Plant-based dietary practices in Canada:

Examining definitions, prevalence and determinants of animal source food exclusions using the 2015 Canadian Community Health Survey-Nutrition

by

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Abstract

The newly released 2019 Canadian dietary guidelines recommend consuming more plant-based foods, especially plant-based sources of protein as part of a healthy eating pattern. While plant-based dietary practices (PBDPs) have been recommended to improve both population health and environmental sustainability outcomes, no nationally representative study has described Canadian trends regarding exclusions of animal-based foods. This thesis therefore aimed to: 1) operationalize definitions for PBDPs based on animal source food exclusions to estimate the prevalence of Canadians who adhere to PBDPs; and 2) explore potential correlates of PBDPs. Nationally representative data on dietary exclusions drawn from the 2015 Canadian Community Health Survey–Nutrition were used to operationalize definitions of PBDPs and examine their prevalence. Potential correlates of PBDPs were explored through bivariate analyses using chi-square tests and multivariable analyses using logistic regression models, including sex-stratified models. Respondents' PBDPs were categorized as: 1) vegan (excluded red meat, poultry, fish, eggs, and dairy); 2) vegetarian (excluded red meat, poultry, and fish); 3) pescatarian (excluded red meat and poultry); and 4) meat-excluder (excluded red meat). In 2015, approximately 5% of Canadians reported adhering to PBDPs (all categories combined) with the majority (2.8%) identifying as a meat-excluder, 1.3% categorized as vegetarian, 0.7% as pescatarian and 0.28% as vegan. The significant determinants of vegetarian status after including sex, age, urban/rural residence, Canadian province of residence, self-identified racial/cultural group, immigration status, education, marital status and income in the model were self-identifying as South Asian relative to White (OR:16.70, 95%CI:8.01, 34.82) and living in Quebec (OR:0.24, 95%CI: 0.09, 0.63) or the Prairies (OR:0.43, 95%CI:0.19, 0.96) relative to the

Atlantic Provinces. While self-identified South Asian ethnicity was significant in both male and female stratified models, immigrant status and province of residence were only significant in the female-only model. Despite growing public discourse around PBDPs, few Canadians reported total exclusion of animal products in 2015. Reported PBDPs were strongly associated with racial/cultural group: across all multivariable models, the main predictor of vegetarian status was self-identified South Asian ethnicity. Understanding factors shaping adherence to PBDPs among Canadians is valuable for informing strategies aimed at promoting environmentally sustainable diets.

Lay Summary

The newly released 2019 Canadian dietary guidelines recommend consuming more plant-based foods as part of a healthy eating pattern. While plant-based dietary practices (PBDPs) have been recommended to improve health and environmental sustainability outcomes, no nationally representative study has described Canadian trends regarding exclusions of animal-based foods. Using data from one nation-wide survey conducted by Statistics Canada in 2015, the focus of this research was to construct measurable definitions of PBDPs based on animal-based food exclusions to estimate the percent of Canadians following PBDPs, and to examine what characteristics were associated with PBDPs. In 2015, less than 5% of the Canadian population reported a PBDP. After accounting for factors such as age, sex, and education, this study found that self-identified ethnicity and province of residence were associated reporting PBDPs. Understanding factors shaping adherence to PBDPs among Canadians is valuable for informing strategies aimed at promoting environmentally sustainable diets.

Preface

I conducted this research as a student in the MSc Human Nutrition Program as part of the Public Health and Urban Nutrition research group at the University of British Columbia. Data for this work were accessed through Statistic Canada's Research Data Centre (RDC) Program. Ethics approval was granted through the Statistics Act of Canada. I led the development of the research objectives and analysis plans in collaboration with my supervisor Dr. Jennifer Black with input from my committee members Dr. Gerry Veenstra and Dr. Annalijn Conklin. I was responsible for managing data, conducting the statistical analysis, ensuring the accuracy of the results presented, and writing the thesis.

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List of Abbreviations

AHS: Adventist Health Study

AMPM: Automated Multiple Pass Method

BC: British Columbia

BMI: Body Mass Index

CI: Confidence Interval

CCHS: Canadian Community Health Survey

EPIC-Oxford: European Prospective Investigation into Cancer and Nutrition, Oxford Cohort

FFQ: Food Frequency Questionnaire

g: gram

kg: Kilogram

m: metre

MeSH: Medical Subject Headings

NHANES: National Health and Nutrition Examination Survey

NB: New Brunswick

NFL: Newfoundland

NS: Nova Scotia

OR: Odds Ratio

PEI: Prince Edward Island

PBDP: Plant-based Dietary Practices

RDC: Research Data Centre

SES: Socioeconomic Status

UK: United Kingdom

USA: United States of America

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Chapter 1: Introduction

1.1 Current Relevance of Plant-Based Dietary Practices

An estimated 680 million people worldwide exclude meat from their diets, whether by choice or because of necessity according to household expenditure survey data from a study published in 2010 (1). From different narrative reviews on those choosing to adhere to plant-based dietary practices (PBDPs), key motivators for plant-based eating are related to health and/or ethical implications of animal welfare and the environment (2,3). In a study from 2014, it was estimated that a global shift towards a predominantly PBDP compared to the current omnivorous diet (i.e., a diet without any restrictions on food group consumption) would result in a 0-18% decrease in all-cause mortality rate and no net increase in greenhouse gas emissions by 2050 (4). More recent estimates from a 2016 study have suggested that switching to a more PBDP (including vegetarian and vegan practices) compared to an omnivorous dietary pattern would result in a decrease in global mortality by 6-10%, or roughly 7.3 million avoided deaths per year by 2050 (5). Thus, the perceived individual and global benefits of adopting a PBDP could be an attractive option for those with the privilege to consider dietary changes.

1.2 Importance of Plant-Based Dietary Practices for Health and Sustainability

PBDPs have been gaining attention in mainstream discourse, popularized by celebrities such as Natalie Portman and Miley Cyrus (6). Other proponents of PBDPs are physicians such as Dr. Dean Ornish, Dr. Michael Gregor and Dr. Neal Barnard, all of whom are featured on an online database of plant-based doctors (7) and have penned bestselling popular science books touting the benefits of said dietary practices (8–10). Additionally, consumer interest in PBDPs is rising, illustrated by the increase in online searches for the term "vegan" from 2004 to 2019, as reported by Google Trends (11).

Prominent figures and popular culture aside, several reputable nutrition and governmental organizations have statements supporting PBDPs as a healthful way of eating. A 2003 joint position statement from the Dietitians of Canada and American Dietetic Association (now known as the Academy of Nutrition and Dietetics) stated that well-planned vegetarian diets can be nutritionally adequate, healthful and may provide benefits in preventing and treating certain diseases such as type 2 diabetes and heart disease (12). More recently, the Academy of Nutrition and Dietetics (formerly the American Dietetic Association) echoed this statement to include vegan diets, adding that plant-based diets use fewer natural resources and are less damaging to the environment (13). A vegetarian dietary pattern is also recommended as an example of a healthy dietary pattern in the United States Department of Agriculture's (USDA) 2015-2020 Dietary Guidelines for Americans (14).

In addition to reputable nutrition organizations, other health organizations have also voiced their positions on PBDPs. The American Institute for Cancer Research recommends a plant-based diet for cancer prevention and for cancer survivors (15). As vegetarian diets are often lower than omnivorous diets in total fat, saturated fat, and cholesterol, the American Heart Association states that vegetarian diets can be healthful and nutritionally adequate provided that all essential nutrients are accounted for (16). In the Nutrition Therapy chapter detailing the clinical practice guidelines for diabetes, Diabetes Canada includes a low-fat vegan diet and a calorie restricted vegetarian diet as examples of possible dietary patterns that may be beneficial for individuals with diabetes (17). Position papers are not restricted to an adult population alone. The Canadian Paediatric Society acknowledges that a well-balanced vegetarian diet with appropriate caloric intake and monitoring of growth can provide for the needs of children and adolescents (18). Thus, PBDPs can be relevant to a variety of populations from children to adults, as well as those living with certain chronic diseases such as diabetes or heart disease.

The importance of PBDPs is not only due to health benefits, but also due to their environmental impact. Recently, a "universal healthy reference diet" to benefit both health and environmental sustainability was proposed by a group of researchers from various fields such as health and agriculture comprising the EAT-Lancet Commission group (19). The commission recommended a target diet higher in diverse plant-foods, with limited amounts of seafood and poultry and low to no red and processed meat, to be combined into a framework together with other food systems targets to improve both the health and sustainability of the planet (19). While no single solution will be enough to combat climate change, changes towards more PBDPs contribute to mitigating greenhouse gas emissions, tackling one piece of the overall puzzle in the problem of sustainability (20). Meat production through livestock farming is estimated to contribute to 14.5% of global anthropogenic greenhouse gas emissions (21). It has been estimated that ruminant meats (such as beef and lamb) have about 250 times the greenhouse gas emissions per gram of protein compared to legumes (4). In addition, one 3 ounce serving (using USDA definitions) of beef is estimated to result in more greenhouse gas emissions than 20 servings of vegetables (4). Recent estimates suggest that transitioning towards more plant-based diets from conventional omnivorous diets could reduce food sector-related greenhouse gas emissions by 29-70% by the year 2050, compared to a reference scenario based on projections from the United Nations Food and Agriculture Organization (5). Given the high environmental demands caused by industrial farming such as increased land and water use, resulting in deforestation, reduced biodiversity and soil degradation, PBDPs present a more environmentally sustainable dietary option (22). Furthermore, studies have demonstrated that veganism and vegetarianism are among the diets contributing the least to greenhouse gas emissions, land use, and water use (23). Health Canada supports these statements, stating that "diets higher in plant-based foods and lower in animal-based foods are associated with a lesser environmental impact" (24).

With the recent release of the 2019 updated national food guide, discourse surrounding PBDPs has become more relevant in the Canadian context relative to the release of the last national food guide from 2007. In contrast to the 2007 edition, the new consumer-facing version of Canada's Food Guide has eliminated the use of serving sizes to focus on proportions of food on a plate as the new template for healthy eating, representing a drastic shift from the previous food guide (25,26). Health Canada now recommends that half of one's plate should be comprised of vegetables and fruit (25). In addition, Health Canada highlights that a shift towards dietary patterns emphasizing plant-based foods, especially plant-based sources of protein, may improve health, as studies on these dietary patterns are associated with lowered risks of cardiovascular disease, colon cancer and type 2 diabetes (24). Health Canada claims that shifting towards plant-based foods can help Canadians consume less processed meat and replace foods that are high in saturated fat with foods high in unsaturated fat (24).

Chapter 2: Literature Review

2.1 Plant-Based Diet Definitions

Plant-based diets have been defined in many different ways. Some researchers define "Plant-based diets" separately from diets such as "vegetarian" or "vegan", basing the definition of "plant-based diets" according to dietary inclusions as opposed to animal-source product exclusions (27). Often, the distinction is made for "Whole-foods, plant-based" diets which encourage consumption of plant foods in "whole", minimally processed forms such as vegetables, fruit, legumes, seeds and nuts but again are not necessarily defined by strict meat-exclusion (27). Other researchers use the term "plant-based diet" as a broad category referring to plant-emphasized diets which include veganism and different combinations of lacto-ovo-pesco-vegetarianism, the followers of which generally consume dairy, eggs, fish and meat but in lower quantities than the standard western diet (28). Similar to the latter definition of "plant-based diet", the term "plant-based dietary practice" will be used in this thesis, defined as the broad group of dietary practices encompassing dietary patterns characterized according to animal source food exclusions. This definition will be used to accommodate the wide spectrum of meat-exclusionary dietary patterns that may be identified in the Canadian population.

Theoretical definitions of different PBDPs from health organizations and narrative review literature can be found in Table 1.1. This table indicates the variety of PBDPs and how each dietary practice may be theoretically defined. For example, though the common aspect of the definition of vegetarianism is an absence of red meat in the diet, definitions of vegetarianism range from "those who do not consume meat, poultry or fish" to more specific definitions like lacto-vegetarianism: "those who consume dairy but exclude meat, poultry, seafood and eggs". In measuring dietary patterns in population studies, there have been a wide array of assessment methods and attempts to translate the theoretical definitions of PBDPs into more concrete measurable definitions or operationalized definitions. Examples of these operationalized definitions from plant-based epidemiological studies can be found in Table 1.2.

Some researchers have suggested minimizing the use of self-report measures in favour of dietary assessment methods instead, in order to better define types of vegetarianism (categorized according to the different animal source food exclusions) as those who self-report as "vegetarian" may not necessarily fall within strictly defined dietary exclusion categories and thus may be hard to account for in a population based study (2,29). Self-report measures generally involve asking the participant to self-identify as a follower of a dietary practice such as the vegetarians assessed in the Nutri-Net Santé study (Table 1.1), while dietary assessment methods focus on the participant's reported consumption, regardless of whether or not they identify as a follower of any specific dietary practice. Some studies have shown discrepancies in self-reported vegetarian status compared to dietary assessment measures such as Food Frequency Questionnaires (FFQs) which measure what a participant's usual dietary intake over the long term and 24-hour Dietary Recalls which focus on what a participant consumed in the last 24-hours. For example, Gilsing et al. found that 50% of self-reported vegetarians in the Netherlands reported consuming meat and fish on an FFQ (30). Moreover, Vinnari et al. reported that out of 783 self-defined vegetarians in Finland, only 13% followed a lacto-ovo-vegetarian diet or stricter after verifying with FFQs (29). Further, Bedford and Barr observed that in their 2005 population-representative study in British Columbia (B.C.), while the prevalence of self-reported vegetarianism was 5.8%, only 1.5% of respondents would be classified as true vegetarians if the strict definition (no consumption of seafood, poultry or meat) was used (31). In the United States, data from the National Health and Nutrition Examinations Survey (NHANES) 2007 – 2008 and 2009 – 2010 iterations found that while 2.1% of the population self-identified as vegetarian, only 3% of self-identified vegetarians reported no consumption of any animal protein products and more than a quarter of self-identified vegetarians reported red meat consumption in the past 24-hours (32). Definitions of vegetarianism can often be constrained by study design, as some studies use data from national surveys that do not necessarily focus on nutrition, meaning that neither dietary assessments nor questions about specific animal source food exclusions are included in data collection (33).

The heterogeneity of the definitions in PBDP literature can be a barrier to conducting and comparing empirical research (2,34). Different definitions of plant-based eating can create challenges in comparing results between studies as well as interpreting the potential correlates and efficacy of PBDPs as a whole. Furthermore, there have been no operationalized definitions PBDPs from a Canadian context. Given the importance of these types of dietary practices for health and environmental sustainability as mentioned previously, these definitions would be integral as a starting point for studying plant-based eating to provide a consistent measure to begin exploring potential correlates of PBDPs in Canada which have yet to be studied.

Table 2.1 Theoretical Definitions of PBDPs

Diet	Definitions by Organization			Definitions from Literature	
	Academy of Nutrition and Dietetics (13)	**Dietitians of Canada** (35)	**Vegetarian Society** (36)	**Vegetarian Diets: Definitions and Pitfalls in Interpreting Literature on Health Effects of Vegetarianism** (2)	**Nutritional Update for Physicians: Plant-Based Diets** (27)
Vegetarian	Devoid of flesh foods (like meat, poultry, seafood), may or may not include eggs or dairy products	Usually exclude meat, chicken and fish, possibly choosing to eat eggs and dairy	Excludes food that consists of meat, fish, poultry, shellfish, insects, by-products of slaughter with or without dairy products, honey and/or eggs	All diets excluding meat and fish regardless of if animal products such as dairy/eggs are also excluded	-
Vegan/Strict Vegetarian	Devoid of flesh foods, excludes eggs and dairy products and may also exclude honey	Excludes meat, fish, poultry, dairy and eggs and products containing these ingredients	Vegetarians who do not eat dairy products, eggs, or any other animal-derived foods	Diet not containing any animal foods nor by-products of animal husbandry such as milk and honey	Excludes all animal products including meat, seafood, poultry, eggs and dairy
Lacto-vegetarian	Devoid of flesh foods, consumes milk but not egg products	-	Vegetarian that avoids eggs but eats dairy products	Diet containing dairy but not eggs, meat, fish or seafood	Excludes meat, poultry, seafood and eggs, but includes dairy products
Ovo-vegetarian	Devoid of flesh foods, consumes egg but not dairy products	-	Vegetarian that avoids dairy products but eats eggs	Diet containing eggs but not dairy, meat, fish or seafood	Excludes meat, poultry, seafood and dairy products, but includes eggs
Lacto-Ovo-vegetarian	Devoid of flesh foods, consumes milk and egg products	Includes milk and eggs but excludes meat, fish and poultry	Vegetarian that eats dairy products and eggs	Diet containing dairy or eggs but not meat, fish or seafood	Excludes meat, poultry, seafood, but includes dairy products and eggs
Pescatarian	-	-	-	Diet containing fish or seafood but excluding meat	-
Semivegetarian	-	-	-	Those following predominantly vegetarian diets with occasional inclusion of meat or fish (occasional defined as no more than once per week)	-

Table 2.2 Operationalized Definitions of PBDPs

Study	European Prospective Investigation into Cancer and Nutrition, Oxford Cohort (EPIC-Oxford) (37)	Adventist Health Study (AHS) (38)	National Health and Nutrition Examination Survey 1999 – 2004 (NHANES) (39)	NutiNet-Sante Study (40)
Dietary Assessment Method	Survey Question or FFQ[1]	FFQ	24-hour recall (from one day)	Survey Question[2]
Vegetarian	Those who refrain from meat (including poultry) but consume dairy and/or eggs	-	Those who did not consume meat, poultry or fish on the day of the survey	Does not eat meat but eats other animal products
Vegan/Strict Vegetarian	Those who eat no animal products	Consume meat, poultry and fish a total of less than once per month or not at all	-	Does not eat any meat, fish, eggs or dairy products
Lacto-vegetarian	-	-	-	-
Ovo-vegetarian	-	-	-	-
Lacto-Ovo-vegetarian	-	Consume meat, poultry and fish a total of less than once per month, may consume dairy and/or eggs	-	-
Pescatarian	Those who refrain from meat (including poultry) but consume fish	Consumes fish one or more times per month, consumes meat and poultry less than one time per month, may consume dairy, and/or eggs	-	-
Semivegetarian	-	Consumes red meat, poultry, and/or fish one or more times per month in total but less than once per week, may consume dairy, and/or eggs	-	-

1. Participants recruited through mail advertisement were asked four survey questions: 1. Do you eat any meat (including bacon, ham, poultry, game, meat pies, sausages)? 2. Do you eat any fish? 3. Do you eat any dairy products (including milk, cheese, butter, yoghurt)? 4. Do you eat any eggs (including eggs in cakes and other baked foods)? Participants recruited in the pilot phase of the study by nurses were categorized according to FFQ
2. The first survey question was "Currently do you follow a specific diet?" if yes then participants were asked to specify the main reason with the choices being: for medical reasons (other than weight loss); weight loss; to avoid gaining weight; to stay in shape; **because I am a vegetarian (I do not eat meat but I eat other animal products)**; **because I am a vegan (I do not eat any meat, nor fish, nor eggs, nor dairy products)**; because of personal or religious beliefs

2.2 Prevalence of Plant-Based Dietary Practices

In order to find the literature for this section, using the Ovid Medline database, the Medical Subject Headings (MeSH) terms “Vegetarian” (expanded to also include the MeSH term “Vegan”) as well as “Prevalence” and “Social Determinants of Health” were used. In addition, searches involving the keyword form of the previously mentioned MeSH terms as well as the keywords “plant based” and “plant-based” were also carried out to find the most relevant literature for this topic. Similar searches were also carried out using the Web of Science database. Studies that contained clear definitions of PBDPs, prevalence estimates of PBDPs and demographic data of the sample were included. As the focus of this review was on PBDPs in the general population, studies that were limited to specific demographics were excluded (i.e. studies including females only or teenagers only were excluded). Studies were not limited by year of publication, but when reporting prevalence estimates, studies from the most recent datasets collected within that country were preferred. Studies were limited to those in English. Study titles and abstracts that did not meet the above criteria were excluded. In addition to studies found from these searches, any potentially relevant literature that was cited within the gathered studies was also examined and included if it met the inclusion criteria.

This component of the literature review focuses on results from publications describing studies using population-representative sampling methods (i.e., probability sampling methods) as well as publications describing non-population-representative sampling methods of those following PBDPs. The reason being that while population-representative studies may be more valid in describing the differences in factors between animal source excluders and those that eat animal source products in the population, it may be beneficial to examine if these differences persist or differ when looking at studies that used non-probability methods to recruit the study sample, especially since the majority of non-probability sampled studies oversampled those following PBDPs in order to ensure a sufficient sample size for analysis. Both types of studies can be used to understand the factors which shape the context of PBDP worldwide.

2.2.1 Prevalence of Plant-Based Dietary Practices Internationally

Internationally, there are few studies that estimate the prevalence of plant-based diets from nationally representative data. In the United States, the reported prevalence of vegetarianism is approximately 2% (32,33,41). Food Frequency Questionnaire data from the 2003 – 2004 and 2004 – 2005 National Health and Nutrition Examination Survey (NHANES) suggested that 2.4% of Americans were "vegetarian" (including the wide spectrum of diets from "semi-vegetarian" to "vegan") (41). Data from the combined 2007 – 2008 and 2009 – 2010 iterations of the NHANES suggested that 2.1% of Americans self-identified as vegetarian, with only 3% out of these self-identified vegetarians reporting no consumption of animal protein foods at all (ie. dairy, eggs*, and* meat) (32). Furthermore, from the 2012 population representative National Health Interview Survey conducted in America (n = 34,525), the prevalence of those who reported trying vegetarian or vegan diets in their lifetime was 4%, while 1.9% reported following a vegetarian or vegan diet in the past 12 months (33). From a national survey in Germany conducted from 2008-2011, the prevalence of vegetarianism was reported to be 4.3% of the population (42). More recently, the prevalence of vegetarians (including those following vegan diets) was 2.7% from a 2014 nationally representative survey in Germany (43). In Italy, prevalence of self-reported vegetarianism was 0.8% (44). In Finland, the prevalence of self-reported vegetarianism was 3.3%, but only 0.4% followed a lacto-ovo-vegetarian diet or stricter when FFQ data was used to confirm vegetarian status (29). From the 2007 Survey of Lifestyles, Attitudes and Nutrition in Ireland, after dropping outliers that had one standard deviation of total food consumption away from the mean (measured in serving sizes of all food groups), the prevalence of vegetarianism was 0.9% and the prevalence of pescatarianism was 0.7% (45).

The prevalence of vegetarianism appears to be higher in India than in North America and Europe. Data from the 2005 – 2006 National Family Health Survey in India suggested that the prevalence of plant-based diets was 5.2% semi-vegetarian, 2.2% pesco-vegetarian, 3.2% lacto-ovo vegetarian, 24.2 % lacto-vegetarian, and 1.6% vegan (46). The prevalence of vegetarianism (again including the wide spectrum of diets from "semi-vegetarian" to "vegan") was estimated to be 33% from the 2010 – 2011 Centre for Cardiometabolic Risk Reduction in South-Asia (CARRS) cohort, which sampled Chennai, New Delhi and Pakistan in South Asia (41). The relatively large proportion of those adhering to vegetarian diets in India may be due to the association of vegetarianism with tradition, power, and status (47,48). Often vegetarianism in India is a lifelong pattern with many generations adhering to the diet (46). In addition, meat-exclusion practices may stem from an attitude of non-violence, which is one of the key foundations of Hinduism, one of the religions widely practiced in India (49).

2.2.2 Prevalence of Plant-Based Dietary Practices in Canada

From data collected through polls and surveys from 2016 to 2018 mainly commissioned from vegetarian societies, the estimated prevalence of people following PBDPs in the UK, USA, and Canada ranges between 1% to 10% (50–52). A recent 2018 poll suggested that 7.1% of

Canadians consider themselves vegetarians while 2.3% considered themselves vegan (51). These estimates may not be population-representative as these data were not collected using probability sampling methods, and may be biased towards respondents who feel strongly about plant-based eating or happened to have access to the poll. Currently, there has yet to be a population-representative study reporting the prevalence of PBDPs in Canada. While a previous 2003 joint position statement on vegetarian diets from the Dietitians of Canada and the American Dietetic Association stated that the prevalence of adult vegetarians in Canada was 4% according to a 2002 survey, verification of the original source that was cited mentioned no such statistic and thus could not be corroborated (12,53). On a provincial level, one population representative study from the province of B.C in 2005 estimated that 6% of the province self-defined as vegetarian, but most did not report adhering to a strictly meatless diet (31).

Currently, no prevalence estimates of PBDP followers in Canada based on population-representative data exists. This information would be imperative to assessing the nation's trends in plant-based eating, especially with the recent release of a more plant-focused national food guide. Without a baseline estimate, changes in PBDP popularity or uptake cannot be assessed.

2.3 Correlates of Plant-Based Dietary Practices

2.3.1 Geographic Factors

From Canada-wide polling of respondents aged 18 years and older collected in 2018, respondents from British Columbia and Ontario reported the highest percentage of self-identified vegetarians (around 8%), followed by Quebec (6%), and the Atlantic and Prairie regions (around 5%) (51). Data from this poll suggested that people living in British Columbia were three times more likely to identify as vegans and vegetarians than people living in the Atlantic or Prairie regions (51) and that people living in cities were three times more likely to identify as vegans as people living in small towns (54). However, this Canadian poll is limited in that the evidence is cited from media sources as details about the sampling methods or statistical analysis used have not been made accessible by its primary authors (following direct e-mail requests). Similarly, in a population-representative German sample, larger cities had higher proportions of vegetarians compared to rural residences (42). These observations are reasonable given evidence from an American study suggesting decreased diversity and fewer food options in rural locations, and a study conducted in Quebec suggesting that distances to supermarkets selling fresh fruits and vegetables are longer in rural areas which may make it harder for people following exclusionary diets to find desirable food alternatives (55,56).

2.3.2 Meat and Masculinity

One association reported in most population-based studies on PBDPs is that between vegetarianism and female sex. This has been reported in population-representative studies and studies including oversampled vegetarians from Canada, America, the UK, France, and the Netherlands(30,31,33,37,40). These studies used sex to measure the construct of gender, but there are other studies that have linked meat-eating behaviour with gender itself. One explanation for the association of vegetarianism and being female may be the association of meat and masculinity that is reported across different cultures to varying degrees (34). For instance, in a study of second generation Turkish, Chinese and Dutch participants, the Turkish group showed the strongest meat-masculinity link when assessed using survey questions inquiring about topics such as preferred meat portion size, familiarity with meat replacers and willingness to reduce meat consumption (57). In a nutritional attitudes survey conducted in the UK, compared to men, women were more likely to agree that "using animals for food cannot be morally justified" and less likely to support the idea that a healthy diet should always include meat (58). Further, from one study that asked participants from a Western country to rate qualities of masculinity and femininity based on short vignettes describing a hypothetical story of someone consuming an omnivorous diet or meat-free diet, while results suggested that vegetarian and omnivorous diets were rated equally in terms of masculinity, vegan in comparison to omnivorous diets still lead to perceptions of lower masculinity (59).

2.3.3 Age

From data on populations where sampling was conducted in order to increase the number of vegetarians included in the sample, PBDPs have been associated with younger age. There have been two cohort studies which explored the association between age and plant-based diets. In France, an online cohort study of meat-eaters and PBDP followers found that both vegetarians and vegans were 20 to 70% less likely to be in the older age category (50-65 years old) relative to a younger age category (18-30 years old) compared to meat eaters (40). In a UK cohort, median age at recruitment into the study was highest for meat-eaters and decreased progressively for pescetarians, vegetarians, and vegans (37). Additionally, recent poll data in Canada suggested that vegetarians were three times more likely to be under the age of 35 compared to being 49 years of age or older (51).

Population-representative studies have also suggested associations between vegetarianism and age. In a sample of vegetarians and omnivores in B.C., vegetarianism was associated with younger age, being more likely to be in the 19 to 30 year old age range category compared to the 31-50, 50-70 or 71+ age categories (31). Vegetarians in Germany were more likely to be in the 18-29 age category compared 70-79 age category, after adjusting for gender, education, municipality size and hours of sporting activity per week (42). In Finland, after adjusting for gender, there was a significantly higher prevalence of vegetarianism among people aged 18-29 compared to other age groups ranging from ages 30 to 79 (29). While most studies found vegetarianism to be more likely associated with younger age, other studies suggested otherwise. In 2012, Americans who reported trying vegetarianism or veganism in the past 12 months for health reasons were more likely to be in the 30-39, 40-49, 50-64 age groups and less likely to be over 65 years of age compared to the youngest age group (18-29 years old) when other significant factors were adjusted for (the factors adjusted for were not listed explicitly in the publication) (33). In South Asia, vegetarians in the sample tended to be significantly older, with higher proportions in the 40-49, 50-59 and 60-69 age groups compared to the non-vegetarian age distribution (41). Similarly, in Italy there were significantly more vegetarians in the > 65 age group compared to the under 18 age group (44).

The majority of the studies demonstrating an association of vegetarianism with younger age may reflect the preferences of the youth or their willingness to try novel diets. This is supported by evidence suggesting that those who achieved high scores in the personality trait of openness had a higher probability of being vegetarian (43). Younger vegetarians have also been shown to differ in their motivations for following a PBDP. There is reason to believe that younger people might prioritize concerns of a sustainable future over worries related to personal health problems. One survey exploring consumer’s perceived benefits of vegetarian diets found that the members of the younger age group (age 15-39 years) were more likely than the members of the older age groups (40-55 years and 56-91 years) to agree that eating a vegetarian diet could "help the environment" (60). Additionally, one study found that younger vegetarians were more likely to be motivated by environmental reasons while older vegetarians were more likely motivated by health concerns, though this study has limited generalizability due to being conducted on a 7th day Adventist college campus (61). Perhaps the reason for a shift towards older age in the age distribution of vegetarians in South Asia and Italy reflect a change towards PBDPs for health concerns, given that diets such as vegetarianism have been recommended by various health organizations to manage chronic disease (15,16,62).

2.3.4 Socioeconomic Factors: Education, Income, and Occupation

Other characteristics affecting avoidance of meat consumption fall under the blanket of socioeconomic status: education, income, and occupation. The following sections will examine the associations between each factor in detail.

Although associations between education and PBDPs were conflicting, when examining non-population-representative studies the majority of studies appear to suggest an association between PBDPs and a higher level of education (though all of these studies were conducted in developed countries). In Canada, a 2018 poll of 1027 adults over the age of 18 reported that a higher percentage of consumers with graduate degrees reported a desire to reduce meat consumption relative to consumers with other education levels such as high-school or having a "university certificate" (63). This poll may be limited in that while the report suggests that the estimates are from a "representative sample of the Canadian market", no details on sampling methodology are mentioned. From the Adventist Health Study 2 (AHS-2) which examined a population of 7th day Adventists from the USA and Canada, the lacto-ovo-vegetarian group had the highest proportion of college graduates (60.1%) compared to nonvegetarians, semi-vegetarians, pesco-vegetarians and strict vegetarians (45%-54% range) (38). Similarly, in the Netherlands, respondents who did not consume meat had one higher level of education on average compared to meat-eaters (levels of education were "lower vocational", "medium vocational" and "university and higher vocational") (64). While these forms of vegetarianism seem to be associated with higher education level, two other studies in Europe have suggested otherwise. In the UK, pescetarians were more likely to have university degrees compared to all other dietary groups (omnivore, vegetarian and vegan) (37). Furthermore, vegans in France more likely to have a lower educational level compared to meat consumers (40).

When examining population-representative studies, vegetarianism and high education appear to be associated more consistently. From a study published in 2017 on American vegetarians, having had at least some college education relative to not finishing high school significantly increased the odds of reporting vegetarianism (33). Among those who reported vegetarianism in India, there was a greater proportion of highly educated people compared to people with less than a secondary school education (46). Having a high education level was also associated with vegetarianism in Germany, Italy and Finland, even when accounting for other factors such as age and sex (29,42,44). The only study that suggested otherwise was a 2005 study from B.C., Canada where vegetarianism was not associated with education level (31).

One explanation for the association of vegetarianism and higher education status may be due to climate change. It is possible that those with higher education are more likely to be well-informed about the impacts of climate change, and environmental sustainability is one of the key motivators to adhere to a PBDP (2,47,60). However, while education does have a small effect on climate change belief, political affiliation and ideology (left wing) are more highly correlated with climate change belief in comparison (65).

The association with income level and PBDPs has been variable across different studies. Canadians sampled through an online poll who were earning more than $150,000 per year were more likely to self-identify as vegetarian than people earning less than $80,000 (51). In contrast, vegetarians in France were more likely to belong to the lower income group compared to meat consumers (40). Similarly, in examining population- representative studies, in B.C. among vegetarians, a significantly larger proportion was in the low income group (37.2%) compared to the proportion of those in the low-income group among non-vegetarians (22.8%) (31). In a study of vegetarians, consumers of meat substitutes and meat consumers in the Netherlands, dietary practices were not associated with income (66). Likewise, vegetarianism was not associated with income in Germany (43).

There were few studies examining the occupational status of those following PBDPs, with inconsistent results among studies. In France, respondents who were self-employed or never employed had higher odds of veganism and vegetarianism than respondents employed as managerial staff (40). A population-representative study in the Netherlands used a composite socioeconomic status variable taking into account education, occupation and occupational position, and found that vegetarians were more likely to have a higher socioeconomic status compared to meat consumers (66). Thus, while the majority of studies suggest an association between PBDPs and high levels of education, associations with income level and occupational status are less consistent in current studies.

2.3.5 Marital Status

Data from non-population representative samples of people following PBDPs suggest an association between PBDPs and marital status. In France, both vegetarians and vegans were more likely to be single and without children compared to being coupled and/or having children (40). In the European Prospective Investigation into Cancer and Nutrition Oxford cohort (EPIC-Oxford), the vegans in the sample contained a higher proportion of those who were single (41%) compared to meat-eaters (21%), though the authors did not conduct any statistical tests to verify if this discrepancy was significant (37). In another cohort overpopulated with vegetarians in the Netherlands, among married people there was a lower proportion of vegetarians, pescatarians and low meat consumers (defined as one day per week) than among single people (30). While the majority of the aforementioned studies reported associations between PDBP and single status, in one study people reporting lacto-ovo vegetarian and vegan diets had the highest proportion of married subjects in the AHS-2 compared to pescatarian, “semi-vegetarian” (defined as those who consume animal flesh based products once per month but less than once per week) and non-vegetarians (38).

Data from population-representative studies suggest that vegetarianism is also associated with not being in a relationship. From a 2005 population-representative study in B.C., when examining the distribution of marital status among vegetarians, a higher proportion of vegetarians were single compared to non-vegetarians (31). In America, being in a relationship decreased the odds of reporting vegetarianism or veganism, after adjusting for other factors such as age and sex (33). Similarly, those in Italy and Finland were also more likely to be separated or single relative to non-vegetarians, when adjusting for confounders (29,44).

2.3.6 Supplement Intake, Physical Activity and Body Mass Index

Nutrients of concern for those following vegetarian and vegan diets include omega-3 fatty acids, iron, zinc, calcium, vitamin D and B12 exist, and dietary supplementation of these nutrients may be warranted (13,67). In particular, the estimated prevalence of vitamin B12 deficiency status ranges from 0 to 86.5% for adults and elderly individuals among vegetarians based on reported serum total B12 levels as reported by Pawlak et al. in 2014 (68). Two population-representative studies have suggested that reporting a PBDP is associated with dietary supplement use. Pescatarians and vegetarians in Finland were more likely to use supplements relative to non-vegetarians after adjusting for factors such as age and gender (29). In a 2005 B.C. study, significantly more male vegetarians (71%) relative to male non-vegetarians (51%) were supplement users, but for women supplement intake did not differ significantly between vegetarians and non-vegetarians (31). Thus, although there is evidence for the association of PBDPs with supplement use, this association may differ by gender, with significant differences in supplement intake only among male vegetarians compared to male non-vegetarians.

The link between physical activity and PBDPs has not been clearly established. Physical activity did not appear to be associated with meat exclusionary diets in the Netherlands (30). Among a sample of 7th day Adventists, the lacto-ovo vegetarian group had the lowest proportion of respondents engaging in 45 minutes or more of vigorous physical activity while non-vegetarians had the highest proportion in comparison to pescatarian and vegan groups, although the proportions were generally similar across all groups (38). Studies using population-representative samples also suggested mixed results. In America, respondents who reported moderate intensity and high intensity exercise relative to being sedentary had higher odds of reporting adherence to a vegetarian or vegan diet (OR: 1.40, 95% CI: 1.21, 1.61, and OR: 1.52, 95% CI: 1.20, 1.92 respectively) (33). Similarly, in Germany, the odds of vegetarianism were higher for people who reported participating in over 4 hours per week of sports activity relative to less than 4 hours, after adjusting for gender, age, education and municipality size (42). In B.C., while there was no difference in physical activity among male vegetarians compared to male non-vegetarians, female vegetarians were more likely to report participating in physical activity 4 or more times per week compared to female non-vegetarian (31). In contrast, vegetarians were more likely to be sedentary (defined as "time spent lying down or sitting, not including sleeping") compared to non-vegetarians in South Asia (41). As there is evidence to suggest that adult vegetarians are more health-consciousness than non-vegetarians, and that health-related reasons have been found to be one of the main motivators of meat exclusion, this may be one explanation for the association between physical activity and plant-based eating (2,31,69).

Most studies exploring the connection between smoking and PBDPs were consistent. In the Netherlands, low meat consumers, vegetarians and pescatarians were less likely to smoke compared to meat consumers (30). Likewise, in the AH-2 study, the highest proportion of subjects who had used tobacco were in the non-vegetarian group, compared to vegan, vegetarian and pescatarian groups (38). Population representative studies reported analogous results. In India, among non-smokers, there was a higher proportion of lacto-ovo vegetarians compared to smokers which was the opposite of non-vegetarians who comprised a higher proportion of the smoking group (46). Vegetarians in America, South Asia as well as B.C. were also less likely to smoke compared to non-vegetarians (31,41). Respondents reporting recent vegetarianism or veganism (in the last 12 months) were less likely to smoke in another more recent American sample (33). Although a significantly higher proportion of smokers were vegetarian in Italy compared to non-smokers, this association was later lost when other factors such as age, gender and education status were adjusted for (44). Thus, most studies suggested that a decreased likelihood of smoking was associated with following a PBDP, which again may be related to the health motivations behind choosing a PBDP (2,69).

Reporting a PBDP has been associated with lower Body Mass Index (BMI) in a number of observational studies. Vegans in a sample of adult 7th day Adventists had the lowest mean BMI (24.1 kg/m^2) while conversely non-vegetarians in the sample had the highest BMI (28.6 kg/m^2), after adjusting for age, sex, race, physical activity and dietary pattern (38). In France, vegetarians were more likely to have a BMI under 20 compared to meat-eaters after adjusting for sex, age, education level, occupation, income, household composition and living area (40). Mean BMI was significantly lower for vegetarians and pescatarians compared to meat consumers in a cohort in the Netherlands (30). Among population representative studies, BMI also appeared to be lower for PBDP reporters. In a 2005 B.C. study, age-adjusted mean BMI was lower in vegetarians compared to non-vegetarians but only for females (31). Vegetarians in both South Asia and America had significantly lower BMI than non-vegetarians after adjusting for age, sex, education, tobacco and alcohol intake (41). In a more recent study conducted in America, respondents with a BMI within the 25 – 30 kg/m^2 range and above, relative to the 18.5 – 25 kg/m^2 range, had a 33-42% lower odds of reporting using a vegetarian diet in the last year, after adjusting for other factors such as age and sex (33). The only study to report inconsistent results regarding BMI compared with the previous mentioned studies was by Ponzio et al in 2015. This study conducted in Italy found that while vegetarians comprised a significantly higher proportion of respondents in the overweight/obese group (defined as a BMI > 25 kg/m^2) compared to the proportion of vegetarians in the non-overweight/obese category, this association was lost after adjusting for confounders (44).

When used as intervention for weight loss, vegetarian diets have been shown to reduce mean weight, with greater weight loss seen in samples with higher baseline weights and longer intervention durations among other factors (70). In a meta-analysis of dietary quality, vegetarians consumed more nutrient-dense foods such as whole grains, total fruit and plant proteins relative to meat-consumers (71). It is possible that the higher intakes of fibre from the foods consumed more frequently among PBDP adherers, as well as replacement of red-meat which is generally higher in saturated fat and cholesterol, could be driving the weight loss (71).

2.3.7 Chronic Disease

As mentioned previously, certain PBDPs such as vegetarianism have been advocated as healthful ways of eating by different health organizations, including the American Institute for Cancer Research, The American Heart Association and Diabetes Canada (15–17). Additionally, the following sections will detail the evidence suggesting inverse associations between PBDPs and chronic diseases such as heart disease, diabetes, and cancer.

There is evidence to suggest that vegetarian diets may improve cardiovascular disease risk factors such as obesity, serum lipids, and blood glucose profiles while decreasing inflammation markers (13,70,72,73). Vegetarian diets have also been associated with lower blood pressure (74). In particular, lacto-ovo-vegetarianism and veganism have been associated with a lower odds of hypertension compared to non-vegetarians, specifically in 7th day Adventist cohorts (75). Furthermore, reviews and meta-analysis studies suggest that vegetarian diets are associated with lower incidence of and mortality from heart disease (76,77). Related to the animal source exclusionary component of certain PBDPs, avoidance of red meat to improve blood lipid levels has been explored as a dietary strategy to reduce cardiovascular risk(78). Vegan diets appear to be the most beneficial in decreasing heart disease risk factors, as these types of diets tend to be higher in fibre and lower in saturated fat and cholesterol (13). Despite this evidence, there may be complexities such as sex difference that affect this association. For instance, in a cross sectional study vegetarians from B.C., female vegetarians had a higher prevalence of hypertension than female non-vegetarians while male vegetarians were more likely to report heart disease compared to male non-vegetarians (31).

Plant-based diets have also been associated with a lower prevalence of type 2 diabetes and have been recommended by Diabetes Canada for medical nutrition therapy in type 2 diabetes management (79). Intervention studies have shown PBDPs to be as effective, if not more so than other diets in improving weight, insulin sensitivity and cardiovascular risk factors (70,79).

Prevalence of diabetes in the Adventist Health Study 2 was lowest in respondents following a vegan diet with the highest prevalence found for non-vegetarians (75). Population-representative results from India suggest that vegetarianism (including lacto- and lacto-ovo-vegetarians) had a 30-33% lower odds of self-reported diabetes status (46).

Indirect support for the protective effects on cancer of PBDPs, which generally include a lower to nonexistent meat consumption, may come from evidence which suggests that increased red meat and processed meat intake has been associated with colorectal cancer (77,80). The procedure for preparing processed meat may lead to an increase of carcinogen precursors such as polycyclic aromatic hydrocarbons and nitrosamines which could explain the association of increased meat intake with cancer (81). Vegetarian diets have been associated with a lower incidence of total cancer though the results are mixed (76,77). Veganism has been associated with a reduced risk of total cancer (76).

2.4 Knowledge Gaps in the Canadian Context, Study Purpose and Significance of this Research

The significance of plant-based diets for both health and sustainability, combined with the recent release of the 2019 Canada's Food Guide and Canada's Dietary Guidelines, makes the discourse surrounding PBDPs including how to measure their uptake, their prominence in the country, and who follows them more important than ever in a Canadian context. To date, there has been no population-representative estimates of PBDP prevalence using nationally representative data in Canada. In addition, there have been no PBDP definitions tailored to the

Canadian population. Without such definitions, quantifying and comparing the variations in characteristics and dietary quality which may differ between vegetarians and omnivores is difficult, and has not yet been explored in the Canadian context.

Exploring the geographic, sociodemographic, and lifestyle/health predictors of certain dietary exclusions could have many implications. This information could help inform environmental sustainability advocacy groups in appealing to the most receptive target audience to adopt their message but also inform them of potential audiences that might be worth appealing to in order to improve overall population uptake of plant-based eating. Related to this, it may help factor into provincial level calculations regarding Canada's environmental footprint and greenhouse gas emissions. Understanding the demographic information of people adopting PBDPs could also aid companies marketing meat substitutes and other plant-based snack foods. Following recent policy updates, exploring demographic predictors of dietary excluders in Canada could assist in identifying Canadians who may already be adhering to the proposed guidelines for Canada's new 2019 food guide. This could also provide a starting point for research regarding which groups might be more willing to accept Canada's new 2019 food guide and its recommendations in adopting a more PBDP.

2.5 Specific Aims

My research objectives are therefore to:

i. Operationalize definitions for PBDPs based on animal source food exclusions to estimate the prevalence of Canadians who adhere to PBDPs, and
ii. Explore the correlates of PBDPs in the Canadian context

Chapter 3: Research Methods

3.1 2015 Canadian Community Health Survey- Nutrition

Data were obtained from the 2015 Canadian Community Health Survey – Nutrition (CCHS). All data analysis was conducted in the Research Data Centre (RDC) located in Koerner's Library at the University of British Columbia. As this research was a secondary analysis of anonymous data, a behavioural research ethics board review was not required.

The 2015 CCHS is a national, population representative, cross-sectional survey focused on the dietary patterns, supplement intake, and relevant sociodemographic and health characteristics of Canadians with a sample size of approximately 20 487 people (82). The survey collected data on food consumption and supplement use, information on specific health conditions, socioeconomic factors and demographic characteristics and aimed to contribute to knowledge regarding dietary practices of Canadians (82). A multi-stage cluster sampling design was used to ensure that the survey was nationally and provincially representative of the population in terms of age, sex, geography, and socioeconomic status (82).

Survey interviews consisted of a "Health Component" questionnaire and a 24-hour dietary recall component. 24-hour recalls were administered using the computer-assisted Automated Multiple-Pass Method (AMPM) created by the United States Department of Agriculture. The primary data component used for this study was the "Health Component" questionnaire. The survey response rate was 61% (82).

3.1.1 Target Population

As detailed in the reference guide by Health Canada, in total 20,487 people, aged 2 years and above, from the ten provinces of Canada were included in the survey (82). Individuals who were full-time members of the Canadian Forces, lived in the Territories, on reserves and other Aboriginal settlements, in some remote areas, or in institutions such as prisons or care facilities were excluded. The analytical sample included those that had answered the dietary exclusion question which was asked in the "Health Component" part of the survey.

3.1.2 Defining Plant-Based Dietary Practices

The CCHS is an optimal dataset to explore plant-based dietary practices as it is the first nationally-representative survey to include a question inquiring about complete dietary exclusion of animal source products. This dietary exclusion question (listed below) was a recent addition to the CCHS, and asked whether respondents completely excluded from their diet different types of animal source food as well as gluten.

> "Do you completely exclude any of the following foods from your diet? By "completely exclude" we mean you never eat it on its own or as part of a prepared dish"

- ☐ Meat (beef, pork, lamb, etc.)
- ☐ Poultry (chicken, turkey, duck etc.)
- ☐ Fish and shellfish
- ☐ Eggs
- ☐ Dairy products (milk, cheese, etc.)
- ☐ Gluten sources (wheat, barley, rye, triplicate, etc.)
- ☐ None

Respondents had the option to choose any/all of the aforementioned food categories they excluded. “Completely excluded” was defined as never eating the food on its own or as part of a prepared dish (82). This question was specifically developed for the 2015 edition for possible examination of different types of vegetarianism (83).

The definitions of different PBDPs were operationalized from the responses to this question depending on which exclusions each respondent reported. To ensure that no exclusion combination was missed, a user generated command in Stata “groups.ado” was run (84). This command listed all the frequencies for every possible iteration of the dietary exclusion combinations. Each combination of exclusions was reviewed and manually coded into a category based on a-priori definitions informed by how each PBDP category had been defined in the literature. For example, respondents that reported excluding meat, poultry, fish and shellfish, eggs and dairy were coded as “Vegans” whether or not they excluded gluten. “Vegetarians” were coded as those that reported excluding at least meat, poultry, fish and shellfish with no restrictions on eggs, dairy or gluten. The exception to being categorized as “Vegetarian” would be someone who excludes meat, poultry, fish and shellfish, eggs, and dairy as these respondents would fall under the category of “Vegan” instead. In this way, exclusions were created as a gradient from most exclusionary (“Vegan”) to least exclusionary (“Meat-Nonexcluder”); The categories were “Vegan”, “Vegetarian”, “Pescatarian”, “Meat-excluder” and “Meat-Nonexcluder”. While each category would technically satisfy the requirements to be in the subsequent less exclusionary category, all categories were designed to be mutually exclusive.

Other combinations that did not fit within the definitions of the a-priori defined PBDP categories were also included in the prevalence estimates. For instance, respondents who reported only one exclusion (e.g., people who only reported excluding eggs) were also included in the results. An “Other Exclusions” category was also constructed to capture exclusion combinations that did not fit the PBDP categories (i.e., those who reported excluding eggs and fish only were placed in the “Other Exclusions” category).

3.1.3 Potential Correlates of Plant-Based Dietary Practices: Variables of Interest

As guided by the literature review in Chapter 2, variables that were suggested in the literature to have some association with plant-based eating are:

- Region of Canada
- Urban vs Rural
- Sex
- Age
- Marital Status
- Immigration Status
- Self-Identified Cultural/Racial Group
- Education
- Working Status
- Food Insecurity
- Income
- Supplement Use
- Physical Activity
- Chronic Disease Status
- Smoking
- BMI

All variables were categorical with the exception of age and BMI which were measured as continuous variables. Age was measured in years. Measured BMI (in kg/m^2) was used when available; otherwise self-reported BMI was used instead.

Many of the categorical variables were collapsed into fewer groups due to the limitation that within each descriptive table each cell must contain an $n > 5$ to protect the confidentiality of the respondents (as will be described in further detail in the following section 3.3.2.1). Regions of Canada were categorized as follows with certain provinces collapsed into one region: Atlantic (Nova Scotia, New Brunswick, Newfoundland and Prince Edward Island), Quebec, Ontario, Prairie (Alberta, Manitoba, Saskatchewan) and British Columbia. Urban and rural categorization was based on the number of households in each pre-determined geographic area, according Census Dissemination Areas created by Statistics Canada (82). Biological sex was reported as a dichotomous variable (male or female). Marital status was also dichotomized into single (including widowed or separated) versus coupled (including married and common law). Self-identified cultural identity was collapsed into White, South Asian, and Other categories, the latter of which encompassed all other cultural identities. The highest education level of the respondent was collected for respondents over the age of 14 and categorized into 3 levels: 1) high school equivalent and below, 2) certificate or diploma below bachelor's level, and 3) bachelor's degree or higher. Working status in the last week was measured in respondents aged 15 to 75 and dichotomized into unemployed or employed. Household food insecurity status in the past 12 months was a derived composite variable based on the 18-item US Household Food Security Survey Model questionnaire, dichotomized into food secure and food insecure (82). Total household income before taxes was dichotomized into high and low income using $30,000 per year as a conservative cut-off based on the Statistics Canada defined 2015 Market Basket Measures (a low income measure based on the cost of a basket of goods representing a basic standard of living) that were found to be around $30,000 to $40,000 depending on the area in Canada (85,86). Supplement use in the past month was dichotomized into a yes or no question. Adult physical activity was collected for those aged 18 and above and determined whether or not respondents participated in 150 minutes per week of "moderate or vigorous" physical activity, with "moderate" defined as causing an increase in heart rate. Chronic disease status was collected for respondents aged 19 and above and asked whether or not the participant reported one or more of high blood pressure, diabetes, heart disease or cancer. Smoking status was collected from respondents aged 12 and above and dichotomized into smoker and non-smoker.

3.2 Statistical Analysis

3.2.1 Estimating the Prevalence of Plant-Based Dietary Practices in Canada

Survey weighted frequency tables were constructed using the operationalized definitions of PBDPs as described in the earlier section.

3.2.2 Exploring Correlates of Plant-Based Dietary Practices in Canada

3.2.2.1 Bivariate Analyses

To explore bivariate associations between the previously mentioned Variables of Interest and PBDP categories, data were presented in weighted frequency distribution tables and analyzed using Rao-scott chi-square tests. For continuous variables, a simple linear regression model was used with PBDP category as the independent variable and the continuous variable (age or BMI) as the dependent variable. A p-value of < 0.05 was defined as statistically significant, with a Bonferroni correction applied to account for multiple comparisons for the analyses on continuous variables.

To protect confidentiality, for the CCHS 2015, Statistics Canada does not allow release of descriptive tables that contain cells with $n < 5$. Therefore, to increase the sample size within some PDBP categories, “Vegans” were collapsed into the “Vegetarian” category. Additionally, for this reason, many of the variables mentioned in the Variables of Interest section were also collapsed into fewer levels, or dichotomized (e.g., province, self-identified racial/cultural group, income, etc., as mentioned previously in section 3.3.3) in order to release the data from the Research Data Centre. For example, if there were n = 0 pescatarians that self-identified as Filipino, Filipinos were collapsed to be included in the Other cultural/racial grouping to ensure the number of total pescatarians was over 5. Sensitivity analyses were conducted to make sure the collapse of categories did not substantially affect the results or interpretation of key findings: i.e., magnitude and associations between PBDPs and other variables.

3.2.2.2 Multivariable Analyses

To explore the multivariable associations between the various sociodemographic variables and reporting a PBDP while controlling for potentially confounding factors, the outcome variable was dichotomized into "Vegetarians" versus "Non-vegetarians", and a multivariable logistic regression model was built using a theory-driven serial adjustment strategy. Model fit was assessed at each step using the Wald test. In the outcome variable, both Vegans and Vegetarians were included in the "Vegetarian" category, while all other PBDP categories were in the "Non-vegetarian" category, as detailed in Table 3.1. The reason for this categorization was to explore the most widely accepted theoretical definition of vegetarianism in the literature respondents who exclude flesh-based foods such as meat, poultry, and seafood from their diet (as detailed in section 2.1). The rationale behind dichotomizing the outcome variable was to enable the results to be comparable to those in the literature, the majority of which also examined vegetarian status in a dichotomy (29,33,43,44). In addition, sensitivity analyses were conducted using crude multinomial logistic regression models with each Variable of Interest as a predictor and each of the PBDP categories from the bivariate analysis as the outcome variable.

The results of the sensitivity analyses confirmed that the logistic regression results were robust to model specification in that the majority of significant associations in the multinomial logistic regression were found when comparing the odds of reporting "Vegetarian" and "Meat-Excluder" relative to "Meat-Nonexcluder" categories (reported in Appendix A).

Table 3.1 PBDPs Collapsed Into Dichotomous Outcome Variables

	Outcome Variable	
Outcome Variable Levels	Vegetarians	Non-Vegetarians
PBDP Categories Included in Outcome Level	• Vegan • Vegetarian	• Pescatarian • Meat-Excluder • Meat-NonExcluder

3.2.2.3 Logistic Regression Model Approach

The purpose of building this logistic regression model was to identify the significant predictors associated with reporting vegetarian status. In building the mode, the intent was to only include variables in the model that had robust evidence and theoretical justification for potentially predicting vegetarian status, in a modified forward selection method. Sex was included in the model as gender and sex have been shown to be consistently associated with plant-based eating, particularly in regards to females being more likely to report vegetarianism in the literature (30,31,33,37,40). Next, while age was not associated with PBDP status in the exploratory bivariate analyses presented in the next chapter using CCHS data, the majority of previous studies have demonstrated an association between vegetarianism and younger age (29,31,37,40,42,51,60). In addition, including age in the model would contribute to increasing face validity. Geographic factors such as urban residence and Canadian province of residence were included in the model as these have been shown to be associated with plant-based eating

(42,51). In the case of urban/rural residence, this association makes sense theoretically given the potentially decreased diversity and availability of food in some rural locations (55). These first 4 variables in the model (sex, age, urban/rural residence, Canadian provincial residence) were also collected from the entire sample regardless of age, which differ from the following variables that will be described. Ethnicity and immigration status were included in the model as the prevalence of Vegetarianism has been shown to differ between countries, and views on meat-eating have also been shown to differ by culture, so it is likely that those who have immigrated from different countries or who self-identify within a certain culture may be more or less likely to be vegetarian, depending on the culture (29,33,43–46). The last set of variables added to the model were education and income which encompass aspects of socioeconomic status, and marital status which refers to the availability of social support. Again, these variables have been associated with vegetarian status in previous studies but with less consistent directionality of the associations. For education, while many studies have suggested a positive association between vegetarianism and education status, this finding was not replicated in the one study conducted in B.C., Canada (29,31,42,44). While studies that included income in regards to vegetarian status showed inconsistent associations, there is reason to believe that income would be associated with a meat-exclusionary diet, as price has been suggested as a barrier to consumers choosing meat-substitute products, which could be part of the Vegetarian diet, over meat (31,40,42,66,87). Vegetarians were more likely to be single in all but two of the studies examined (29,31,33,44). Missing data were deleted in a case-wise manner. Model n decreased by around 30% when socioeconomic variables were introduced as education was not collected for those under the age of 14.

The model was also run on the samples stratified by sex. In their 2015 study, Bedford and Barr suggested in there may be differences between male and female vegetarians in food choice motivations and lifestyles which provided impetus to examine sex differences in the current study's models (31).

Variables from the univariate analyses that were not included in the multivariable model include working status in the last week, food insecurity, BMI, chronic disease, smoking, supplement use and physical activity. One reason for not including all of the Variables of Interest in the model is to avoid overfitting the model and to make it as parsimonious as possible. Some of these variables such as smoking, supplement use, and physical activity may be behaviours that cluster with the behaviour of following a plant-based dietary practice but might not necessarily be a cause of vegetarian status. For example, there is the possibility that supplement intake is a behaviour that follows an adoption of a vegetarian diet to ensure consumption of any nutrients that may be missing from a meat-exclusionary diet (such as vitamin B12). Sensitivity analyses were conducted with each of these other variables included in the final model to examine their associations with vegetarian status (i.e., final model + working status, final model + food insecurity, etc.) and can be found in Appendix C.

Survey weights were applied to all analyses to produce nationally representative estimates. The sampling weight was applied to each respondent and represents the number of people in the population that the respondent represents (83). Standard errors were obtained using the bootstrapping method with provided bootstrap weights from Statistics Canada (83). Analysis for all objectives was conducted using Stata version 12 (88).

Chapter 4: Results

4.1 Operationalized Definitions of Plant-Based Dietary Practices in Canada

Respondents that reported excluding meat, poultry, fish and shellfish, dairy products, *and* eggs were defined as “Vegans”. Respondents that reported excluding meat, poultry, and fish and shellfish were defined as “Vegetarians”. Pescatarians were defined as those who reported excluding meat and poultry. “Meat-Excluders” were defined as those who reported excluding meat. All other dietary exclusion combinations or lack thereof were defined as “Meat-NonExcluder”. Each definition was mutually exclusive. These definitions, in order of most to least exclusionary can be found in the following Table 4.1. More detailed categorization of each type of exclusion can be found in Appendix B.

Table 4.1 Operationalized Definitions of PBDPs from CCHS 2015

PBDP category	**Defined by exclusion of:**				
	Meat	Poultry	Fish and Shellfish	Eggs	Dairy Products
Vegan	X	X	X	X	X
Vegetarian	X	X	X		
Pescatarian	X	X			
Meat-Excluder	X				
Meat-NonExcluder					

X indicates the animal-source food was **excluded** from the diet

4.2 Prevalence of Plant-Based Dietary Practices in Canada

Table 4.2 Weighted Prevalence of Self-Reported Dietary Exclusions in Canada in 2015

Theoretical Exclusion Category	%	SE	Defined as those who excluded:
Vegan	0.28	0.08	Meat, Fish, Poultry, Eggs, Dairy (MFPED)
Vegetarian	1.29	0.16	Meat, Fish, Poultry (MFP)
Pescatarian	0.65	0.13	Meat, Poultry (MP)
Excluded Meat Only	2.31	0.22	Meat only
Excluded Poultry Only	0.20	0.06	Poultry only
Excluded Fish and Shellfish Only	5.29	0.33	Fish and Shellfish only
Excluded Eggs Only	0.52	0.09	Eggs only
Excluded Dairy Only	1.15	0.17	Dairy only
Excluded Gluten Only	1.24	0.13	Gluten only
Other Exclusions	1.43	0.14	Other combinations of exclusions not captured in the above categories*
Total Exclusions	14.30		
NonExcluders	85.63	0.47	Did not report any exclusions
Total	99.93**		

*E.g. A respondent who reported excluding only eggs and gluten from their diet would be categorized under "Other exclusions"
**Totals do not equal 100% due to rounding;
SE = standard error

The weighted prevalence of different dietary exclusions of Canadians in 2015 is detailed in Table 4.2. The exclusion category with the highest prevalence was fish and shellfish only exclusions (5.3%) while the second highest was meat only exclusions (2.3%). Those who reported vegetarianism, dairy-only exclusions, gluten-only exclusions, and other exclusions was around 1% for each category. Other exclusions were defined as exclusion categories that would not fit within the definitions of the exclusions listed in this table. Vegans, pescatarians, chicken-only excluders and egg-only excluders comprised under 1% of the population each. Overall, just over 14% of the population reported at least one of the exclusions presented in the questionnaire.

Table 4.3Weighted Prevalence of Reported PBDPs in Canada in 2015

Theoretical PBD Category	%	SE	Defined as those who excluded*:
Vegans	0.28	0.08	Meat, Fish, Poultry, Eggs, Dairy (MFPED)
Vegetarians	1.29	0.16	Meat, Fish, Poultry (MFP)
Pescatarians	0.65	0.13	Meat, Poultry (MP)
Meat-Excluders	2.81	0.23	Meat (M)
Meat-NonExcluders	94.97	0.32	All other non-PBDP related exclusions + Did not report exclusions**
Total	100		

*Note: If an exclusion (out of the categories of Meat, Fish, Poultry, Eggs, Dairy and Gluten) is not listed, the respondent may or may not have excluded them in their diet; e.g. *Meat, Fish, Poultry* means respondent excluded Meat, Fish, and Poultry but may or may not have excluded Eggs, Dairy or Gluten

**E.g. Those who reported excluding Fish and Shellfish Only were included in the Meat Eater category as this definition does not fit within any theoretical definitions of PBDs

Table 4.3 details the Canadian prevalence of PBDPs in 2015. Under 5% of Canadians reported total exclusion of animal source products, with the majority identifying as a meat-excluder (2.8%), followed by those reporting vegetarianism (1.3%), pescatarianism (0.7%) and veganism (0.3%). Meat-Nonexcluders comprised the majority of the sample (95%).

4.3 Bivariate Analyses among Variables of Interest

Table 4.4 Proportion of Reported PBDPs by Sociodemographic Variables

Characteristics	PBDP categories								P-value
	Vegetarians†		Pescatarians		Meat-Excluders		Meat-NonExcluder		
	%	SE	%	SE	%	SE	SE	%	
Total	1.57	0.18	0.65	0.13	2.81	0.23	94.97	0.32	
Region of Canada[1]									0.009*
Atlantic Provinces	1.22	0.29	0.56	0.21	1.86	0.37	96.36	0.51	
Quebec	0.44	0.13	0.66	0.38	2.34	0.49	96.56	0.63	
Ontario	2.17	0.38	0.77	0.22	3.37	0.45	93.69	0.63	
Prairie Provinces	1.36	0.29	0.35	0.10	2.63	0.34	95.66	0.49	
British Columbia	2.25	0.63	0.76	0.21	2.73	0.48	94.27	0.79	
Urban/Rural Residence									0.027*
Urban	1.73	0.22	0.72	0.15	2.99	0.25	94.56	0.36	
Rural	0.77	0.22	0.32	0.19	2.00	0.53	96.92	0.67	
Sex									0.038*
Female	1.89	0.29	0.69	0.14	3.35	0.34	94.07	0.46	
Male	1.23	0.20	0.62	0.22	2.26	0.26	95.89	0.38	
Marital Status[2]**									0.078
Single	1.14	0.23	1.05	0.31	2.53	0.40	95.27	0.56	
Coupled	1.88	0.29	0.55	0.15	2.96	0.33	94.61	0.45	
Immigrated to Canada**									<0.001*
Yes	3.94	0.59	1.00	0.34	4.76	0.66	90.29	0.92	
No	0.82	0.13	0.54	0.13	2.21	0.22	96.43	0.29	
Identify Culturally/Racially as**									<0.001*
White	0.67	0.13	0.53	0.13	1.72	0.19	97.08	0.26	
South Asian	14.41	2.23	0.65	0.38	13.38	2.08	71.56	3.03	

Characteristics	PBDP categories Vegetarians†		Pescatarians		Meat-Excluders		Meat-NonExcluder		P-value
	%	SE	%	SE	%	SE	SE	%	
Other	1.50	0.42	1.11	0.40	4.14	0.63	93.24	0.82	
Education[3]**									0.001*
≤ High School	1.37	0.22	0.37	0.09	2.47	0.33	95.79	0.41	
< Bachelor's level	1.11	0.25	0.82	0.35	2.28	0.34	95.79	0.55	
≥ Bachelor's degree	2.57	0.55	1.16	0.35	4.07	0.64	92.19	0.86	
Working Status in the Last Week[4]**									0.335
Unemployed	1.60	0.30	0.64	0.17	3.48	0.48	94.27	0.57	
Employed	1.69	0.28	0.79	0.22	2.52	0.29	95	0.47	
Household Food Insecurity									0.846
Food Secure	1.60	0.19	0.67	0.14	2.81	0.23	94.93	0.33	
Food Insecure	1.22	0.44	0.51	0.24	2.92	0.60	95.35	0.85	
Household Income[5]									0.210
Low	1.17	0.31	1.13	0.55	3.44	0.65	94.26	0.92	
High	1.64	0.20	0.57	0.12	2.70	0.23	95.10	0.34	
Age[6]	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	0.315
	37.87	1.79	41.03	2.25	41.32	1.35	41.28	0.13	

All data analyzed using Chi-square corrected with Rao and Scott method except for age which was analyzed using simple linear regression.
† Vegans included in Vegetarian grouping
* p-value < 0.05
** Not including N/A and missing. Sensitivity analysis were completed to ensure dropping of missing data did not result in changes in significance of association between variables 1) Atlantic provinces include Nova Scotia, New Brunswick, Newfoundland and Prince Edward Island; Prairie provinces include Alberta, Manitoba, and Saskatchewan 2) Single includes widowed and separated; Coupled includes married and common law 3) This corresponds to the education of the respondent and was collected for those aged 14+; Levels include up to high school equivalent, certificate or diploma below bachelor's level, and bachelor's degree or higher 4) This information was collected for those aged 15-75 5) Total household income before taxes; Cut-off for low income was under $30,000 per year 6) Age measured in years; age also measured as a categorical variable according to DRI cutoffs was also not significant (data not shown due to vetting restrictions regarding low cell counts by Statistics Canada)

Table 4.4 provides the sociodemographic characteristics associated with PBDPs. Among the provinces the highest proportion of vegetarians appears to live in B.C. (2.3%), with Ontario close behind (2.2%). Ontario also had the greatest proportion of meat-excluders residing in the area (3.37%). Respondents reporting PBDPs were more likely to reside in urban locations (1.7% for vegetarians, 0.7% for pescatarians, 3% for meat excluders) compared to rural locations (0.8% for vegetarians, 0.3% for pescatarians, 2% for meat excluders). A higher proportion of females reported vegetarianism (1.89%), pescatarianism (0.69%) and meat-exclusion (3.4%) relative to men (1.2%, 0.6%, and 0.3%, respectively). Similarly, a higher percent of respondents in the highest education level reported vegetarianism (2.6%), pescatarianism (1.2%) and meat-exclusion (4.1%) relative to other education level categories. Among respondents who reported immigrating to Canada, there was a higher proportion of PBDP reporters (3.9% vegetarian, 1% pescatarian, and 4.8% meat-excluder) than among respondents who did not immigrate to Canada (0.8%, 0.5%, and 2.2%, respectively). Among respondents who self-identified as South Asian, there was a far higher proportion of vegetarians (14.4%) and meat-excluders (13.4%) than among respondents identifying as White (0.67%, and 1.27% respectively) . Marital status, working status, food insecurity, income, and age were not significantly associated with reporting a PBDP. Though age was reported as a continuous variable, sensitivity analyses examining age as a categorical variable produced similar results.

Table 4.5 Proportion of Reported PBDPs By Supplement Intake, Physical Activity, Chronic Disease, Smoking and BMI

Characteristics	PBDP categories: Vegetarians†		Pescatarians		Meat-excluders		Meat-Nonexcluder		P-value
	%	SE	%	SE	%	SE	SE	%	
Total	1.57	0.18	0.65	0.13	2.81	0.23	94.97	0.32	
Has Taken Supplement in Past Month**									0.012*
Yes	2.16	0.29	0.82	0.20	3.03	0.33	94.00	0.48	
No	1.08	0.20	0.51	0.17	2.63	0.29	95.78	0.41	
Participated in 150 minutes of Physical Activity/Week[1]**									0.303
Yes	1.14	0.27	0.81	0.24	2.71	0.38	95.34	0.49	
No	1.92	0.30	0.70	0.21	2.88	0.35	94.51	0.54	
Has at least one Chronic Disease[2]**									0.261
Yes	1.80	0.49	0.38	0.10	3.33	0.57	94.50	0.70	
No	1.48	0.21	0.82	0.21	2.66	0.29	95.03	0.42	
Smoker[3]									<0.001*
Yes	0.32	0.17	0.42	0.20	1.28	0.32	97.98	0.41	
No	1.87	0.25	0.79	0.17	3.14	0.29	94.20	0.41	
BMI[4]**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	<0.001*
	25.37^{a}	0.56	24.93^{ab}	0.87	26.58^{ab}	0.49	27.18^{b}	0.10	

Categorical data analyzed using Chi-square corrected with Rao and Scott method; BMI analyzed using simple linear regression † Vegans included in Vegetarian grouping *p-value < 0.05 ** Not including N/A and missing. Sensitivity analysis were completed to ensure dropping of missing data did not result in changes in significance of association between variables 1) This information was collected for those aged 18+ 2) Has at least one chronic disease out of high blood pressure, diabetes, heart disease or cancer, this information was only collected for those aged 19+ 3) This information was collected for those aged 12+ 4) Measured BMI was used. When measured BMI was unavailable, reported BMI was used. Means sharing a group letter (a, b) are not significantly different; Refers to adult BMI; This information was collected for those aged 18+

Table 4.5 shows the associations between other characteristics and reporting a PBDP. Supplement users had a higher proportion of vegetarians (2.2%), pescatarians (0.8%) and meat-excluders (3%) compared to those who did not take supplements in the last month (1.1%, 0.5%, and 2.6% respectively). PBDP reporters comprised a smaller proportion of smokers (0.3% vegetarian, 0.4% pescatarian, and 1.3% meat-excluder) relative to non-smokers (1.9%, 0.8% and 3.1% respectively). The mean BMI of vegetarians was significantly lower (25.4), but only compared to meat-nonexcluders (27.2). Physical activity and reporting a chronic disease were not associated with reporting a PBDP.

4.4 Multivariable Associations Among Variables of Interest

Table 4.6 Multivariable Logistic Regression Analysis of Reported Vegetarian Status by Sociodemographic Variables

	Odds of Vegetarianism
Sex	
Male	Reference
Female	1.72 [1.00, 2.96]
Age[1]	1.00 [0.98, 1.01]
Urban/Rural Residence	
Rural	Reference
Urban	1.84 [0.89, 3.81]
Region of Canada[2]	
Atlantic Provinces	Reference
Quebec	0.24** [0.09, 0.63]
Ontario	0.51 [0.23, 1.13]
Prairie Provinces	0.43* [0.19, 0.96]
British Columbia	0.55 [0.19, 1.55]
Identify Culturally/Racially as	
White	Reference
South Asian	16.70*** [8.01, 34.82]
Other	1.63 [0.76, 3.50]
Immigrated to Canada	
No	Reference
Yes	1.67 [0.90, 3,12]
Education[3]	
≤ High School	Reference
< Bachelor's level	0.90 [0.49, 1.66]
≥ Bachelor's degree	1.41 [0.78, 2.56]
Marital Status[4]	
Single	Reference
Coupled	1.28 [0.78, 2.07]
Income[5]	
Low	Reference
High	1.34 [0.58, 3.08]

Results displayed are odds ratios; 95% confidence intervals in brackets; *p<0.05, **p<0.01, ***p<0.001
The model includes sex, age, urban/rural residence, province of residence, self-identified racial/cultural grouping, immigration status, education, marital status and income 1) Age measured in years 2) Atlantic provinces include Nova Scotia, New Brunswick, Newfoundland and Prince Edward Island; Prairie provinces include Alberta, Manitoba, and Saskatchewan 3) This corresponds to the education of the respondent and was collected for those aged 14+; Levels include up to high school equivalent, certificate or diploma below bachelor's level, and bachelor's degree or higher 4) Single includes widowed and separated; Coupled includes married and common law 5) Total household income before taxes; Cut-off for low income was under $30,000

The odds of reporting Vegetarianism by sociodemographic factors are presented in Table 4.6. In the multivariable model, sex, age, urban/rural residence, Canadian provincial residence, self-identified cultural/racial grouping, immigrant status, education, marital status and income were included. Results from the multivariable model suggest that those living in Quebec (OR: 0.24, 95% CI: 0.09, 0.63) and those living in the Prairies (OR: 0.43, 95% CI: 0.19, 0.96) were less likely to report a Vegetarian dietary practice. Self-identified South Asian cultural/racial grouping was associated with a much higher odds of reporting Vegetarianism relative to the other variables (OR: 16.70, 95% CI: 8.01, 34.82). Sex, age, urban/rural residence, immigration status, education, marital status and income were not associated with Vegetarianism in the multivariable model.

Table 4.7 Final Logistic Regression Models of Reported Vegetarian Status by Sociodemographic Variables Stratified by Sex

	Odds of Vegetarianism	
	Females	Males
Age[1]	0.99 [0.96, 1.01]	1.01 [0.98, 1.04]
Urban/Rural Residence		
Rural	Reference	Reference
Urban	1.52 [0.64, 3.61]	2.91 [0.60, 14.12]
Region of Canada[2]		
Atlantic Provinces	Reference	Reference
Quebec	0.17** [0.05, 0.60]	0.40 [0.08, 2.04]
Ontario	0.36 [0.12, 1.05]	0.88 [0.21, 3.62]
Prairie Provinces	0.21** [0.08, 0.59]	1.07 [0.25, 4.47]
British Columbia	0.51 [0.12, 2.07]	0.61 [0.16, 2.38]
Identify Culturally/Racially as		
White	Reference	Reference
South Asian	17.18***[7.00, 42.16]	14.80***[3.50, 62.71]
Other	1.58 [0.56, 4.45]	1.58 [0.42, 5.91]
Immigrated to Canada		
No	Reference	Reference
Yes	2.16* [1.20, 3.89]	1.17 [0.32, 4.36]
Education[3]		
≤ High School	Reference	Reference
< Bachelor's level	1.11 [0.50, 2.48]	0.65 [0.24, 1.76]
≥ Bachelor's degree	1.31 [0.59, 2.89]	1.58 [0.53, 4.70]
Marital Status[4]		
Single	Reference	Reference
Coupled	1.27 [0.63, 2.55]	1.22 [0.57, 2.60]
Income[5]		
Low	Reference	Reference
High	2.06 [0.81, 5.22]	0.76 [0.21, 2.79]

Results displayed are odds ratios; 95% confidence intervals in brackets; *p<0.05, **p<0.01, ***p<0.001
The models include age, urban/rural residence, province of residence, self-identified racial/cultural grouping, immigration status, education, marital status and income 1) Age measured in years 2) Atlantic provinces include Nova Scotia, New Brunswick, Newfoundland and Prince Edward Island; Prairie provinces include Alberta, Manitoba, and Saskatchewan 3) This corresponds to the education of the respondent and was collected for those aged 14+; Levels include up to high school equivalent, certificate or diploma below bachelor's level, and bachelor's degree or higher 4) Single includes widowed and separated; Coupled includes married and common law 5) Total household income before taxes; Cut-off for low income was under $30,000

Results from the multivariable model stratified by sex are presented in Table 4.7. For females, respondents who self-identified as South Asian had higher odds of reporting

Vegetarianism than respondents who self-identified as White (OR: 17.18, 95% CI: 7.00, 42.16), and respondents who immigrated to Canada had higher odds of reporting Vegetarianism than respondents who were born in Canada (OR: 2.16, 95% CI: 1.20, 3.89). Respondents who lived in Quebec (OR: 0.17, 95% CI: 0.05, 0.60) or the Prairies (OR: 0.21, 95% CI: 0.08, 0.59) had lower odds of reporting Vegetarianism than respondents living in the Atlantic provinces. Age, urban/rural residence, education, marital status, and income were not significantly associated with Vegetarian status. For males, the only significant predictor was self-identified South Asian cultural/racial grouping, which was similar in magnitude and direction as it was for females (OR: 14.80 95% CI: 3.50, 62.71).

Chapter 5: Discussion

At the time of this study, this thesis was the first to explore the prevalence and determinants of animal source food exclusions in Canada using population-representative data from the most recent CCHS. This study is timely for Canadians in that it coincides with the release of the 2019 version of Eating Well with Canada's Food Guide which introduces an emphasis on the consumption of plant-based foods, particularly plant-based proteins in its messaging. It also coincided with the release of the EAT-Lancet commission report which urges consumers to consume less meat products for the health and sustainability of the planet. As such, the insights forthcoming from this study could add Canadian context-specific elements to the conversation around sustainable eating.

Results from this study suggested that the prevalence estimates of PBDPs in 2015 according to population-representative Canadian data were less than those previously reported in Canada and less than most international prevalence estimates. When examining correlates of reporting PBDPs, self-identified ethnicity had the strongest magnitude of association both in the bivariate and multivariable analyses, followed by province of residence. It is interesting to note that variables such as sex and age were not associated with reporting PBDPs in the multivariable models. Finally, when results were stratified by gender, self-identified South Asian ethnicity was a strong predictor in both models, whereas immigration status and Canadian province of residence were only associated with vegetarianism in the female-only model.

5.1 Definitions and Prevalence Comparisons of Plant-Based Dietary Practices Locally and Internationally

This study found that the prevalence of PBDPs in Canada in 2015 was less than 5% of the population, with 1.3% of the population reporting a vegetarian dietary practice, and less than 1% reporting a vegan dietary practice based on questions that define vegetarianism as total exclusion of flesh-based products, and veganism as total exclusion of meat, poultry, fish and shellfish, eggs, and dairy. These findings are considerably less than recent estimates reported in a 2018 Canadian poll which stated that 7.1% of Canadians were vegetarian and 2.3% were vegan (51). The discrepancies between findings from the CCHS data and the poll conducted in 2018 could indicate rising interest in PBDPs in Canada since the CCHS was collected in 2015. However, it is more likely that differences in sample methodology, i.e., using convenience sampled polling data versus multistage cluster sampled government datasets, are a better explanation for the discrepancies between studies.

The data from the 2018 poll was reported from an online blog written by author of the report, Sylvain Charlebois (51). However, the original report that contained the primary source of data does not yet appear to be published and from the limited description of how the poll was administered, obtained from a PowerPoint slide deck, it appears that the sample size was 1027, and that the bilingual survey was a "representative sample for [the] Canadian market"(63). Despite this claim, polling data are generally collected using convenience sampling methodology, in which certain respondents in the population may not necessarily have a chance to be selected for the sample, the estimates of which are likely susceptible to bias (89). An example of convenience sampling would be advertising a poll on a social media website. In this situation, those who have access to social media or who feel strongly about plant-based eating could be more likely to respond than the general population. In contrast, CCHS data is collected using a multi-stage cluster sampling method in which the majority of the Canadian population (with the exception of people living in the Territories and in non-private dwellings such as hospitals or prisons) has some probability of being selected to be in the sample, decreasing the risk of bias. The data was collected in this way to ensure that the sample was population representative in terms of age, sex, geography, and socioeconomic status. In addition, while the response rate of the 2018 poll was higher than the CCHS (96% versus 61%), ultimately the sample size of the CCHS was much larger (n = 20,000) so it is likely that CCHS-based results more accurately reflect the prevalence of PBDPs in Canada.

This study found that among those living in B.C. the prevalence of vegetarianism was 2.3% which was lower than the prevalence reported in the only other population-representative vegetarian study conducted in B.C. from Bedford and Bar in 2004 (5.8%) (31). While both datasets used were population representative, discrepancies between our study and Bedford and Barr's study could be due to the difference in definitions and measures of vegetarianism. While our study operationalized the definition of vegetarianism using the available data on animal source food exclusions, respondents in the 2004 survey were asked to self-identify as vegetarian. Furthermore, Bedford and Barr found that when looking at the dietary data of these self-identified vegetarians, less than 1.5% reported excluding seafood, poultry and meat from their diet which is more similar to our estimate of vegetarians (1.3%), including vegans (0.3%) of 1.6% (31).

When comparing data from our study to the most recent international estimates of PBDPs that use data sources with similar methodology to the CCHS (nationwide population representative surveys), it does appear that CCHS-based estimates were lower than the majority of the international studies, with the exception of Italy and Ireland where the prevalence of vegetarianism in Italy in 2004 was reported at 0.79% while the prevalence in Ireland in 2007 was 0.9% (44,45). Our prevalence estimate of vegetarianism in Canada (1.3%) was lower than the prevalence estimates of vegetarianism in Germany from 2014 (2.5%), Finland from 1997, 2000, and 2002 (3.3%), the United States in 2012 (4.0%), India from 2006 (27.4% lacto and lacto-ovo vegetarians).

While these prevalence estimates could reflect the true differences in vegetarianism worldwide, one possible reason for these discrepancies could again be due to differences in defining PBDPs. Table 5.1 illustrates the definitions and survey questions in more detail. Most of the prevalence estimates with the exception of those in Ireland and Finland used survey questions to assess PBDP adherence (29,33,43–46). However, while the definitions in our study were based on survey questions inquiring about self-reported combinations of animal source food exclusions, most of the other studies asked participants slightly different variations of the question “are you a vegetarian?”. Some studies such as those conducted in Italy and America did not appear to provide definitions regarding the terms “vegetarian” and “vegan” at the time the survey questions were administered (33,44). Similarly, in Finland where both self-identified vegetarian status and FFQ was collected, there was no definition for “vegetarian” provided when the self-identified vegetarian survey question was asked. Thus it is possible that respondents in these studies may have different ideas about what constitutes vegetarianism and as such the validity of the survey question in measuring the construct of "vegetarianism" may be compromised. In Ireland as well as Finland, FFQs were used to determine PBDP status, the definitions of which are more similar to the ones used in our study compared to the vegetarian self-identity survey questions as both FFQs and our survey questions probe and define vegetarianism based on whether a respondent completely excludes certain foods (29,45). In addition, the study conducted in India also asked how often a participant consumed certain food groups with the response choices ranging from "daily, weekly, occasionally or never" which is also similar to our study's definitions of PBDPs in that respondents who did not consume flesh-based foods were categorized into the spectrum of PBDPs ranging from vegan to semi-vegetarian (46). Thus, the definitions that our study uses potentially fall somewhere in between the simplicity of a self-report vegetarian status question and the complexity of self-reporting an estimate of the usual intake of certain foods consumed. It may be more appropriate to compare our definitions to studies using FFQs, as these studies use definitions explicitly based on omitted foods, similar to our definitions.

Table 5.1 Definitions and Prevalence of PBDPs Internationally

Dataset	Country	Year(s)	Prevalence of PBDP	PBDP Definition	PBDP Assessment Method
CCHS	Canada	2015	Vegan: 0.23%	Self-reported meat, poultry, fish and shellfish, dairy and egg excluders[1]	Survey Question
			Vegetarian: 1.29%	Self-reported meat, poultry, fish and shellfish excluders not otherwise classified as Vegans[1]	
			Pescatarian: 0.65%	Self- reported meat, poultry not otherwise classified as Vegetarians or Vegans[1]	
Health and Use of Health Care in Italy Survey (44)	Italy	2004	Vegetarian: 0.79%	Self-identified Vegetarian[2]	Survey Question
Survey of Lifestyles, Attitudes, and Nutrition (45)	Ireland	2007	Vegetarian: 0.9%	Those who consumed meat and poultry less than once a month or never	FFQ
			Pescatarian: 0.7%	Those who consumed meat, poultry and fish less than once a month or never	
German Socio-Economic Panel (43)	Germany	2014	Vegan: 2.5%	Self-identified Vegan[3]	Survey Question
			Vegetarian 0.3%	Self-identified Vegetarian[3]	
National FINRISK study and Health 2000 Health Examination Survey (29)	Finland	1997, 2000, 2002	Vegetarian: 3.3%	Self-identified Vegetarian[4]	Survey Question FFQ[4]
National Health Interview Survey (33)	United States	2012	Vegan and Vegetarian: 4%[5]	Self-identified ever use/past 12 months use of Vegan/Vegetarian diet for health reasons[5]	Survey Question

Dataset	Country	Year(s)	Prevalence of PBDP	PBDP Definition	PBDP Assessment Method
National Family Health Survey-3 (46)	India	2006	Vegetarian: 27.4%[6]	Those who reported never consuming fish, chicken or meat including those who reported never consuming fish, chicken, meat or eggs[6]	Survey Question

1. Definitions for each category created from survey question regarding animal source food exclusions
2. Collected via the survey question "What kind of diet do you follow?". Vegetarians were those that answered "Vegetarian".
3. Survey question was based on the provided definition "Vegetarians are people who do not eat meat and if so also avoid fish. Vegans do not eat any products of animals.".
4. Collected via survey question "Do you consider to yourself to be a vegetarian?" in the National FINRISK 1997 and 2002 Surveys and by choosing the "Vegetarian diet" option on the list of special diets that could be reported on the Health 2000 survey. Data reported in table are from self-identified vegetarian status.
5. Percentage presented is ever use of Vegan/Vegetarian diet. Self-report status was collected with the survey question "Have you ever used any of the following special diets for two weeks or more for health reasons: vegetarian, including vegan?" If yes, participants were asked whether they had used a vegetarian, including vegan diet for health reasons during the past 12 months
6. Vegetarian including Lacto-Vegetarian and Lacto-Ovo-Vegetarian. Status was collected through the survey question "How often do you yourself consume the following food items: daily, weekly, occasionally or never?" related to consumption of milk/curd, pulses/beans, dark green leafy vegetables, fruit, eggs, fish, chicken or meat.

5.2 Self-Identified Ethnicity as the Strongest Predictor of Vegetarian Status

In the bivariate analysis, out of all of the Variables of Interest, the largest proportion of Vegetarians and Meat-Excluders were among those that self-identified as South Asian (14.4% and 13.4%, respectively). Even after adjusting for geographic factors such as urban/rural residence, Canadian province of residence, and sociodemographic factors such as age, sex, education, immigration status, marital status, and income, self-identified South Asian ethnicity was significantly associated with reporting a Vegetarian (including Vegan) practice.

Compared to the other significant predictors in the multivariable model (residing in Quebec or the Prairies relative to the Atlantic), Self-identified South Asian racial/cultural grouping was the strongest predictor of Vegetarian status (OR: 16.70 95% CI: 8.01, 34.82). This association may be explained by the relatively high number of PBDP reporters in India (27% Vegetarian) relative to other countries internationally, as detailed in Section 5.1 (46). While some scholars have argued that the high prevalence of vegetarianism in India may be an overestimate, driven by the socio-political pressures to mask meat-eating by certain castes or groups, even the most modest estimates of the prevalence of vegetarianism (20%) are still at least double the estimates from other countries (90). Another potential explanation is that perhaps those who immigrated from South Asia to Canada are less susceptible to acculturation of diet, and thus continue to practice traditional eating habits from their country of origin. While a recent 2017 review suggested changes in energy and macronutrient intake of South Asians after immigrating to Western countries, the review highlighted the need for more studies examining differences in food group intake in this population (91).

The high prevalence of meat-exclusionary dietary patterns among South Asians in Canada and India may be due to cultural or religious reasons, with elements of meat exclusion present in Hinduism and Jainism which are practiced in India (49). The concept of "ahimsa," or non-harming, while present in Hinduism, is more emphasized in Jainism, translating into adherence to a strict Vegan diet (48,49,92). Vegetarianism appears to be an important part of the caste system, and in some parts of India vegetarian food is deemed to be more "pure" than non-vegetarian food, and as such are typically consumed by the higher castes (93). These concepts of purity and asceticism are found in Hindu vegetarianism where the focus is on keeping the body free of the pollution associated with meat consumption (48,92). Often vegetarianism in India is a practice one is born into, with similar eating practices passed down through generations, which is different than in western societies where vegetarianism is often a personal dietary choice (46). Additionally, it has been suggested that psychological associations for vegetarianism differ between Western vegetarians (i.e., from America or Canada) compared to Indian Vegetarians (92). While Euro-American and Euro-Canadian vegetarians relative to omnivores were significantly more concerned with environmental and animal welfare relative to Euro-American and Euro-Canadian non-vegetarians, these differences were not significant when comparing Indian vegetarians to Indian omnivores (92). In addition, the belief that eating meat is "polluting" was more strongly supported by Indian vegetarians, whereas these views were not present among Euro-Canadian and Euro-American vegetarians (92).

5.3 Differences in Vegetarian Status Among Canadian Provinces

From the descriptive analyses presented in Table 4.4, the prevalence of Vegetarians (including Vegans) was highest in British Columbia (2.25%) followed by Ontario (2.17%) and the Prairies (1.36%). These estimates were far lower than those reported in a recent 2018 poll conducted by researchers at Dalhousie University which claimed that the highest prevalence of vegetarians (not including vegans) reside in British Columbia and Ontario (around 8% each) and Quebec (around 6.5%), according to an infographic reported on a news website (51). Reasons for these discrepancies may be the potential for bias from data collected through polls which are derived using sampling methods that differ from those used in the collection of large, population datasets as detailed previously in section 5.1.

Furthermore, after accounting for other variables, the full multivariable model presented in Table 4.6 suggests that the only significant predictors among the Canadian provincial residence variable was that respondents living in Quebec had a 75% lower odds of reporting Vegetarianism compared to respondents living in the Atlantic provinces (OR: 0.24, 95% CI: 0.09, 0.63). Similarly, but to a lesser extent, respondents living in the Prairie provinces had a 57% lower odds of reporting Vegetarianism relative to respondents living in the Atlantic provinces (OR: 0.43, 95% CI: 0.19, 0.96). One explanation for this might be the cattle production industry in the Prairie regions, with Alberta reporting the largest cattle herd (41.6%), followed by Saskatchewan (20.7%), and Manitoba (8.8%) according to the 2016 Census of Agriculture conducted by Statistics Canada (94). Similarly, among all the provinces, Quebec had the highest number of pigs comprising almost one third of all the pigs in Canada (95). Perhaps the increased availability and importance of meat production for the economy of these regions may relate to the decreased likelihood of reporting Vegetarianism relative to the Atlantic region.

5.4 Factors Not Associated with Plant-Based Dietary Practices in Canada

In the multivariable model, the factors that were not significantly associated with reported vegetarian status were age, urban/rural residence, immigration status, education, marital status, and income. The following section will detail how these results compare to those in the PBDP literature.

Surprisingly, age was not associated with PBDPs in the descriptive analysis both in continuous and ordinal age groups nor with reported Vegetarian status in the multivariable model. This finding was surprising because the majority of studies examined in France, the UK, Canada, Germany and Finland found associations between PBDP adherence and younger age in both unadjusted and adjusted analyses (29,31,37,40,42). Apart from these studies, studies conducted in America, South Asia and Italy suggested a correspondence between vegetarianism and older age, findings that also differ from our study (33,41,44). One reason for the discrepancies between our study and others in the literature could be the categorization of age into a categorical variable as opposed to a continuous variable as used in our study. However, even when we categorized our continuous age variable into accepted Dietary Reference Intake age subgroups used in Canadian literature working on the same dataset, there were no significant associations in the bivariate analyses (96). Another explanation could be that while a recent Canadian poll has suggested that vegetarians and vegans tend to be younger, it is possible that older adults are also starting to adopt PBDPs as these types of diets have been recommended to mitigate certain chronic conditions, which may be more prevalent in older populations (13,16,79). Indeed, this potential effect-cause mechanism of older adults adopting PBDPs for health reasons cannot be explored through a cross-sectional study, where only correlation can be evaluated.

While it did appear that there were more PBDP reporters in urban locations relative to rural areas in the descriptive analysis, this association was lost when examining vegetarian status with adjustment for other factors in Table 4.6. This observation was different than the results from an adjusted logistic regression model conducted through a German study which found that vegetarians were more likely to live in urban locations relative to rural locations (42). One explanation as to this discrepancy might be that while more plant-based dining alternatives might be present in bigger cities, perhaps much of Canada's rural farmland is also abundant in produce such as fruit or other plant proteins which often make up a large proportion of vegetarian dietary patterns (71).

While immigration status was significantly associated with PBDPs in the descriptive analyses and in the female-only multivariable models with reported vegetarian status as the outcome, this association was not found in the male-only or the full model. Moreover, marital status was not significantly associated in the descriptive nor the multivariable analysis in this study. These descriptive analyses were different than a 2015 study conducted in B.C. where a higher number of vegetarians were single compared to non-vegetarians (31). When comparing our multivariable models to models from studies in the USA, Italy, and Finland, the international studies supported the observation that vegetarians were more likely to be single which was not replicated in our study (29,33,44). One reason for these discrepancies could be that within the "single" categorization in our marital status variable, both respondents who were widowed or divorced were included with those who were never married in order to increase the sample size to meet data vetting requirements and that there may be real differences between these three groups. However, in Finland, vegetarianism was more prevalent among those single, widowed and divorced and in Italy, those who were single as well as those who were separated/divorced had a higher odds of vegetarianism, even after adjusting for multiple factors (29,44).

Income was another factor not associated with vegetarian status in the multivariable model. These differed from the published population-representative study on vegetarians in B.C. which found that among vegetarians, a significantly larger proportion was in the low-income group (37.2%) compared to non-vegetarians (22.8%). While discrepancies in this finding could be due in part to the unadjusted nature of Bedford and Barr's analysis for this particular variable, our comparable descriptive analysis also found no association between income and PBDP status as shown in Table 4.4. Our results were similar to those found in the Netherlands and Germany, wherein income was not associated with PBDPs (43,66). On reason for this discrepancy could be that income was dichotomized into high and low based on the cut-off of 30,000$ before tax income that was recorded on the CCHS. While this dichotomization was performed in order to meet the Statistics Canada vetting requirements regarding minimum cell size count to report our descriptive analyses, it is possible that the complexity of income data was lost.

Results from the descriptive analyses of this CCHS study suggested that education was associated with PBDPs, with a higher percent of vegetarians, pescatarians and meat-excluders in the highest education category relative to the other education categories. This association was not found in a B.C. study conducted in 2015 (31). Additionally, while higher education was associated with PBDPs in studies in Germany, Italy and Finland, this finding was not replicated in our multivariable models (29,42,44). According to the 2016 Census, close to 40% of immigrants between the ages of 25 and 64 held a bachelor's degree or higher compared to under 25% of those born in Canada in the same age range (97). Thus, it is possible that in adjusting for immigration status in the model, the association of education with PBDPs was attenuated. Furthermore, while studies in Germany, Italy and Finland adjusted for factors such as age and sex, immigration status did not appear to be collected and thus not adjusted for in the models presented in these studies (29,42,44).

5.5 Factors Associated with Plant-Based Dietary Practices after Stratification by Sex

While sex was not associated with PBDPs in the adjusted model, given that sex was associated in the descriptive analyses, coupled with the strong evidence in the literature for the associations between sex and PBDPs, this prompted us to stratify our analyses by sex to observe any differences that may have arisen. Compared to the non-stratified model, self-identified South Asian ethnicity persisted as being a significant predictor of vegetarian status, and also persisted as the only significant predictor in the male-only model which adds further evidence to the robustness of South Asian culture as the main predictor of Vegetarian status in Canada. Additionally, it may be possible that many of the other associations with vegetarian status are driven by female vegetarians, since predictors such as Canadian province of residence as well as immigration status were significant in the female-only model.

There is evidence that sex differences in meat consumption could differ by culture, with certain cultural groups supporting the meat-masculinity link over others (57). Given Canada's multicultural population, perhaps adjusting for self-identified ethnicity and immigration attenuated the association between flesh-based exclusions and sex. This is evident in Models 5 and 6 in Table 4.6, where after introduction of ethnicity and immigration variables into the model, sex loses significance as a predictor.

5.6 Limitations and Strengths of This Study

This study is limited by the cross-sectional nature of the data which means that no causation can be implied, only correlation. In addition, the small sample sizes of certain PBDP groups warranted collapsing of certain multilevel nominal variables (income, marital status) into dichotomous factors for the data to be released from the RDC which may have resulted in the loss of precision of the data. An example would be marital status which was collapsed into "single" and "coupled" categories, wherein the "single" group included both never married and divorced individuals, individuals who may differ in dietary choice. Related to this, limitations were also evident in the ways in which other variables were recoded. For instance, the before tax household income cut-off for "low income" was chosen to be $30,000. However, this cut-off may be too low, and household income was not corrected for number of people in the household; $30,000 for a single occupant may have different implications than for a family of three people. Another limitation was with the education variable which was collected for respondents aged 14 years and above. It is possible that education may not be a meaningful indicator of socioeconomic status for youth still in high school, and perhaps highest education of respondent might have been a better variable to use.

This study was also limited in that self-identified vegetarian status was not collected which may have led to wrongly classifying certain combinations of animal source excluder reporters in the vegetarian category. However, the definitions of PBDP categories were based on exclusion combinations that have been reported in previous vegetarian literature. Another limitation was that there was no question probing how long ago the respondent began excluding animal-source foods from their diet, so it is possible that this study is capturing transient PBDP adherers who may not be representative of long-term PBDP adherers.

Strengths of this study are that it is the first prevalence estimate of different PBDPs of Canadians using population representative data from the 10 provinces of Canada that can be generalized to the majority of Canadians. It is also the first to create detailed, operationalized definitions of PBDPs using Canadian data that may be replicated in further studies or future iterations of the CCHS. Another strength was the access to and inclusion of many different types of variables using a large dataset, which allowed in-depth exploration of the correlates of PBDPs. Finally, it is the first study to explore the demographics of Canadians PBDP adherers which have been shown to be distinct from vegetarians in other countries.

5.7 Future Directions for Plant-Based Dietary Practice Research in Canada

Given the creation of PBDP categories for use with the CCHS, an important next step would be to examine the dietary quality of those adhering to PBDPs to see if they differ markedly from those not following a PBDP. As mentioned in the literature review, PBDPs have been recommended by health professionals for a variety of conditions so there is impetus to find out if these meat-exclusionary diets are healthier than omnivorous diets (15–17,62). While some studies have suggested that those following vegetarian diets score higher on dietary quality indexes, other studies have found that dietary quality and health biomarkers such as triglyceride/HDL ratio and fasting insulin did not differ between vegetarians and non-vegetarians (71,98). Additionally, examining the dietary data could be used to confirm the validity of the created PBDP categories by checking whether those who report dietary exclusions actually exclude the foods from their 24-hour dietary recall.

Given that there were other types of excluders who were not captured in the PBDP categorizations, it might also be worthwhile to explore if determinants if those reporting any other exclusions that do not fall under the PBDP-defined exclusions differ from those reporting PBDPs. Doing so provide deeper insight into determinants of dietary exclusions in general.

Another potential future research direction would be to apply these same PBDP categories to future iterations of the CCHS-Nutrition component surveys, should they include the dietary exclusion question. This information might be able to accurately describe whether PBDPs are on the rise or another passing trend.

5.8 Conclusion

In conclusion, this study found that the prevalence of PBDPs in Canada, as defined by self-reported animal source exclusions, was more conservative compared to most international estimates, which could be due to a number of factors including sampling and defining PBDPs. These estimates also differed substantially when compared to results from Canadian polling data, suggesting that the prevalence estimates of vegetarianism have been overestimated by media outlets. These comparisons raise questions about how prevalence estimates may change given the criteria used to define these diets. Thus, clearly defining PBDPs, especially for use in country-wide nutrition surveys, is crucial to the dialogue surrounding healthy and sustainable planetary consumption.

Additionally, the main predictors of reported vegetarianism in Canada were province of residence and self-identified cultural/racial grouping, after accounting for variables such as age and sex that were previously associated with PBDPs in the literature. These findings were novel and differed from previous descriptions of Canadian vegetarians which emphasized younger age, female sex, and higher education and did not account for other factors. To promote plant-based eating, more emphasis could perhaps be placed in province-wide initiatives. This study also suggests that self-identified cultural/racial grouping plays an important part in determining animal source food exclusions, and that the effects of culture, tradition, or religion may be stronger than socioeconomic or geographic factors. These findings contribute to the complexity of sustainable diet choice in the modern Canadian context, an issue worthy of deeper discussion given the importance of dietary choice in mitigating climate change.

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Appendix A Crude Multinomial Logistic Regression Sensitivity Analysis

Table 0.1 Crude ORs of Plant-based dietary patterns in relation to Geographic, Sociodemographic and Health/Lifestyle Characteristics

	Vegetarians (including Vegans) OR (95% CI)	**Pescatarians** OR (95% CI)	**Meat-excluders** OR (95% CI)
Geographic			
Regions of Canada			
Atlantic Provinces (NS, NB, NFL, PEI)	Reference	Reference	Reference
Quebec	0.36 (0.16, 0.79)	1.19 (0.23, 6.04)	1.25 (0.70, 2.26)
Ontario	1.82 (1.00, 3.31)	1.42 (0.50, 4.04)	**1.86 (1.14, 3.04)***
Prairie Provinces (AB, MN, SK)	1.12 (0.58, 2.15)	0.64 (0.24, 1.70)	1.42 (0.87, 2.31)
British Columbia	1.88 (0.85, 4.13)	1.40 (0.50, 3.94)	1.50 (0.89, 2.51)
Rural vs Urban			
Rural	Reference	Reference	Reference
Urban	**2.31 (1.19, 4.51)***	2.32 (0.59, 9.18)	1.53 (0.86, 2.72)
Sociodemographic			
Sex			
Male	Reference	Reference	Reference
Female	**1.56 (1.02, 2.39)***	1.14 (0.49, 2.63)	**1.51 (1.12, 2.04)***
Marital Status			
Single (including widowed or separated)	Reference	Reference	Reference
Coupled (including married, common law)	**1.66 (1.03, 2.69)***	0.52 (0.24, 1.14)	1.18 (0.80, 1.73)
Immigrated to Canada			
No	Reference	Reference	Reference
Yes	**5.11 (3.37, 7.74)**	1.97 (0.86, 4.51)	**2.30 (1.62, 3.28)**
Identify culturally/racially as			
White	Reference	Reference	Reference
South Asian	**29.00 (17.52, 48.00)**	1.65 (0.37, 7.32)	**10.57 (6.95, 16.06)**
Other	**2.32 (1.20, 4.48)**	2.18 (0.92, 5.15)	**2.51 (1.71, 3.68)**
Education (Ages 14+)			
Up to High School Equivalent	Reference	Reference	Reference
Certificate or Diploma below Bachelor's level	0.81 (0.47, 1.38)	2.23 (0.81, 6.11)	0.92 (0.63, 1.35)
Bachelor's degree or higher	**1.95 (1.16, 3.27)**	**3.27 (1.50, 7.12)**	**1.71 (1.12, 2.62)**
Working status in the last week (Ages 15 – 75)			
Unemployed	Reference	Reference	Reference
Employed	1.05 (0.66, 1.66)	1.22 (0.56, 2.67)	0.71 (0.51, 1.02)
Household Food Insecurity			

	Vegetarians (including Vegans) OR (95% CI)	**Pescatarians** OR (95% CI)	**Meat-excluders** OR (95% CI)
Food Secure	Reference	Reference	Reference
Food Insecure	0.76 (0.34, 1.72)	0.77 (0.23, 2.55)	1.03 (0.67, 1.59)
Income			
Low (under $30,000/yr)	Reference	Reference	Reference
High	1.38 (0.78, 2.46)	0.50 (0.16, 1.59)	0.78 (0.52, 1.16)
Health/Lifestyle			
Has Taken Supplement in Past Month			
No	Reference	Reference	Reference
Yes	**2.04 (1.37, 3.04)***	1.62 (0.73, 3.59)	1.17 (0.87, 1.59)
Participated in 150 minutes of physical activity/week (Ages 18+)			
Yes	Reference	Reference	Reference
No	0.59 (0.34, 1.01)	1.15 (0.50, 2.68)	0.93 (0.64, 1.35)
Has at least one Chronic Disease (out of High Blood Pressure, Diabetes, Heart Disease or Cancer)? (Ages 19+)			
No	Reference	Reference	Reference
Yes	1.22 (0.66, 2.23)	0.47 (0.22, 1.00)	1.26 (0.84, 1.89)
Smoking status			
Nonsmoker	**Reference**	**Reference**	**Reference**
Smoker	0.17 (0.02, 1.67)	0.50 (0.16, 1.59)	**0.39 (0.23, 0.66)**
Continuous Variables			
Age (continuous variable)	0.99 (0.99, 1.00)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
BMI (Ages 18+)[bc]	0.94 (0.89, 0.98)	0.92 (0.86, 0.99)	0.98 (0.95, 1.01)

Appendix B Detailed PBDP Definition Categorizations

Table 0.2 PBDP Categorizations in Detail

	Meat	Poultry	Fish & Shellfish	Eggs	Dairy	Gluten	Sub-category
1	Y	Y	Y	Y	Y	Y	Vegan
2	Y	Y	Y	Y	Y	N	
3	Y	Y	Y	Y	N	Y	Vegetarian (Includes lacto-ovo, ovo, lacto vegetarians)
4	Y	Y	Y	Y	N	N	
5	Y	Y	Y	N	Y	Y	
6	Y	Y	Y	N	Y	N	
7	Y	Y	Y	N	N	Y	
8	Y	Y	Y	N	N	N	
9	Y	Y	N	Y	Y	Y	Pescatarian
10	Y	Y	N	Y	Y	N	
11	Y	Y	N	Y	N	Y	
12	Y	Y	N	Y	N	N	
13	Y	Y	N	N	Y	Y	
14	Y	Y	N	N	Y	N	
15	Y	Y	N	N	N	Y	
16	Y	Y	N	N	N	N	
17	Y	N	Y	Y	Y	Y	No Meat
18	Y	N	Y	Y	Y	N	
19	Y	N	Y	Y	N	Y	
20	Y	N	Y	Y	N	N	
21	Y	N	Y	N	Y	Y	
22	Y	N	Y	N	Y	N	
23	Y	N	Y	N	N	Y	
24	Y	N	Y	N	N	N	
25	Y	N	N	Y	Y	Y	
26	Y	N	N	Y	Y	N	
27	Y	N	N	Y	N	Y	
28	Y	N	N	Y	N	N	
29	Y	N	N	N	Y	Y	
30	Y	N	N	N	Y	N	
31	Y	N	N	N	N	Y	
32	Y	N	N	N	N	N	MEAT ONLY EXCLUDERS
33	N	Y	Y	Y	Y	Y	Grouped in with Meat Eaters (Other exclusions)
34	N	Y	Y	Y	Y	N	

	Meat	Poultry	Fish & Shellfish	Eggs	Dairy	Gluten		Sub-category
35	N	Y	Y	Y	N	Y		
36	N	Y	Y	Y	N	N		
37	N	Y	Y	N	Y	Y		
38	N	Y	Y	N	Y	N		
39	N	Y	Y	N	N	Y		
40	N	Y	Y	N	N	N		
41	N	Y	N	Y	Y	Y		
42	N	Y	N	Y	Y	N		
43	N	Y	N	Y	N	Y		
44	N	Y	N	Y	N	N		
45	N	Y	N	N	Y	Y		
46	N	Y	N	N	Y	N		
47	N	Y	N	N	N	Y		
48	N	Y	N	N	N	N		POULTRY ONLY EXCLUDERS
49	N	N	Y	Y	Y	Y		
50	N	N	Y	Y	Y	N		
51	N	N	Y	Y	N	Y		
52	N	N	Y	Y	N	N		
53	N	N	Y	N	Y	Y		
54	N	N	Y	N	Y	N		
55	N	N	Y	N	N	Y		
56	N	N	Y	N	N	N		FISH AND SHELLFISH ONLY EXCLUDERS
57	N	N	N	Y	Y	Y		
58	N	N	N	Y	Y	N		
59	N	N	N	Y	N	Y		
60	N	N	N	Y	N	N		EGGS ONLY EXCLUDERS
61	N	N	N	N	Y	Y		
62	N	N	N	N	Y	N		DAIRY ONLY
63	N	N	N	N	N	Y		GLUTEN ONLY
64	N	N	N	N	N	N		No exclusions

This table shows all possible combinations that respondents could have chosen and what PBDP group each combination was categorized into. The Y's in the table stand for "Yes", as in yes this food was excluded and the N's stand for "No".

Appendix C Multivariable Logistic Regression Sensitivity Analysis

Table 0.3 Sensitivity Analyses: Logistic Regression Analysis of Reported Vegetarian Status by Other Variables

	Odds of Vegetarianism						
	Model A[1]	**Model B[2]**	**Model C[3]**	**Model D[4]**	**Model E[5]**	**Model F[6]**	**Model G[7]**
Sex							
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	1.79* [1.03, 3.12]	1.72 [1.00, 2.96]	1.53 [0.84, 2.79]	1.71 [0.95, 3.06]	1.61 [0.93, 2.80]	1.58 [0.88, 2.83]	1.65 [0.94, 2.91]
Age	0.99 [0.97, 1.02]	1.00 [0.98, 1.01]	0.99 [0.97, 1.02]	0.99 [0.96, 1.02]	0.96 [0.98, 1.01]	0.99 [0.98, 1.01]	1.00 [0.98, 1.02]
Urban vs Rural							
Rural	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Urban	1.83* [0.83, 4.04]	1.84 [0.86, 3.81]	2.45 [0.98, 6.10]	2.29 [1.00, 5.22]	1.85 [0.89, 3.81]	1.69 [0.80, 3.57]	2.35 [1.04, 5.30]
Regions of Canada[a]							
Atlantic Provinces	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Quebec	0.21** [0.08, 0.56]	0.25** [0.09, 0.63]	0.19** [0.06, 0.58]	0.22** [0.08, 0.60]	0.24** [0.09, 0.61]	0.25** [0.09, 0.67]	0.21** [0.08. 0.59]
Ontario	0.51 [0.22, 1.18]	0.51 [0.23, 1.13]	0.53 [0.22, 1.31]	0.45 [0.19, 1.09]	0.49 [0.22, 1.10]	0.49 [0.22, 1.09]	0.46 [0.19, 1.08]
Prairie Provinces	0.42* [0.18, 0.97]	0.43* [0.19, 0.97]	0.40* [0.16, 0.99]	0.39* [0.16, 0.92]	0.42* [0.19, 0.96]	0.41* [0.18, 0.92]	0.41* [0.17, 0.94]
British Columbia	0.57 [0.19, 1.64]	0.55 [0.19, 1.57]	0.54 [0.17, 1.71]	0.51 [0.17, 1.53]	0.52 [0.18, 1.47]	0.53 [0.18, 1.54]	0.53 [0.18, 1.53]
Identify culturally/racially as							
White	Reference	Reference	Reference	Reference	Reference	Reference	Reference
South Asian	14.94*** [7.10, 31.40]	16.70*** [8.00, 35.21]	12.15*** [5.56, 26.59]	14.97*** [6.89, 32.52]	15.28*** [7.32, 31.91]	16.90*** [8.05, 35.44]	14.48*** [7.02, 29.87]

	Odds of Vegetarianism						
	Model A[1]	**Model B**[2]	**Model C**[3]	**Model D**[4]	**Model E**[5]	**Model F**[6]	**Model G**[7]
Other	1.53	1.65	1.18	1.46	1.54	1.69	1.39
	[0.70, 3.36]	[0.77, 3.52]	[0.50, 2.74]	[0.67, 3.21]	[0.71, 3.32]	[0.78, 3.62]	[0.67, 2.91]
Immigrated to Canada							
No	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.76	1.66	2.10*	1.92	1.69	1.66	1.96
	[0.92, 3.37]	[0.90, 3.08]	[1.04, 4.24]	[0.95, 3.92]	[0.91, 3.13]	[0.89, 3.11]	[1.00, 3.82]
Education[b]							
≤ High School	Reference	Reference	Reference	Reference	Reference	Reference	Reference
< Bachelor's level	0.94	0.89	0.89	0.98	0.89	0.86	0.95
	[0.50, 1.77]	[0.48, 1.65]	[0.46, 1.71]	[0.53, 1.83]	[0.48, 1.67]	[0.46, 1.59]	[0.52, 1.74]
≥ Bachelor's degree	1.47	1.41	1.55	1.62	1.37	1.32	1.47
	[0.81, 2.66]	[0.77, 2.56]	[0.80, 2.98]	[0.87, 3.05]	[0.76, 2.48]	[0.72, 2.42]	[0.80, 2.69]
Marital Status[c]							
Single	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Coupled	1.33	1.27	1.32	1.39	1.23	1.31	1.30
	[0.78, 2.25]	[0.79, 2.06]	[0.75, 2.32]	[0.79, 2.43]	[0.75, 1.99]	[0.81, 2.12]	[0.77, 2.18]
Income[d]							
Low	Reference	Reference	Reference	Reference	Reference	Reference	Reference
High	1.47	1.33	1.31	1.29	1.23	1.33	1.29
	[0.57, 3.78]	[0.63, 2.81]	[0.52, 3.27]	[0.53, 3.10]	[0.55, 2.89]	[0.58, 3.01]	[0.56, 2.97]
Employment Status[e]							
Unemployed	Reference						
Employed	1.05						
	[0.65, 1.72]						
Food Insecurity							
No		Reference					
Yes		0.99					
		[0.35, 2.82]					

	Odds of Vegetarianism						
	Model A[1]	**Model B**[2]	**Model C**[3]	**Model D**[4]	**Model E**[5]	**Model F**[6]	**Model G**[7]
BMI			0.98 [0.93, 1.04]				
Chronic Disease[f]							
No				Reference			
Yes				1.85 [0.73, 4.71]			
Smoking[g]							
No					Reference		
Yes					0.30 [0.07, 1.29]		
Supplement Intake[h]							
No						Reference	
Yes						1.71 [1.00, 2.91]	
Physical Activity[i]							
No							Reference
Yes							0.85 [0.48, 1.50]

Odds ratios; 95% confidence intervals in brackets; *p<0.05, **p<0.01, ***p<0.001 1) Model A is the final model adjusted for working status in the last week 2) Model B is the final model adjusted for food insecurity 3) Model C is the final model adjusted for BMI 4) Model D is the final model adjusted chronic disease 5) Model E is the final model adjusted for smoking 6) Model F is the final model adjusted for supplement intake 7) Model G is the final model adjusted for physical activity a) Atlantic provinces include Nova Scotia, New Brunswick, Newfoundland and Prince Edward Island; Prairie provinces include Alberta, Manitoba, and Saskatchewan b) This corresponds to the education of the respondent and was collected for those aged 14+; Levels include up to high school equivalent, certificate or diploma below bachelor's level, and bachelor's degree or higher c) Single includes widowed and separated; Coupled includes married and common law d) Total household income before taxes; Cut-off for low income was under $30,000 per year e) This information was collected for those aged 15-75; Refers to working status in the last week f) Has at least one chronic disease out of high blood pressure, diabetes, heart disease or cancer, this information was only collected for those aged 19+ g) This information was collected for those aged 12+ h) Refers to supplement intake in the last month i) This information was collected for those aged 18+; Refers to participation in 150 minutes of physical activity/week