the benefits of consuming these healthy and economical "superfoods" which may lead to reduced risk of lifestyle-related diseases in Canadian adults. As mentioned, this study only looked at one day dietary intakes, which does not provide a true picture of pulse consumption in regards to frequency of intake. It may be suggested that prospective studies use methods that measure frequency of pulse consumption in order to obtain results on weekly pulse consumption habits so that a more accurate pattern of their intake can be measured and achieved. As well, the summary of current findings does not take into account certain groups of the population. Future studies examining pediatric pulse consumption rates may give better measures of pulse consumption patterns in Canada as would surveys that included information on all geographic areas of the country. Further clarification of the reasons for the effects of pulse consumption on potential improvements in diet as well as the potential effects on vitamin D and B_{12} status and sodium intake will need to be elucidated so that dietary advice to consume pulses can include ways to enhance or mitigate any positive or negative effects, respectively. In this way, the substantial beneficial effects of pulse consumption on nutrient intake can be realized.

Chapter 6.0 References

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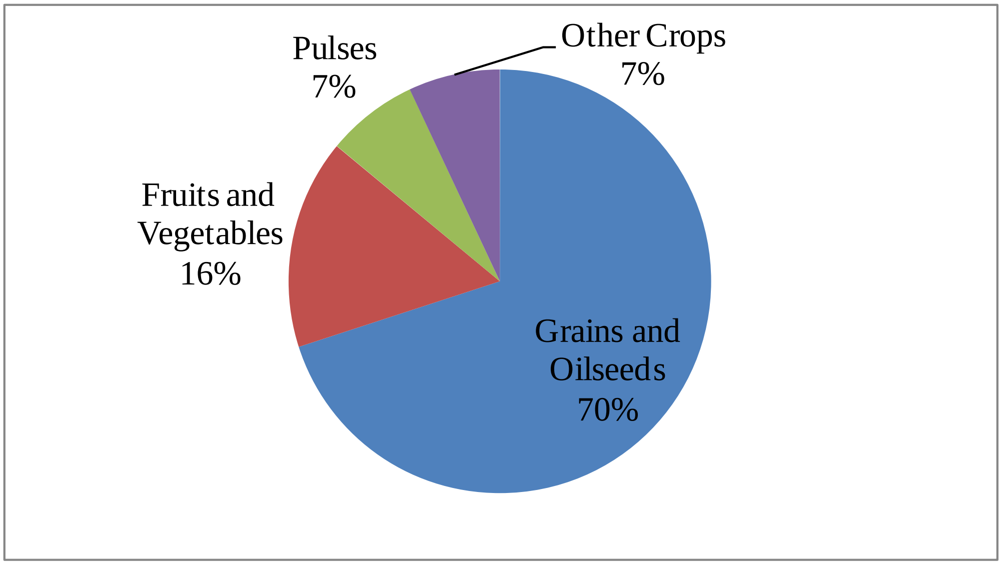
Appendix A: Overview of the Canadian Pulse Industry



Appendix A Figure 1. Value of Pulses to Canadian Crop Production (2009)
Source: Agriculture and Agri-Food Canada, 2009. Overview of the Canadian Pulse Industry. Available at: http://www.ats.agr.gc.ca/can/4753-eng.htm

Appendix A Table 1. Canada's Top Locations for Pulse Export (million $)

Country	2007	2008	2009
1. India	366.8	422.5	530.8
2. Bangladesh	87.5	53.2	241.4
3. Turkey	16.3	220.6	135.3
4. China	77.4	70.0	106.5
5. United Arab Emirates	43.6	71.3	116.5
6. United Kingdom	37.6	59.2	70.5
7. Colombia	49.4	63.2	61.9
8. United States	39.4	64.9	62.1
9. Spain	34.6	27.1	28.0
10. Pakistan	27.0	34.2	71.5
Total Value of Canadian Pulse Exports	**1,287.8**	**1,848.8**	**2,096.1**

Excluding seeds for sowing. Source: Statistics Canada, May 2010

Appendix A Table 2. Canada's Top Pulse Export Products (2006-2009)

	Volume	Value
Red Lentils	441%	928%
Green Lentils	17%	146%
Yellow Peas	54%	119%
Kidney Beans	46%	115%
Split Peas	33%	106%
Green Peas	10%	93%
Black Beans	31%	85%
Great Northern Beans	5%	69%
Pinto Beans	19%	54%
Red Kidney Beans, Light	-17%	46%
All pulse exports	**24%**	**123%**

Excluding seeds for sowing. Source: Statistics Canada, May 2010

Appendix ATable 3. Canada's Top Suppliers of Pulses (million $)

	2007	2008	2009
1. United States	24.7	41.1	37.9
2. China	5.0	6.7	6.8
3. Thailand	2.4	5.3	4.5
4. India	1.3	1.7	3.7
5. Australia	0.2	0.7	2.1
6. Other	5.8	8.9	7.8
Total Value of Canadian Pulse Imports	**44.4**	**39.3**	**64.4**

Excluding seeds for sowing. Source: Statistics Canada, 2010.

Appendix A Table 4. Canada's Top Imports of Pulses (million $)

	2007	2008	2009
1. Navy/White Pea Beans	7.8	20.9	15.6
2. Beans, not specified as to type	5.6	9.2	9.5
3. Feed Peas	4.3	1.9	5.2
4. Mung Beans, Green, Gram Beans	2.1	3.0	4.9
5. Lentils, not specified as to type	2.0	4.1	3.4
6. Other	17.5	25.3	24.3
Total Value of Canadian Pulse Imports	**39.3**	**64.4**	**62.8**

Excluding seeds for sowing. Source: Statistics Canada, 2010.

Appendix B: Pulse Food Database

Appendix B Table 5. Pulse and pulse containing food items and the amount of pulse per 100 g in the Canadian Nutrient File, version 2001b.

Food name	Amount of pulse (g) per 100 g food product
soup, bean with wieners, canned, condensed	22.3
soup, bean with wieners, canned, condensed, + water	22.3
soup, bean with bacon, dehydrated, + water	22.3
beans, pinto, frozen, unprepared	99.4
beans, shellie, canned, solids and liquid	99.4
cowpeas (blackeyed peas), immature seeds, raw	99.4
cowpeas (blackeyed peas), immature seeds, frozen, unprepared	99.4
yardlong beans (asparagus bean/cowpea), raw	99.4
yardlong beans (asparagus bean/cowpea), boiled, drained	99.4
hyacinth-beans, raw	99.4
hyacinth-beans, boiled, drained	99.4
lentils, sprouted, raw	99.4
lentils, sprouted, stir-fried	99.4
pigeon peas, raw	99.4
beans, pinto, mature seeds, sprouted, boiled, drained	99.4
beans, adzuki, yokan (bean jelly)	72
beans, baked, home-prepared	72
beans, black turtle soup, raw	99.4
beans, black turtle soup, boiled	99.4
beans, great northern, raw	99.4
beans, great northern, boiled	99.4
beans, great northern, canned, solids + liquid	99.4
beans, pink, raw	99.4
beans, pink, boiled	99.4
broadbeans (fava beans), canned, solids + liquid	99.4
black-eyed peas (cowpeas), catjang, raw	99.4
black-eyed peas (cowpeas), common, mature seeds, raw	99.4
black-eyed peas (cowpeas), common, canned, with pork	72
beans, hyacinth, raw	99.4

beans, hyacinth, boiled	99.4
lupins, raw	99.4
lupins, boiled	99.4
moth beans, raw	99.4
moth beans, boiled	99.4
beans, mungo, raw	99.4
peas, pigeon (red gram), raw	99.4
beans, yardlong, boiled	99.4
beans, winged (goa beans), raw	99.4
beans, winged (goa beans), boiled	99.4
beans, adzuki, boiled, salt added	99.4
beans, black, boiled, salt added	99.4
beans, black turtle soup, boiled, salt added	99.4
beans, cranberry (roman), boiled, salt added	99.4
beans, french, mature seeds, boiled, salt added	99.4
beans, great northern, boiled, salt added	99.4
beans, kidney, light red, boiled, salt added	99.4
beans, pink, boiled, salt added	99.4
beans, pinto, boiled, salt added	99.4
beans, small white, boiled, salt added	99.4
broadbeans (fava beans), dry, boiled, salt added	99.4
black-eyed peas (cowpeas), catjang, boiled, salt added	99.4
black-eyed peas (cowpeas), common, boiled, salt added	99.4
beans, hyacinth, boiled, salt added	99.4
lupins, boiled, salt added	99.4
mothbeans, boiled, salt added	99.4
beans, mung (green gram), boiled, salt added	99.4
beans, mungo, boiled, salt added	99.4
peas, pigeon (red gram), boiled, salt added	99.4
beans, yardlong, boiled, salt added	99.4
beans, winged (goa beans), boiled, salt added	99.4
beans, kidney, dark red, boiled, salt added	99.4
beans, navy, boiled, salt added	99.4
beans, white, boiled, salt added	99.4
chickpeas (garbanzo beans, bengal gram), boiled, salt added	99.4
fast foods, mexican, burrito with beans and cheese	40.6
fast foods, mexican, burrito with beans and chili peppers	40.6
fast foods, mexican, burrito with beans and	31.4

meat	
fast foods, mexican, burrito with beans, cheese and beef	5.8
fast foods, mexican, burrito with beans,cheese and chili peppers	16.1
fast foods, mexican, chimichanga with beef and red chili peppers	7.1
fast foods, mexican, chimichanga with beef,cheese,red chili peppers	6.5
fast foods, mexican, enchirito with cheese, beef and beans	11
fast foods, mexican, frijoles (pinto beans) with cheese	19.6
fast foods, mexican, nachos with cheese,beans, ground beef, peppers	9.4
fast foods, mexican, taco salad with chili con carne	12.9
fast foods, mexican, tostada with beans and cheese	40.6
fast foods, mexican, tostada with beans, beef and cheese	37.2
broadbeans (fava beans), in pod, raw	91.5
mixed dishes, chili con carne with beans, canned	26.1
chili con carne with beans and rice	61.8
beans, dry, cooked, not specified as to type and as to fat added in cooking	91.5
white beans, dry, cooked, not specified as to fat added in cooking [navy (pea), great northern]	91.5
pinto, calico, or red mexican beans, dry, cooked, not specified as to fat added in cooking [october beans, shellie beans]	91.5
pinto, calico, and red mexican beans, dry, fat not added in cooking [October beans, shellie beans]	99.5
black beans, cuban style (habichuelas negras guisadas a la cubana)	68
cowpeas, dry, cooked, not specified as to fat added in cooking [blackeye peas, field peas]	91.5
chickpeas, dry, cooked, not specified as to fat added in cooking [garbanzos]	91.5
chickpeas, dry, cooked, fat added in cooking [garbanzos]	91.5
Mexican frozen dinner with fried beans	23.9
beans and franks, frozen dinner	72

enchilada with beef and beans [enchilada, non food specified]	24.7
beef enchilada, chili gravy, rice, refried beans (frozen meal) [frozen Mexican meal]	20.3
cheese enchilada with beans and rice (frozen meal)	26.4
peas, cowpeas, field peas, or blackeye peas (not dried), cooked, not specified as to fat added in cooking [crowder peas, pinkeyed peas, purple hull peas]	91.5
peas, cowpeas, field peas, or blackeye peas (not dried), cooked, fat added in cooking [crowder peas, pinkeyed peas, purple hull peas]	91.5
pigeonpeas, cooked (assume no fat added in cooking)	99.5
yookan (japanese dessert made with bean paste and sugar)	10.6
soup, canned, bean with wieners, condensed, + water	22.3
burrito with beans and chili peppers	49.9
burrito with beans and meat	49.9
burrito with beans, cheese, and chilli peppers	37.2
enchirito with cheese, beef, and beans	37.2
chalupa with beans, cheese, lettuce and tomato	38
chalupa with beans, chicken, cheese, lettuce and tomato	25.4
chimichanga with beans and cheese, meatless, with lettuce and tomato	38
cowpeas with snap beans, cooked, fat not added in cooking	99.4
beans, navy, mature seeds, sprouted, raw	99.4
beans, navy, mature seeds, sprouted, boiled, drained	99.4
cowpeas, immature seeds, frozen, boiled, drained	99.4
pigeon peas, boiled, drained	99.4
winged beans (goa bean), raw	99.4
winged beans (goa bean), boiled, drained	99.4
beans, pinto, mature seeds, sprouted, raw	99.4
cowpeas, boiled, drained, salt added	99.4
beans, baked, canned, with beef	72
beans, small white, raw	99.4
beans, small white, boiled	99.4

black-eyed peas (cowpeas), catjang, boiled	99.4
falafel, home prepared	81.4
beans, cranberry, canned, solid + liquid	99.4
broadbeans (fava beans), dry, boiled	99.4
lentils, boiled, salt added	99.4
lentils, pink, raw	99.4
chili con carne with beans and macaroni	20.8
beans, dry, cooked, not specified as to type, fat not added in cooking	99.4
black, brown, or bayo beans, dry, cooked, not specified as to fat added in cooking	99.4
red kidney beans, dry, cooked, not specified as to fat added in cooking	91.5
cowpeas, dry, cooked, fat added in cooking [blackeye peas, field peas]	91.5
lentils, dry, cooked (assume no fat added in cooking)	99.4
peas, cowpeas, field peas, or blackeye peas (not dried), cooked, fat not added in cooking [crowder peas, pinkeyed peas, purple hull peas]	99.4
tostada with beans and cheese	40.6
tostada with beans, beef, and cheese	37.2
soup, bean with ham, chunky, canned, ready-to-serve	22.3
cowpeas, young pods with seeds, raw	99.4
beans, adzuki, canned, sweetened	99.4
black-eyed peas (cowpeas), common, canned, plain, solid+liquid	99.4
peas, pigeon (red gram), boiled	99.4
beans, yardlong, raw	99.4
hummus, home prepared	100
beans, dry, cooked with ground beef	72
cowpeas, dry, cooked, fat not added in cooking [blackeye peas, field peas]	99.4
enchilada with chicken and beans	26.4
enchilada with chicken, beans, and cheese	18.1
rice with beans and pork	30
beans, mung, mature seeds, sprouted, stir-fried	99.4
beans, french, mature seeds, raw	99.4
black-eyed peas (cowpeas), common, mature seeds, boiled	99.4
beans, mung (green gram), raw	99.4
beans, mung, long rice (chinese noodles),	24

dehydrated	
beans, mungo, boiled	91.5
beans, dry, cooked, not specified as to type, fat added in cooking	91.5
white beans, dry, cooked, fat added in cooking [navy (pea), great northern]	91.5
mung beans (assume no fat added in cooking)	92
beans, dry, cooked with pork	72
portuguese bean soup	44.6
enchilada with beans and cheese, meatless	26.4
manapua, filled with bean paste, meatless	20.0
macaroni or noodles with beans or lentils and tomato sauce	37.4
rice with beans and chicken	28.7
chili con carne, commercial	26.1
beans, pinto, frozen, boiled, drained	99.4
cowpeas, young pods with seeds, boiled, drained	99.4
beans, mung, mature seeds, sprouted, canned, drained solids	99.4
beans, adzuki, boiled	99.4
beans, navy, raw	99.4
beans, navy, boiled	99.4
pinto, calico, or red mexican beans, dry, cooked, fat added in cooking [October beans, shellie beans]	91.5
enchilada with beef, beans, and cheese	18.5
burrito with beans, cheese, and beef	40.6
beans, cranberry (roman), raw	99.4
taco or tostado with beans, meatless	46.7
nachos with cheese, beans, ground beef, + peppers	9.4
cowpeas (blackeyed peas), immature seeds, boiled, drained	99.4
beans, adzuki, raw	99.4
beans, white, canned, solid + liquid	99.4
beans, kidney, light red, raw	99.4
white beans, dry, cooked, fat not added in cooking [navy (pea), great northern]	99.4
soup, bean with pork, canned, condensed, + water	22.3
beans, kidney, mature seeds, sprouted, boiled, drained	99.4
beans, baked, canned, with pork and sweet	72

sauce	
chili beef soup, chunky style	22.3
red kidney beans, dry, cooked, fat not added in cooking	99.4
bean soup, with macaroni and meat [pasta fazool]	16
jai, monk's food (mushrooms, lily roots, bean curd, water chestnuts)	20.0
broadbeans (fava), fresh, raw	99.4
broadbeans (fava), fresh, boiled, drained	99.4
beans, black turtle soup, canned, solid + liquid	99.4
beans, navy, canned, solid + liquid	99.4
taco or tostado with beans and cheese, meatless	46.7
rice with beans and tomatoes	37.4
soup, lentil with ham, canned, ready-to-serve	35.4
beans, kidney, mature seeds, sprouted, raw	99.4
beans, cranberry (roman), boiled	99.40
chickpea flour (besan)	100
black, brown, or bayo beans, dry, cooked, fat added in cooking	91.5
black, brown, or bayo beans, dry, cooked, fat not added in cooking	99.4
burrito with chicken, beans, and cheese	35.7
burrito with beans and cheese, meatless	50
burrito with beans and cheese	40.6
bean cake	55.1
chili with beans, canned	26.1
burrito with beef, beans, and cheese	40.6
bean dip, made with refried beans [garbanzo bean dip]	80
beans, pinto, canned, solid + liquid	99.4
beans, kidney, dark red, raw	99.4
chili con carne, not specified as to beans	26.1
kidney bean salad	60.3
falafil	81.4
chickpeas, dry, cooked, fat not added in cooking [garbanzos]	99.4
burrito with chicken and beans	47.4
beans, baked, canned, with pork and tomato sauce	72
broadbeans (fava beans), dry, raw	99.4
garbanzo or chickpea soup	60.1
refried beans	86.3

Boston baked beans	72.1
beans, kidney, light red, boiled	99.4
red kidney beans, dry, cooked, fat added in cooking	91.5
bean soup, non food specified	44.6
enchilada with beans, meatless	43.6
burrito with beef and beans [burrito, non food specified]	49.6
soup, bean with bacon, dehydrated	22.3
beans, pinto, boiled	99.4
soup, dehydrated, bean with bacon, + water	22.3
soup, bean with pork, canned, condensed	22.3
beans, baked, canned, with wieners	72
taco or tostado with beans, cheese, and meat (assume beef or chicken)	50.2
beans, black, boiled	99.4
pinto bean soup	19.6
black bean sauce	6.5
vegetarian chili (made with meat substitute)	26.1
chickpeas (garbanzo beans, bengal gram), boiled	99.4
baked beans, with tomato sauce [vegetarian baked beans]	72
baked beans, non food specified	72
soup, canned, bean with bacon, condensed, + water	22.3
beans, pinto, raw	99.4
lentils, dry, cooked, not specified as to fat added in cooking	93.4
rice with beans	50
beans, black, raw	99.4
beans, white, boiled	99.4
chickpeas (garbanzo beans, bengal gram), canned, solid + liquid	99.4
chickpeas (garbanzo beans, bengal/golden gram), raw	99.4
beans, white, raw	99.4
beans, kidney, all types, canned, solid + liquid	99.4
refried beans, canned	99.4
hummus, commercial	100
beans, kidney, dark red, boiled	99.4
lentils, boiled	99.4
lentils, raw	99.4
beans, baked, canned, with pork	72

lentil soup	15.1
beans, baked, canned, plain or vegetarian	72
chili con carne with beans [kidney beans and hamburger with tomato sauce]	26.1
beans, mung, mature seeds, sprouted, raw	99.4
beans, kidney, dark red, canned, solid + liquid	99.4
beans, mung, mature seeds, sprouted, boiled, drained	99.4
burrito with beans, meatless	64.4

Appendix C: Provincial Descriptive Data

Appendix C Table 6. Mean pulse consumption[1] (g) per province

	Total pulse (g) per 1000 kcal ± SE
Newfoundland and Labrador	47.7 ±7.8
Prince Edward Island	39.8 ±4.7
Nova Scotia	43.1 ±5.8
New Brunswick	35.7 ±4.8
Quebec	28.2 ±3.0 **
Ontario	40 ±3.2
Manitoba	35.4 ±4.1
Saskatchewan	33.0 ±6.8
Alberta	36.7 ±12.0
British Columbia	30.6 ±8.7 *

[1]According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian Adults aged ≥ 19 y.

* $p < 0.05$, significant when compared to Newfoundland and Labrador (the province with the highest consumption in g)

** $p < 0.01$, significant when compared to Newfoundland and Labrador (the province with the highest consumption in g)

Appendix D: Demographic Descriptive Statistics

Appendix D Table 7. Mean pulse consumption[1] (g) by community setting

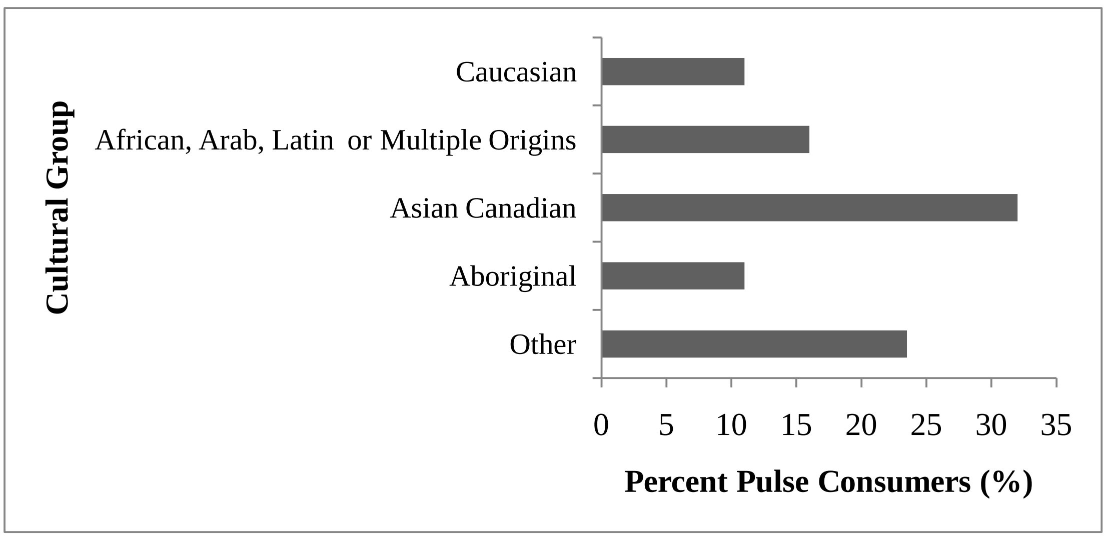
	Total Pulse (g) ± SE	Total pulse (g) per 1000 kcal ± SE
Urban	72.2 ±1.7	38.1 ± 1.0
Rural	77.8 ± 3.5	38.3 ± 1.6

[1]According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian Adults aged ≥ 19 y.

Appendix D Table 8. Mean pulse consumption[1] (g) per cultural group

	Total Pulse (g) ± SE	Total pulse (g) per 1000 kcal ± SE
White	104.8 ±5.1	34.5 ±4.4
African Canadian, Latin, Arabic or Multiple origins	129.5 ±34.4	48.0 ±12.3
Asian	135.1 ±37.4	35.2 ±5.7
Aboriginal	90.9 ±33.1	30.9 ±15.3
Other	76.5 ±44.9	40.5 ±17.0

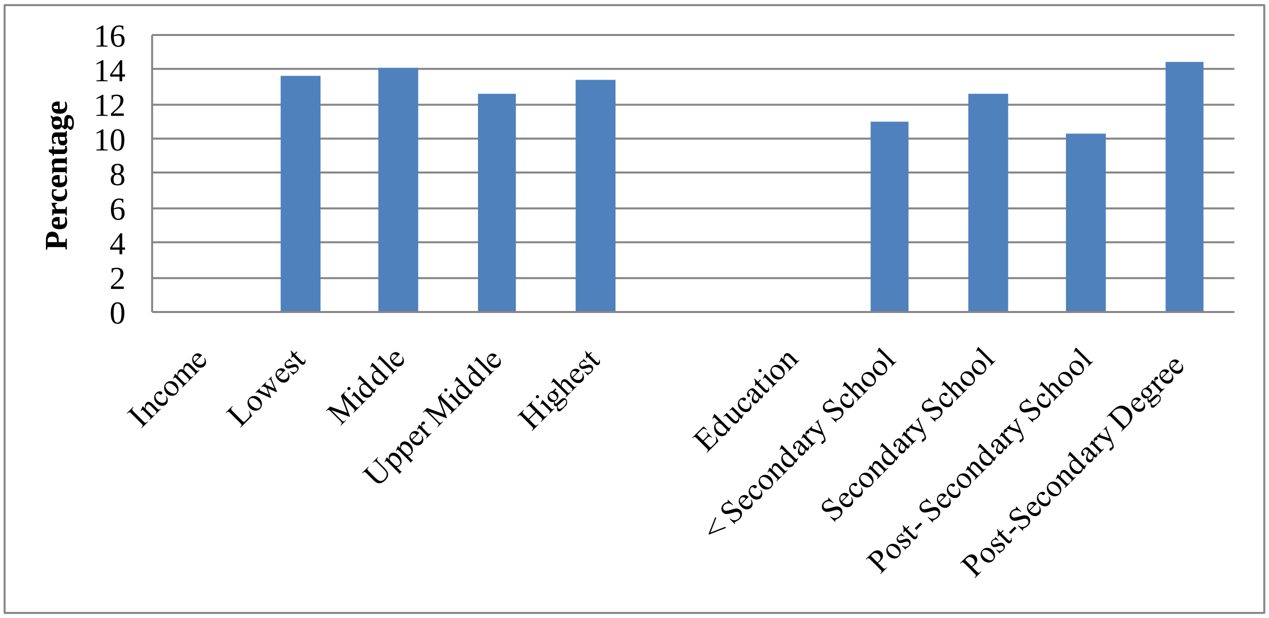
[1]According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian Adults aged ≥ 19 y.



Appendix D Figure 3. Cultural Characteristic of Pulse Consumers in the Canadian Adult Population[1] (n=20,156)

[1] According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian Adults aged ≥ 19 y.

* $p < 0.05$



Appendix D Figure 4. Socio-economic characteristics of Pulse Consumers in the Canadian Adult Population[1] (n=20,156)
[1] According to one day 24 hour dietary recall of the CCHS 2.2 (2004) of Canadian Adults aged ≥ 19 y.

Appendix D Table 9. Food Group Intake (by serving) by Cultural Group and Pulse Consumption

Cultural Group **Food Group**	Caucasian	African Canadian, Latin, Arabic or of Multiple Origins	Asian Canadian	Aboriginal	Other
Fruit and Vegetable	*5.2* 5.9	*5.9* 6	*5.2* 6.3	*4.2* 5.4	*5.4* 4.5
Meat & Alternative	*3.9* 5.8	*4* 5.8	*4.9**** 5.9	*1.5 ł* 1.2	*3.1* 5.5
Grain Products	*5.7* 5.7	*5.7* 5.7	*6.6* 8.2***	*5.7* 4.6	*6.9* 4.4
Milk & Alternatives	*1.7* 1.7	*1.4*** 1.4	*1.3** 1.5	*1.5* ł 1.2	*1.4* 1.2

Non-consumer servings are noted by italicized font.
* p < 0.05 when compared with Caucasian group
** p < 0.01 when compared with Caucasian group
*** p < 0.001 when compared with Caucasian group
ł approaching significance when compared with Caucasian group

Appendix E: Canadian Community Health Survey, Cycle 2.2 (2004) Descriptive Data

Appendix E Table 12. Province of Residence of Respondent (Variable name GEOD_PRV)

	Sample	Population
Newfoundland and Labrador	1,734	512,500
Prince Edward Island	1,430	136,000
Nova Scotia	1,705	909,500
New Brunswick	1,633	730,000
Quebec	4,780	7,369,500
Ontario	10,921	12,176,500
Manitoba	4,194	1,093,500
Saskatchewan	2,041	925,000
Alberta	3,021	3,108,000
British Columbia	3,648	4,071,000
Total	**35,107**	**31,030,722**

Source: Health Canada, 2010

Appendix E Table 13. Age/Sex Groupings According to the Dietary Reference Intakes (Variable name DHDDDRI)

	Sample	Population
Male, 19-30 y	1,900	2,594,500
Female, 19-30 y	2,084	2,522,500
Male, 31-50 y	2,752	4,876,500
Female, 31-50 y	2,937	4,896,000
Male, 51-70 y	2,730	3,147,000
Female, 51-70 y	3,412	3,272,000
Male, 71 or older	1,605	1,056,000
Female, 71 or older	2,777	1,436,000
Total	**20,197**	**23,800,500**

Source: Health Canada, 2010

Appendix F: Body Mass Index (BMI) Classifications

Appendix Table 14. BMI Classification and Risk of Developing Health Problems

	BMI Range (kg/m^2)	Risk of Developing Health Problems
Underweight	< 18.5	Increased
Normal Weight	18.5-24.9	Least
Overweight	25.0-29.9	Increased
Obese Class I	30.0-34.9	High
Obese Class II	35.0-39.9	Very High
Obese Class III	≥ 40	Extremely High

Source: Health Canada, 2010.