Ethical Diets and Validation of a No Harm Diet

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ABSTRACT

Over the past few decades, it has become increasingly recognized that the dietary choices we make are tightly connected to the health of our planet. This first section of this thesis examines the link between dietary choices and sustainability, which has prompted the development of many limited harm-based diets such as vegetarianism or veganism. This literature review examines ethical diets in terms of trends, health benefits, and limitations as well as the rationale behind following an limited harm based diet. Limited harm diets have been increasing in popularity for many reasons including the health benefits some of them can provide. However, if the dietary pattern is unbalanced, these diets can have some health limitations such as nutritional deficiencies. While there are many limitations to following limited harm diets, there are many that appear to be better for human health and the health of the planet.

This prompted the creation of a new limited harm diet called the No Harm Diet by Dr. Mark Lefsrud. The No Harm Diet is based on the principle of limiting harm to the organism from which we receive our food. The only acceptable foods for consumption are those produced by the plant or animal which can be harvested without harm to the organism as well, those which the consumption does not cause harm to the next generation. This was the first study conducted evaluating the nutritional quality of the No Harm Diet. A seven- day meal plan was created following the ethical guidelines of the diet as well as staying close to a standard adult diet of 2000 kcal. The meal plan was then evaluated with Nutritionist Pro to calculate the total amount of each nutrient found in the diet using the Canadian Nutrient File. The results suggested, for most nutrients the No Harm Diet met the Daily Recommended Intake (DRI) recommendations. There were some limitations including omega-3, omega-6, iodine, iron, vitamin D, vitamin E, and biotin as they were lower than the recommended values. However, some of these values were due to software limitations and those that were not, could be mitigated by including supplements. In conclusion, this study indicated that the No Harm Diet is nutritionally adequate.

With a positive conclusion, the study continued by assessing quantifying and comparing the nutritional quality and carbon emissions of the No Harm Diet compared to two common Canadian dietary patterns (omnivore and vegan). It was hypothesized that the No Harm Diet would have the smallest carbon footprint while being nutritionally adequate based on the DRI requirements. The nutritional quality was determined by creating a 7-day meal plan for each diet following dietary guidelines of each dietary pattern and foods commonly consumed by Canadians.

The nutritional quality was evaluated using Food Processor (with the Canadian Nutrient File) to obtain the nutritional values of each food within each dietary pattern. The nutrient values were compared between the three dietary patterns and to the DRIs and average Canadian intakes. To evaluate the environmental impact of each diet, a carbon footprint analysis was conducted. Nine foods from each dietary pattern were chosen and analysed. Data was pulled from existing literature and modeled in OpenLCA. The results of this study showed that the No Harm Diet was nutritionally adequate based on the DRI requirements and nutritionally comparable to both the vegan and omnivore diets. The No Harm Diet offered some nutritional benefits compared to nutrient concentrations typically consumed by Canadians such as lower saturated fat and sodium as well as higher calcium, vitamin A, and vitamin D. In terms of carbon emissions, the results show no significant difference among all three of the dietary patterns. The carbon footprint analysis should be expanded to include a wider range of foods and a wider range on impact categories in order to get a more accurate view on the environmental impact of the No Harm Diet. Overall, the No Harm Diet is nutritionally adequate and comparable to other common Canadian dietary patterns. However, the No Harm Diet is not more environmentally friendly than either an omnivore or vegan dietary pattern.

RÉSUMÉ

Au cours des dernières décennies, il est devenu de plus en plus reconnu que les choix alimentaires que nous faisons sont étroitement liés à la santé de notre planète. Cette première section de la thèse examine les régimes alimentaires éthiques car le lien entre les choix alimentaires et la durabilité a incité le développement de nombreux régimes alimentaires éthiques tels que le végétarisme ou le véganisme. Cette revue de la littérature examine les régimes alimentaires éthiques en termes de tendances, d'avantages pour la santé et de limites ainsi que la justification de suivre un régime basé sur l'éthique. Les régimes éthiques sont de plus en plus populaires pour de nombreuses raisons, notamment les avantages pour la santé que certains d'entre eux peuvent offrir. Cependant, si le régime alimentaire est déséquilibré, ces régimes peuvent avoir des limitations de santé telles que des carences nutritionnelles. Bien qu'il existe de nombreuses limites à suivre un régime éthique, il y en a beaucoup qui semblent être meilleurs pour la santé humaine et la santé de la planète.

Cela a incité le Dr Mark Lefsrud à créer un nouveau régime éthique appelé No Harm Diet. Le régime No Harm est basé sur le principe de limiter les dommages à l'organisme sous lequel nous recevons notre nourriture. Ainsi, les seuls aliments acceptables pour la consommation sont ceux qui nous sont donnés par la plante ou les animaux en tant que « cadeau » et ceux dont la consommation ne nuit pas à la génération suivante. Il s'agissait de la première étude menée pour évaluer la qualité nutritionnelle du régime No Harm. Un plan de repas de sept jours a été créé en suivant les directives éthiques du régime tout en restant proche d'un régime alimentaire standard pour adultes de 2000 kcal. Le plan de repas a ensuite été évalué avec Nutritionist Pro pour calculer la quantité totale de chaque élément nutritif présent dans l'alimentation à l'aide du Fichier canadien sur les éléments nutritifs. Les résultats suggérés, pour la plupart des nutriments, le régime sans danger a atteint les recommandations de l'apport quotidien recommandé (ANREF). Il y avait certaines limitations, notamment les oméga-3, les oméga-6, l'iode, le fer, la vitamine D, la vitamine E et la biotine, car elles étaient inférieures aux valeurs recommandées. Cependant, certaines de ces valeurs étaient dues à des erreurs logicielles et celles qui ne l'étaient pas pourraient être atténuées en incluant des suppléments. En conclusion, cette étude a indiqué que le régime No Harm est nutritionnellement adéquat. Avec une conclusion positive, l'étude s'est poursuivie en évaluant la quantification et la comparaison de la qualité nutritionnelle et des émissions de carbone du régime sans danger par rapport à deux modèles alimentaires canadiens courants (omnivore et végétalien).

Il a été émis l'hypothèse que le régime No Harm aurait la plus petite empreinte carbone tout en étant nutritionnellement adéquat en fonction des exigences des ANREF. La qualité nutritionnelle a été déterminée en créant un plan de repas de 7 jours pour chaque régime en suivant les directives diététiques de chaque régime alimentaire et des aliments couramment consommés par les Canadiens tels que les graisses saturées et le sodium inférieurs ainsi que plus de calcium, de vitamine A et de vitamine D. La qualité nutritionnelle a été évaluée à l'aide d'un robot culinaire pour obtenir les valeurs nutritionnelles de chaque aliment dans chaque modèle alimentaire. Les valeurs nutritives ont ensuite été comparées aux ANREF, aux apports canadiens moyens et aux valeurs des autres régimes alimentaires. Pour évaluer l'impact environnemental de chaque régime, une analyse de l'empreinte carbone a été réalisée. Neuf aliments de chaque régime alimentaire ont été choisis et analysés. Les données ont été extraites de la littérature et du modèle existants dans OpenLCA. Les résultats de cette étude ont montré que le régime No Harm était nutritionnellement adéquat sur la base des exigences des ANREF. De plus, il était comparable sur le plan nutritionnel aux régimes végétaliens et omnivores. Le régime sans danger offrait également certains avantages nutritionnels par rapport aux concentrations de nutriments généralement consommées par les Canadiens. En termes d'émissions de carbone, les résultats ne montrent aucune différence significative entre les trois régimes alimentaires. L'analyse de l'empreinte carbone devrait être élargie pour inclure une gamme plus large d'aliments et une gamme plus large de catégories d'impact afin d'obtenir une vision plus précise de l'impact environnemental du régime sans danger. Dans l'ensemble, le régime sans danger est adéquat sur le plan nutritionnel et comparable à d'autres habitudes alimentaires courantes au Canada. Cependant, le régime sans danger n'est pas plus respectueux de l'environnement qu'un régime alimentaire omnivore ou végétalien.

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Contribution of Authors

The No Harm Diet was created by Dr. Mark Lefsrud. Natalie Wu design, perform, analysis, and wrote all parts of this thesis. Dr. Mark Lefsrud and Dr. Anne-Sophie Brazeau are the major editors of this thesis. Victorio Morello helped with formatting. Chapter 1, chapter 2, chapter 3, and chapter 4 were all written by Natalie Wu. Chapter 1, chapter 2, chapter 3, and chapter 4 were all major edited by Dr. Mark Lefsrud, and Dr. Anne-Sophie Brazeau.

Introduction

As of 2020, the global population has reached 7.8 billion people and is projected to increase up to 9.7 billion people by 2050 (United Nations, 2019; Bureau, 2020). This increase in population has increased the demand for food which has attempted to be met through technological advances in agriculture to increase food production (Baroni, 2006). Along with these technological advances and urbanization, social and economic structures, as well as social norms have shifted causing a change in the foods originally demanded to a more typical "Western diet" characterized by a high proportion of red meat and processed foods containing large quantities of salt, and sugar along with a low consumption of fruits, vegetables and whole grains (Laestadius, 2019). This dietary trend has degraded human health by increasing noncommunicable chronic diseases such as type 2 diabetes and coronary heart disease as well as degraded the health of our environment through environmental pollution and resource depletion (Tilman, 2014; Aiking, 2019). This has sparked the creation of "limited harm diets" as people have become more concerned about the food they choose to consume due to the realization that diet, sustainability, and health are all tightly connected. While there are many ethic-based diets followed throughout the world, this thesis is focused on a new ethical diet referred to as the No Harm Diet.

The No Harm Diet was developed by Dr. Mark Lefsrud, Head of the Biomass Production Laboratory at McGill University. This diet is derived from ethical vegetarianism and veganism, in which the underlying principle is that the harm done to the organism providing food, including plants, and animals, is prevented or limited. All living organisms have a right to life and respect regardless if they are viewed to not have feeling, emotions, or react to stimuli. Within this dietary regime, acceptable foods are those that do not injury, cause physiological stress responses, or affect the progeny of an organism that is providing the food. Acceptable foods based on these guidelines include fruits, diary products, eggs, honey, and single celled organisms. Unacceptable food products include vegetable (leaf crops, root crops, flowers and other parts of a plant), seeds, nuts, grains and meat as these part have to result in the death of the organism or are taken and weaken the organism.

The aim of this thesis is to evaluate the nutritional adequacy and environmental impact of the No Harm Diet. The first objective of this thesis is to assess, quantify, and compare the nutritional quality of the No Harm Diet to the average intakes of Canadians. The second objective of this study was to assess, quantify and compare the nutritional quality (according to the dietary reference intake (DRI) requirement) of the three dietary patterns (No Harm, vegan, and omnivore). The third objective is to assess, quantify, and compare the carbon footprint of the same three dietary patterns. It is hypothesized that the No Harm Diet, a novel sustainable diet originating from Quebec, will have the smallest carbon footprint while being nutritionally adequate based on the DRI requirements.

Chapter 1: An Evaluation of Limited Harm Diets

1.1 Abstract:

Over the past few decades, it has been recognized that diet and sustainability are tightly connected. The dietary choices and habits of a population greatly impact the environment. This has led to the development of many ethically based diets such as vegetarianism. This review aims to examine limited harm diets in terms of trends, health benefits and limitations as well as the rationale behind following an ethical based diet. Limited harm diets have been increasing in popularity across many countries especially in industrialized countries such as Canada and the United States. With the increasing popularity, it is important to know the health effects of following such diets. There have been a number of reported health benefits associated with following ethical diets like vegetarianism such as lower rates of chronic diseases including heart disease, hypertension and diabetes. However, if not well balanced, these diets can have some health limitations including nutritional deficiencies. The most common nutritional deficiencies associated with vegetarianism include iron, calcium and vitamin B12. However, it is often thought that the benefits outweigh the limitations. Health benefits are one of the major reasons for following limited harm diets however there are other reasons such as animal rights, sustainability or religion. Regardless of the reason for following an ethical diet, people face many barriers including stigma, strained relationships and restricted social situations. While there are many limitations to following ethical diets, these diets appear to be better for human health as well as the health of the planet.

1.2 Introduction:

Over the past few decades people have become more concerned about the foods they are consuming either for sustainability, ethical or health reasons. Diet and sustainability are tightly connected considering food choices, eating habits and food consumption all affect the climate, biodiversity and other aspects of the environment (Dagevos, Voordouw 2013, Smil 2002, de Boer, Helms et al. 2006). This has led to the development of many limited harm diets. Limited harm diets are diets that aim to limit harm to either the planet, our food sources (animals and/or plants), and/or to ourselves. The low-carbon diet is based on reducing the greenhouse gas emissions that come from food production and consumption by minimizing the emissions released in these processes (Favaro 2017, Lin, Lin 2014). The 100-mile diet has a similar bases to the Low-Carbon Diet but foods consumed in this diet must be grown and produced within a 100 miles of where the person lives (Smith, MacKinnon 2007, Rose et al. 2008). This diet has sparked the term "locavore" which essentially describes when people shift their diet to local-only products (Favaro 2017, Rose et al. 2008). People believe that shorting the distance their food has to travel (farm to plate) is better for the planet (Favaro 2017, Rose et al. 2008). However, according to the Consultative Group on International Agricultural Research (CGIAR) the problem is not only the distribution but the production of food in which contributes 80-86% of the agricultural global greenhouse gas emissions (Favaro 2017). While reducing the diet to a 100-mile radius will shave off a small percent of the carbon footprint, switching to foods that make a low footprint when produced will reduce the carbon footprint the most, as some foods are inherently more energy-intensive to produce than others (Favaro 2017). It is reported that the consumption of animal products has greater harmful effects on the environment (Dagevos, Voordouw 2013, de Boer, Helms, et al. 2006, Smil 2002, Garnett et al. 2009). The Food and Agriculture Organization (FAO) showed that consuming more plant-based foods is better for the environment and is more energy efficient than animal-based foods (Dagevos, Voordouw 2013). Livestock account for roughly 18% of all anthropogenic greenhouse gas emissions including carbon dioxide, methane, and nitrous oxide which are released into the environment (Garnett, T., et al. 2009, Steinfeld 2006, McMichael, A.J., et al. 2007, Rosenzweig 2011). In addition, livestock farming plays a role in water depletion and pollution (Garnett et al. 2009, Steinfeld 2006, Hoekstra, Chapagain 2007). While there are many diets that focus on sustainability and the environment, there are others that focus more on other aspects. Vegetarianism is a popular diet but focuses more on ethics/animal rights and health. Yankelovich Partners showed that 46% of people become vegetarian for health reasons while 24% switched for ethical and environmental reasons (Sabaté, Ratzin-Turner 2001, Melina, Craig et al. 2016). Vegetarianism is an umbrella term used to describe plant-based diets. Vegetarian diets involve a wide variety of practices and have a high level of variability depending on the dietary choices (McGirr, McEvoy et al. 2017, Melina, Craiget al. 2016, Olfert, Wattick 2018). For example, there are pescatarians who exclude red meat and poultry but eat fish and shell fish while lacto-ovo-vegetarians exclude all meat, fish, and poultry while still consuming milk, milk products and eggs (McGirr, McEvoy et al. 2017, Melina, Craig et al. 2016). There are more restrictive vegetarian diets such as vegan and fruitarian. Vegans do not consume any food that is from animal origin while still consuming plant foods, grains, legumes, nuts/seeds and vegetable oils (McGirr, McEvoy et al. 2017, Melina, Craig et al. 2016). Fruitarian is considered to be an extreme form of veganism in which all animal-based foods are excluded as well as any food that would injure a plant such as a root or leaf therefore only the fruit portion of the plant is consumed (Boyle 2011). While the foods consumed vary greatly depending on the type of diet that is followed, they all have the same underlying principle which is to limit harm. In low carbon diets the idea is to limit harm to the environment by reducing the greenhouse gases produced in food processing and production while vegetarianism limits harm to animals by not consuming animals and/or animal-based products. Many of these diets are consumed for a variety of reasons including health, religious and ecological beliefs. This review will examine the advantages, limitations and reasoning for following a limited harm diet in particular a vegetarian diet.

1.3 Trends and Evolutions:

The idea of limited harm diets has been around for centuries dating back to ancient Greece (Ruby 2012, Leitzmann 2014). During more recent years, the limited harm diets have been gaining popularity especially in industrialized countries (McGirr, McEvoy 2017). During World War II, it was estimated that about 0.25% of the population in the U.K. was vegetarian; in 1984 about 2% were vegetarian which grew to 5.4% in 1997 (Sabaté, Ratzin-Turner 2001). Currently, through polls and surveys it was estimated that in the European Union, United States, and Canada the prevalence of vegetarianism ranges from 1-10%. For example, in the United States 3-10% of people classify themselves as vegetarian (McGirr, McEvoy et al. 2017, Melina, Craig et al. 2016, Leitzmann 2014), with 46% of those who identify as vegetarian are vegan (Melina, Craig et al. 2016). In Canada approximately 4-8% of people consider themselves to be vegetarians (Ruby 2012, Leitzmann 2014). In Israel approximately 8.5% are vegetarian (Ruby 2012, Leitzmann 2014) while in in India about 35-40% of the population is vegetarian. There have been other polls conducted in other countries suggesting that vegetarianism is popular worldwide (Sabaté, Ratzin-Turner 2001). While the polls showed that there have been an increasing number of individuals who are self-defined vegetarians, there was another trend identified showing a higher percentage of women are vegetarian seen both in the USA and UK (Sabaté, Ratzin-Turner 2001). Another trend identified was that young adults are more likely to be vegetarian, 6% of young adults are vegetarian/vegan while 2% of those 65 years or older (Melina, Craig et al. 2016).

1.4 Health Advantages:

With the variety and variability of limited harm diets, it is important to examine the advantages and limitations of each diet to the consumer's health. When carefully planned, limited harm/ vegetarian diets can have some health advantages. In 2018, the diabetes guidelines recommended vegetarian diet and as of January 2019, Health Canada updated their dietary guidelines suggesting to consume plant-based protein more often as well as vegetables, fruit and whole grains (Committee D.C.C.P.G.E. 2018, Canada, 2019). A study done by EXIC-Oxford and the Oxford Vegetarian Study showed that vegetarians are found to have lower mortality rates with a standardized mortality ratio of 0.46 (95% CI, 0.42, 0.51) than the general population due to overall lifestyle and diet (Appleby et al. 1999). Orlich et al. conducted a cohort study examining the associations between vegetarian dietary patterns and mortality (Orlich, et al. 2013). They concluded that vegetarian diets are associated with lower all-cause mortality (HR, 0.88, 95% CI, 0.80-0.97) as well as a reduction in some cause-specific mortality such as cardiovascular mortality (HR, 0.87; 95% CI, 0.75-1.01), non-cardiovascular non-cancer mortality (HR, 0.85, 95% CI, 0.73-0.99), renal mortality (HR, 0.48, 95% CI, 0.28-0.82) and endocrine mortality (HR 0.61; 95% CI 0.40-0.92) (Orlich et al. 2013). People who follow a vegetarian diet have shown lower rates of multiple chronic diseases such as heart disease, hypertension and diabetes (Mangels, Messina et al. 2011, Kahleova, Levin et al. 2018, Dinu et al. 2017).

Heart disease is one of the major causes of death in the developed world and is suggested to be responsible for 46% of non-communicable disease deaths (Sabaté, Ratzin-Turner 2001, Kahleova, Levin et al. 2018). In Shanghai, 1 out of every 15 deaths (about 7%) is due to heart disease while in America it is predicted that about 34% of Americans die of cardio vascular disease (CVD) (Mangels, Messina et al. 2011). It is estimated that 85.6 million Americans have some form of cardiovascular disease (Kahleova, Levin et al. 2018). Through a series of prospective studies done in the UK it was seen that death due to ischemic heart disease was 24% lower in vegetarians than non-vegetarians, for people who followed the diet for more than five years (Key, et al. 1999). The reasoning behind the lowered risk could be due to the lower serum total cholesterol found in vegetarians (Key et al. 1999, Dinu et al. 2017). The Oxford Vegetarian Study showed total cholesterol levels to be lower in vegetarians compared to non-vegetarians (Thorogood, et al. 1987). Vegans have a mean total cholesterol level of 4.29 mmol/l, vegetarians have a concentration of 4.77 mmol/l while meat eaters have a concentration of 5.31 mmol/l (Thorogood, et al. 1987). A meta-analysis conducted by Dinu et al. showed that vegetarian diets compared to an omnivore had lower serum total cholesterol (-1.56 mmol/L) (Dinu et al. 2017). However, it is important to consider high-density lipoproteins (HDL) levels in vegans. A study conducted by Knuiman et al. showed that HDL tends to be lower in vegans (Knuiman, et al. 1987). They speculated that this decrease in HDL was due to the HDL2 fraction which is accompanied by a fall in apolipoprotein A-1 (Knuiman, et al. 1987). A study conducted comparing cholesterol and triglyceride levels by gender between vegetarian/vegan and omnivore diets showed that for both men and women, vegans had lower HDL levels (β= -6.53, P=0.004; β= -5.72, P <0.0001) (Jian, et al. 2015). Wang et al. pooled an estimate of HDL concentrations from nine studies and concluded that vegetarian diets showed lower HDL concentrations (-0.10 mmol/L, 95% CI -0.55 to -0.17; P <0.001), contrary to that of Dinu et al. which showed that vegans did not have significantly lower HDL levels compared to omnivores while vegetarians had lower levels (0.151 mmol/L) (Mariotti 2017, Yokoyama et al. 2014).

It was seen that lacto-ovo vegetarians and vegans have lower total serum cholesterol levels and lower levels of low-density lipoprotein cholesterol (LDL-C), the mean total cholesterol was 3.4 mmol/L which was 25% lower while LDL-C was 1.8 mmol/L which was 3% lower (Resnicow, et al. 1991, Fraser, et al. 2014, Kahleova, Levin et al. 2018). Vegans for example tend to have lower concentration of LDL-C than omnivores and other vegetarians (-1.27 mmol/L) (Turner 1979, Dinu et al. 2017). A study conducted by De Biase et al. showed that LDL-C levels for omnivores was about 6.86 +/- 2.37 mmol/L while for vegans the LDL-C level was 3.85 +/- 1.64 mmol/L (De Biase, et al. 2007). A systematic review and meta-analysis conducted by Wang et al. concluded that vegetarian diets cause a reduction in LDL-C concentrations, a pooled estimated effect of -0.34 mmol/L (Wang, et al. 2015). The current Canadian guidelines for LDL targets is <3.5 mmol/L, however it has been suggested that LDL levels to minimize atherosclerosis progression and coronary heart disease events occur at <3.89 mmol/L (Canada, 2009, O'Keefe, et al. 2004). Plant based dietary interventions produce a decrease in LDL-C levels, lacto-ovo vegetarians produced a decrease of LDL-C of about 10-15% and a 15-25% decrease for vegans (Ferdowsian, Barnard 2009). A decrease in cholesterol levels of about 1% can reduce the risk of heart disease as much as 2.5% (Holme 1990, Grundy et al. 2004). A gluten free vegan diet can lead to an even further reduction in LDL and can decrease the levels of circulating oxidized LDL-C (Elkan et al. 2008). After being on a gluten free vegan diet for 12 months, average LDL-C levels of the subjects were 2.4 mmol/L while the LDL-C levels of non-vegans was 3.2 mmol/L. These changes in LDL-C levels were considered a result of a vegan diet and were not a result of reduced inflammatory activity. The oxidized LDL-C levels for vegans were significantly lower than those of non-vegans (48.6 µL/well compared to 55.2 µL/well). This reduction in oxidized LDL –C levels is important because oxidized LDL-C can be taken up by macrophages in the artery wall which may develop into foam cells (Elkan et al. 2008).

The high amount of antioxidants in vegetarian diets such as vitamin C and E can reduce heart disease risk by protecting LDL-C from being oxidized (Hamilton, et al. 2000). Vegetarians on average have higher blood levels of both vitamin C and E (Mangels, Messina et al. 2011). β-carotene, found in higher levels in vegetarians, has been shown to inhibit the oxidation of lipoprotein A (LPA) to the modified form of LDL-C and is an independent risk factor for chronic heart disease (CHD). Additionally, female vegetarians had LPA levels 45% lower than those of omnivores (Mangels, Messina et al. 2011). CHD however is linearly related to increasing blood pressure (Sabaté, Ratzin-Turner 2001, Kahleova, Levin et al. 2018). Increasing blood pressure can eventually lead to hypertension which is a common and deadly disease that affects 22.7% of Canadians over the age of 20 as well as 29.0% of Americans (Canada, 2010, Grundy, et al. 2004). Vegetarian diets have the possibility to lower blood pressure, in a group of 55-59 year old men whose systolic blood pressure can be reduced by 5 mm Hg (John, Edward 1985). As well, is estimated to reduce major coronary events by about 7% (Yokoyama, et al. 2014). A meta-analysis conducted by Yokoyama et al. showed that in clinical trials vegetarian diets were associated with a mean -4.8 mm Hg reduction in systolic blood pressure (95% CI, -6.6 to -3.1) and a -2.2 reduction in diastolic blood pressure (95% CI, -3.5 to -1.0) (Yokoyama, et al. 2014). From observational studies, consuming a vegetarian diet was associated with a lower mean systolic blood pressure (-6.9 mm Hg, 95% CI, -9.1 to -4.7) and a lower mean diastolic blood pressure (-4.7, 95% CI, -6.3 to -3.1) (Yokoyama, et al. 2014). Not only is blood pressure lower in vegetarians but the prevalence of hypertension is lower as well (Mangels, Messina et al. 2011, Alexander, et al. 2017). It has been shown that non-vegetarian men and women were 50% more likely to have hypertension than vegetarians (Fraser 1999). A cohort conducted by Chuang et al. showed that vegetarians had a

34% decrease in risk of hypertension (OR: 0.66, 95% CI, 0.50-0.87) when compared to matched non-vegetarians (Chuang, et al. 2016). Out of all the types of vegetarians, vegans have the lowest prevalence of hypertension and the lowest blood pressure readings followed by Lacto-ovo-vegetarians (Alexander, et al. 2017). In a study conducted by Fontana et al., the blood pressure of the vegan group was 104/62 mmHg while the western diet group was 132/79 mmHg (Fontana, et al. 2007). The lowered blood pressure and prevalence of hypertension could be due to a plant based diet which improves vasodilation, greater antioxidant content, decreased blood viscosity and even improved insulin sensitivity (Alexander, et al. 2017, Chuang, et al. 2016).

Insulin is an anabolic hormone that promotes the uptake of glucose into hepatic, muscle and adipose cells (Nahikian-Nelms, Sucher 2015). Insulin sensitivity is important for these cells, if they become insulin resistant there is an increased need for insulin that forces the pancreas to increased production eventually causing it to lose its ability to produce insulin (Nahikian-Nelms, Sucher 2015). Insulin resistance is found in people with prediabetes, Type 2 diabetes and gestational diabetes. The prevalence of Type 2 diabetes is reaching epidemic proportions and affecting both low- and high-income countries (Mangels, Messina et al. 2011, Cho, et al. 2017). It was estimated that worldwide in 2017 there was an estimated 451 million cases of diabetes (Olfert, Wattick 2018, Cho, et al. 2017). Vegetarians are less likely to develop diabetes, the rate and risk of diabetes among Seventh-day Adventist (SDA) vegetarians is approximately half the risk for both men and women compared to all US whites (Mangels, Messina et al. 2011, Snowdon, Phillips 1985). Pesco and semi- vegetarians had a reduction of about one third while vegans and lacto-ovo vegetarians were associated with about one half of the reduction of risk of type 2 diabetes (Tonstad et al. 2009). A study conducted by Chiu et al. investigated the association between a vegetarian diet and diabetes risk in a Taiwanese Buddhist population (Chiu et al. 2018). This study showed that consistently vegetarians showed about a 40-60% reduction in risk of diabetes when compared to non-vegetarians (Chiu et al. 2018). The reason for this could be due to vegans consuming one third more fruits and vegetables than non-vegetarians (Tonstad et al. 2009, Chiu et al. 2018). Many of these foods may protect against diabetes due to their high content of fiber and magnesium (Dong, et al. 2011, Chiu et al. 2018). A meta-analysis conducted by Ye et al. indicated that the intake of whole grains is inversely associated with the risk of type 2 diabetes, those consuming 48-80 g/d of whole grains had a 26% reduction in type 2 diabetes (Ye, et al. 2012). Aune et al. conducted a meta-analysis in which they concluded that high whole grains as well as total grain intake protects against type 2 diabetes with a reduction of 32% and 17% (Aune, et al. 2013). This could potentially be related to higher magnesium intake, since magnesium helps prevent insulin signaling impairment (Olfert, Wattick 2018). A major factor leading to type 2 diabetes is obesity especially when the body adiposity is central since it increases the degree of insulin resistance (Nahikian-Nelms, Sucher 2015). BMI, which is a big contributing factor to insulin resistance, is lower among vegetarians than non-vegetarians (Tonstad et al. 2009, Berkow, Barnard 2006). It was seen that on average the BMI of non-vegetarians is approximately 28.8 kg/m^2 while adults vegetarians such as lacto-ovo or vegan have BMIs of roughly 25.7 and 23.6 kg/m^2 respectively (Tonstad et al. 2009, Berkow, Barnard 2006). While these are some of the major advantages of a limited harm/vegetarian diet there are many others, refer to Table 1 in the appendix.

1.5 Health Limitations:

While there are lots of advantages to a limited harm diet, there are limitations to it as well. A vegetarian diet is good for preventing CHD, yet it seems to be less protective in women (Mangels, Messina et al. 2011). In a combined prospective study, it was seen that death rates were only 20% lower in women compared to 32% in men (Mangels, Messina et al. 2011). This could be due to the protective effect estrogens has on CHD in premenopausal women (Lohe 2003). Estrogen protects by improving endothelium-dependent vessel reactivity, lowering LDL oxidation, decreasing the thrombotic potential and increasing fibrinolytic activity (Lohe 2003).

If not well balanced, a limited harm vegetarian diet can be damaging (McGirr, McEvoy et al. 2017). An unbalanced diet can lead to deficiencies in necessary micronutrients such as iron, calcium, iodine and vitamin B12 (Kimball 2002 Gajski et al. 2018). Iron is an important nutrient that has many physiological roles including transferring oxygen as part of a heme group in proteins (Sabaté, Ratzin-Turner 2001). Iron deficiency can occur because of inadequate intake as well as poor absorption in the gastrointestinal (GI) tract of non-heme iron (McGirr, McEvoy et al. 2017). While it is possible for vegetarians to achieve the necessary iron from a balanced diet, plant sources of iron are non-heme and are less bioavailable than heme in meat (Obeid et al. 2002, Schüpbach et al. 2017). Phytate, soy protein and polyphenols/tannins can inhibit iron absorption (Craig 2009, Schüpbach et al. 2017). This can lead to vegetarians having reduced iron stores as well as lower serum ferritin levels. A study conducted by Obeid et al. showed that 37% of their vegetarian participants had low ferritin levels (Obeid, et al. 2002). A systematic review and meta-analysis conducted by Hairder et al. concluded that adult vegetarians have significantly lower serum ferritin levels than non-vegetarians (-29.71 μg/L, 95% CI -39.69,-19.73) (Haider, et al. 2018). Female vegetarians have about half the concentration of serum ferritin than female omnivores (24.7 μg/l omnivore) (Reddy, Sanders 1990). This difference is likely due to the heme-Fe in the meat found in the female omnivores diet. The heme-Fe provided is roughly 3 mg/d (Reddy, Sanders 1990). While ferritin concentrations in vegetarians tends to be below the normal range (15-300 ng/mL), vegans tend to have similar serum iron and hemoglobin levels to omnivores (Reddy, Sanders 1990, Akinbami, et al. 2013, Sabaté, Ratzin-Turner 2001).

Another nutrient of concern is calcium, which is the most abundant mineral in the body and is mostly found in bone and teeth (Kimball 2002). Calcium is needed in the body to optimize bone density in order to protect against osteoporosis which is characterized by low bone mass and micro architectural deterioration of bone tissue leading to fractures (Kanis, et al. 1994, Weaver, Plawecki 1994). Vegans tend to have lower intakes of calcium compared to omnivores and other vegetarians (Schüpbach et al. 2017, Davey, et al. 2003). In Canada, vegan women tend to consume only 578 mg of calcium per day compared to 875 mg for lacto-ovo-vegetarians and 950g for omnivores (Janelle, Barr 1995). Vegan women are also more likely to have lower calcium intakes than vegan men, women intake about 582 mg/day while men intake 610 mg/day (Davey, et al. 2003). In a more recent study, approximately 54% of their vegan subjects consumed amounts of calcium below the recommendation (estimated average requirement (EAR) 800 mg/dl) compared to only 28% of omnivores (Schüpbach et al. 2017). The lower intake of calcium puts vegans at a higher risk of low bone mineral density (BMD) (Sabaté, Ratzin-Turner 2001). A study done in Taiwan showed that vegan postmenopausal women had a higher risk of lumbar spine fracture and a higher risk of being classified as having osteopenia of the femoral neck (Chiu, et al. 1997). With this increased risk, vegans must ensure they consume adequate calcium (Janelle, Barr 1995). In the EPIC-Oxford study, lacto-ovo-vegetarians and omnivores had the same risk for bone fracture where vegans had a 30% higher risk (Appleby, et al. 2007).

Iodine is another important nutrient that is a concern to vegetarians since it is an essential trace element needed for normal growth and development (Phillips 2005, Brantsæter et al. 2018). Major sources of iodine include milk and seafood which are foods not consumed by vegans therefore putting them at a higher risk of low iodine intakes (Phillips 2005, Brantsæter et al. 2018). A study conducted by Krajcovicova-Kudlackova et al. showed that the iodine intake of vegans was substantially below recommended levels and roughly 80% of vegans were iodine deficient compared to only about 9% of meat-eaters (Krajcovicová-Kudlácková, et al. 2003). Severe deficiency was seen in 27% of the vegans, 10% of the vegetarians and 0% in the omnivores (Krajcovicová-Kudlácková, et al. 2003). A study done in Finland showed that on average vegans only take in 29 µg of iodine per day while omnivores consume roughly 222 µg (Rauma, et al. 1994). This was also observed in Norway (Brantsæter et al. 2018).). The recommendation for iodine intake is >150 µg/day in order to prevent goiter induced by iodine deficiency (Krajcovicová-Kudlácková, et al. 2003). In addition to lower intakes, vegans also have lower urinary iodine concentrations compared omnivores (Schüpbach et al. 2017). While not consuming iodine rich foods puts vegans at higher risk for deficiency, consuming iodized salt can alleviate the problem. Iodized salt is one of the most important sources of dietary iodine (Lawrence 2013). WHO, UNICEF and ICCIDD created guidelines that recommend salt be fortified with 20-40 mg of iodine/kg but the level of fortification depends on a country's salt consumption patterns and the median level of urinary iodine of the population (Lawrence 2013). In Canada, salt is fortified to ensure proper iodine consumption (Government of Canada 2012). It was seen that once iodized salt was introduced globally, in the first decade of the 21st century, countries with previously reported iodine deficiencies saw the prevalence decreased by half (Lawrence 2013). Voluntary salt iodization is the most common policy option implemented in HICs and is used by food manufactures and the salt industry in which they decide when, what vehicle is used and what level of iodization will happen. This is often done for household salts but salts used in food manufacturing still tend to remain non-iodized (Lawrence 2013). Use of these iodized salts can help reduce the risk of iodine deficiency.

Vitamin B12 (B12) is another nutrient that is of concern to vegetarians. B12 is needed for the normal maturation of red blood cells (RBC) and for the synthesis of sphingomyelins which are used to make myelin sheaths in nerve tissues (Rizzo et al. 2016). B12 is generally found in eggs and other dairy products, however it is not naturally found in significant amounts in plant foods (Sabaté, Ratzin-Turner 2001). Lacto-ovo-vegetarians are therefore less likely to have a vitamin B12 deficiency while vegans are at a significantly higher risk (Majchrzak, et al. 2006). A cohort study done by EPIC-Oxford found that intakes of B12 by both vegan males and females were low (0.41 µg/day males and 0.49 µg/day females) while the RNI is 1.5 µg/day (Davey, et al. 2003). It was noted that vegans have lower serum B12 levels, most vegans have levels less than 200 pg/ml

(Bar-Sella, Rakover et al. 1990). A study conducted by Gajski et al. analyzing health-related biomarkers between vegetarians and non-vegetarians revealed that even with supplementation vegetarians had significantly lower values of B12 (Gajski, et al. 2018). The main reason for a B12 deficiency is due to inadequate B12 absorption either because of insufficient B12 intake in the diet or lack of intrinsic factors produced in the stomach that are needed for absorption (Phillips 2005). A B12 deficiency can go unnoticed in vegans and other vegetarians if they have high intakes of folic acid since it masks megaloblastic anemia. If the deficiency in B12 is not treated promptly it can lead to permanent neurological damage including peripheral neuropathy (Phillips 2005).

While there is some concern with micronutrients, there are concerns with a vegetarian diet in terms of macro nutrients. Protein is often thought to be a concern for vegetarians. It has been seen that protein intake of vegans and vegetarians tend to be lower than omnivores (Sanders, 1999). However, if their protein intake is roughly 12% of their energy intake, it should be sufficient for nitrogen balance assuming their energy intake is adequate (Sanders, 1999). There are a few features that differ between animal and plant protein such as amino acid content through protein quality (Lynch, Johnston et al. 2018, Wolfe, et al. 2018). Protein quality is determined by amino acid composition, digestibility and bioavailability (Hoffman, Falvo 2004). Plant proteins can have a lower biological value and tend to be in a less utilizable form than animal proteins, regardless the essential amino acid requirements can still be met by a vegetarian diet (Sanders, 1999). When looking at the digestibility-corrected amino acid score, it can be seen that isolate soy protein can meet nitrogen balance as effectively as animal protein but wheat protein alone can result in insufficient nitrogen (Young, et al. 1975). Protein digestibility corrected amino acids score (PDCAAS) is a measure used to evaluate dietary protein quality where a score of <1 indicates there is at least one limiting amino acid (Hoffman, Falvo 2004). Milk, whey and eggs all have a PDCAAS of 1.00 while pea, oat and whole wheat all have scores less than one (0.67, 0.57, and 0.45, respectively) (van Vliet, Burd et al. 2015). Plant based protein sources may have lower digestibility than animal protein sources (van Vliet, Burd et al. 2015). The Digestible Indispensable Amino Acid Score (DIAAS) is a quantifier of dietary protein quality and was developed to improve upon the limitation of PDCAAS (Wolfe, et al. 2018). DIAAS is based on the content and profile of the essential amino acids in the test protein compared to their requirements while the digestion is determined at the terminal ileum. For DIAAS a score below 100% reflects the most limiting essential amino acid in a protein (Wolfe, et al. 2018). It has been reported that animal proteins including those found in dairy and eggs are highly digestible (>90%), whereas plant-based proteins such as oat, bean and pea exhibit digestibility ranging anywhere from 45-80% (van Vliet, Burd et al. 2015). This could be due to the content of other nutrients such as fiber or the presence of anti-nutritional factors such as protease inhibitors (Gilani, Cockell et al. 2005). Foods such as legumes, cereals, potatoes and tomatoes all contain enzyme inhibitors such as trypsin, chymotrypsin, carboxypeptidases, elastase and α-amylase. Exposure to soybean trypsin inhibitors causes an increase in synthesis and secretion of proteases which include trypsin, chymotrypsin and elastase as well as pancreatic hypertrophy and hyperplasia thus the growth depression caused by these trypsin inhibitors causes endogenous amino acid losses. Tannins are water-soluble polyphenolic compounds that are present in plants including cereal grains and legume seeds (Gilani, Cockell et al. 2005). While tannins provide protection against insects, birds and fungus they also reduce nutritional quality, reducing both protein and amino acid digestibility (Gilani, Cockell et al. 2005, Duodu, et al. 2003). There are some concerns with indispensable amino acids such as the branch-chain amino acids leucine, isoleucine and valine which are important for promoting muscle protein synthesis (Lynch, Johnston et al. 2018). Lysine is an indispensable amino acid that is found in lower concentrations in plant foods than in animal foods (Young, Pellett 1994). The percent of lysine in total protein in quinoa (6.5%), soy (6.2%), rice (3.8%), maize (2.8%), and wheat (2.8%) are all lower than the lysine content found in animal sources such as whey (10.6%), beef (8.9%), cod (8.8%) and egg (7.1%) (van Vliet, Burd et al. 2015). Leucine and methionine are other amino acids that have lower concentrations in plant protein compared to animal proteins (van Vliet, Burd et al. 2015). Leucine has been described as an important amino acid that is responsible for the postprandial stimulation of muscle protein synthesis (van Loon, 2012). When comparing different protein sources it was seen that whey had the highest content with 13.6% thus making it the superior protein source for muscle protein synthesis compared to sources such as soy (8.0%) (van Vliet, Burd et al. 2015). When comparing the total essential amino acid content in terms of total protein, animal proteins are better sources than plant proteins. The total essential amino acids as a percentage of total protein from plant sources range from 30-41% while animal sources range from 40-52% (van Vliet, Burd et al. 2015).

Another nutrient of concern to vegetarians and vegans is n-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Derbyshire 2018). These are typically found in fish, eggs and algae. A-linolenic acid (ALA) is a plant-based n-3 fatty acid and can be converted to

EPA and DHA (Craig 2009, Derbyshire 2018). For vegetarian flaxseed oil is the main source of ALA (Derbyshire 2018). Flaxseed oil can contain up to 56% ALA (Derbyshire 2018). However, the conversion of ALA to EPA is roughly 8% and the conversion of ALA to DHA is estimated to be around 4% (Williams, Burdge 2006). Vegetarian diets that include dairy products and eggs provide 0.02 g/d of DHA (Derbyshire 2018). When compared to non-vegetarians it was seen that vegetarians and in particular vegans have lower blood levels of long chain n-3 fatty acids (Craig, 2010). There has been some conflicting data as there have been a number of negative health effects linked to the consumption of omega-3 fatty acids such as CVD, cancer, Alzheimer's disease and dementia, depression and brain development (Shahidi, Ambigaipalan 2018). According to the American Heart Association, there are no current randomized control trials (RCTs) that suggest the benefits of omega-3 PUFA supplements on prevention of CVD in people with or at risk for diabetes mellitus (Siscovick, et al. 2017). The overall relative risk reduction was 19% (P=0.01) while for those with prior CVD the reduction was 19% (P=0.048) compared to 18% (P=0.132) for those without prior CVD (Yokoyama, et al. 2007, Siscovick, et al. 2017). In the secondary prevention subgroup it was shown that EPA treatment was associated with a significant reduction of 28% in the incidences of unstable angina (Yokoyama, et al. 2007). The American Heart Association suggests there are no evidence from RCTs that omega-3 PUFAs prevent stroke, prevent heart failure or atrial fibrillation (Siscovick, et al. 2017). It is important for vegetarians to include good sources of ALA such as canola oil, soy and flaxseed into their diet (Craig, 2010). While these are some of the major limitations of a limited harm/vegetarian diet there are many others, refer to Table 1 in appendix.

1.6 Social and ecological aspects:

One main reason people follow limited harm diets is for the health benefits they provide, however this is not the only reason people follow these types of diets. Limited harm diets are often based on ethics which are our values (what we think is good) and our principles (what we think is right) (Food Ethics Council, 2022). For many, sustainability and animal welfare are important ethical positions and are driving factors in why many follow a limited harm vegetarian diet.

Climate, biodiversity and other aspects of the environment are all effected by food choices, eating habits and food consumption (Dagevos, Voordouw 2013, Poore, Nemecek 2018, Sakadevan, Nguyen 2017). A study done by Baroni et al. looked at the environmental impacts of different dietary patterns including omnivorous, vegetarians and vegans (Baroni, et al. 2006). What they found was that a “normal” diet based on products from chemical-conventional agriculture and farming has the greatest negative impact on the environment compared to vegan diets based on organic products which have the smallest environmental impact (Baroni, et al. 2006). It has been reported that the consumption of animal-based foods is harmful to the environment (Dagevos, Voordouw 2013). A recent study done by Poore and Nemecek looked at the environmental impact of 40 major foods in which they concluded that animal-based products highly contribute to greenhouse gas emissions (Poore, Nemecek 2018). Beef is in the 90^{th} percentile of greenhouse gas emission of 105 kg of CO_2eq per 100 g of protein, this being 12 times greater than the 10^{th} percentile of dairy beef (milk demand). It was seen that dairy beef greenhouse emissions are 36 times greater than that of peas (Poore, Nemecek 2018). The Food and Agriculture Organization (FAO) showed that plant-based foods are better for the environment and for energy efficiency than animal-based foods (Dagevos, Voordouw 2013). The FAO estimated that livestock activities account for about 18% of the total anthropogenic greenhouse gas emissions from the five major greenhouse gas reporting sectors (energy, industry, waster, land use change, and forestry/agriculture) (Steinfeld et al. 2006). In the agriculture sector alone, livestock contributes about 80% of the emissions (Steinfeld et al. 2006, McMichael et al. 2007). The three major greenhouse gases that livestock contribute to are carbon dioxide, methane and nitrous oxide (Garnett, et al. 2009, Steinfeld et al. 2006, McMichael et al. 2007). Livestock account for 9% of the anthropogenic emissions of CO_2 due to the increase in fossil fuel use in the livestock food chain (Steinfeld et al. 2006). It is estimated that 35-40% of the global anthropogenic emissions of methane come from livestock. About 80% of the methane produced by livestock comes from enteric fermentation and manure. Nitrous oxide however is the greenhouse gas produced mostly by livestock at approximately 65% of the global anthropogenic emissions. These gases are produced at almost every step of the livestock production process and contribute to climate change or air pollution (Steinfeld et al. 2006). It has been suggested that reducing animal derived foods could be possible to reduce greenhouse gases (White, Hall 2017). A model produced by White and Hall showed that greenhouse gases declined by 2.6% in the US agricultural system when farmed animals were eliminated (White, Hall 2017).

Livestock production play a role in water depletion and water pollution (Steinfeld, Food Agriculture Organization of the United Nations. et al. 2006, Sakadevan, Nguyen 2017). The agricultural sector uses the most freshwater at an estimated 70% of water use and 93% of water depletion worldwide (Steinfeld et al. 2006). This depletion in water was linked to our eating habits (Baroni, et al. 2006). Technological advances and urbanization, social and economic structures, as well as social norms have shifted resulting in a demand for a more typical "Western diet" (Laestadius, 2019). A typical Western diet is characterized by excess consumption of red meat and processed foods containing large quantities of salt, and sugar along with low consumption of fruits, vegetables, and while grains (Laestadius et al. 2019). Western diets are becoming more common in lower and middle income countries thus the consumer demand for animal derived foods and in particular red meat are growing across the globe (Laestadius et al. 2019). It was estimated that producing 1 kg of animal protein requires 100 times more water than producing 1 kg of vegetable protein (Pimentel, et al. 1997). For example, it takes 3500 L of water to raise broiler chickens in order to make 1 kg of meat while to produce 1 kg of soy it only takes 1500 L (Sakadevan, Nguyen 2017). Along with water depletion, the livestock sector is responsible for water pollution. Livestock account for 55% of erosion and for 32% of nitrogen and 33% of phosphorus found in fresh water which are considered to be the main water-polluting agents (Steinfeld et al. 2006).

Livestock production have a negative impact on biodiversity (Steinfeld et al. 2006). The major threat to biodiversity caused by livestock is habitat destruction, fragmentation and degradation (Steinfeld et al. 2006, Sakadevan, Nguyen 2017). For example, it has been reported that about 50% of the globally threatened birds are affect by habitat destruction either due to logging or tree cutting and general deforestation to obtain pasture land (Steinfeld et al. 2006). It was estimated that producing 1 kg of beef requires between 150 and 250 square meters of land and that cattle ranching is the single purpose 80% of the Amazon basin had been defrosted (Favaro, 2017). In Central America, roughly 40% of forest area has been destroyed while cattle population and pastures have rapidly increased (Sakadevan, Nguyen 2017). In Brazil roughly 18.9 million ha were deforested between the years 2000-2004 for the single purpose of creating more space for pastures. Livestock is the largest land user in the world, using roughly 30% of earth's land surface. It is estimated that in some counties 85% of agricultural land is used for livestock production (Sakadevan, Nguyen 2017).

While many are concerned with sustainability of their diets, people also adopt limited harm diets because of how animal foods are produced. A majority of studies have shown that most vegetarians are motivated by the ethics of raising and slaughtering animals (Beardsworth et al. 1991). Factory farms are particularly under scrutiny for how they treat their animals (Sabate, Ratzin-Turner 2001). Farm factories are known to keep veal calves in crates, chickens in tiny cages and cattle in pens which do not allow movement (Preece, Chamberlain 1993). Chickens are known to be highly social creatures with complex communication systems in order to communicate and bond with others in their flock (Linzey, Linzey 2018). In factory farms chickens are often confined to barren wired cages which limits their ability to engage in natural behaviors (Linzey, Linzey 2018). Chickens can be debeaked and their toes clipped in order to prevent them from harming each other in their cages (Preece, Chamberlain 1993). Due to their genetic selection allowing them to grow abnormally large, chickens in factory farms often suffer from broken bones, weak legs, heart failure, etc (Linzey, Linzey 2018). In nature, calves nurse for months and build strong bonds with their mother, on most dairy farms the calves are separated from their mothers a few hours after birth (Ventura, et al. 2013). This is done so the milk produced by the cow can be sold rather than being consumed by the calf. Weaning in nature is a gradual process that occurs over several months, but in dairy farms it occurs within 4-12 weeks (Ventura, et al. 2013). The separation has an effect on the mother cow, after calving the cows increase their vocalization and activity which in nature is a way to reunite cow and calf (von Keyserlingk, Weary 2007). Pigs are another common factory farm animal and are highly social and intelligent (Linzey, Linzey 2018). Often female pigs will be kept in a narrow metal sow stall which prevents them from turning around as well as making many other movements. Pigs much like cows have their offspring taken away from them thus preventing them from engaging in normal mothering behaviors (Linzey, Linzey 2018). Animals can lose weight and some die from stress when in factory farms (Preece, Chamberlain 1993). Many vegetarians consider it to be immoral to cause such suffering to animals and believe that animals have rights, including the right to not be exploited by man (Beardsworth et al. 1991).

While concerns for animal rights and the environment are two main reasons for people to follow a limited harm diet, sociocultural variables such as religion is another influential reason. Limited harm diets are based on our values and principles and religion is a major driving factor in how we define our values and principles. For as long as history can recall, religion and food have been intertwined (Sabate, Ratzin-Turner 2001). Many religions have distinct views on food. The responsibility for and taking care of nature is a compelling justification for limited harm diets/vegetarianism in religion. Zoroastrianism, one of the world's oldest creed- based religions, believed that bringing harm to nature was forbidden and thus any defilement of soil or water was considered as violation, therefore no meat was eaten (Sabate, Ratzin-Turner 2001). In most Eastern religions the concept of ahimsa (nonviolence) comes into play (Davidson, 2003). This concept can be most seen in Jainism. Jainism is based on the belief on absolute nonviolence to all living things (Bhatti, Mahida et al. 2007). Therefore, Jains are supposed to be vegetarians (Federation of American Societies for Experimental Biology n.d.). Jains are mostly either lacto-vegetarians or vegans and are not allowed to consume any roots or tubers (Bhatti, Mahida et al. 2007). They are not allowed to consume roots and tubers because uprooting them from the ground will cause harm to small insects therefore going against ahimsa (Mariotti, 2017). Jains have restrictions on eating times. For example, they are not allowed to cook and eat after sunset because there is the possibility of small insects being unknowingly consumed (Mariotti, 2017). Buddhism is another religion based on the sacredness of life. It was said that Buddha advocated for non-violence and non-killing, which was the center of his concept of mercy towards all things (Sabate, Ratzin-Turner 2001). In some teaching, Buddha explained how it was wrong to eat food that was prepared from a slaughtered animal and that eating flesh of another living creature was barbaric especially if the animal lost its life solely to provide that individual with food (Sabate, Ratzin-Turner 2001). In China, Buddhist monks and nuns are expected to maintain a vegetarian diet abstaining from all forms of meat, fish and eggs (Sterckx 2005). Buddhism however is broken up into two major sects, Theravada and Mahayana (Davidson, 2003). In Theravada, its original practice included begging for food and now allows meat eating due to the fact they are bound to eat whatever is placed in their bowls. Mahayana grow or buy their own food so they avoid all kinds of meat (Davidson, 2003). Hinduism adopted many things from Buddhism including its idea of the sacredness of life (Sabate, Ratzin-Turner 2001). In Hinduism, they believe that every form of life including water and trees have consciousness and energy (Sabate, Ratzin-Turner 2001). Today many Hindus are lacto-ovo-vegetarians or just lacto-vegetarians (Mariotti, 2017). However, non-vegetarian Hindus predominantly consume a plant-based diet since many do not consume meat on religious days. While this various by group, the most common days being Monday, Tuesday, Thursday, Friday, and Saturday. Leaving Wednesday and Sunday as the only days to consume meat. During religious fasts, many Hindus consume only water, milk and whole fruit while avoiding foods such as rice, wheat, vegetables and spices (Mariotti, 2017). Some Christians take part in a fast called the Daniel Fast which comes from the prophet Daniel who was said to only consumed vegetables and water for 10-21 days at a time (Venegas-Borsellino, Sonikpreet et al. 2018). This fast represents a vegan diet and prohibits refined foods, white flour, preservatives, additives, sweeteners, flavorings, caffeine and alcohol (Venegas-Borsellino, Sonikpreet et al. 2018). While there are many reasons for people to follow a limited harm diet, religion is still a top factor.

While there are many reasons people become vegetarians, there are a lot of barriers that have to be overcome during the transition. A survey conducted in Australia where one thousand randomly selected individuals were given a questionnaire in order to learn about personal barriers vegetarians have faced (Lea, Worsley 2003). It revealed that the primary barrier is the enjoyment of consuming meat (Lea, Worsley 2003). Unwillingness to change eating habits, one's family eats meat and lack of knowledge about vegetarian diets are important barriers people must overcome (Ruby 2012). Women were more likely than men to feel that their family, spouse, or partner were a significant barrier due to their unwillingness to become vegetarian. Pressure from non-vegetarian to eat meat is another barrier identified in a study that looked at high school vegetarian students (Ruby 2012). While studies have identified pressure from non-vegetarians as a barrier, it is important to acknowledge that this is a two-way street as there is pressure for non-limited harm diet follower, for example a non-vegetarian, to become a limited harm diet follower (vegetarian). This pressure can be insensitive to traditions and history of racial/ethnic groups such as Indigenous people and other non-Europeans (Deckha, 2020; Piracha, 2017).

Once people overcome these barriers there are still difficulties they have to face while maintaining their diet. One being to manage relationships with family and friends who are non-vegetarian (Jabs, Sobal et al. 2000, Rosenfeld 2018). Parents tend to tease and make jokes about their vegetarian children's dietary practices and can be skeptical about the nutritional adequacy (Jabs, Sobal et al. 2000, Rosenfeld 2018). One study showed that 82.5% of people face negative reactions from family and friends once becoming vegan (Rosenfeld 2018). For adults it was seen that once a vegetarian diet was adopted there was a decrease in interactions with family members especially in events that involved food (Jabs, Sobal et al. 2000). For example, symbolic foods during the holidays can be a source of tension. It was noted that many felt restricted in other social situations because of their dietary practices. When going to non-vegetarian households for a meal, vegetarians reported they took steps to avoid upsetting the host such as telling the host they were vegetarian on the invitation and bringing their own food (Jabs, Sobal et al. 2000). There are more difficulties for vegans in social situations. A host will often attempt to accommodate the restrictive vegan diet however they often include eggs and cheese because they thought it was acceptable to a vegan (Jabs, Sobal et al. 2000, Rosenfeld 2018). This often puts vegans in a difficult situation where they do not want to offend the host but also do not want to violate their beliefs (Jabs, Sobal et al. 2000). Studies have shown that in order to avoid conflict some vegetarians will refrain from mentioning their dietary preferences (Rosenfeld 2018). When asked, vegetarians reported that they felt that people's dietary choices are a personal matter and wished others would not judge people based on dietary choices (Jabs, Sobal et al. 2000). We can see here that dietary practices are complex and influenced by a number of things including culture, beliefs and society.

1.7 Conclusion:

There has been an increase in awareness with the foods being consumed over the recent years. This has led to the development of various diets based on ethics or health. Many of these diets follow the idea of limited harm, meaning they try to cause as little to no harm to any living thing. Among limited harm diets, vegetarian diets seem to be the most popular. Over the years it can be seen in many countries that vegetarian diets are becoming increasingly popular. Vegetarian diets have several health benefits including lowering the rates of chronic diseases such as heart disease, hypertension and diabetes, but also overall mortality. Despite those benefits, limited harm diet could lead to nutritional deficiencies. The most common deficiencies in a vegetarian diet are iron, calcium and vitamin B12 but with careful planning these can be mitigated. However, it is often thought that the benefits outweigh the limitations. While health benefit is one of the major reasons for following a limited harm diet, ethical reasons such as animal rights and sustainability or religion influence people's decisions to become vegetarian. Regardless of the reason to become vegetarian, people have many barriers to overcome. There is often a stigma around vegetarian diets and they are often not well understood by non-vegetarians. While some of the research can be a bit conflicting, overall limited harm vegetarian diets appear to be better for human health as well as for the health of the planet. We should consider investing more resources into understanding why and how limited harm diets can improve our health and how these diets can help improve the planet we live on. While there is potential for limited harm diets to have a positive impact, it is important to be aware of whose foods and food systems we are encouraging at the expense of others. As well, it is important to remain sensitive to the food traditions of racial/ethnic groups. There are many different versions of limited harm diets, Table 1.1 summarizes the current most common limited harm diets.

While these are the most common limited harm diets currently, with increased awareness of the impact our food choices have on sustainability and our health the creation of new limited harm diets such as the No Harm Diet is becoming more common. While there has been research done on the nutritional adequacy and environmental impacts of more commonly followed limited harm diets such as vegetarians and veganism, there is little to no research done on newer limited harm diets such as the No Harm Diet. The following chapters will evaluate the nutritional adequacy and the environmental impact of a new limited harm diet called the No Harm Diet.

Table 1.1: Summary of Common Limited Harm Diets

Pescatarian	Lacto-ovo	Vegan	Fruitarian	100 Mile	Low Carbon
•No red meat •No poultry •Fish and shell fish acceptable	•No meat •No fish •No poultry •Milk & milk products acceptable •Eggs acceptable	•No animal products •Grains acceptable •Legumes acceptable •Nuts & seeds acceptable •Vegetable oils acceptable	•No animal products •No foods that injure a plant •Fruits are accetable	•All foods must be grown and produced within a 100 miles of where the person lives	•Foods produced and consumed with minimal emissions

Table 1.2: Advantages and Limitations to Limited Harm Diets

Type of Diet (And key references)	Benefits	Potential Harms
Vegetarian (Dagevos, Voordouw 2013; Smil 2002; Lin, Lin 2014; Steinfeld, Food Agriculture Organization of the United Nations. et al. 2006; Rosenzweig, 2011; Jian, et al. 2015; Hamilton, et al. 2000; Tonstad et al. 2009; Obeid, et al. 2002)	▪ ↓ total serum cholesterol ▪ ↓ blood pressure ▪ ↓ risk of hypertension ▪ ↓ risk for diabetes ▪ ↓ BMI ▪ ↓ cancer rate ▪ ↓ mortality due to cancer ▪ Better prevention and management of kidney disease ▪ ↓ incidence of renal stone formation ▪ ↓ development of gallstones	▪ ↓ Fe stores and serum ferritin levels ▪ Ca intake ▪ ↓ intake of vitamin D ▪ ↓ mean serum vitamin D ▪ ↓ serum B12 levels ▪ Iodine deficiency ▪ Intake of EPA and DHA may not be optimal ▪ ↓ amino acid score ▪ ↓ EPA and DHA
Lacto-ovo (Hamilton, et al. 2000; Tonstad et al. 2009)	▪ ↓ total blood cholesterol ▪ ↓ formation of renal stones	
Vegan (Dagevos, Voordouw 2013; Smil 2002; Lin, Lin 2014; Steinfeld, Food Agriculture Organization of the United Nations. et al. 2006: Rosenzweig 2011; Gilani, Cockell et al. 2005; Jian, et al. 2015; Hamilton, et al. 2000;	▪ ↓ total blood cholesterol ▪ ↓ LDL-C ▪ ↓ blood pressure ▪ ↓ risk of type 2 ▪ ↓ BMI ▪ ↓ GFR ▪ ↓ urinary protein levels	▪ ↓ Ca intake ▪ ↑ risk of low BMD ▪ ↑ risk of osteopenia ▪ Insufficient intake to maintain blood levels of 25-hydroxyvitamin D ▪ High PTH levels ▪ ↓ serum B12 levels

Canada, o. 2010; Tonstad et al. 2009; Obeid, et al. 2002)		▪ More likely to have intakes bellow recommended levels of iodine ▪ ↓ levels of DHA in mothers milk ▪ ↓ HDL
Fruitarian (Turner, 1979)		▪ Low Fe intake ▪ ↓ Ca intake ▪ ↓ vitamin D intake ▪ ↓ protein intake ▪ ↓ energy
100 Mile (Rose, 2008; Smith, 2007)	▪ ↑ fruit and vegetable intake	▪ ↓ energy intake ▪ ↓protein intake ▪ ↑ saturated fat intake ▪ ↑ dietary cholesterol
Low Carbon (Payne, 2016)	▪ ↓ saturated fat intake ▪ ↓ salt intake	▪ ↑ sugar intake ▪ ↓ lower level of essential micronutrients

BMI: Body Mass Index, EPA: eicosapentaenoic acid, DHA: docosahexaenoic acid, Fe: iron, Ca: calcium, LDL-C: low-density lipoprotein-cholesterol, GFR: glomerular filtration rate, BDM: bone mineral density, PTH: parathyroid hormone, HDL: high-density lipoprotein

Chapter 2: Nutritional Adequacy of the No Harm Diet

2.1 Abstract:

Ethical diets have taken the world by storm due to people's increasing awareness of sustainability, animal rights and the environment. While these diets can potentially provide benefits to the health of the planet, it is not clearly known whether they provide enough nutrients needed to live a healthy life. The No Harm Diet is a diet based on the principle of limiting harm to the organism from which we receive our food. For this diet the only acceptable foods are those The only acceptable foods for consumption are those produced by the plant or animal which can be harvested without harm to the organism as well, those which the consumption does not cause harm to the next generation. For this study, the No Harm Diet was evaluated to see if it meets the Daily Recommended Intake (DRI). A seven-day meal plan was created following the ethical guidelines of the diet as well as staying close to a standard adult diet of 2000 kcal. The meal plan was then subjected to evaluation in Nutritionist Pro which calculated the amounts of each nutrient. Basic statistical were calculated through Excel. To compare the No Harm Diet to the average nutrient intake of Canadians, all averages were standardized by 1000 kcal and 1 SD was used to determine if the Canadian average intakes fit within the No Harm averages. Our results suggested that for most nutrients the No Harm Diet met the Adequate Intake (AI), Acceptable Macronutrient Distribution Range (AMDR), Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA) without going over the Tolerable Upper Intake Level (UL). However, some limitations were noticed in a few nutrients specifically omega-3 and omega-6 fatty acids, iodine, iron, vitamin D, vitamin E and biotin where lower than the recommended values were observed. Our study concludes that this No Harm Diet is nutritionally adequate but may have a few nutritional problems. However, these may be mitigated by altering a few foods that are recommended in this report. In conclusion, our study indicated that a different menu design based on No Harm Diet can replace the regular diet in order to obtain the benefit of individual's health and the health of the plant.

2.2 Introduction to the No Harm Diet:

Over the past few decades people have grown more concerned about the food they consume whether it could be because of sustainability reasons, ethical reasons or health reasons. It is widely recognized that the consumption of animal products could be harmful to the environment (Dagevos, Voordouw 2013). The Food and Agriculture Organization (FAO) conducted a study that showed that plant-based foods are better for the environment and for energy efficiency than animal-based foods (Dagevos, Voordouw 2013). It is estimated that livestock activities account for about 18% of the total anthropogenic greenhouse gas emissions including carbon dioxide, methane, and nitrous oxide while also playing a role in water depletion and pollution (Steinfeld, Food Agriculture Organization of the United Nations. et al. 2006).

Diet and sustainability are tightly connected since food choices, eating habits and food consumption affect the climate, biodiversity and other aspects of the environment (Dagevos, Voordouw 2013). There are many diets that have taken these concerns into consideration including the Low-Carbon Diet, the 100 Mile Diet and vegetarianisms. The Low-Carbon Diet is based on reducing the greenhouse gas emissions that come from food production and consumption by minimizing the emissions released in these processes (Favaro 2017). Foods produced and shipped from various countries consumes considerable amounts of energy while adding to the accumulation of greenhouse gases and pollution of the environment thus The 100 Mile diet focuses on eating locally sourced foods which are grown and produced with a 100 miles radius of where a person lives (Smith, MacKinnon 2007, Sim, et al. 2007). Vegetarianism on the other hand focuses more on ethics and health; 46% of people become vegetarian for health reasons while 24% did so for ethical/environmental reasons (Sabate, Ratzin-Turner 2001). Vegetarianism is one of the most popular ethical based diets and is an umbrella term that describes plant-based diets. When carefully planned, vegetarian diets can have some health advantages which were covered in Chapter 1.

While there are many ethic-based diets, not all are able to meet the needs of a healthy adult while still maintaining its underlying principles. This study aimed at evaluating a new ethical diet referred to as the No Harm Diet. The No Harm Diet is a sustainable diet developed by Dr. Lefsrud, Head of the Biomass Production Laboratory at McGill University. This diet is derived from ethical vegetarianism or veganism, in which the underlying principle is that harm to the organism providing food, including plants and animals, is prevented or limited. While some food sources have been viewed to not have feelings, emotions or react to stimuli they are still a living organism and have the right to life and respect. Harm is defined as anything that induces injury, causes a physiological stress response, or affects the growth and development of the progeny of an organism that is providing the food. Within this dietary regime, acceptable foods are those that do not induce injury, cause a physiological stress response or affect the progeny of an organism that is providing food, or in other words, does not cause harm to the organism providing food.

Acceptable foods for this diet are foods that do not cause harm to the plant or animal or to the next generation and can been seen in Table 2.1. For instance, fruits are considered acceptable however we must make sure their seeds are removed before consumption or will be unharmed as they pass through the GI tract. Some dairy products are acceptable in this diet. Certain animals have a higher rate of milk production than what can be consumed by its offspring; it is acceptable to consume dairy products made from the milk of these animals once their offspring has consumed the necessary amount for growth. Unfertilized eggs are acceptable in this diet since they are sterile and are laid on a consistent basis. Honey is considered acceptable since the honey produced by bees that exceeds the amount they can consume. Fermented foods from fruit, milk, eggs and honey are also acceptable. Unacceptable food products include vegetable (leaf crops, root crops, flowers and other parts of a plant), seeds, nuts, grains and meat as these part have to result in the death of the organism or are taken and weaken the organism.

No Harm Guidelines	Acceptable Foods	Nonacceptable Foods
	Fruits ● Any seed-bearing structure in flowering plants	Vegetables ● Leaf crops ● Root crops ● Flowers ● Other parts of a plant
	Dairy Products ● Milk, butter, cream, yogurt, cheese	Seeds ● Those which will get destroyed during digestion must be removed
	Eggs ● Unfertilized	Nuts
	Honey	Grains
	Single Celled Organisms ● Fermented products	Meat ● Poultry ● Meat ● Fish ● Shellfish

Table 2.1: No Harm Diet Guidelines for Acceptable and Nonacceptable Foods for Consumption

2.3 Objective:

The purpose of this study is to see theoretically if consuming this No Harm Diet can meet the DRIs for an average healthy Canadian adult.

2.4 Materials and Methodology:

A seven-day meal plan was created based on a 2000 kcal diet (Appendix A). Each of the seven days consisted of three main meals and two snacks. Each meal was created to be balanced according to the DRI recommendations (Health Canada 2006) and adhere to the No Harm Diet guidelines. Foods were chosen by first identifying what foods were allowed to be consumed by the No Harm guidelines (Table 2.1). From there, foods that can be found in Canadian grocery stores were chosen. These foods were then used to create the variety of meals and snacks found in the meal plan. Different cooking methods were featured in the meal plan. For example, eggs can be cooked a variety of ways while still complying to the No Harm guidelines. In the meal plan, eggs are featured as hard-boiled eggs, frittata, poached, and an omelet.

For each main meal the aim was to balance (as a percentage) protein (10%-35%), fat (20%-35%) and carbohydrates (45%-65%). The aim for the snacks was to try to focus on specific nutrients that were missing from the main meals or that were lacking overall in the diet. The overall goal was to create a meal plan that on average would meet the 2010 Canadian Dietary Reference Intakes (DRIs) for both macro- and micro- nutrients. Each main meal was balanced by entering all food components into the nutrition software (Nutritionist Pro software version 5.2.0 (Axxya Systems, Texas, USA) to evaluate the percentage of protein, fat, and carbohydrates. Amounts of each food and types of foods were adjusted to make sure all percentages fell into the AMDR range while still being a plausible intake.

The 7-day meal plan was also evaluated using Nutritionist Pro software version 5.2. in which each food item used was selected from the Canadian Nutrient File (Health Canada 2018). For foods not found in the Canadian Nutrient File, nutrition facts were found from nutrition labels from products sold in Canada. For certain foods which do not have their own food code in the Canadian Nutrient File on Nutritionist Pro, the Government of Canada Canadian Nutrient file website food search was used in order to determine the correct equivalency. For example, cherry tomatoes do not have their own food code and are found under tomato, red, ripe, raw, year round average. One cherry tomato is equivalent to 17.0 g of the tomato, red, ripe, etc. Based on the amount required for the diet, equivalences were determined and the amount in grams was entered into Nutritionist Pro.

Once all the 7 days from the meal plan (Appendix A) were entered into Nutritionist Pro, the nutrient values for all macro- and micro-nutrients were extracted on to an Excel spreadsheet. The data was then analyzed using various data analysis functions on Excel (Excel 2013, Microsoft Office 365). Average, standard deviation (using the n-1 method), range (minimum and maximum) for all macro- and micronutrients were calculated. For the macro-nutrients, percent of energy was determined by multiplying the average by the number of kcal then dividing by the total kcal. For example, total protein was calculated by multiplying 82.5g by 4kcal/g then dividing by 2043.2.

Once all the basic statistical data were obtained, the daily average values were compared to that of the DRI's. DRI information was found from the Government of Canada Dietary Reference Intake Tables (Health Canada 2006). This information was put into an Excel spreadsheet categorizing the data by age (19-30, 31-50, and 51-70 y) sex (male and female) and nutrient. The diet was then compared to the DRI values to see if it met the Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA) without going over the Tolerable Upper Intake Level (UL). For nutrients with no EAR, the average of the diet was compared to the Adequate Intake (AI) and UL.

Once the diet was evaluated based on the recommended intakes, it was compared to the average intake of Canadians in 2004. The values for the Canadian average were retrieved from the Canadian Community Health Survey Cycle 2.2, Nutrition (Health Canada 2004). Only the data for Canada excluding territories was used for this analysis. It is important to note that those living on reserve are not included in the CCHS, thus the findings of this study would not apply to them. To better compare to average Canadian intakes, all No Harm nutrients and Canadian averages were standardized by 1000 kcal. To compare the No Harm diet with Canadian average intake, we calculated the difference between the two averages of each nutrient. If the difference was within one SD of the No Harm diet, we conclude that there were no important differences between the two. To determine if there was a difference between the No Harm averages and the Canadian averages, SD was used (Agrawal, 2016).

2.5 Results*:*

To evaluate the nutritional adequacy of the No Harm Diet, a seven-day meal plan was created based on a 2000 kcal diet (Appendix A). Each of the seven days consisted of three main meals and two snacks. Each meal was created to be balanced according to the DRI recommendations (Health Canada 2006) and adhere to the No Harm Diet guidelines. The seven-day meal plan was evaluated using Nutritionist Pro to determine its average macro- and micro-nutrient content. Average nutrient content was compared to the DRIs and the average intake of Canadians in 2004. Figure 2.1 compared the percent energy that the No Harm Diet provides compared to the AMDR. Table 2.2-2.4 compare the average nutrient content of the No Harm Diet to the DRI recommendations for men. Table 2.5-2.7 compared the average nutrient content of the No Harm Diet to the DRI recommendations for men. Table 2.8 compares the nutrient content of the No Harm Diet compared to the average nutrient intakes for both Canadian men and women when standardized by 1000 kcal. The No Harm Diet provides 2043.2 kcal per day which is lower than what Canadian men typically consume (2420 kcal/day) but higher than what Canadian women typically consume (1775 kcal/day). Since this ethical diet calorie intake varies from what is usually consumed by Canadians this could account for some discrepancies seen between the No Harm intakes and the average Canadian intakes. Therefore, all results were standardized by 1000 kcal to allow comparison between average Canadian intakes and the No Harm Diet.

Figure 2.1 compared the precent energy provided by the No Harm diet to the AMDR recommendations. For protein, the percent energy the No Harm diet provided was 16%. The AMDR recommendation for protein is between 10%-35%. For carbohydrates, the AMDR recommendation is between 45%-65%, while the No Harm Diet provided 59%. Finally, the AMDR for fat is between 20%-35%. The No Harm Diet provided 27%. Per design, protein, carbohydrates, and total fat content in the No Harm Diet all meet the AMDR recommendations as well as the 2010 DRIs for both men and women.

Table 2.2 compared the average macronutrient content of the No Harm Diet to the DRIs for men. For total energy, the No Harm Diet provided on average 2043.2 calories. However, there were no DRI recommendations for the total energy for men. For protein, the RDA was 56 g/day which was met by the No Harm Diet (82.5 g/day). The EAR for carbohydrates is 100 g/day and the RDA is 130 g/day. The No Harm diet was able to meet both the EAR and RDA by providing 304.7 g/day of carbohydrates. For total fat, saturated fat, and trans-fat the DRI has not been determined. The AI for omega-3 is 1.6 g/day. The No Harm Diet was unable to meet the AI for omega-3 as it only provides on average 1.1 g/day. Similar to omega-3, the AI for omega-6 (14-17 g/day) was not met by the No Harm Diet (5.3 g/day).

Table 2.3 compared the average mineral content of the No Harm Diet to the DRIs for men. The AI for sodium is 1,300-1,500 mg/day while the UL is 2,300 mg/day. The No Harm Diet was able to meet the AI without exceeding the UL as it provided on average 2,138.1 mg/day. The EAR for calcium is 800 mg/day, while the RDA is 1,000 md/day and the UL is 2,500 mg/day. The No Harm Diet was able to meet both the EAR and RDA without exceeding the UL. The No Harm Diet on average provided 1,711.1 mg of calcium per day. The EAR for iodine is 95 μg/day, while the RDA is 150 μg/day and UL is 1,100 μg/day. The No Harm Diet was unable to meet the EAR for iodine, as the No Harm Diet did not provide any iodine (0.0 μg/day). For iron, the No Harm Diet was able to meet both the EAR (6 mg/day) and the RDA (8 mg/day) as it provided on average 12.6 mg/day. As well, the No Harm Diet did not exceed the UL for iron (45 mg/day). The EAR for magnesium is 330-350 mg/day while the RDA is 400-420 mg/day. The No Harm Diet was able to meet both the EAR and RDA (438.7 mg/day) without exceeding the UL (350 mg/day). The AI for manganese is 2.3 mg/day which was met by the No Harm Diet (4.0 mg/day) without exceeding the UL (11 mg/day). The EAR for phosphorus is 580 mg/day while the RDA is 700 mg/day. The No Harm Diet was able to meet both the EAR and RDA without exceeding the UL (4,000 mg/day) by providing 1,876.2 mg/day. The amount of selenium (70.0 μg/day) provided by the No Harm Diet met both the EAR (45 μg/day) and RDA (55 μg/day) without exceeding the UL (400 μg/day). The EAR for zinc is 45 mg/day while the RDA is 11 mg/day. The No Harm Diet was able to meet both the EAR and RDA without exceeding the UL (40 mg/day) by providing 11.0 mg/day. Finally, the AI for potassium is 4,700 mg/day which was met by the No Harm Diet (6,440.7 mg/day).

Table 2.4 compared the average vitamin content of the No Harm Diet to the DRIs for men. The No Harm Diet provided 7,723.5 IU/day of vitamin A which met both the EAR (2,083 IU/day) and the RDA (3,000 IU/day) without exceeding the UL (10,000 IU/day). Similar to the amount of vitamin A, the amount of vitamin C provided by the No Harm Diet (369.8 mg/day) met both the EAR (75 mg/day) and the RDA (90 mg/day) without exceeding the UL (2,000 mg/day). The amount of vitamin D and vitamin E provided by the No Harm diet was insufficient to meet the EAR. The No Harm Diet provided 7.1 μg/day of vitamin D while the EAR was 10 μg/day. While the amount of vitamin E provided by the No Harm Diet was 6.5 mg/day which was insufficient in meeting the EAR of 12 mg/day. The No Harm Diet was able to meet the AI (120 µg/day) for vitamin K by providing 142.0 µg/day. The No Harm Diet was able to meet the EAR and RDA for thiamin, riboflavin, niacin, vitamin B6, vitamin B12, and folate. The No Harm Diet provided 1.4 mg/day of thiamin, 3.8 mg/day riboflavin, 17.0 mg/day of niacin, 3.3 mg/day mg/day of vitamin B6, 7.3 µg/day of vitamin B12, and 473.3 µg/day of folate. The AI for pantothenic acid (5 mg/day) was met by the No Harm Diet (10.0 mg/day). Biotin was the final vitamin examined, however, the amount of biotin provided by the No Harm Diet was insufficient in meeting the AI. The AI for bitcoin is 30 µg/day while the No Harm Diet only provided 0.1 µg/day.

Table 2.5 examined the average macronutrient content of the No Harm Diet compared to the DRIs for women. Similar to the DRI for men, there are no DRI recommendations for total energy, however the No Harm Diet provided 2043.2 kcal/day. The No Harm Diet provided 82.5 g/day of protein which met the RDA (46 g/day). Carbohydrates provided by the No Harm Diet averaged 304.7 g/day which was sufficient to meet both the EAR (100 g/day) and the RDA (130 g/day). Total fat, saturated fat, and trans fat did not have DRI values to compare the No Harm averages to. The amount of omega-3 provided by the No Harm Diet (1.1 g/day) was enough to meet the AI (1.1 g/day). Omega-6 was the only macronutrient that wasn't able to meet the DRI recommendations. The No Harm Diet on average provided 5.3 g/day of omega-6 while the AI ranged from 11-12 g/day.

Table 2.6 compared the average mineral content of the No Harm Diet compared to the DRIs for women. Sodium, Manganese, and potassium provided by the No Harm Diet was enough to meet the AIs. The AI for sodium is 1,300-1,500 mg/day. The No Harm Diet provided 2,138.1 mg/day which exceeded the AI but did not exceed the UL (2,300 mg/day). The AI for manganese is 1.8 mg/day which was met by the No Harm Diet (4.0 mg/day). In terms of potassium, the AI was 4,700 mg/day which was met by the No Harm Diet (6,440.7 mg/day). The amounts of calcium, magnesium, phosphorus, selenium, and zinc provided by the No Harm Diet was sufficient to meet both the EAR and RDA of each. The No Harm Diet on average provided 1,711.1 mg/day of calcium which met the EAR (800-1,000 mg/day) and the RDA (1,000-1,200 mg/day). The EAR for magnesium was 255-265 mg/day while the RDA was 310-320 mg/day while the No Harm Diet provided 438.7 mg/day. The EAR for phosphorus was 580 mg/day while the RDA was 700 mg/day which were both met by the No Harm Diet (1,876.2 mg/day). The No Harm Diet on average provided 70.0 µg/day which is more than the EAR (45 µg/day) and the RDA (55 µg/day). The EAR for zinc is 6.8 mg/day while the RDA is 8 mg/day. The No Harm Diet was able to meet both of these recommendations by providing 11.0 mg/day on average. The two minerals that were not able to meet DRI recommendations was iodine and iron. The EAR for iodine is 95 µg/day however, the No Harm Diet provided 0.0 µg/day. As for iron, the EAR was able to be met (5-8.1 mg/ day) however, the RDA of 8-18 mg/day was not. The No Harm Diet was only able to provide 12.6 mg/day of iron.

Table 2.7 compared the amount of vitamins provided by the No Harm Diet to the DRI recommendations for women. The amount of vitamin K and pantothenic acid provided by the No Harm Diet was sufficient to meet the AI. The AI for vitamin K is 90 µg/day while the No Harm Diet provides 142.0 µg/day. The AI for pantothenic acid is 5 mg/day which was met by the No Harm Diet (10.0 mg/day). The average amount of vitamin A, vitamin C, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, and folate provided by the No Harm Diet met both the EAR and RDA for each vitamin. The EAR for vitamin A is 1,667 IU/day while the RDA is 2,333 IU/day. The amount of vitamin A provided by the No Harm Diet was 7,723.5 IU/day. The amount of vitamin C provided by the No Harm Diet was 369.8 mg/day which met the EAR (60 mg/day) and the RDA (75 mg/day). The No Harm Diet on average provided 1.4 mg/day of thiamin while the EAR is 1.0 mg/day and the RDA is 1.1 mg/day. The EAR for riboflavin is 0.9 mg/day while the RDA is 1.1 mg/day. The No Harm Diet provided 3.8 mg/day of riboflavin. The amount of niacin provided by the No Harm Diet was 17.0 mg/day while the EAR was 11 mg/day and the RDA 14 mg/day. The EAR for vitamin B6 is 1.1-1.3 mg/day while the RDA is 1.3-1.5 mg/day. The No Harm Diet was able to meet both the EAR and RDA by providing on average 3.3 mg/day of vitamin B6. For vitamin B12, the No Harm Diet provided 7.3 µg/day which was able to meet both the EAR (2.0 µg/day) and the RDA (2.4 µg/day). Folate was the final vitamin that was able to meet both the EAR and RDA. The No Harm Diet provided on average 473.3 µg/day while the EAR was 320 µg/day and the RDA was 400 µg/day. The amount of vitamin D, vitamin E, and biotin provided by the No Harm Diet was insufficient in meeting the DRI recommendations. The EAR for vitamin D is 10 µg/day. The No Harm Diet was only able to provide on average 7.1 µg/day of vitamin D. The EAR for vitamin E is 12 mg/day while the No Harm Diet was only able to provide 6.5 mg/day. Finally, the amount of biotin provided by the No Harm Diet was only 0.1 µg/day while the AI was 30 µg/day.

Table 2.8 compares the daily nutrient composition standardized by 1000 kcal to the usually intakes of Canadian men and women standardized by 1000 kcal. All macronutrients intakes for Canadian men and Canadian women (protein, carbohydrates, total fat, saturated fat, omega-3, and omega-6) are within 1SD of the No Harm Diet mean intakes. There was no data available about the amount of trans fat both Canadian men and women usually intake. When comparing the standardized mineral content of average Canadian intakes to the No Harm Diet, it was seen that only phosphorus was within 1SD of the No Harm Diet for both men and women. For magnesium, only the standardized intakes for Canadian women were within 1 SD of the No Harm Diet. For Canadian men, there intakes are 2SD lower than the No Harm Diet mean. The amount of sodium consumed by both the Canadian men and women is 2SD higher than the mean intake of the No Harm Diet. While the diet does provide an adequate amount of sodium, a slight reduction could be beneficial. When looking at the standardized results of calcium, it can be seen that the mean of the No Harm Diet is 2SD higher than what is being consumed by both Canadian men and women. Iron is being consumed more by Canadian men as the mean intake is 4SD above the mean of the No Harm Diet. Similar to Canadian men, Canadian women's iron intake is 4SD above the mean of the No Harm Diet. For potassium, the average Canadian women intake was 4SD away from the No Harm mean, while the average Canadian men intake was 5SD away from the No Harm mean. For manganese there are no Canadian averages to compare. No conclusion can be made on how selenium compared to the Canadian intakes since no data was found. When comparing the standardized intakes for zinc, it can be seen that both the Canadian men and women intakes are 2SD higher than the No Harm Diet mean intake. The standardized intakes showed that the average intake of vitamin A for Canadian women fell within 1SD of the No Harm mean. However, for Canadian men, the intake fell 2SD away from the No Harm mean. For vitamin C, the average intake for both Canadian men and women fell 2SD below the mean for the No Harm Diet. The average intake of vitamin D for Canadian women 275SD above the mean provided by the No Harm Diet. For Canadian men, 250SD above the No Harm mean. The average intake of thiamin for both Canadian women and Canadian men were within 1SD of the No Harm mean. The average intakes of riboflavin for both Canadian men and Canadian women are 2SD below the No Harm mean. The average Canadian men and women intake of niacin are 5SD above the No Harm mean. For vitamin B6, the No Harm mean is 2SD above the average intake for both Canadian men and women. For vitamin B12 and folate, the Canadian average intakes for both men and women are within 1SD of the No Harm mean. There was no Canadian intake data for vitamin E, vitamin K, pantothenic acid, and biotin.

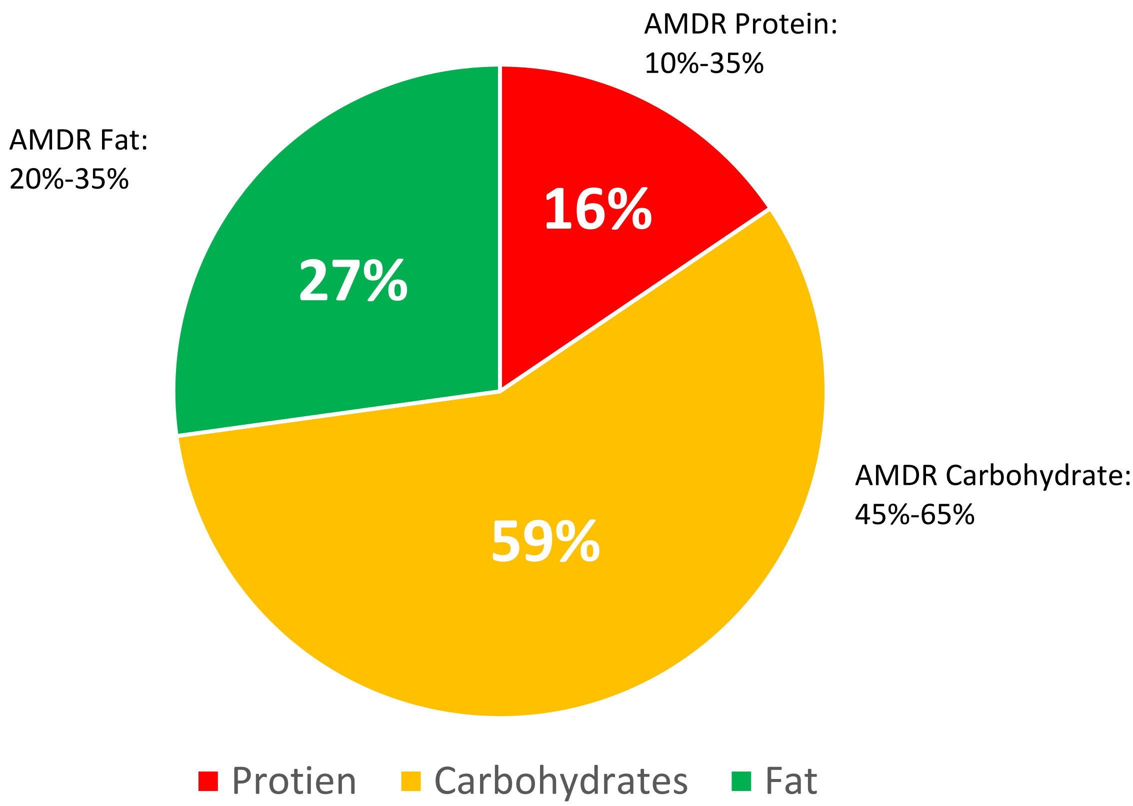

Figure 2.1: Percent Energy of the No Harm Diet 7-Day Meal Plan to the AMDR

	Average	Range	SD	% Energy	AMDR	Age	AI	EAR	RDA	UL
Total Energy Kcal/day	2043.2	2002-2068	26			19-30 31-50 51-70	ND ND ND			ND ND ND
Protein g/day	82.5‡	66-122	20	16%	10%-35%	19-30 31-50 51-70			56 56 56	ND ND ND
Carbohydrates g/day	304.7‡	218-390	60	59%	45%-65%	19-30 31-50 51-70		100 100 100	130 130 130	ND ND ND
Total Fat g/day	63*	44-89	19	28%	20%-35%	19-30 31-50 51-70	ND ND ND			ND ND ND
Saturated Fat g/day	19.3	13-29	6			19-30 31-50 51-70				ND ND ND
Omega-3 g/day	1.1	1-1.4	0.2	0.5%	0.6%-1.2%	19-30 31-50 51-70	1.6 1.6 1.6			ND ND ND
Omega-6 g/day	5.3	3-7	2	2%	5%-10%	19-30 31-50 51-70	17 17 14			ND ND ND
Trans Fat g/day	0.6	0-1	0.3	0.3%		19-30 31-50 51-70				ND ND ND

Table 2.2 Daily Average Macronutrient Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Men

ND= not determinable, * = meets AI, † = meets EAR, ‡ = meets RDA

	Average	Range	SD	Age	AI	EAR	RDA	UL
Sodium mg/day	2138.1*	843.1-3228.2	815.7	19-30	1500			2300
				31-50	1500			2300
				51-70	1300			2300
Calcium mg/day	1711.1‡	1479.6-2116.2	214.4	19-30		800	1000	2500
				31-50		800	1000	2500
				51-70		800	1000	2000
Iodine µg/day	0.0	0.0-0.0	-	19-30		95	150	1100
				31-50		95	150	1100
				51-70		95	150	1100
Iron mg/day	12.6‡	10.3-15.3	2.3	19-30		6	8	45
				31-50		6	8	45
				51-70		6	8	45
Magnesium mg/day	438.7‡	399.6-472.7	26.1	19-30		330	400	350
				31-50		350	420	350
				51-70		350	420	350
Manganese mg/day	4.0*	2.1-7.0	1.6	19-30	2.3			11
				31-50	2.3			11
				51-70	2.3			11
Phosphorus mg/day	1876.2‡	1595.7-2319.0	760.1	19-30		580	700	4000
				31-50		580	700	4000
				51-70		580	700	4000
Selenium µg/day	70.0‡	57.1-86.9	11.0	19-30		45	55	400
				31-50		45	55	400
				51-70		45	55	400
Zinc mg/day	11.0‡	9.1-14.0	1.6	19-30		9.4	11	40
				31-50		9.4	11	40
				51-70		9.4	11	40
Potassium mg/day	6440.7*	5421.4-7269.5	635.7	19-30	4700			ND
				31-50	4700			ND
				51-70	4700			ND

Table 2.3 Daily Average Mineral Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Men

ND= not determinable, * = meets DRI, † = meets EAR, ‡ = meets RDA

	Average	Range	SD	Age	AI	EAR	RDA	UL
Vitamin A IU/day	7723.5‡	4430.0-11421.1	2752.4	19-30 31-50 51-70		2083 2083 2083	3000 3000 3000	10,000 10,000 10,000
Vitamin C mg/day	369.8‡	167.3-680.3	179.1	19-30 31-50 51-70		75 75 75	90 90 90	2000 2000 2000
Vitamin D µg/day	7.1	5.0-10.3	1.9	19-30 31-50 51-70		10 10 10	15 15 15	100 100 100
Vitamin E mg/day	6.5	5.6-14.2	1.9	19-30 31-50 51-70		12 12 12	15 15 15	1000 1000 1000
Vitamin K µg/day	142.0*	114.2-183.1	24.5	19-30 31-50 51-70	120 120 120			ND ND ND
Thiamin mg/day	1.4‡	0.9-2.3	0.5	19-30 31-50 51-70		1 1 1	1.2 1.2 1.2	ND ND ND
Riboflavin mg/day	3.8‡	2.0-5.0	0.7	19-30 31-50 51-70		1.1 1.1 1.1	1.3 1.3 1.3	ND ND ND
Niacin mg/day	17.0‡	10.7-25.2	5.8	19-30 31-50 51-70		12 12 12	16 16 16	35 35 35
Vitamin B6 mg/day	3.3‡	2.5-4.4	0.6	19-30 31-50 51-70		1.1 1.1 1.4	1.3 1.3 1.7	100 100 100
Vitamin B12 µg/day	7.3‡	5.0-10.6	2.2	19-30 31-50 51-70		2 2 2	2.4 2.4 2.4	ND ND ND
Pantothenic acid mg/day	10.0*	8.0-10.9	1.2	19-30 31-50 51-70	5 5 5			ND ND ND
Biotin µg/day	0.1	0.0-0.6	0.2	19-30 31-50 51-70	30 30 30			ND ND ND
Folate µg/day	473.3‡	290.9-626.4	105.0	19-30 31-50 51-70		320 320 320	400 400 400	1000 1000 1000

Table 2.4 Daily Average Vitamin Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Men

ND= not determinable, * = meets DRI, † = meets EAR, ‡ = meets RDA

	Average	Range	SD	% Energy	AMDR	Age	AI	EAR	RDA	UL
Total Energy Kcal/day	2043.2	2002.1-2068.0	25.6			19-30 31-50 51-70	ND ND ND			ND ND ND
Protein g/day	82.5‡	65.6-121.8	20.2	16%	10%-35%	19-30 31-50 51-70			46 46 46	ND ND ND
Carbohydrates g/day	304.7‡	217.6-390.0	59.7	59%	45%-65%	19-30 31-50 51-70		100 100 100	130 130 130	ND ND ND
Total Fat g/day	63	43.7-88.5	18.7	28%	20%-35%	19-30 31-50 51-70	ND ND ND			ND ND ND
Saturated Fat g/day	19.3	13.2-28.8	6.4	8.7%		19-30 31-50 51-70				ND ND ND
Omega-3 g/day	1.1	0.8-1.4	0.2	0.5%	0.6%-1.2%	19-30 31-50 51-70	1.1 1.1 1.1			ND ND ND
Omega-6 g/day	5.3	2.9-7.2	1.6	2%	5%-10%	19-30 31-50 51-70	12 12 11			ND ND ND
Trans Fat g/day	0.6	0.2-0.9	0.3	0.3%		19-30 31-50 51-70				ND ND ND

Table 2.5 Daily Average Macronutrient Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Women

ND= not determinable, * = meets AI, † = meets EAR, ‡ = meets RDA

	Average	Range	SD	Age	AI	EAR	RDA	UL
Sodium	2138.1*	843.1-3228.2	815.7	19-30	1500			2300
mg/day				31-50	1500			2300
				51-70	1300			2300
Calcium	1711.1‡	1479.6-2116.2	214.4	19-30		800	1000	2500
mg/day				31-50		800	1000	2500
				51-70		1000	1200	2000
Iodine	0.0	0.0-0.0	-	19-30		95	150	1100
µg/day				31-50		95	150	1100
				51-70		95	150	1100
Iron	12.6†	10.3-15.3	2.3	19-30		8.1	18	45
mg/day				31-50		8.1	18	45
				51-70		5	8	45
Magnesium	438.7‡	399.6-472.7	26.1	19-30		255	310	350
mg/day				31-50		265	320	350
				51-70		265	320	350
Manganese	4.0*	2.1-7.0	1.6	19-30	1.8			11
mg/day				31-50	1.8			11
				51-70	1.8			11
Phosphorus	1876.2‡	1595.7-2319.0	760.1	19-30		580	700	4000
mg/day				31-50		580	700	4000
				51-70		580	700	4000
Selenium	70.0‡	57.1-86.9	11.0	19-30		45	55	400
µg/day				31-50		45	55	400
				51-70		45	55	400
Zinc	11.0‡	9.1-14.0	1.6	19-30		6.8	8	40
mg/day				31-50		6.8	8	40
				51-70		6.8	8	40
Potassium	6440.7*	5421.4-7269.5	635.7	19-30	4700			ND
mg/day				31-50	4700			ND
				51-70	4700			ND

Table 2.6 Daily Average Mineral Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Women

ND= not determinable, * = meets AI, † = meets EAR, ‡ = meets RDA

	Average	Range	SD	Age	AI	EAR	RDA	UL
Vitamin A IU/day	7723.5‡	4430.0-11421.1	2752.4	19-30 31-50 51-70		1667 1667 1667	2333 2333 2333	10,000 10,000 10,000
Vitamin C mg/day	369.8‡	167.3-680.3	179.1	19-30 31-50 51-70		60 60 60	75 75 75	2000 2000 2000
Vitamin D µg/day	7.1	5.0-10.3	1.9	19-30 31-50 51-70		10 10 10	15 15 15	100 100 100
Vitamin E mg/day	6.5	5.6-14.2	1.9	19-30 31-50 51-70		12 12 12	15 15 15	1000 1000 1000
Vitamin K µg/day	142.0*	114.2-183.1	24.5	19-30 31-50 51-70	90 90 90			ND ND ND
Thiamin mg/day	1.4‡	0.9-2.3	0.5	19-30 31-50 51-70		1 1 1	1.1 1.1 1.1	ND ND ND
Riboflavin mg/day	3.8‡	2.0-5.0	0.7	19-30 31-50 51-70		0.9 0.9 0.9	1.1 1.1 1.1	ND ND ND
Niacin mg/day	17.0‡	10.7-25.2	5.8	19-30 31-50 51-70		11 11 11	14 14 14	35 35 35
Vitamin B6 mg/day	3.3‡	2.5-4.4	0.6	19-30 31-50 51-70		1.1 1.1 1.3	1.3 1.3 1.5	100 100 100
Vitamin B12 µg/day	7.3‡	5.0-10.6	2.2	19-30 31-50 51-70		2 2 2	2.4 2.4 2.4	ND ND ND
Pantothenic acid mg/day	10.0*	8.0-10.9	1.2	19-30 31-50 51-70	5 5 5			ND ND ND
Biotin µg/day	0.1	0.0-0.6	0.2	19-30 31-50 51-70	30 30 30			ND ND ND
Folate µg/day	473.3‡	290.9-626.4	105.0	19-30 31-50 51-70		320 320 320	400 400 400	1000 1000 1000

Table 2.7 Daily Average Vitamin Intake of the 7-Day No Harm Meal Plan Compared to the DRIs for Women

ND= not determinable, * = meets AI, † = meets EAR, ‡ = meets RDA

Nutrient	No Harm Mean	±SD	Canadian Men	Canadian Women
Protein	36.2	10.9	40.9*	41.1*
Carbohydrate	128.3	33.8	120.7*	125.1*
Total Fat	45.0	11.8	36.4*	36.6*
Saturated Fat	12.3	3.8	11.8*	11.9*
Omega-3	0.7	0.3	0.9*	0.9*
Omega-6	4.5	2.3	5.2*	5.2*
Trans Fat	0.1	0.1	-	-
Sodium	846.4	420.5	1482.2	1497.5
Calcium	639.4	186.1	384.7	446.8
Iodine	0	0	-	-
Iron	4.8	0.6	6.7	6.9
Magnesium	188.8	24.0	150.4	166.8*
Manganese	1.4	0.4	-	-
Phosphorus	662.8	159.4	626.0*	665.4*
Selenium	22.0	8.6	-	-
Zinc	4.3	0.9	5.5	5.4
Potassium	2752.1	308.5	1429.8	1576.3
Vitamin A	6972.6	5508.7	1041.3	1211.3*
Vitamin C	189.5	94.6	55.0	67.6
Vitamin D	2.6	0.4	102.5	112.7
Vitamin E	4.1	1.3	-	-
Vitamin K	75.5	21.4	-	-
Thiamin	0.6	0.2	0.8*	0.8*
Riboflavin	1.4	0.3	0.9	0.9
Niacin	8.2	2.2	19.2	19.2
Vitamin B6	1.5	0.3	0.9	0.9
Vitamin B12	2.7	0.9	2.1*	2.1*
Pantothenic Acid	4.0	1.2	-	-
Biotin	0.3	0.3	-	-
Folate	224.9	72.8	214.9*	228.2*

Table 2.8 1000 Kcal Standardized Daily Nutrient Intakes Compared to 1000 Kcal Standardized Canadian Men and Women Usually Intakes
* Within 1SD of No Harm Mean

2.6 Discussion:

With the increasing awareness of the foods people are consuming ethical diets have become very popular. However, it is important to evaluate these diets to ensure it is possible to provide the necessary nutrients. The No Harm Diet is an ethical diet derived from ethical vegetarianism or veganism and is based on the idea of limiting harm to the organisms in which we receive our food. The underlying principle is that harm to the organism providing food, including plants and animals, is prevented, or limited. Thus, only fruits, and certain other foods are allowed to be consumed. With the elimination of vegetables, grains, and meat it is important to evaluate if we can achieve adequate nutritional intakes with this diet to see if it is possible to get the nutrients required for normal function. This diet meets the requirements for macronutrients as well as most micronutrients. However, there are a few limitations with omega-3 and omega-6 fatty acids, iodine, iron, vitamin D, vitamin E, and biotin being lower than recommended.

When looking at the macro-nutrients provided by the No Harm Diet, it can be seen that this dietary pattern meets the DRI/AMDR recommendations for both men and women for protein, carbohydrates, and total fat. There are no DRI recommendations for saturated fat. However, the amount of saturated fat provided by the No Harm Diet is not significantly different from the amount of saturated fat typically consumed by both Canadian men and Canadian women. While there is no difference in the amount provided, it could be beneficial to lower the amount of statured fat found in the No Harm Diet as there is a strong positive correlation between saturated fat intake and rates of CHD (Langella 2012). Saturated fats affect vascular inflammation and the health of the endothelium. A study done by Nicholls et al. showed that a meal consumed with high saturated fat (1g of fat/kg of body weight) results in an increased expression of ICAM-1 and VCAM-1 adhesion molecules which could lead to the impairment of HDL anti-inflammatory properties (Nicholls, et al. 2006). Higher intakes of saturated fats can lead to an increased expression of pro-inflammatory adhesion molecules and endothelial dysfunction (Langella 2012). One problem the No Harm Diet has, is the amount of omega-3 and omega-6 fatty acids. For both men and women, the amount of omega-3 and omega-6 provided by the No Harm Diet are below DRI recommendations. Since humans are unable to synthesize omega-3 and omega-6 fatty acids it is important to get them from the diet. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are two fatty acids both typically found in fish, eggs and algae. A-linolenic acids (ALA) is a plant-based n-3 fatty acid which can be converted to EPA and DHA however the conversion of ALA to EPA is 8% while ALA to DHA is 4% (American Dietetic Association 2009, Williams, Burdge 2006). These fatty acids are required for growth, reproduction, maintenance of skin and regulation of cholesterol metabolism (Mangels, Messina et al. 2011). Higher linoleic fatty acids (LA) intakes are associated with lower blood pressure as well as a reduced risk of diabetes (Grimsgaard, et al. 1999, Salmeron, et al. 2001). ALA has been shown to be associated with a reduced risk of coronary artery disease, myocardial infraction and fatal heart disease (Djousse, et al. 2001, Campos, Baylin et al. 2008, Hu, et al. 1999). The best sources of both LA and ALA in the No Harm Diet are avocados, eggs, and milk. However, in order to get approximately 1.6 g of ALA in this diet, one would need to consume 10 cups of avocado, 94 regular eggs or 160 cups of milk (Mangels, Messina et al. 2011). Consuming this much of one of these foods would displace other foods needed for a nutritionally adequate diet while still remaining under 2000 kcal. Replacing olive oil and butter in the diet with avocado oil or adding omega-3 eggs in the diet could be good solutions that will be explored when the diet is revised. In terms of trans fats, there are no guidelines on how much to consume provided by Health Canada other than try to consume as little as possible while still consuming a nutritionally adequate diet. There were no Canadian averages to compare the No Harm Diet but the No Harm Diet meal plan was made with the best attempt at minimizing trans fats.

The mineral content of the No Harm Diet was evaluated and compared it to the DRI values for men and women. It can be seen that all the minerals meet the DRI values (both EAR and RDA) except for iodine and iron (women only). According to Nutritionist Pro, the No Harm Diet provides no iodine. In Canada table salt is iodized and there should have been iodine in the diet but it is possible that there was an error in Nutritionist Pro. There was no data available on the usual intake of iodine by the Canadian population to compare. The No Harm Diet provides roughly 12.6 mg/day of iron. This amount is sufficient for meeting the EAR and RDA for men. For women, this amount of iron is enough to meet the EAR meaning it is ok for the general population. The No Harm Diet falls short of meeting the RDA for iron and was significantly different than what both Canadian men and Canadian women typically consume. The amount of iron consumed by both Canadian men and women are 2SD above what is provided by the No Harm Diet. It would be beneficial to increase the amount of iron provided by the No Harm Diet as it is an important mineral as its primary function is to transport oxygen (Mangels, Messina et al. 2011). If iron needs are not met, iron stores will begin to decrease and once depleted will depress hemoglobin production (Mangels, Messina et al. 2011). Iron deficiency can occur because of inadequate intake and poor GI absorption of non-heme iron (McGirr, McEvoy et al. 2017). If not treated, this will progress to iron-deficiency anemia and can result in functional impairment due to inadequate oxygen delivery and abnormal enzyme function (Mangels, Messina et al. 2011).

When evaluating the mineral content of the No Harm Diet it was seen that some of the minerals differ from what is currently being consumed by Canadians. The amount of sodium provided by the No Harm Diet was 2SD below what is consumed on average by both Canadian men and Canadian women. High intakes in sodium have been linked to higher blood pressure (Campbell, Lackland et al. 2013). In a few cohort studies, it was seen that higher sodium intakes are associated with an increase in stroke risk by 24%, 63% higher risk of stroke death and a 32% higher risk of coronary heart disease death (Campbell, Lackland et al. 2013). Therefore, the lower amounts of sodium in the No Harm Diet could be beneficial. Calcium was another mineral that differed compared to Canadian averages. The amount of calcium provided by the No Harm Diet was 2SD higher than what is typically consumed by both Canadian men and Canadian women. Calcium is an essential nutrient which provides mechanical rigidity to bones and is involved in most metabolic processes (Nordin 1997). The calcium found in the skeleton acts as a reserve supply of calcium in times of calcium deficiency. When a deficiency occurs in adults, mobilization of bone calcium occurs and can eventually lead to osteoporosis. A common feature of aging is osteoporosis which occurs at the time of menopause in women and around age 55 in men leading to an increased risk of fractures. The risk of fractures however is inversely related to bone density which is determined by the density achieved at maturity as well as subsequent rate of bone loss (Nordin 1997). Therefore, adequate amounts of calcium are important to promote a higher peak bone density. The No Harm Diet could help promote higher bone density as well as help decrease the risk of osteoporosis in adults. Potassium was another mineral that had a higher concentration in the No Harm Diet than what was being consumed on average. The amount of potassium provided by the No Harm Diet is 4SD higher than what is typically consumed by Canadian women and 5SD higher that what is usually consumed by Canadian men. There have been many studies done that show an inverse relationship between higher potassium intakes and lower blood pressure (Institute of Medicine 2004). The Intersalt study showed that a 50 mmol higher excretion of urinary potassium lower systolic blood pressure by 2.5 mmHg while lowering diastolic blood pressure by 1.5 mmHg (Institute of Medicine 2004). Therefore, the higher intake of potassium in the No Harm Diet could help reduce blood pressure as well as reduce the risk of hypertension. In terms of magnesium, the amount typically consumed by Canadian women was not significantly different from what is provided by the No Harm Diet. However, Canadian men consumed amount of magnesium that is 2SD lower that what is provided by the No Harm Diet. Magnesium is an important mineral as it is required for energy production, cofactor for enzymes that regulate diverse biochemical reactions such as protein synthesis and contributes to the structural development of bone (NIH, 2022). Habitually low intakes of magnesium can cause changes in biochemical pathways and can increase the risk of hypertension/cardiovascular disease, type 2 diabetes, and osteoporosis (NIH, 2022). Therefore, the higher amounts of magnesium provided by the No Harm Diet could be beneficial. For zinc, the average intake for Canadian men and women is 2SD higher than what is provided by the No Harm Diet. However, the amount of zinc provided by the No Harm Diet was sufficient to meet the EAR and RDA for both men and women. There was no average Canadian intake data for manganese or selenium.

Most of the vitamins in the No Harm Diet meet both the EAR and RDA for men and women without reaching the UL. The vitamins that ran into shortage in the No Harm Diet were Vitamin D, Vitamin E and Biotin. Vitamin D failed to meet the EAR for both men and women. The EAR for men and women at all age groups is 10 µg/day while the No Harm Diet only provides around 7.12 µg/day. As well, when compared to the average Canadian intakes, it can be seen that the No Harm Diet provides 275SD less than Canadian women 275SD and 250SD less than Canadian men.

A Vitamin D deficiency in adults can lead to under mineralization of the bone matrix osteoid leading to excessive bone loss and osteomalacia (Mangels, Messina et al. 2011). However, it is important to take into account that Vitamin D is not an essential nutrient since with sufficient exposure to sunlight it can be endogenously synthesized in an adequate amount to meet DRI requirements (Mangels, Messina et al. 2011). Both seasons and latitude can affect the amount of Vitamin D synthesized by the skin. The No Harm Diet should supply sufficient amounts of Vitamin D for people who live in places with exposure to sufficient amounts of sunlight, roughly 3 hours per month depending on month and latitude (Webb, Kline et al. 1988). For people living in places where this amount of sunlight exposure is not possible, increasing the amount of fortified milk and margarines may be a way to get sufficient amounts of Vitamin D while following the No Harm Diet. Another vitamin that may cause some concern in the No Harm Diet was Vitamin E. As seen in Table 2.3, Vitamin E does not meet the EAR for men and women at all age groups. The EAR is 12 mg/day while the No Harm Diet only provides 6.5 mg/day. The most important function of Vitamin E is that it is an antioxidant and traps free radicals and prevents the oxidation of polyunsaturated fatty acids (PUFAs) thus decreasing diseases related to free radicals such as heart disease and cancer (Mangels, Messina et al. 2011). It is important to take into account that there are multiple forms for Vitamin E (α-tocopherol, β-tocopherol, γ-tocopherol and δ-tocopherol) however only α- tocopherol is used in setting the EAR and RDA. Conversion factors must be used for the other forms. It is possible that Nutritionist Pro only took into account α-tocopherol and conversion factors must be used to get a more accurate view of the actual vitamin E content of the No Harm Diet. There was no data available to compare Vitamin E content of the No Harm Diet with Canadian average intakes. Biotin was the last vitamin that caused some concern. The amount of biotin provided by the No Harm Diet was 0.1 µg/day while the AI for both men and women is 30 µg/day. Biotin functions as a coenzyme for enzymes that take part in glucose and fatty acid synthesis as well as the metabolisms of amino acids. A good source of biotin is egg yolks (11 µg per 1 medium egg) (Mangels, Messina et al. 2011). The No Harm Diet however consists of many eggs (roughly 2-3 eggs per day) thus should provide sufficient amounts of biotin. One possible explanation for this is that Nutritionist Pro did not take into account biotin found in eggs thus making the diet appear insufficient in biotin. Nutritionist Pro uses data from the Canadian Nutrient File but the Canadian Nutrient File has no data on the content of biotin in eggs.

The amount of vitamin A provided by the No Harm Diet met the EAR and RDA for both men and women. When compared to the Canadian averages, it was seen that for women, the amount of vitamin A is similar to what is provided by the No Harm Diet. However, for Canadian men, the amount typically consumed is 2SD lower that what is provided by the No Harm Diet. Vitamin A plays important roles in vision, growth, cellular differentiation and proliferation, reproduction and in the immune system (Mangels, Messina et al. 2011). A deficiency in vitamin A can have some severe consequences. The first sign of a deficiency is night blindness (Whitney, et al. 2016). In night blindness, the retina does not get enough retinal to regenerate the visual pigments bleached by light thus a person will lose the ability to see after dark. Following night blindness is total blindness. At the beginning the cornea will become dry and hard due to insufficient mucus secretion (xerosis) which is followed by keratomalacia which is the softening of the cornea that leads to blindness. Keratinization can occur in other parts of the body if a vitamin A deficiency is untreated. Keratinization is when the skin becomes dry, rough and scaly due to the accumulation of keratin (Whitney, et al. 2016). The No Harm Diet provides the recommended amount of vitamin A for both men and women and thus may reduce the risk of vitamin A deficiency. Vitamin C was another nutrient that was seen to be consumed less by Canadians compared to what the No Harm Diet could provide. For Canadian women and Canadian men, the average intake is 2SD lower that what is provided by the No Harm Diet. It is known that vitamin C is necessary to prevent scurvy however it has other important functions in the body. In vivo, vitamin C has been shown to suppress endothelial apoptosis that is mediated by inflammatory cytokines and oxidized LDL (Rossig, et al. 2001). Vitamin C has also been seen to reduce vascular smooth muscle cell apoptosis this preventing plaque instability in late-stage atherosclerosis (Siow, et al. 1999). With its antioxidant properties, it is possible for vitamin C to reduce the risk of cardiovascular disease thus giving benefits to the No Harm Diet. The amount of thiamin provided by the No Harm Diet was sufficient to meet both the EAR and RDA for both men and women. As well, the amount of thiamin provided by the No Harm Diet was not significantly different from the amount of thiamin typically consumed by Canadian men and women. Similar to thiamin, the amount of riboflavin provided by the No Harm Diet was sufficient to meet the EAR and RDA for both men and women. However, the amount of riboflavin was significantly different from the amount both Canadian men and women typically consume. For both Canadian men and women, the typically intake was 2SD lower than what was provided by the No Harm Diet. Riboflavin is an essential component of two major coenzymes, flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD), which play roles in energy production, cellular function, and metabolism (NIH, 2022). Riboflavin deficiency can dimmish levels of FMN and FAD which in turn impacts to metabolism of other nutrients including other B vitamins and iron which can lead to other health conditions such as anemia (Mahabadi, 2022). Therefore, the higher amounts of riboflavin provided by the No Harm Diet could be beneficial. Niacin is another vitamin that meet the EAR and RDA for both men and women however, the amount provided by the No Harm Diet is lower than what is typically consumed by Canadian men and women. The amount of niacin consumed by both Canadian men and women is 5SD higher that was is provided by the No Harm Diet. While a deficiency in niacin can lead to pellagra, it is unlikely to occur when following the No Harm Diet as the No Harm Diet meets the DRIs for niacin (NIH, 2021). The vitamin B6 intake of both Canadian men and women is lower that what the No Harm Diet provides. The amount of vitamin B6 consumed by Canadians is 2SD lower than the mean of the No Harm Diet. Inadequate amounts of vitamin B6 is a risk factor for both heart disease and stroke (Kelly, et al. 2003). It was seen that vitamin B6 can be associated with protection against myocardial infraction (Ellis, McCully 1995). The elevated levels of B6 in the No Harm Diet could help protect people from heart disease. The amount of Vitamin B12 and folate provided by the No Harm Diet was sufficient to meet the EAR and RDA for both men and women. As well, amounts were similar to what both Canadian men and women consume (within 1SD of the No Harm mean). No Canadian dietary intake data was available for vitamin K and pantothenic acid.

While the results show that there are some inadequacies in the No Harm Diet, overall, this diet is nutritionally adequate. This was the first study investigating the nutritional quality of the No Harm Diet. One strength of this study was that the meal plan nutritional averages were compared to both the DRIs and average Canadian intakes. Allowing to better highlight the nutritional strengths and limitations of the No Harm Diet. However, there were several limitations to this study. Firstly, the meal plan was based on 2000 kcal which is over what is usually recommended for women. Having meal plans tailored for both men and women would increase the accuracy of the nutritional analysis. Secondary, only 7 days were being evaluated thus limiting the conclusion. To get a better idea of the nutritionally adequacy of the No Harm Diet, a larger meal plan should be analyzed. Third, the meal plan was created to be balanced. While this important to show that it is possible to be nutritionally adequate while following the No Harm Diet, it might not accurately reflect what would be typically consumed by Canadians. A follow up study investigating implementation of the diet and long-term adherence to the No Harm Diet could be of value. Fourth, Nutritionist Pro had some software limitations which made some micronutrients appear to be insufficient in the No Harm Diet. It did not consider biotin found in eggs thus making the diet appear insufficient in biotin. Iodine was not accounted for in any of the foods within the No Harm Diet even though Canadian table salt is iodized. As well, Nutritionist Pro only took into account α-tocopherol for vitamin E, giving an inaccurate view on the actual amount of vitamin E in the No Harm Diet. Finally, since this study was based on the general Canadian population the generalizability and transferability of the results are limited and do not necessarily represent BIPOC communities. Consideration if this diet is culturally appropriate for all Canadian individuals/communities needs to be investigated in further studies.

2.7 Conclusion:

The No Harm Diet is an ethical diet based on the basic philosophy of limiting harm to the organisms in which we receive our food. This study was conducted to evaluate the nutritional adequacy of this diet to see if it was possible to eat a diet where no animal or plant is harmed yet still provides the nutrients required for normal physiological function. A seven-day meal plan was created based on the diet guidelines and evaluated using Nutritionist Pro. Our results suggest that the No Harm Diet meets almost all the nutritional requirements presented by the DRIs. However, problems were presented with the content of omega-3, omega-6, iodine, iron, Vitamin D, Vitamin E, and biotin in the No Harm Diet. For both men and women, the amount of omega-3 and omega- 6 provided by the No Harm Diet is insufficient in meeting the DRI recommendations. We recommend that by changing a few food items to address the shortage of both omega-3 and omega- 6 fatty acids. When compared to the average intake of Canadians, all macro-nutrients and some micro-nutrients (magnesium, phosphorus, vitamin A, thiamin, vitamin B12, and folate) were similar to the amount provided by the No Harm Diet. Overall, our No Harm Diet plan could adequately replace regular diets, however further research is needed as there is a limited generalizability and transferability of the results for BIPOC communities.

Chapter 3: Nutritional and Environmental Impact of the No Harm Diet

3.1 Abstract

The transition to a diet high in processed foods, refined sugars, refined fats, and meats is being seen throughout the world. This dietary trend has degraded human health and has also degraded the health of our environment as our food systems have heavily contributed to environmental pollution and resource depletion. There have been several studies investigating the environmental and health impacts of the foods we choose to eat and the diets we choose to follow however, few of them have been done on Canadian dietary patterns. Based on the limited data about the environmental impacts of different dietary patterns in Canada specifically in Quebec, the overall aim of this study is to investigate how dietary choices impact the health and environmental impacts of those living in Montreal, QC. The first objective of this study was to assess, quantify and compare the nutritional quality (according to the dietary reference intake (DRI) requirement) of the three dietary patterns (No Harm, vegan, and omnivore). The second objective is to assess, quantify, and compare the carbon footprint of the same three dietary patterns. It is hypothesized that the No Harm Diet, a novel sustainable diet derived from ethical vegetarianism or veganism developed by Dr. Mark Lefsrud of McGill University, will have the smallest carbon footprint while being nutritionally adequate based on the DRI requirements. For each of the three diets (No Harm, vegan, and omnivore) a 7-day meal plan was created. Separate meal plans were made for men and women as the require calorie intake differs between sexes. The overall nutritional values from each diet were then compared to the DRI recommendations and each other. For the carbon footprint, the analysis approach was based on ISO 14040/14044 standards to determine the global warming potential and modeled in OpenLCA version 1.10.3. For each dietary pattern, three foods per macronutrient category was chosen to be examined in the carbon analysis. Our results suggested that the No Harm was nutritionally adequate as it met the DRIs for most nutrients. Compared to a vegan and omnivore dietary pattern, the No Harm Diet provided similar nutrients as it is very difficult to meet all DRI requirements regardless of the dietary pattern. For the carbon footprint, there was no significant difference among all three of the dietary patterns. The No Harm Diet produced 2.2 kg CO_2 eq for women and 2.4 kg CO_2 eq for men, the vegan diet

only produced 0.8 kg CO2 eq for women and 0.9 kg CO2 eq for men while the omnivore diet provided 2.0 kg CO2eq for women and 2.2 kg CO2 eq for men. The carbon footprint analysis should be expanded to include a wider range of food and a wider range of impact categories in order to get a more accurate view on the environmental impacts of the No Harm Diet. In conclusion, the No Harm Diet is nutritionally adequate however, appears to have a higher environmental impact than other common Canadian Dietary patterns.

3.2 Introduction

In 2020, the global population reached 7.8 billion people and is projected to reach 8.5 billion people in 2030, 9.7 billion in 2050 and 11.2 billion by 2100 (United Nations, 2019.; Bureau, 2020). With this increase in population there is an increased demand for food. It has been reported that malnutrition affects one in every three people, the largest number and proportion of malnourished people ever in human history (Baroni, 2006). Advances in technology have drastically impacted modern agriculture allowing for increases in food production (Baroni, 2006). Modern industrialized food systems produce a variety of resource-intensive and energy-dense food products from around the globe due to technological advances in agricultural production, food processing and transportation (Laestadius, 2019). Along with these technological advances and urbanization, social and economic structures, as well as social norms have shifted causing a change in the foods originally demanded to a more typical “Western diet” (Laestadius, 2019). A Western diet is characterized by a high proportion of red meat and processed foods containing large quantities of salt, and sugar along with a low consumption of fruits, vegetables and whole grains (Laestafius, 2019). This shift in dietary choices has had an increasingly strong impact on human health and the environment (Tilman, 2014).

The transition towards a diet high in processed foods, refined sugars, refined fats, and meats is a trend seen in both high-income Western countries as well as lower- and middle-come countries as they become more urbanized and have a more developed economy (Tilman, 2014; Laestafius, 2019). This dietary shift has resulted in increased body mass indices (BMI) along with non-communicable chronic diseases such as type 2 diabetes and coronary heart disease (Tilman, 2014). Obesity has become a global epidemic with rates nearly tripled since 1975 with more than 1.9 billion adults over 18 years overweight and of these 650 million obese (WHO 2021). As of 2019, it is estimated that 38.2 million children under the age of 5 years are overweight or obese (WHO, 2021). In 2015, high BMI was attributed to 4 million deaths worldwide with cardiovascular disease (CVD) being the leading cause related to high BMI followed by diabetes (Hawkins, 2019). Diabetes is considered a global epidemic as 422 million people in 2014 had diabetes and in 2019, 1.5 million deaths were directly caused by diabetes (Hawkins, 2019, WHO, 2021). It is projected that by 2030, the number of people in the world with type 2 diabetes will be 54% (Hawkins, 2019). Along with CVD and diabetes, obesity is a risk factor for 13 types of cancer (Hawkins, 2019; DC, 2017). In the United States alone, 630,000 people were diagnosed with obesity related cancer in 2014 (CDC, 2017). It is predicted that if dietary trends continue in this fashion, these chronic non-communicable diseases will make up two-thirds of the global burden of disease (Tilman, 2014).

While these dietary trends have degraded human health, they have also degraded the health of our environment. Our food systems have heavily contributed to environmental pollution and resource depletion of our air, water, soil, and living organisms (animals, plants, and microorganisms) (Aiking, 2019). It is estimated that one-third of the global greenhouse gas (GHG) emissions are cause by our food system (Crippa, 2021). These GHG emissions come from four major sources: 1) Clearing land for pastures or croplands, 2) production and use of nitrogen fertilizers, 3) production of rice and ruminants emitting methane, and 4) fossil fuel and electricity use on farms (Clark, 2018). Different food groups have different GHG intensities with animal products being the most GHG-intensive (Aiking, 2019). The increase in global consumption of ruminant meats, diet related GHG emissions are expected to increase between 50%-80% between 2010 and 2050 (Clark, 2018). Nitrogen and phosphorus fertilizers are commonly applied on agricultural land and their use is predicted to increase by 190% for nitrogen and 50% for phosphorus by 2050 (Clark, 2018). Runoff of these fertilizers pollute water supplies and can create marine dead zones similar to the Gulf of Mexico dead zone (Clark, 2018, Aiking, 2019). Water pollution is not the only threat to biodiversity, agricultural land expansion threatens biodiversity and is forecasted to increase to 1,00 million hectares by 2050 (Clark, 2018). This expansion threatens many types of animals especially large-bodied animals due to their large habitat needs and low population sizes (Clark, 2018). By 2050, it is hypothesized that the population of large mammals will decline by 18%-35% (Clark, 2018). The environmental impacts of food consumption are expected to increase and has become a difficult challenge to mitigate (Clark, 2018, Castane, 2017). This challenge is referred to as the diet-environment-health trilemma

(Clark, 2018). Solutions to this trilemma require quantitative links between diets, the environment and human health (Tilman, 2014).

There have been several studies investigating the environmental and health impacts of the foods we choose to eat and the diets we choose to follow. Clark et al. (2019) conducted a study evaluating multiple health and environmental impacts of 15 different foods as dietary choices, both type and amount, are determinates of health and environmental sustainability. It was seen that there is substantial variation in health outcomes of different foods as well as variation in the environmental impact (Clark, 2019). Foods such as whole grain cereals, fruits, vegetables legumes, nuts, and olive oil are all associated with improved health as well had the lowest environmental impacts (Clark, 2019). Those foods associated with the largest negative environmental impacts such as unprocessed and processed red meat were the foods with the largest increase in disease risk (Clark, 2019). Rather than looking at individual foods, Baroni et al. (2006) evaluated the environmental impact of three different dietary patterns (omnivorous, vegetarian, and vegan) as well as two different production methods (conventional farming and organic agriculture). It was seen that a vegan diet based on organic products had the smallest environmental impact while a "normal" diet based on conventional agriculture and farming had the greatest environmental impacts. Similarly, Castane & Anton (2017) evaluated the nutritional quality and the environmental impact of two food diets, Mediterranean and a vegan diet. Like the study conducted by Baroni et al, the vegan diet had the lowest environmental impact as the Mediterranean diet contributed twice as much to the global warming potential (GWP), three times as much to land use (LU), and three times as much to the regional biodiversity (RBI) than a vegan diet (Castane & Anton, 2017). Along with a lower environmental impact, the vegan diet had a higher nutrient rich food index (NRF 9.3) score than the Mediterranean diet (103 vs 90.6) (Castane, Anton, 2017). NRF 9.3 is based on 12 nutrients, 9 to encourage (protein, fiber, vitamin A, C, and E, minerals calcium, iron, magnesium, and potassium) and 3 to limit (saturated fat, added sugar, and sodium) (Castane, Anton, 2017). The vegan diet had a higher score as it contained less saturated fat, added sugar and sodium along with more fiber, vitamins A and E and minerals Fe, Mg, and K (Castane, Anton, 2017). While there have been many studies investigating the environmental and health impacts of dietary choices, few have been done on the Canadian diet. Location is an important factor when calculating the environmental impact of food. Veeramani et al. (2017) conducted the first exploratory study of the impact of the Canadian dietary patterns on climate change with a case study investigating the carbon footprint of dietary patterns in Ontario, Canada. Their results showed Canadians follow seven different dietary patterns in which dietary patterns higher in animal products (particularly beef) had the highest GWP (Veeramai, 2017).

Based on the limited data about the environmental impacts of different dietary patterns in Canada specifically in Quebec, the overall aim of this study is to investigate how dietary choices impact the health and environmental impacts of those living in Montreal, QC. The first objective of this study was to assess, quantify and compare the nutritional quality (according to the dietary reference intake (DRI) requirement) of the three dietary patterns (No Harm, vegan, and omnivore). The second objective is to assess, quantify, and compare the carbon footprint of the same three dietary patterns. It is hypothesized that the No Harm Diet, a novel sustainable diet originating from Quebec, will have the smallest carbon footprint while being nutritionally adequate based on the DRI requirements.

3.3 Methods

For each of the three diets (No Harm, vegan, and omnivore) a 7-day meal plan was created. Each day consisted of breakfast, lunch, dinner and two snacks. Separate meal plans were made for men and women as the require calorie intake differs between sexes. For women, each meal plan was designed to have on average 1,800 kcal while the meal plans for men were on average 2,000 kcal. Each meal was created to maintain a well-balanced diet. All foods were chosen by first identifying what foods were allowed to be consumed by each diet’s guidelines. For example, any food that was a vegetable, grain, seed, nut, or meat was excluded from the food list for the No Harm Diet. While for vegan, any animal-based product was excluded but any plant-based food was acceptable. From there, foods that can be found in Canadian grocery stores were chosen. These foods were then used to create a variety of meals and snacks found in the meal plans. The No Harm Diet meal plan was designed to follow the No Harm guidelines (Appendix A) as best as possible however some guidelines such as consuming milk/milk products from excess milk after the calf consumed all it needed, were not able to be met, therefore, milk and milk products regularly found at Canadian grocery stores were chosen. Refined sugars were minimized on the No Harm meal plan as they are not considered acceptable. Sample meals are shown in Figure 1.

No Harm	Vegan	Omnivore
Baked Denver Omelet	Breakfast Hash	Breakfast Quesadillas
1 tsp olive oil	1/2 red pepper	2 tortillas
1/2 green pepper	1 clove garlic	1/4 cup cheddar cheese
1/4 cup shredded cheddar cheese	5 mushrooms	1 egg
2 eggs	1/2 potato	1 Tbs olive oil
1/8 tsp salt	1/2 onion	1/4 red bell pepper
1/8 tsp chili flakes	1 Tbs olive oil	1/4 cup mushrooms
1 cup nonfat milk	2 tsp paprika	2 slices bacon
	1/8 tsp salt	1 cup milk
	1/8 tsp pepper	

Figure 3.1: Sample breakfast for No Harm, vegan and omnivore (women)

To evaluate the nutritional quality of the diets, ESHA Genesis R&D Food Processor was used to obtain the nutritional value of each food (kcal, macronutrient, and micronutrient concentrations) using ESHA's Food and Nutrition Database which consist of complied nutrition data from over 1,900 sources including the Canadian Nutrient file database, Food and Nutrient Database for Dietary Studies, and the USDA Standard Reference Database. Each food was selected to match the type, cook and portion of the food specified by the meal plan. Once all days were completed, nutritional values were extracted to a spreadsheet. All nutritional values were summed and averaged to obtain the overall daily nutritional value for each diet. These overall nutritional values were then compared to the DRI recommendations (Government of Canada, 2006).

This study used a carbon footprint analysis approach based on the ISO14040/14044 (2006) standards to determine the global warming potential (GWP) of each dietary pattern. Modeling was performed in OpenLCA version 1.10.3.

The functional unit (FU) is the basis for relative comparison however, in food life-cycle assessments (LCAs) this has become a methodological challenge to link the nutritional function of foods with environmental impact leading to a variety of approaches and functional units (Heller, 2013). As the primary function of food and diets are to provide nutrition the functional unit should be nutritionally based (Heller, 2013). The FU for this study is the total calories needed for a healthy diet with 1800 kcal for women and 2000 kcal for men. To reach the FU, each diet was broken up into three sections representing each of the macronutrients (carbohydrates, fat and protein). Each macronutrient contributed to the FU based on the acceptable macronutrient distribution range (AMDR) recommendations. The AMDR was used rather than DRIs as there is no RDA for total fat. Since the AMDRs are ranges (45-65% kcal from carbohydrates, 20-35% kcal from fat and 10-35% kcal from protein) the average of each range was used (55% kcal from carbohydrates, 27.5% kcal from fat and 22.5% kcal from protein) (Government of Canada, 2006). Therefore, the caloric contribution for the FU for women was 990 kcal from carbohydrates, 495 kcal for fat, and 405 kcal for protein. For men, carbohydrates contributed 1,100 kcal, fat contributed 550 kcal, and 450 kcal for protein. As the FU is total calories needed for a healthy diet of either 1800 kcal or 2000 kcal, the carbon footprint analysis was done as a per person statistics rather than applied to a whole population.

For each diet (No Harm, vegan, and omnivore), three foods per macronutrient category was chosen to be examined in the carbon analysis. Foods were chosen by first determining what foods are commonly consumed by Canadians using food availability data in Canada (Statistics Canada, 2020). From the most consumed foods, those that contribute the most to either carbohydrates, fat, or protein per 100 g were chosen from each diet. From the foods that contributed the most to each macronutrient category, foods used in the carbon analysis were chosen based on their ability to meet each diet's guidelines. Three foods per macronutrient category were chosen as there was a limitation on the amount of protein contributing foods that could be chosen to represent the No Harm Diet without repeats. Foods chosen can be seen in Table 3.1.

	Carbohydrates			Protein			Fat		
No Harm	Apples	Banana	Oranges	Eggs	Yogurt	Milk	Olive Oil	Butter	Avocado
Vegan	Bread	Banana	Potato	Almonds	Cashews	Canned Beans	Olive Oil	Avocado	Peanut Butter
Omnivore	Bread	Banana	Potato	Chicken	Beef	Pork	Olive Oil	Butter	Peanut Butter

Table 3.1: Foods Selected for Carbon Footprint Analysis

For the carbon footprint analysis, the system boundaries included farm-based activities, raw material extraction, processing, packaging, and transport to Montreal. Due to data gaps and negligible contributions to GWP, production of capital foods, storage at retail, port and distribution centers, waste management, and household activities were not included (Veeramani, 2017). Carbon emissions were based on literature values (Verge, 2013; Flysjo, 2011; Environmental and Energy Study Institute, 2015; Apparicio, 2007; Chaudhary, 2018; Canadian Roundtable on Sustainable Crops, 2017; Espinoza-Orias, 2011; Canadian National Millers Association, 2019; Iriarte, 2014; DP World, 2020; Walsh, 2012; Kendall, 2015; Marvinney, 2015; Volpe, 2015; Pattara, 2016; Pelletier, 2017; Government of Canada, 2021; Oryschak, 2020; Wikstrom, 2010; Ontario Ministry of Agriculture, Food, and Rural Affairs, 2021; Gonza,ez-Garcia, 2014; Bell, 2020; Sabate, 2019; Verge, 2013; Qin, 2020; Astier, 2014; Ontario Apple Growers, n.d.; Dyer, 2018; Tua, 2017; Parajuli, 2021; Statistics Canada, 2015; Center for Agricultural and Rural Sustainability, 2012; Peanut Bureau of Canada, 2020; National Peanut Board, 2021; Li, 2020; Beauchemin, 2010; Alberta Agriculture and Forestry, 2021; Agyemang, 2016; Figueiredo, 2016; Bonou, 2016; Djekic, 2015; Brisson, 2015; Economics Research Group University of Guelph Ridgetown Campus, 2010; Pernilla, 2015; Gustafson, 2017; Borghi, 2018; CN, 2021).

All statistics were completed with RStudio version 1.3.1093. Descriptive statistics were calculated for the diet type. Diet type comparison and the carbon footprint analysis was done using a one-way ANOVA with a 0.05 level of significance. Normality of data was checked visually. Non-normal data distributions were transformed and rechecked for normality. The Tukey Multiple

Comparisons of Means test was used as the post hoc test and confidence level was set to 95%.

3.4 Results

To determine the nutritional quality of all three dietary patterns, three seven-day meal plans based on each dietary requirement was created for both men and women (Appendix A). Tables 3.2-3.4 compare the average nutrient content of the No Harm Diet, vegan diet, and omnivore diet to the DRI recommendations for women and the average Canadian women (age 19+) intake values. Tables 3.5-3.7 compare the average nutrient content of the No Harm Diet, vegan diet, and omnivore diet to the DRI recommendations for men and the average Canadian men (age 19+) intake values. The p-value in tables 3.2-3.7 shows if there is a significant difference in the average amount of each nutrient provided by the three different diets. Lettering in each table represents the Tukey's Post Hoc test that was simultaneously done with the ANOVA. The lettering shows where the differences between the diets lie. More detailed tables can be found in Appendix B.

Tables 3.2 examined the difference between macronutrient concentrations for each of the three diets for women. The amount of total energy provided by each of the three diets were not significantly different. For total energy the DRI is not determined. For protein, the RDA is 46.0 g/day which all three of the diets met. Between the different dietary patterns, the ANOVA showed that the amount of protein significantly differed. Based on Tukey's Post Hoc Test, all three diets were significantly different from each other. The omnivore diet provided the most amount of protein while the vegan diet provided the least. For carbohydrates, the EAR is 100.0 g/day. Each of the three dietary patterns meet the EAR for carbohydrates. Between the three different diets, the ANOVA showed that there was no significant difference between the amount of carbohydrates each of the diets provided. For total fat the AI has not been determined by the DRIs. In terms of saturated fat, the results showed that there was not a significant difference in the amounts provided by each of the three diets. For omega-3 the AI is 1.1 g/day which was met by each of the three dietary patterns. There was no significant difference between the amount of omega-3 provided by each of the diets. Omega-6 has an AI of 12.0 g/day which was met by only the omnivore diet. Both the No Harm Diet (5.5 g/day) and the vegan diet (10.8 g/day) fell short of the AI. The ANOVA test showed that there was a significant difference in the amount of omega-6 provided by three diets. The post hoc test showed that the No Harm Diet was significantly different from both the vegan and the omnivore diet. The No Harm Diet provided significantly less omega-6 than the vegan diet and the omnivore diet. The vegan diet and the omnivore did not provide significantly different amounts of the omega-6 from each other. The final macronutrient investigated in this study was trans-fat. There was no DRI data for trans-fat. The ANOVA showed that there was a significant difference in the amount of trans fat provided by each of the three dietary patterns. Tukey's Post Hoc showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided the least amount of trans fat. The No Harm Diet and the omnivore diet provided amounts of trans fat that were not significantly different form each other.

Table 3.3 examined the differences in the mineral content of each of the three dietary patterns for women. Sodium was the first mineral examined. Each of the three diets met the AI (1500.0 mg/day). The ANOVA showed that between the three diets, there was not a significantly different amount of sodium provided. All three diets meet the EAR (800.0 mg/day) for calcium. The ANOVA showed that there was a significant difference in the amount of calcium provided by all three diets. The post hoc test showed that all three diets were significantly different from each other. The No Harm Diet provided the most amount of calcium, while the vegan diet provided the least. The EAR for iodine is 95.0 µg/day which was not met by any of the three diets examined in this study. As well, there was no significant difference between the amount of iodine provided by each of the three diets. For iron, the EAR (8.1 mg/day) was met by all three of the diets. The ANOVA test showed that there was a significant difference in the amount of iron provided by each of the diets. The post hoc test showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided a higher amount of iron than both the No Harm Diet and the omnivore diet. The No Harm Diet and the omnivore diet provided amounts of iron that was not statically different from each other. Following iron, magnesium was analyzed. All three dietary patterns met the EAR (255.0 mg/day) for magnesium. The ANOVA showed that there was no significant difference in the amount of magnesium provided by all three diets. The amount of manganese provided by all three diets was sufficient in meeting the AI (1.8 mg/day). The ANOVA showed that there was a significant difference between the diets in the amount of manganese provided. The post hoc test showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided the most amount of manganese while No Harm and omnivore provided statistically similar amounts. All three diets met the EAR for phosphorus (580.0 mg/day), selenium (45.0 µg/day), and zinc (6.8 mg/day). The ANOVA tests showed that there was a statistically significant difference in the amount of phosphorus, selenium, and zinc provided by the three diets. The post hoc test for phosphorus showed that all three diets were significantly different from each other. The omnivore diet provided the highest amount while the vegan diet provided the least. The post hoc test for selenium showed that the omnivore diet was significantly different from both the No Harm Diet and the vegan diet. The omnivore diet provided more selenium than both the other diets which were not significantly different from each other. Finally, the post hoc for zinc showed that the omnivore diet was significantly different from both the No Harm Diet and the vegan diet. The omnivore diet provided the most amount of zinc while the vegan and No Harm Diet provided similar amounts. For selenium and zinc the No Harm Diet and the vegan diet provided amounts that were statistically similar. The final mineral examined was potassium. Only the No Harm Diet was able to meet the AI for potassium (4700.0 mg/day). There was a significant difference seen in the ANOVA between the three diets. The post hoc test showed that the No Harm Diet was significantly different from both the vegan and omnivore diets. The No Harm Diet provided the most amount of potassium compared to the vegan and omnivore diet.

Table 3.4 examined the difference in vitamin content of each of the three dietary patterns for women. The EAR for vitamin A (1667.0 IU/day) and vitamin C (60.0 mg/day) was met by all three of the diets. Based on the ANOVA, there was no significant difference between the amounts of vitamin A and vitamin C provided by each of the diets. The No Harm Diet (218.7 IU/day) was the only diet unable to meet the EAR for vitamin D (400.0 IU/day). The ANOVA showed that there was a statistical difference seen in the average amounts of vitamin D between the three diets. The post hoc showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided the most vitamin D while the No Harm Diet and the omnivore diet were not statistically different. All three dietary patterns were able to meet the EAR for vitamin E (12.0 mg/day). The ANOVA showed that there was a significance difference between the three diets. The Post hoc showed that the difference can be seen between the No Harm Diet and the vegan/omnivore diets. The No Harm Diet provided statistically more vitamin E. All three diets were able to meet the AI (90.0 µg/day) for vitamin K. The ANOVA showed that there was no significant difference between the average amounts of vitamin K provided by each of the dietary patterns. The EAR (0.9 mg/day) for thiamin and riboflavin were met by each of the different diets. The ANOVAs showed that there were significant differences seen between the average amounts of both thiamin and riboflavin. For both thiamin and riboflavin, the post hoc showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided the most while the No Harm Diet and the omnivore diet provided statistically similar amounts. For niacin, all three diets met the EAR (11.0 mg/day). The ANOVA showed that there was a significant difference seen in between the amount of niacin provided by each diet. The post hoc showed that the No Harm diet was significantly different from both the vegan and omnivore diets. The No Harm Diet provided the least amount compared to vegan and omnivore. While the vegan and omnivore diet provided statistically similar amounts. All dietary patterns met the EAR for vitamin B6 (1.1 mg/day) and vitamin B12 (2.0 μg/day). The ANOVA showed that there was no significant difference in the amount of B6 provided by each of the diets however, there was a difference seen in B12. The post hoc showed that there was a significant difference in the amount of vitamin B12 provided by the No Harm Diet and the vegan diet. The No Harm Diet provided significantly more B12 than the vegan diet. The AI for pantothenic acid was met by all three diets. The ANOVA showed that there was a significant difference seen in the average amounts provided by all three diets. The post hoc showed that the difference could be seen between the No Harm Diet and the omnivore diet. The omnivore diet provided significantly more pantothenic acid than the No Harm Diet. All diets met the AI (30.0 μg/day) of biotin. The ANOVA showed that there was a significant difference seen between the amounts of biotin each diet provided. The post hoc showed that the difference was seen between the omnivore diet and No Harm/vegan. The omnivore diet provided more biotin than the No Harm Diet and the vegan diet, which provided non-significant different amounts. The final vitamin examined was folate. All three diets met the EAR (320.0 μg/day) for folate. The ANOVA showed that there was a significant difference seen in the amount of folate provided by the vegan diet. The post hoc showed that the vegan diet provided more folate than both the No Harm Diet and the omnivore diet.

Table 3.5 examined the difference between macronutrient concentrations in each of the three diets for men. For total energy there is no AI determined. The ANOVA showed that there was no significant difference between the amount of total energy provided by the three different diets. The RDA for protein is 46.0 g/day which was met by all three diets. The ANOVA showed that there was a significant difference observed in between the average amounts of protein. The post hoc test showed that the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provided less protein than the No Harm and omnivore diets. The EAR (100.0 g/day) for carbohydrates was met by all three diets. The ANOVA showed that there was no significant difference in the average amount of carbohydrates provided by the three dietary patterns. There was no AI for total fat. The ANOVA test showed that there was not significant difference seen in the amount of total fat. There was no DRI for saturated fat. For saturated fat, there was a significant difference seen in the ANOVA. Based on Tukey's Post Hoc, the vegan diet was significantly different from both the No Harm and omnivore diets. The vegan diet provided less saturated fat. The AI (1.1 g/day) for omega-3 was met by all three diets. There was no significant difference between the average amounts of omega-3 provided by the three different diets seen in the ANOVA. The AI for omega-6 (12.0 g/day) was met by only the omnivore diet. There was a significant difference seen in the ANOVA between the average amounts of omega-6 provided by the three diets. The post hoc test showed that the No Harm Diet was significantly different from both the vegan and omnivore diets. The No Harm Diet provided less omega-6 than both the vegan diet and the omnivore diet. Trans fat was the final macronutrient analyzed. There was no DRI for trans-fat. However, the ANOVA show there was a significant difference between the amount of trans fat provided by all three diets. The post hoc showed that the difference lied between the No Harm Diet and the vegan diet. The vegan diet provided less trans-fat.

Table 3.6 examined the difference between mineral concentrations in each of the three diets for men. All three diets met the AI for sodium (1500.0 mg/day). The ANOVA showed that there was no significant difference between the average amounts of sodium in each diet. For calcium, all three diets met the EAR (800.0 mg/day). The ANOVA showed that there was a significant different in the average amount of calcium provided by the different diets. Tukey's Post Hoc showed that the No Harm Diet was significantly different from both the vegan and omnivore diets. The No Harm Diet provided more calcium than both the vegan diet and the omnivore diet. The vegan and omnivore diet did not provide statistically different amounts of calcium from one another. None of the diets met the EAR (95.0 μg/day) for iodine. As well, there was no significant different the average amounts of iodine provided by any of the diets. For iron, all three diets meet the EAR (6.0 mg/day). The ANOVA showed that there was a significant difference between the averages. Tukey's showed that the difference reported between the vegan diet and the No Harm/omnivore diets. The vegan diet provided more iron than both the No Harm and omnivore diets, which provided amounts of iron that were not statistically different. All three diets met the EAR for magnesium (330.0 mg/day). The ANOVA showed no significant difference in the amount of magnesium provided by each diet. The AI (2.3 mg/day) for manganese was met by all the different diets. The ANOVA showed that there was a significant difference between the means. The post hoc test showed that the difference lied between the vegan diet and the No Harm/omnivore diets. The vegan diet provided more manganese than both the No Harm and omnivore diets. The No Harm diet did not provide a statistically different amount of manganese compared to the omnivore diet. All three diets met the EAR for phosphorus (580.0 mg/day). The ANOVA showed that there was a significant difference among the phosphorus averages. The No Harm Diet and the omnivore diet were significantly different from the vegan diet. Both the No Harm and omnivore diets provided more phosphorus than the vegan diet. However, the No Harm Diet did not provide significantly different amounts of phosphorus compared to the omnivore diet. All diets provided enough selenium to meet the EAR (45.0 μg/day). There was a significant difference in the average amounts of selenium provided by each diet. A post hoc test showed that the difference lied between the omnivore diet. The omnivore diet provided more selenium than both the No Harm Diet and the vegan diet, which provided similar amounts. All diets met the EAR for zinc (9.4 mg/day). The ANOVA showed that there was no significant difference in the amount of zinc provided by each diet. The final mineral analyzed was potassium. All three diets met the AI for potassium (4700.0 mg/day). The ANOVA showed that there was a significant difference seen among the diet averages. The post hoc reveled that the No Harm Diet was significantly different from both the vegan and the omnivore diet. The No Harm Diet provided more potassium than both the vegan and omnivore diets (which provided similar amounts).

Table 3.7 examined the difference between vitamin concentrations in each of the three diets for men. For both vitamin A and vitamin C, all three diets met the EAR (2083.0 IU/day and 75.0 ng/day). The ANOVA showed that there was no significant difference seen between the means for either vitamin A or vitamin C. For vitamin D, only the No Harm Diet (221.9 IU/day) was unable to meet the EAR (400.0 IU/day). Based on the ANOVA, there was a significant difference seen among the average amounts of vitamin D provided per dietary pattern. Based on the Tukey's Post Hoc, the vegan diet was significantly different from both the No Harm Diet and the omnivore diet. The vegan diet provides significantly more vitamin D than both the No Harm Diet and the omnivore diet. The No Harm Diet and the omnivore diet do not provide significantly different amounts from each other. All the diets provided enough vitamin E to meet the EAR (12.0 mg/day). There was a significant difference in the average amount of vitamin E between the different diets. The No Harm Diet was significantly different from both the vegan diet and the omnivore diet. The No Harm Diet provided more vitamin E than both the vegan diet and the omnivore diet. The omnivore diet and the vegan diet did not provide statistically different amounts of vitamin E. All three diets provided enough vitamin K to meet the AI (120.0 μg/day). There was no significant difference among the averages of vitamin K. The amounts of thiamin, riboflavin, niacin, vitamin B6, and vitamin B12 provided by all three diets was sufficient in meeting the EARs (1.0 mg/day, 1.1 mg/day, 12.0 mg/day, 1.1 mg/day, 2.0 μg/day). ANOVA tests showed significant differences in the average amounts of thiamin, riboflavin, and niacin. For thiamin and riboflavin, the vegan diet provided significantly more than both the No Harm Diet and the omnivore diet. The No Harm Diet and the omnivore diet provide similar amounts of both thiamin and riboflavin. For niacin, the No Harm Diet was significantly different from both the vegan and omnivore diets. The No Harm Diet provided less than both the vegan and the omnivore diet. The vegan and omnivore diet provided similar amounts of niacin. The AI for pantothenic acid is 5.0 mg/day, which was met by all three dietary patterns. There was a significant difference seen between the averages of pantothenic acid. The difference was seen between the No Harm Diet and the omnivore diet. The No Harm Diet provide less pantothenic acid than the omnivore diet. Biotin has an AI of 30.0 μg/day which was met by all the diets. There was a significant difference between the average amount of biotin. The difference can be seen between the No Harm Diet and the omnivore diet. The No Harm Diet provided significantly less biotin than the omnivore diet. The final vitamin analyzed was folate. All the diets met the EAR for folate, which is 320.0 μg/day. The ANOVA showed that there is a significant difference between the average amounts of folate provided by each diet. The post hoc showed that the difference can be seen between the vegan diet and the No Harm/omnivore. The vegan diet provided significantly more folate than both the No Harm Diet and the omnivore diet. The No Harm Diet and the omnivore diet provided similar amounts of folate.

Our results show that the No Harm Diet is nutritionally adequate as it meets the DRI recommendations for all the macronutrients and the majority of micronutrients. This diet offers higher amounts of calcium and potassium despite all the diets covering the EAR. While the No Harm Diet is considered nutritionally adequate, there are some nutrients that were not able to meet the DRIs. Omega-6, iodine, vitamin D, and biotin all fell short of the DRIs.

To determine the environmental impact of each of the diets a carbon footprint analysis was conducted. Figures 3.2 and 3.3 show the carbon footprint of each diet per kcal for women and men. Statically analysis showed there is no significant difference in the amount of carbon for each dietary pattern. When the dietary patterns are broken down into their macronutrient components, it can be seen that protein contributed the most to the weighted total CO_2 for each diet for both men and women. For women, the No Harm Diet's protein contributed the most CO2 (1.2 kg CO_2 eq) compared to carbohydrates (0.7 kg CO_2 eq) and fat (0.2 kg CO_2 eq). Between the diets, the highest protein contribution came from the omnivore at 1.5 kg CO_2 eq while vegan had the lowest at 0.4 kg CO_2 eq. Based on figures 3.2 and 3.3, carbohydrates are the second highest carbon emitting macronutrient category. The No Harm Diet's carbohydrates contributed the most CO_2 per kcal contribution for both men and women (0.7 kg CO_2 eq, 0.8 kg CO_2 eq). Finally, fat was the lowest emitting macronutrient category for all three dietary patterns for both men and women. The vegan diet contributed the least carbon from fat (0.1 kg CO_2 eq) while the No Harm Diet and the omnivore diet had similar carbon emissions from fat (0.3 kg CO_2 eq, 0.2 kg CO_2 eq). Based on the carbon emissions data, the No Harm Diet is not more environmentally friendly than either the vegan diet or the omnivore diet.

Macronutrient	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Total Energy Kcal/day	1809.9 ± 57.5	1856.9 ± 17.8	1854.2 ± 25.1	0.05	ND [AI]
Protein g/day	91.0[b] ± 9.2	69.0[c] ± 13.5	118.2[a] ± 13.6	0.00	46.0 [RDA]
Carbohydrates g/day	259.5 ± 48.4	272.2 ± 39.4	215.0 ± 19.9	0.02	100.0 [EAR]
Total Fat g/day	57.9 ± 19.8	63.6 ± 13.5	64.8 ± 5.8	0.63	ND [AI]
Saturated Fat g/day	14.6 ± 6.3	10.5 ± 2.7	16.0 ± 2.7	0.01	-
Omega-3 g/day	1.2 ± 0.2	1.9 ± 1.4	1.5 ± 0.6	0.55	1.1 [AI]
Omega-6 g/day	5.5[b] ± 1.8	10.8[a] ± 3.1	13.8[a] ± 4.2	0.00	12.0 [AI]
Trans Fat g/day	0.4[a] ± 0.3	0.0[b] ± 0.0	0.3[a] ± 0.2	0.01	-

Table 3.2: Women Macronutrient Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences between each diet’s mean found using Tukey’s Post Hoc

Mineral	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Sodium mg/day	2065.2 ± 900.7	1947.3 ± 628.4	1961.8 ± 431.2	0.94	1500.0 [AI]
Calcium mg/day	1945.4[a] ± 291.6	899.9[c] ± 113.3	1240.8[b] ± 105.4	0.00	800.0 [EAR]
Iodine µg/day	33.0 ± 13.8	19.4 ± 9.5	57.4 ± 33.7	0.14	95.0 [EAR]
Iron mg/day	12.2[b] ± 3.1	22.2[a] ± 3.7	14.2[b] ± 2.9	0.00	8.1 [EAR]
Magnesium mg/day	397.8 ± 36.2	431.0 ± 75.0	411.6 ± 26.4	0.48	255.0 [EAR]
Manganese mg/day	4.6[b] ± 1.9	7.2[a] ± 1.7	4.9[b] ± 0.8	0.01	1.8 [AI]
Phosphorus mg/day	1643.3[b] ± 157.3	1057.7[c] ± 167.2	2023.1[a] ± 246.3	0.00	580.0 [EAR]
Selenium µg/day	58.4[b] ± 9.3	55.7[b] ± 10.9	151.3[a] ± 52.2	0.00	45.0 [EAR]
Zinc mg/day	9.3[b] ± 1.1	8.5[b] ± 1.2	11.7[a] ± 1.7	0.00	6.8 [EAR]
Potassium mg/day	6204.3[a] ± 716.3	4515.6[b] ± 721.6	4619.4[b] ± 647.7	0.00	4700.0 [AI]

Table 3.3: Women Mineral Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences found using Tukey's Post Hoc.

Vitamin	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Vitamin A IU/day	9871.7 ± 1071.6	9316.8 ± 3290.8	8539.4 ± 5571.9	0.51	1667.0 [EAR]
Vitamin C mg/day	317.0 ± 103.1	242.6 ± 131.3	268.7 ± 94.0	0.46	60.0 [EAR]
Vitamin D IU/day	218.7[b] ± 89.0	2017.3[a] ± 649.6	825.4[b] ± 707.0	0.00	400.0 [EAR]
Vitamin E mg/day	22.1[a] ± 3.2	13.4[b] ± 2.1	15.0[b] ± 1.5	0.00	12.0 [EAR]
Vitamin K µg/day	145.5 ± 31.2	202.9 ± 103.4	192.3 ± 117.8	0.66	90.0 [AI]
Thiamin mg/day	1.0[b] ± 0.0	3.7[a] ± 2.1	1.6[b] ± 0.2	0.00	0.9 [EAR]
Riboflavin mg/day	2.6[b] ± 0.3	4.3[a] ± 1.7	2.5[b] ± 0.7	0.01	0.9 [EAR]
Niacin mg/day	14.4[b] ± 2.9	31.9[a] ± 10.9	34.3[a] ± 5.4	0.00	11.0 [EAR]
Vitamin B6 mg/day	2.8 ± 0.4	3.9 ± 1.7	3.7 ± 0.5	0.14	1.1 [EAR]
Vitamin B12 µg/day	6.7[a] ± 0.9	4.3[b] ± 2.0	5.1 ± 1.6	0.03	2.0 [EAR]
Pantothenic Acid mg/day	5.9[b] ± 1.2	7.6 ± 1.5	9.3[a] ± 1.7	0.00	5.0 [AI]
Biotin µg/day	19.3[b] ± 7.2	29.7[b] ± 21.6	45.9[a] ± 12.0	0.00	30.0 [AI]
Folate µg/day	431.4[b] ± 73.0	812.9[a] ± 274.0	433.4[b] ± 89.0	0.00	320.0 [EAR]

Table 3.4: Women Vitamin Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences found using Tukey's Post Hoc.

Macronutrient	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Total Energy Kcal/day	2003.4 ± 34.5	2019.9 ± 29.5	2013.6 ± 31.1	0.40	ND [AI]
Protein g/day	105.9[a] ± 16.8	78.9[b] ± 17.0	122.3[a] ± 11.5	0.00	46.0 [RDA]
Carbohydrates g/day	275.9 ± 41.1	298.5 ± 38.8	238.4 ± 26.1	0.02	100.0 [EAR]
Total Fat g/day	65.7 ± 19.7	66.7 ± 14.7	70.9 ± 10.0	0.80	ND [AI]
Saturated Fat g/day	17.6[a] ± 7.3	10.9[b] ± 2.9	17.1[a] ± 3.2	0.01	-
Omega-3 g/day	1.3 ± 0.2	2.2 ± 1.4	3.0 ± 1.1	0.03	1.1 [AI]
Omega-6 g/day	6.1[b] ± 1.7	11.4[a] ± 3.2	14.8[a] ± 4.2	0.00	12.0 [AI]
Trans Fat g/day	0.5[a] ± 0.3	0.0[b] ± 0.0	0.3 ± 0.2	0.00	-

Table 3.5: Men Macronutrient Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences found using Tukey's Post Hoc.

Mineral	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Sodium mg/day	1814.2 ± 363.4	2080.1 ± 703.4	2086.6 ± 557.7	0.60	1500.0 [AI]
Calcium mg/day	2197.3[a] ± 434.1	1006.8[b] ± 154.4	1323.6[b] ± 116.4	0.00	800.0 [EAR]
Iodine µg/day	44.2 ± 16.2	19.4 ± 9.5	61.8 ± 30.5	0.70	95.0 [EAR]
Iron mg/day	13.0[b] ± 2.8	24.9[a] ± 4.7	15.3[b] ± 2.9	0.00	6.0 [EAR]
Magnesium mg/day	438.5 ± 44.8	487.1 ± 76.9	453.7 ± 40.6	0.30	330.0 [EAR]
Manganese mg/day	5.2[b] ± 2.0	8.0[a] ± 1.8	5.3[b] ± 1.0	0.00	2.3 [AI]
Phosphorus mg/day	1900.4[a] ± 297.8	1195.0[b] ± 192.3	2118.8[a] ± 183.0	0.00	580.0 [EAR]
Selenium µg/day	71.0[b] ± 14.4	61.1[b] ± 10.5	159.2[a] ± 52.9	0.00	45.0 [EAR]
Zinc mg/day	11.0 ± 1.5	9.7 ± 1.4	12.2 ± 1.5	0.02	9.4 [EAR]
Potassium mg/day	6643.7[a] ± 744.3	5144.3[b] ± 830.6	4829.4[b] ± 695.9	0.00	4700.0 [AI]

Table 3.6: Men Mineral Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences found using Tukey's Post Hoc.

Vitamin	No Harm Average ± SD	Vegan Average ± SD	Omnivore Average ± SD	p-value	DRI
Vitamin A IU/day	9832.0 ± 853.6	9993.1 ± 3286.9	8592.7 ± 5526.2	0.51	2083.0 [EAR]
Vitamin C mg/day	335.1 ± 118.0	261.2 ± 149.4	275.1 ± 100.0	0.51	75.0 [EAR]
Vitamin D IU/day	221.9[b] ± 91.5	2286.3[a] ± 1067.4	663.1[b] ± 436.0	0.00	400.0 [EAR]
Vitamin E mg/day	23.6[a] ± 2.7	14.8[b] ± 1.7	15.5[b] ± 1.6	0.00	12.0 [EAR]
Vitamin K µg/day	162.0 ± 33.5	227.6 ± 113.2	198.6 ± 116.0	0.62	120.0 [EAR]
Thiamin mg/day	1.0[b] ± 0.1	3.9[a] ± 2.0	1.7[b] ± 0.2	0.00	1.0 [EAR]
Riboflavin mg/day	3.0[b] ± 0.4	4.5[a] ± 1.8	2.5[b] ± 0.5	0.01	1.1 [EAR]
Niacin mg/day	15.4[b] ± 2.6	34.3[a] ± 11.5	35.1[a] ± 5.9	0.00	12.0 [EAR]
Vitamin B6 mg/day	3.0 ± 0.4	4.1 ± 1.7	3.9 ± 0.5	0.16	1.1 [EAR]
Vitamin B12 µg/day	7.7 ± 1.3	4.7 ± 2.5	5.3 ± 1.6	0.02	2.0 [EAR]
Pantothenic Acid mg/day	6.7[b] ± 1.2	8.4 ± 2.0	9.4[a] ± 1.3	0.01	5.0 [AI]
Biotin µg/day	22.0[b] ± 7.1	32.4 ± 20.8	46.6[a] ± 9.1	0.00	30.0 [AI]
Folate µg/day	465.8[b] ± 64.5	910.2[a] ± 278.3	460.2[b] ± 93.9	0.00	320.0 [EAR]

Table 3.7: Men Vitamin Summary Table

p-value is from the ANOVA measuring if the means of each dietary pattern is equal

Letters represent significant differences found using Tukey's Post Hoc.

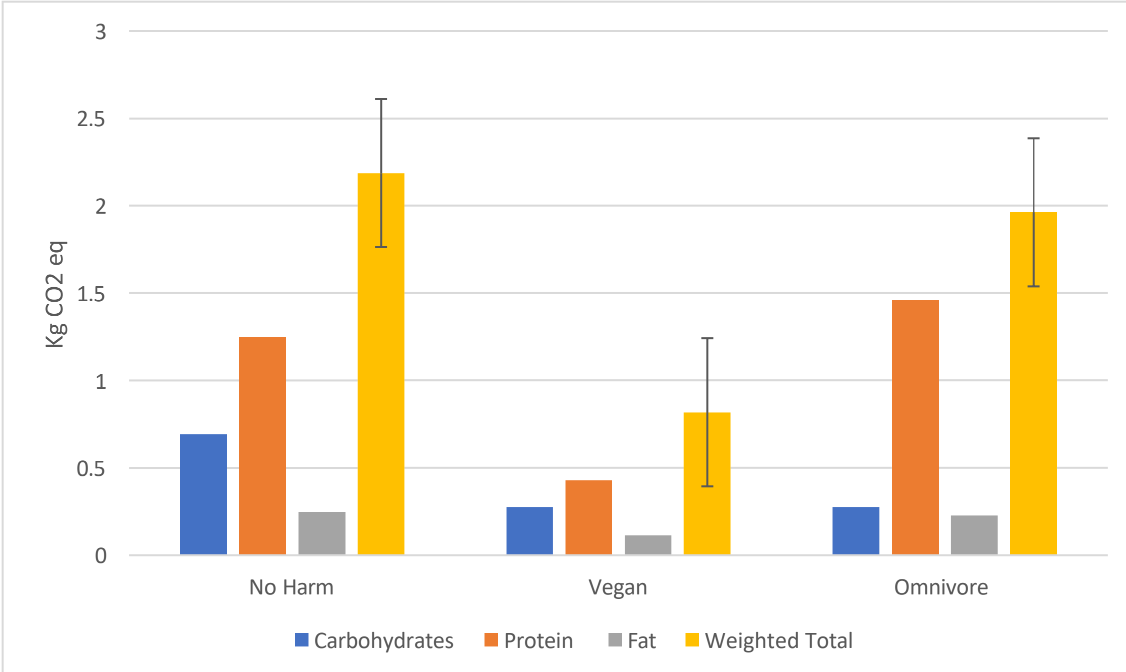

Figure 3.2: Macronutrient Contribution to Diet Total Average CO2 Emissions for Women

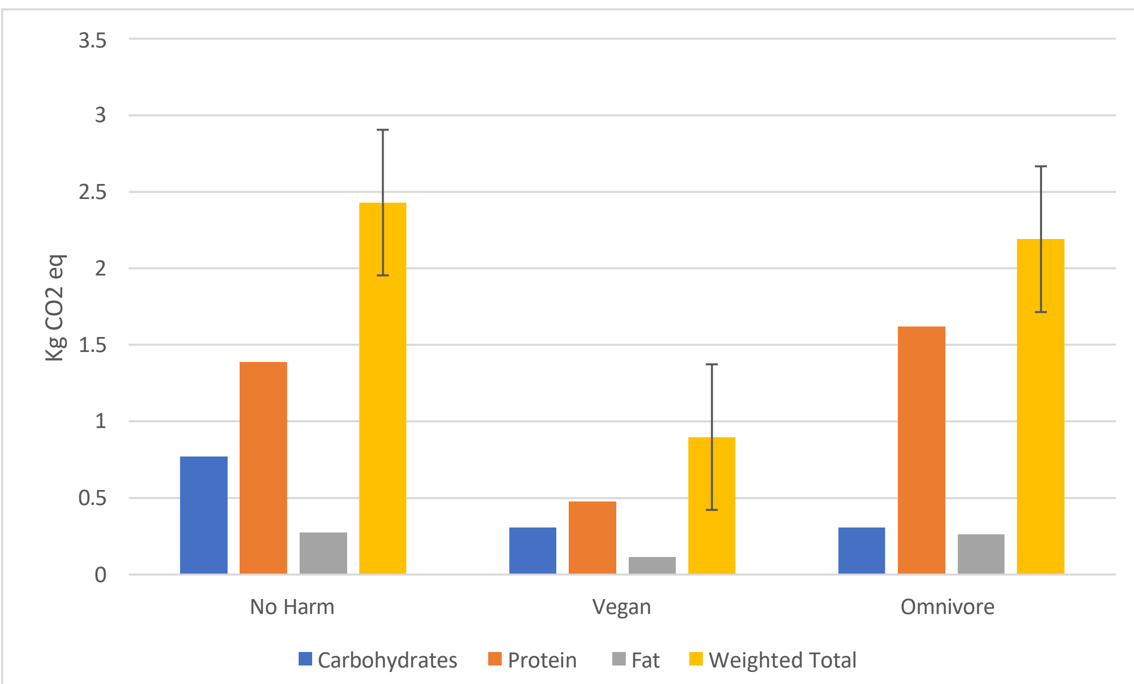

Figure 3.3: Macronutrient Contribution to Diet Total Weighted Average CO2 Emissions for Men

3.5 Discussion:

Industrialization of our food system has greatly impacted our dietary choices. Several studies from around the world have investigated the environmental and health impacts of our food choices, and they have shown that the dietary patterns we choose to follow impact not only our health but the health of the environment. This study was aimed at examining the dietary quality and the carbon footprint of three dietary patterns ranging from a typical Canadian omnivore diet to a restrictive No Harm Diet. It was hypothesized that the No Harm Diet would have the smallest carbon footprint while being nutritionally adequate. To determine the nutritional quality of the dietary patterns, three seven-day meal plans based on each dietary requirement was created for both men and women. To determine the environmental impact, a carbon footprint analysis was conducted using a subset of foods found in each diet. A one-way ANOVA with a 0.05 level of significance was done to test if the means of each diet was equal. If the null hypothesis (all means are equal) was rejected, Tukey's Multiple Comparisons of Means test was used to determine which individual means were significantly different.

Our results show that the No harm diet is nutritionally adequate as it meets the DRI recommendations for all macronutrients and majority of micronutrients. This diet offers higher amounts of calcium and potassium despite all the diets covering the EAR. While the No Harm Diet is nutritionally adequate to the exception of omega 6, iodine, iron, vitamin D, thiamin, niacin, and biotin. The macro-nutrients composition are similar with potentially less SFA for men on the no harm diet.

The No Harm Diet met the DRI recommendations for protein, carbohydrates and total fat. The No Harm Diet provided significantly less protein than the omnivore diet but significantly more than the vegan diet. A study conducted by Clarys, et al. (2014) which compared the nutritional quality of a vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diet saw similar results as the vegan diet had a lower intake of protein. The No Harm Diet provided the most amount of calcium out of the three diets for both men and women. For Canadian women, the average intake of calcium is below the RDA (Canada, 2004). The amount of calcium found in the No Harm Diet could be beneficial to Canadians as calcium is an essential nutrient for bone growth, muscle contractions, neurotransmitter secretion, digestion, and blood coagulation (Theoblad, 2005). Studies have also shown that calcium could help reduce the risk of cancer, CVD risk, and preeclampsia (NIH, 2021). However, calcium deficiency can occur if the intake of calcium is not sufficient. Calcium deficiency can reduce bone strength and lead to osteoporosis

(NIH, 2021). Osteoporosis is a major public health issue and is characterized by bone fragility and increases susceptibility to fractures (Sunyecz, 2008). Therefore, it is important to have an adequate amount of calcium to promote higher peak bone density. The No Harm Diet promotes the consumption of many calcium rich foods such as hard cheese, milk and yogurt which could help decrease the risk of osteoporosis in adults (Cormick, 2019). Potassium was a notable mineral for the No Harm Diet. The amount of potassium provided by the No Harm Diet was significantly more than both the vegan and omnivore diets. Potassium is the most abundant intracellular cation as it is present in all body tissues (NIH, 2021). It is essential for normal cell function as it maintains intracellular fluid volume and transmembrane electrochemical gradients (NIH, 2021). It has been seen that high dietary potassium is associated with a decrease in blood pressure (Weaver, 2013). It is estimated that increasing potassium intake can decrease the incidence of hypertensions in Americans by 17% and increase life expectancy by 5.1 years (Weaver, 2013). Therefore, the higher intake of potassium in the No Harm Diet could be beneficial. While the No Harm Diet was deemed nutritionally adequate, it fell short to meet the DRI recommendations of a few micronutrients including omega-6. For men, the No Harm Diet meet the DRI recommendations but provided significantly less than both the vegan and omnivore diet. Omega 6 is an essential nutrient as it cannot be synthesized in humans (Innes, 2018). Omega 6 fatty acids have two main roles in the body (Mori, 2013). First, they act as structural components of membranes and second, they act as precursors of eicosanoids which modulate renal and pulmonary function, vascular tones, and inflammatory responses (Mori, 2013). Because of these functions, the amount of omega 6 fatty acids consumed has potential to influence a number of chronic diseases and disorders Mori, 2013). It has been seen that diets low in omega 6 fatty acids appear to be associated with an increased risk of cardiovascular disease (Mori, 2013). As well, increasing n-6 PUFA intake in conjunction with decreasing total and saturated fat intake can beneficially influence lipoprotein metabolism, lower blood pressure, and reduce cardiovascular disease risk (Mori, 2013). The No Harm Diet also fell short in meeting the requirements for iodine. However, none of the diets meet the EAR or RDA for iodine. Iodine is naturally found in foods such as fish, seafood, dairy products and in Canada table salt is fortified with iodine (NIH, 2021). All three diets are rich with foods containing iodine suggesting there was a possible error with the USDA database within Food Processor. For iron, the No Harm Diet was able to meet the EAR however, not the RDA such as the vegan diet. Iron is an important mineral as your body uses it to make hemoglobin (NIH, 2021). Without a sufficient intake of iron, iron deficiency can occur leading to anemia (Abbaspour, 2014). Iron deficiency anemia is associated with functional impairments affecting cognitive development, immunity mechanisms, and work capacity (Abbaspour, 2014). For women, iron deficiency during pregnancy can lead to adverse outcomes such as increased risk of sepsis, maternal mortality, perinatal mortality and low birth rate (Abbspour, 2014). Thus, it is important to increase the amount of iron provided in the No Harm Diet. While many iron rich foods are not allowed for consumption based on the No Harm Diet guidelines, increasing the amount of dried fruit could be a solution or introducing iron supplements (NIH, 2021).

In terms of vitamins, the No Harm Diet provide less vitamin D than both the vegan and omnivore diet and did not reach the DRI recommendations. Vitamin D plays an important role in calcium homeostasis and bone metabolism (Sizar, 2021). Deficiencies in vitamin D can lead to osteomalacia in adults which is a metabolic bone disease in which mineralization of the bone matrix is impaired (Zimmerman, 2021). As well, vitamin D deficiency is associated with osteoporosis and the increase risk of many common cancers, multiple sclerosis, rheumatoid arthritis, hypertension, cardiovascular heart disease, and type I diabetes (Holick, 2005). However, it should be noted that 90% or more of our vitamin D requirement comes from exposure to sunlight (Holick, 2005). Therefore, the amount of vitamin D provided by the No Harm diet should be sufficient to maintain health. Thiamin is another vitamin that fell short to reaching the DRI recommendations for the No Harm Diet. While the amount provided from the No Harm Diet reach the EAR it was unable to meet the RDA. Compared to the other diets, vegan provided significantly more thiamin than the No Harm Diet. Thiamin is a water-soluble B vitamin and functions as a coenzyme in the body (Higdon, 2011). Inadequate intake of thiamine can cause thiamin deficiency and can lead to a disease known as Beriberi (Higdon, 2011). Beriberi effects the cardiovascular, nervous, muscular, and gastrointestinal systems leading to burning feet syndrome, abnormal reflexes, rapid heart rate, severe swelling, and congestive heart failure (Higdon, 2011). Therefore, it is important to have an adequate intake of thiamine and would be necessary to increase the intake in the No Harm Diet. Supplementation could be the best solution as good sources of thiamin are foods no allowed for consumption based on the No Harm guidelines (whole-grain cereals, legumes, nuts, and lean pork) (Higdon, 2011). Biotin was the next vitamin which the No Harm Diet had difficulty meeting the DRI. The No Harm Diet was unable to meet the AI and provided significantly less than the omnivore diet. This finding was surprising as biotin is found in many foods but rich sources in egg yolks which is a major component of the No Harm Diet (Higdon, 2011). There is a possibility that the software used to evaluate the nutritional quality of the diets did not take into account biotin found in eggs thus making the No Harm Diet appear insufficient in biotin. Niacin was a problem for the No Harm Diet for men. While it was able to meet the EAR, it fell short of the RDA. The No Harm Diet also provided significantly less niacin for men than both the vegan and omnivore diets. Niacin is an important component for oxidation-reduction reactions and non-redox reactions (Higdon, 2011). Insufficient intake of niacin can lead to niacin deficiency which can cause pellagra (Higdon, 2011). Pellagra can cause a thick scaly darkly pigmented rash, bright red tongue, vomiting, diarrhea, headaches, fatigue, and disorientation (Higdon, 2011). If left untreated, death can occur (Higdon, 2011). Thus, it is important to get sufficient intakes of niacin. While milk does provide some niacin better sources include meat, poultry, red fish, cereals, legumes, and seeds (Higdon, 2011). As many of these cannot be consumed on the No Harm Diet, the intake of milk would need to be increased or niacin supplements would have to added to the diet.

Overall, the No Harm Diet did meet most of the DRI recommendations. Increased dietary intake or supplementation would be necessary to meet all the DRI recommendations. That being said, it is very difficult on any dietary pattern to meet all the recommendations which can be seen for all the diets analyzed. Therefore, the No Harm Diet is a nutritionally adequate diet and comparable nutritionally to both a vegan and omnivore dietary pattern.

For the carbon footprint analysis each diet, three foods per macronutrient category was examined. Foods were examined by mass (1kg) and by calorie contribution. The vegan dietary pattern produced the smallest carbon footprint, followed No Harm, then omnivore. However, from the figures it can be seen that there was no significant difference in the amount of carbon provided by each diet. This is contradictory to many other studies which have shown that a vegan dietary pattern provides the smallest carbon footprint. A study examining the dietary greenhouse gas emissions of meat-eater, fish-eater, vegetarians, and vegans in the UK saw that the GHG emissions for meat-eaters was approximately twice as high as vegans (7.19 $KgCO_2e$/day vs 2.89 $KgCO_2e$/day) (Scarborough, 2014). While a study examining the carbon footprints of omnivorous, vegetarian, and vegan diets based on traditional Turkish cuisine saw that once again a vegan dietary pattern had the lowest carbon footprint (Gorken UCTUG, 2021). The vegan diet produced 18.5 $kgCO_2eq$/FU compared to 27.8 kg CO_2eq/FU for vegetarian, and 35.22 kg CO_2eq/FU for omnivore (Gorken UCTUG, 2021). This was attributed to the absence of meat and dairy in the vegan diet (UCTUG, 2021). In a Canadian context, a study conducted by Veeramani, et al. (2017) examined the carbon footprint of dietary patterns in Ontario, Canada and saw that a vegan diet produced the smallest carbon footprint when the FU was adjusted for calorie intake. The vegan diet produced 955 kg CO_2 eq compared to 2,282 kg CO_2 eq for an omnivore diet. Even when adjusted for protein, the vegan diet still produced less carbon (847 kg CO_2 eq) than the omnivore dietary pattern (1158 kg CO_2 eq). While this study did not examine the No Harm Diet, it did study vegetarianism which would be the closest dietary pattern to the No Harm Diet. Veeramani, et al. (2017) also saw that the vegan diet produced less carbon than a vegetarian diet when calorie adjusted (955 Kg CO_2 eq vs 1053 kg CO_2 eq). However, when protein adjusted the vegetarian diet had a smaller carbon footprint than both vegan and omnivore (715 kg CO_2 eq, 847 kgCO_2, 1158 KgCO_2 eq) (Veeramani, 2017).

When the dietary patterns are broken down to their macronutrient components, it can be seen that protein contributed the most to the weighted total CO_2 for each diet. For example, in the No Harm Diet for women, protein contributed 1.2 kg CO_2 eq compared to 0.7 kg CO_2 eq for carbohydrates and 0.2 kg CO_2 eq for fat. The highest contribution of protein came from the omnivore diet at 1.5 kg CO_2 eq while vegan had the lowest at 0.4 kg CO_2 eq. This is consistent with findings from other studies as Veeramani et al. (2017) saw that an omnivorous dietary pattern contributed the most CO_2 out of all dietary patterns found in (2282 kg CO_2 eq/person/year) while contributed the least (955 kg CO_2 eq/person/year). The animal protein found in an omnivore dietary pattern is what contributes the high quantities of CO_2. Veeramani et al. (2017) saw that protein-dense foods of animal origin had a higher GWP than plant-based protein sources. Saez-Almendros et al. (2013) found similar results as animal products contributed significantly to increasing dietary pattern's carbon footprints. Within the animal protein analysis, beef contributed the most (3.1 kg CO_2 eq for women and 3.4 Kg CO_2 eq for men). Veeramani et al. (2017) found similar results, as beef was the biggest contribution to the GWP of the two most popular dietary patterns. The high impact of beef comes from the emissions associated with its production such as enteric methane, manure, and cultivation of feed (Veeramani, 2017). While the No Harm Diet did not contain any meat, it's main protein sources were still animal based. Eggs and dairy products (milk and yogurt) were the main sources of protein. Both of these were more impactful than the vegan plant-based proteins. Eggs found in the No Harm Diet (1.7 kg CO_2 eq women and 1.9 kg CO_2 eq men) however, contributed more carbon than both yogurt (1.2 kg CO_2 eq women, 1.3 kg CO_2 eq men) and milk (0.8 kg CO_2 eq women, 0.9 kg CO_2 men). A study evaluating the potential contribution of diet choices to climate change mitigation showed eggs contributed more CO_2 per kg of food compared to milk (3.0 kg CO_2 eq/kg food vs 1.0 kg CO_2 eq/kg food) (Gonzalez, 2011). While a study conducted by Heller et al. (2014) showed eggs contributed 0.89 lbs CO_2 eq/servings while milk only contributed 0.72 lbs CO_2 eq/serving. While milk is on the lower end of animal protein emissions, it still contributes more than any of the plant-based protein analyzed. The highest emitting plant-based protein was cashews at 0.6 kg CO_2 eq for women and 0.7 kg CO_2 eq for men.

Based on Figures 3.2 and 3.3, carbohydrates are the second highest carbon emitting macronutrient category. The No Harm Diet's carbohydrates contributed the most CO_2 per kcal contribution for both women and men (0.7 kg CO_2 eq, 0.8 kg CO_2 eq). Vegan and omnivore had the same amount of carbon emissions as they had the same carbohydrate rich foods analyzed for both men and women (0.3 kg CO_2 eq). The food that contributed the most carbon in the No Harm Diet was apples. For women apples emitted 1.0 kg CO_2 eq for women and 1.1 kg CO_2 eq for men. A study examining the energy use and fossil CO_2 emissions for Canadian fruit and vegetables showed that apples were the highest CO_2 emitter among the fruit crops on a unit of product basis rate (Dyer, 2018). Most of the carbon produced by apples comes from apple production (land prep, nutrients and fertilizers, and machinery) (Keyes, 2013).

Fat was the lowest emitting macronutrient category for all three dietary patterns for both men and women. Vegan contributed the least carbon between the three diets for fat for both women and men (0.1 kg CO_2 eq). Omnivore and No Harm had similar carbon emissions for both women and men Harm (0.2 kg CO_2 eq, 0.3 kg CO_2 eq). Omnivore and the No Harm Diet had higher emissions than vegan due to butter. For men butter emitted 0.6 kg CO_2 eq while for women it emitted 0.5 kg CO_2 eq. A study evaluating the carbon footprint of Canadian diary products saw that butter had one of the highest emissions of all dairy products (7.3 kg CO_2e/kg) (Verge, 2013). In the study conducted by Veeramani et al. (2017), butter contributed substantially (5-7%) to the GWP of the omnivorous dietary pattern.

Based on this data there the No Harm Diet did not prove to be more environmentally friendly than an omnivore or vegan dietary patterns. However, other studies have seen that a vegan dietary pattern is more environmentally friendly. More research should be conducted to further evaluate the environmental impact of the No Harm Diet especially compared to a vegan diet to see if the No Harm Diet can be an alternative to the vegan diet in terms of environmental impact. This was the first study investigating the nutritional and environmental impact of the No Harm Diet and an important foundational analysis to understanding the use of the No Harm Diet in Canada. One strength of this study is that meal plans were designed for both men and women. Men and women have different nutritional requirements, and it is important to determine if the No Harm Diet is suitable for both sexes. Another strength included comparing the meal plan average nutrient contributions to both the DRI recommendations and the average intakes of Canadians. Allowing to better highlight the nutritional strengths and limitations of the No Harm Diet. Finally, using total calories the FU was a strength of this study. FU is the basis for relative comparison however, in LCAs it has become a methodological challenge to link the nutritional function of foods with environmental impact leading to a variety of approaches (Heller, 2013). However, the primary function of food is to provide nutrition and the FU should reflect this (Heller, 2013). Total calories are a nutritionally based FU and reflects the primary function of food. However, there were several limitations to this study. First, the meal plans were created to be nutritionally adequate as well as reflect the foods typically consumed by Canadians. It is possible that the pattern of food typically consumed by Canadians could have shifted since the data reflecting the foods typically consumed by Canadians was reported. Dietary patterns could have shifted in response to new diet trends, fluctuations in food costs, and changes in socioeconomic status after the COVID-19 pandemic. Second, since this study was focused on the general Canadian population and the CCHS does not apply to those living on reserve. The generalizability/transferability of the results are limited for BIPOC communities. Third, only 7 days were being compared thus limiting the conclusion. To get a better understanding on the nutritional and environmental impacts of the No Harm Diet, a larger meal plan should be analyzed. Fourth, the number of foods analyzed in the carbon footprint analysis was not sufficient to see a significant difference. However, the No Harm Diet is too restrictive in terms of protein and fat sources to expand this analysis. Examining each food within each meal plan would give a better estimate of the carbon footprint for each diet. Fifth, seasonality was not considered. While many foods can be grown in Canada, minimal foods are produced in the winter and many are imported from other countries. Our emissions data was based on foods that could be grown in Canada during warmer months and did not take into account those same foods when imported. As well, there is a lack of Canadian carbon footprint data and the limited amount of carbon footprint data in general which limited the foods that could be analyzed. While Canadian data was used when available, international data was used for the remaining and they may not be representative of local agriculture and production practices and relate emissions (Veeramani, 2017). Finally, to fully understand food consumption and dietary pattern impact on the environment additional impact categories are needed to capture the overall ling-term environmental implications of dietary patterns (Veeramai, 2017). Using only carbon emissions is a limited perspective on a complex issue.

3.6 Conclusion:

Recent studies have been investigating the environmental and health impacts of the dietary patterns people choose to follow. This study focused on assessing, quantifying, and comparing the nutritional quality and carbon emissions of a novel dietary pattern called the No Harm Diet compared to two common Canadian dietary patterns (omnivore and vegan). The results of this study showed that the No Harm Diet was nutritionally adequate based on the DRI requirements. As well, it was nutritionally comparable to both the vegan and omnivore diets. In terms of carbon emissions, the results show no significant difference among all three of the dietary patterns. The No Harm Diet produced 2.2 kg CO_2 eq for women and 2.4 kg CO_2 eq for men, the vegan diet only produced 0.8 kg CO_2 eq for women and 0.9 kg CO_2 eq for men while the omnivore diet provided 2.0 kg CO_2eq for women and 2.2 kg CO_2 eq for men. The carbon footprint analysis should be expanded to include a wider range of foods and a wider range on impact categories in order to get a more accurate view on the environmental impact of the No Harm Diet.

Chapter 4: Thesis Summary

4.1 Comprehensive Discussion

As of 2020, the global population has reached 7.8 billion people and is projected to increase up to 9.7 billion people by 2050 (United Nations, 2019; Bureau, 2020). With the population increasing so has the demand for food (Baroni, 2006). This demand has attempted to be met through technological advances to increase food production however, these technological advances along with urbanization and a shift in social norms has shifted food demands to reflect a more typical “Western diet” characterized by high quantities of red meat and processed foods (Baroni, 2006; Laestadius, 2019). This dietary trend has degraded human health by increasing noncommunicable chronic diseases such as type 2 diabetes and coronary heart disease as well as degraded the health of our environment through environmental pollution and resource depletion (Tilman, 2014; Aiking, 2019). This has led to an increased awareness that the food we choose to consume impacts our health and sustainability. This has led to the development of various limited harm diets including the vegetarian diet, the vegan diet, the low carbon diet, the 100-mile diet, and a relatively new diet called the No Harm Diet. With other limited harm diets such as vegetarians and veganism being more established, there is more research on the nutritional and environmental impacts. Vegetarian diets have several health benefits including lowering the rates of chronic diseases such as heart disease, hypertension and diabetes, but also overall mortality. Despite those benefits, limited harm diet could lead to nutritional deficiencies. The most common deficiencies in a vegetarian diet are iron, calcium and vitamin B12 but with careful planning these can be mitigated. In terms of environmental impact, multiple studies have shown that plant-based foods tend to be better for the environment as they on average require less water to produce, have limited impacts on biodiversity, and are more energy efficient than animal-based foods. With the increase in research evaluating limited harm diets, there has been no research done on the nutritional and environmental impacts of the No Harm Diet due to it’s novelty. The purpose of this thesis was to assess the nutritional adequacy and carbon emission of the novel dietary patterns called the No Harm Diet.

The No Harm Diet is a sustainable diet developed by Dr. Mark Lefsrud, Head of the Biomass Production Laboratory at McGill University. This diet is derived from ethical vegetarianism or veganism, in which the underlying principle is that harm to the organism providing food, including plants and animals, is prevented or limited. While some food sources have been viewed to not have feelings, emotion, or react to stimuli they are still a living organisms and have the right to life and respect. Within this dietary regime, acceptable foods are those that do not induce injury, cause a physiological stress response, or affect the progeny of an organism that is providing food. Acceptable foods for this diet are foods that do not cause harm to the plant or animal or to the next generation. This includes fruits, some dairy products, unfertilized eggs, honey, and fermented foods from fruits, milk, eggs, and honey. Unacceptable food products include vegetable (leaf crops, root crops, flowers and other parts of a plant), seeds, nuts, grains and meat as these parts have to result in the death of the organism or are taken and weaken the organism. The aim of this thesis is to evaluate the nutritional adequacy and environmental impact of the No Harm Diet. The first objective of this thesis is to assess, quantify, and compare the nutritional quality of the No Harm Diet to the average intakes of Canadians. The second objective of this study was to assess, quantify and compare the nutritional quality (according to the dietary reference intake (DRI) requirement) of the three dietary patterns (No Harm, vegan, and omnivore). The third objective is to assess, quantify, and compare the carbon footprint of the same three dietary patterns. It is hypothesized that the No Harm Diet, a novel sustainable diet originating from Quebec, will have the smallest carbon footprint while being nutritionally adequate based on the DRI requirements.

The results of this study showed that overall, the No Harm Diet was nutritionally adequate when compared to the DRIs and average Canadian intakes. Moreover, it was nutritionally comparable to both the vegan and omnivore diets. With the increased popularity of limited harm diets including veganism and vegetarianism, there has been increasing research on the positive health effects of these diets (Bali, 2023). However, the negative health impacts of these dietary patterns are rarely highlighted (Bali, 2023). A recent literature review examined the overlooked side of following a vegan diet (Bali, 2023). It was seen that low vitamin B12, iron, zinc, calcium, and vitamin D were common among those who followed a vegan diet (Bali, 2023). These low intakes can have negative health consequences including neurological and hematologic problems, carcinogenesis, mental health problems, and increased incidence of fractures (Bali, 2023). Similar to other limited harm diets such as vegetarianism or veganism, the No Harm Diet had some nutritional limitations. When assess the nutritional quality of the No Harm Diet, it was seen that the No Harm Diet meet the macronutrient DRI recommendations for both men and women aside from omega-3 and omega-6. In terms of micronutrient DRI recommendations, the No Harm Diet was able to meet the DRI recommendations for both men and women for a majority of the vitamins and minerals aside from iodine, iron, vitamin D, vitamin E, and biotin. Similar to veganism, lower intakes of nutrients such as omega-3, omega-6, iodine, iron, vitamin D, vitamin E, and biotin can cause negative health impacts. Low intakes of omega-3 and omega-6 can interfere with growth, reproduction, maintenance of skin, and regulation of cholesterol metabolism (Mangels, Messina et al. 2011). While a deficiency in iodine and/or iron can have adverse effects on growth and development, hypothyroidism, anemia, and functional impairments (NIH, 2021; Abbaspour, 2014). In terms of vitamins, low intakes of vitamin D, vitamin E, and biotin can lead to osteomalacia, osteoporosis, heart disease, cancer, and problems in fatty acid synthesis and metabolism (Zimmerman, 2021; Holick, 2005; Messina, 2011). Overall, while the No Harm Diet had some nutritional limitations but like other limited harm diets is overall nutritionally adequate. Like any limited harm diet, in order to be fully nutritional adequate those who follow the No Harm Diet should be closely monitored and have nutrition deficiencies treated (Bali, 2023).

In terms of carbon emission, the results showed that the No Harm Diet emissions were not significantly different from a vegan or omnivore diet. It is often believed that plant-base diets like vegan diets have a more positive impact on the environment especially compared to diets the include animals-based products (Chai, 2019). While some studies have shown that in general vegan diets tend to have lower environmental impacts and greenhouse gas emissions, a systematic review showed that this is not always true (Chai, 2019). It has been shown that many vegans replace animal-based products with plant-based meat and dairy substitutes (Chai, 2019). These plant-based substitutes can have negative environmental impacts (Chia, 2019). As well, for fruit and vegetables, where they are from, how they are grown, and how they are transported greatly impacts their emissions (Chia, 2019). As well, a review exploring the impact on natural resources, climate change, and economies if the world vegan suggested that an exclusive vegan diet could lead to loss of important plant and animal genetic materials, increase pressure on water and land resources and further problems with agricultural crop resides (Dorgbetor, 2022). These reviews and our results show that choosing an overall dietary pattern does not guarantee lower emissions or overall lower environmental impact. What foods you choose to consume, and the amount consumed can impact the amount of carbon emissions emitted regardless of the dietary pattern followed. However, in general a pure plant-based diet such as a vegan diet does seem to produce the lowest emission (Chai, 2019).

Overall, the results of this thesis showed that the No Harm Diet can be considered nutritionally adequate and comparable to other commonly consumed dietary patterns (vegan and omnivore), however, in terms of carbon emissions, the No Harm Diet did not prove to be better than a vegan or omnivore diet.

4.2 Conclusions

The purpose of this research project was to assess the nutritional adequacy and carbon emissions of a novel dietary pattern called the No Harm Diet. The nutrient values were then compared to the DRIs, average Canadian intakes, and the values of the other common Canadian dietary patterns. The results of this study showed that the No Harm Diet overall was nutritionally adequate based on the DRI requirements. Problems were presented with the content of omega-3, omega-6, iodine, iron, Vitamin D, Vitamin E, and biotin in the No Harm Diet. For both men and women, the amount of omega-3 and omega-6 provided by the No Harm Diet is insufficient in meeting the DRI recommendations. When compared to the average intake of Canadians, all macro-nutrients and some micro-nutrients (magnesium, phosphorus, vitamin A, thiamin, vitamin B12, and folate) were similar to the amount provided by the No Harm Diet. This ethical diet overall provided less calories in total than what is typically consumed by the general Canadian population, therefore could lead to some discrepancies seen when comparing the general intake with the amount provided by the No Harm Diet. When compared to two other dietary patterns commonly found in Canada, it was seen that the No Harm Diet was nutritionally comparable to both the vegan and omnivore diets. In terms of carbon emissions, the results show no significant difference among all three of the dietary patterns.

4.2 Recommended Studies

While the No Harm Diet meet most of the nutritional requirements presented by the DRI recommendations, this nutritional analysis could be complemented with a study assessing real life impacts of the No Harm Diet. For instance, having a group of participants follow the diet for three months and assess health markers such as blood pressure, BMI, blood glucose and blood lipids to see if participants can remain healthy on this diet as well to see if any of these health markers can be improved by following the No Harm Diet. A survey-based research study focused on the perception and acceptance of the No Harm Diet would be complementary to this study as well as it is important as it would be a way to better understand the level of public acceptance and better understand the barriers that the No Harm Diet may face. As well, this study was based on the general Canadian population the generalizability and transferability of the results are limited and do not necessarily represent BIPOC communities. Consideration if this diet is culturally appropriate for all Canadian individuals/communities needs to be investigated in further studies.

In terms of the carbon footprint analysis, the No Harm Diet was not significantly different from other common Canadian Dietary patterns. This was the first study investigating the nutritional and environmental impact of the No Harm Diet, however, there were several limitations to this study that should be address in future studies. First, the meal plans were created to be nutritionally adequate as well as reflect the foods typically consumed by Canadians. Before conducting another carbon footprint, a survey should be conducted evaluating the foods Canadians are typically consuming currently. This will give a more accurate evaluation of if the No Harm Diet is more environmentally friendly than common Canadian dietary patterns. Second, the number of foods analyzed in the carbon footprint analysis was not sufficient to see a significant difference. In a follow up study, the amount of food analyzed should be increased, preferably, the whole meal plan of each dietary pattern will be analyzed to give the most accurate view of the carbon emissions. Third, seasonality was not considered. While many foods can be grown in Canada, minimal foods are produced in the winter, and many are imported from other countries. Our emissions data was based on foods that could be grown in Canada during warmer months and did not take into account those same foods when imported. A study evaluating each meal plan in different seasons would complement this study and improve the accuracy of the true emissions of Canadian diets. Finally, to fully understand food consumption and dietary pattern impact on the environment additional impact categories are needed to capture the overall ling-term environmental implications of dietary patterns (Veeramai, 2017). Using only carbon emissions is a limited perspective on a complex issue.

Appendix A

Supplemental Table: Example 7 Day Meal Plan as used to Generate Nutrient Intake Data

Day	Breakfast	Snack	Lunch	Snack	Dinner
1	Yogurt Parfait ● 250 mL nonfat Greek yogurt ● 1 banana ● 4 strawberries ● ½ cup blueberries ● ½ cup raspberries ● 5 mL honey 250 ml orange juice	35 g low fat cheddar cheese 6 apricots	Salad ● 78.5g tomatoes ● ½ cucumber ● 1 tbs olive oil ● 1tbs balsamic vinegar 2 hardboiled eggs 250 ml 0% milk ½ avocado	1 cup grapes 1 medium orange	Zucchini noodles ● 2 zucchini ● 1 tbs olive oil ● ½ cup tomato sauce ● ¼ cup olives 250 mL 0% milk Cherry sorbet ● ½ cup nonfat Greek yogurt ● ½ cup frozen cherries ● 1 tbs 0% milk ● 1 tsp honey
2	Smoothie ● 250 mL nonfat Greek yogurt ● 250 mL 0% milk ● 1/2 cup prune puree ● 1 cup frozen blackberries ● 1 banana	62.85 g dried apricots	Omelet ● 2 eggs ● 1 tsp unsalted butter ● ¼ cup cherry tomatoes ● 50 g shredded cheddar cheese	1 cup blackberries 1 cup nonfat Greek yogurt ½ cup raspberries	Lasagna ● 2 cup eggplant ● 2 zucchini ● ½ large tomato ● ½ cup tomato sauce ● ¼ cup mozzarella ● 1 tbs olive oil

	• ½ cup frozen pineapple		• ½ green bell pepper 1 apple	½ cup mango	
3	Mini frittata • 3 eggs • ½ cup green bell pepper • ¼ cup tomato 30 g low fat cheddar cheese 250 mL 0% milk	5 strawberries 1 cup nonfat Greek yogurt ½ cup prune puree	Stuffed Peppers • 2 red peppers • 1 zucchini • 79 g tomatoes • ½ cup low fat cheddar cheese	1 zucchini 1 tbs olive oil Pinch of salt ½ avocado 1 tbs lime juice ¼ tomato Pinch of salt	Spaghetti squash • 2 cups squash • ½ cup tomato sauce • ½ cup low sodium mozzarella • Pinch of salt • ½ zucchini • 15 g low fat cheddar cheese Watermelon Kiwi Popsicles • 1 medium kiwi • ¾ cup watermelon • Splash of water
4	Smoothie Bowl • 1/2 banana • 1 cup 0% milk • 1 cup nonfat Greek yogurt • 1 kiwi	1 plantain 250 mL orange juice	Papaya Salad • ½ green papaya • ½ chili pepper • 2 tsp lime juice	1 cup watermelon ½ cup blackberries ½ cup blueberries	Baked Eggplant • 2 cups eggplant • 1 tbs olive oil • Pinch of salt • ½ tomato

	• ½ cup blueberries • 1 cup blackberries frozen • ½ raspberries frozen		2 eggs 250 mL 0% milk	½ cup raspberries 1 tbs lime juice	• ¼ tsp red chili flakes • 1/2 cup low sodium mozzarella Oven Roasted Figs • 2 figs • 1 ½ tsp honey • 1 tbs butter
5	Baked Avocado • ½ avocado • 1 poached egg • ¼ low fat cheddar cheese • Pinch of salt • 30 g Monterey jack low fat cheese 250 0% milk	250 ml prune juice ½ cup blackberries frozen ½ banana	Egg Bites • 2 eggs • ½ tbs butter • ¼ cup monetary jack cheese • 15 g low fat cheddar cheese Yogurt Parfait • ½ cup yogurt • ½ cup raspberries • ½ cup blueberries	5 Medjool dates 250 mL prune juice	Oven Roasted Butternut Squash • ½ cups butternut squash • ½ tbs olive oil • Pinch of salt Grilled Zucchini • 1.5 zucchini • ¼ cup lemon juice • 1 tbs olive oil • Pinch of salt Honeydew sorbet • ½ cup honeydew melon

					• 1 tsp lemon juice • 1 tsp honey
6	Roasted Peaches • 2 peaches • 2 tbs honey • 1 tbs unsalted butter • 2 tbs half and half 250 mL 0% milk	1 egg ½ red pepper ½ cup cherry tomatoes 15 g of low fat cheddar cheese	Egg Salad Cucumber Boats • 1 cucumber • 2 hardboiled eggs • Pinch of salt • 1 tbs of >65% oil mayonnaise 250 mL 0% milk	1 cup grapes 5 Medjool dates	Pumpkin Soup • 2 cup pumpkin • 1 cup water • ½ cup half and half • Pinch of salt Baked Apple with Banana Ice Cream • 1 apple • ¼ tbs butter • 1 frozen banana • 3 dates • ¼ cup water • Pinch of salt
7	Baked Denver Omelet • 1 tsp butter • ½ green pepper • ¼ cup low fat cheddar cheese • 2 eggs • Pinch of salt • Pinch of chili pepper	125 mL 0% milk 3 kiwis ½ banana ½ apple 125 ml prune juice	Pulled Jackfruit • 1 cup jackfruit • 1 tbs olive oil • 1 tbs tomato paste • ½ avocado • Pinch of salt • 44 g of pineapple	½ cup watermelon 1 tsp balsamic vinegar 38 g of brie	Eggplant Dip • 1 cup eggplant • 2 tbs lemon juice • Pinch of salt • Pinch of chili pepper Chips • 1 zucchini

	• ¼ cup non fat mozzarella 250 mL 0% milk		250 mL 0% milk		• 1 medium plantain • 1 tbs olive oil • Pinch of salt Lemon Blueberry Popsicles • 10 blueberries • 1 tsp lemon juice • 1 tbs honey • ¼ cup nonfat Greek yogurt

Appendix B

	No Harm			Vegan			Omnivore									
	Average ± SD	Range	% Energy	Average ± SD	Range	% Energy	Average ± SD	Range	% Energy	AMDR	Age	AI	EAR	RDA	UL	Canada Average
Total Energy kcal/day	1809.9	1702.0-1881		1856.9	1824.8-1876.5		1854.2	1809.7-1880.9			19-30	ND			ND	1902.0
	± 57.5			± 17.8			± 25.1				31-50	ND			ND	1850.0
											51-70	ND			ND	1696.0
Protein g/day	91^{b}	75.6-98.9	0.2	69^{c}	47.9-81.9	0.1	118.2^{a}	100.4-136.9	0.3	10%-35%	19-30			46.0	ND	73.0
	± 9.2			± 13.5			± 13.6				31-50			46.0	ND	76.0
											51-70			46.0	ND	72.0
Carbohydrate g/day	259.5	184.0-307.56	0.6	272.2^{a}	202.7-313.3	0.6	215^{b}	193.4-250.7	0.5	45%-65%	19-30		100.0	130.0	ND	247.0
	± 48.4			± 39.4			± 19.9				31-50		100.0	130.0	ND	225.0
											51-70		100.0	130.0	ND	211.0
Fat (total) g/day	57.9	37.4-85.5	0.3	63.6	53.8-89.9	0.3	64.8	58.1-74.8	0.3	20%-35%	19-30	ND			ND	67.0
	± 19.8			± 13.5			± 5.8				31-50	ND			ND	69.0
											51-70	ND			ND	62.0
Saturated Fat g/day	14.6	9.6-25.1		10.5^{b}	8.2-15.6		16^{a}	11.6-19.9			19-30					22.4
	± 6.7			± 2.7			± 2.7				31-50					22.5
											51-70					19.8
Omega 3 g/day	1.2	0.9-1.5		1.9	0.7-4.7		1.5	0.9-2.4			19-30	1.1			ND	1.6
	± 0.2			± 1.4			± 0.6				31-50	1.1			ND	1.8
											51-70	1.1			ND	1.7
Omega 6 g/day	5.5^{b}	2.5-8.4		10.8^{a}	6.6-15.7		13.8^{a}	8.8-19.1			19-30	12.0			ND	9.4
	± 1.8			± 3.1			± 4.2				31-50	12.0			ND	9.8
											51-70	11.0			ND	9.0
Trans Fat g/day	0.4^{a}	0.0-0.8		0^{b}	0-0.1		0.3^{a}	0.1-0.7			19-30					
	± 0.3			± 0			± 0.2				31-50					
											51-70					

Table 3.2: Macronutrient Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Women Intakes. Health Canada, Dietary Reference Intakes Tables. 2006.

ND= not determinable

	No Harm		Vegan		Omnivore							
	Average ± SD	Range	Average ± SD	Range	Average ± SD	Range	Age	AI	EAR	RDA	UL	Canada Average
Sodium mg/day	2065.2 ± 900.7	1048.1-3671.6	1947.3 ± 628.4	915.6-2724.8	1961.8 ± 431.2	1243.4-2503.8	19-30	1500.0			2300.0	2743.0
							31-50	1500.0			2300.0	2778.0
							51-70	1300.0			2300.0	2587.0
Calcium mg/day	1945.4[a] ± 291.6	1587.6-2482.8	899.9[c] ± 113.3	793.1-1070.2	1240.8[b] ± 105.4	1100.1-1384.6	19-30		800.0	1000.0	2500.0	867.0
							31-50		800.0	1000.0	2500.0	827.0
							51-70		1000.0	1200.0	2000.0	740.0
Iodine µg/day	33.0 ± 13.8	12.2-56.7	19.4[b] ± 9.5	12.2-34.8	57.4[a] ± 33.7	5.2-90.6	19-30		95.0	150.0	1100.0	
							31-50		95.0	150.0	1100.0	
							51-70		95.0	150.0	1100.0	
Iron mg/day	12.2[b] ± 3.1	9.7-16.9	22.2[a] ± 3.7	18.6-29.8	14.2[b] ± 2.9	10.2-17.9	19-30		8.1	18.0	45.0	12.4
							31-50		8.1	18.0	45.0	12.4
							51-70		5.0	8.0	45.0	12.4
Magnesium mg/day	397.8 ± 36.2	342.0-452.9	431.0 ± 75	356.6-554.5	411.6 ± 26.4	377.9-449.7	19-30		255.0	310.0	350.0	284.0
							31-50		265.0	320.0	350.0	306.0
							51-70		265.0	320.0	350.0	301.0
Manganese mg/day	4.6[b] ± 1.9	2.7-7.9	7.2[a] ± 1.7	3.9-9.6	4.9[b] ± 0.8	3.6-5.71	19-30	1.8			11.0	
							31-50	1.8			11.0	
							51-70	1.8			11.0	
Phosphorus mg/day	1643.3[b] ± 157.3	1338.3-1821.8	1057.7[c] ± 167.2	840.8-1304.4	2023.1[a] ± 246.3	1736.8-2364.7	19-30		580.0	700.0	4000.0	1192.0
							31-50		580.0	700.0	4000.0	1229.0
							51-70		580.0	700.0	4000.0	1161.0
Selenium µg/day	58.4[b] ± 9.3	42-72.1	55.7[b] ± 10.9	38.2-66.7	151.3[a] ± 52.2	62.0-219.3	19-30		45.0	55.0	400.0	
							31-50		45.0	55.0	400.0	
							51-70		45.0	55.0	400.0	
Zinc mg/day	9.3[b] ± 1.1	7.7-11.2	8.5[b] ± 1.2	6.7-9.8	11.7[a] ± 1.7	9.3-14.4	19-30		6.8	8.0	40.0	9.5
							31-50		6.8	8.0	40.0	9.9
							51-70		6.8	8.0	40.0	9.7
Potassium mg/day	6204.3[a] ± 716.3	4957.2-7330.4	4515.6[b] ± 721.6	3478.3-5508.0	4619.4[b] ± 647.7	3594.4-5486.5	19-30	4700.0			ND	2674.0
							31-50	4700.0			ND	2874.0
							51-70	4700.0			ND	2851.0

Table 3.3: Mineral Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Women Intakes. Health Canada, Dietary Reference Intakes Tables. 2006

ND= not determinable

	No Harm		Vegan		Omnivore							
	Average ± SD	Range	Average ± SD	Range	Average ± SD	Range	Age	AI	EAR	RDA	UL	Canada Average
Vitamin A IU/day	9871.7 ± 1071.6	8321.3-11109.2	9316.9 ± 3290.8	5497.2-15010.5	8539.4 ± 5571.9	3649.4-16741.5	19-30		1667.0	2333.0	10000.0	1964.7
							31-50		1667.0	2333.0	10000.0	2187.8
							51-70		1667.0	2333.0	10000.0	2237.8
Vitamin C mg/day	317.0 ± 103.1	196.8-515.3	242.6 ± 131.3	77.9-390.5	268.7 ± 94	151.1-429.9	19-30		60.0	75.0	2000.0	133.0
							31-50		60.0	75.0	2000.0	117.0
							51-70		60.0	75.0	2000.0	122.0
Vitamin D IU/day	218.7^{b} ± 89	120.3-386.5	2017.3^{a} ± 649.6	941.4-2824.2	825.4^{b} ± 707	203.3-2129.8	19-30		400.0	600.0	4000.0	188.0
							31-50		400.0	600.0	4000.0	208.0
							51-70		400.0	600.0	4000.0	200.0
Vitamin E mg/day	22.1^{a} ± 3.2	18.5-27.2	13.4^{b} ± 2.1	10.0-16.4	15^{b} ± 1.5	12.1-16.7	19-30		12.0	15.0	1000.0	
							31-50		12.0	15.0	1000.0	
							51-70		12.0	15.0	1000.0	
Vitamin K µg/day	145.5 ± 31.2	105.4-192.2	202.9 ± 103.4	107.8-399.4	192.3 ± 117.8	77.6-401.0	19-30	90.0			ND	
							31-50	90.0			ND	
							51-70	90.0			ND	
Thiamin mg/day	1^{b} ± 0	0.9-1.0	3.7^{a} ± 2.1	1.1-6.1	1.6^{b} ± 0.2	1.3-1.9	19-30		0.9	1.1	ND	1.5
							31-50		0.9	1.1	ND	1.5
							51-70		0.9	1.1	ND	1.5
Riboflavin mg/day	2.6^{b} ± 0.3	2.4-3.0	4.3^{a} ± 1.7	1.9-6.2	2.5^{b} ± 0.7	1.9-4.0	19-30		0.9	1.1	ND	1.7
							31-50		0.9	1.1	ND	1.7
							51-70		0.9	1.1	ND	1.7
Niacin mg/day	14.4^{b} ± 2.9	11.1-19.9	31.9^{a} ± 10.9	19.3-44.9	34.3^{a} ± 5.4	24.2-39.7	19-30		11.0	14.0	35.0	33.1
							31-50		11.0	14.0	35.0	36.0
							51-70		11.0	14.0	35.0	33.8
Vitamin B6 mg/day	2.8 ± 0.4	2.3-3.5	3.9 ± 1.7	1.9-5.6	3.7 ± 0.5	2.7-4.1	19-30		1.1	1.3	100.0	1.6
							31-50		1.1	1.3	100.0	1.7
							51-70		1.3	1.5	100.0	1.7
Vitamin B12 µg/day	6.7^{a} ± 0.9	5.5-7.7	4.3^{b} ± 2	1.6-6.8	5.1 ± 1.6	2.7-8.1	19-30		2.0	2.4	ND	3.4
							31-50		2.0	2.4	ND	3.9
							51-70		2.0	2.4	ND	4.0
Pantothenic acid mg/day	5.9^{b} ± 1.2	4.4-7.7	7.6 ± 1.5	5.2-8.8	9.3^{a} ± 1.7	7.0-12.5	19-30	5.0			ND	
							31-50	5.0			ND	
							51-70	5.0			ND	
Biotin µg/day	19.3^{b} ± 7.2	12.4-31.7	29.7^{b} ± 21.6	14.5-77.3	45.9^{a} ± 12	29.8-62.0	19-30	30.0			ND	
							31-50	30.0			ND	
							51-70	30.0			ND	
Folate µg/day	431.4^{b} ± 73	321.1-515.9	812.9^{a} ± 274	444.0-1183.7	433.4^{b} ± 89	317.7-575.5	19-30		320.0	400.0	1000.0	415.0
							31-50		320.0	400.0	1000.0	423.0
							51-70		320.0	400.0	1000.0	400.0

Table 3.4: Vitamin Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Women Intakes. Health Canada, Dietary Reference Intakes Tables. 2006

ND= not determinable

	Average ± SD	Range	% Energy	Average ± SD	Range	% Energy	Average ± SD	Range	% Energy	AMDR	Age	AI	EAR	RDA	UL	Canada Average
Total Energy	2003.4	1964.3-2045.0		2019.9	1976.7-2064.3		2013.6	1981.4-2075.0			19-30	ND			ND	1902.0
kcal/day	± 34.5			± 29.5			± 31.1				31-50	ND			ND	1850.0
											51-70	ND			ND	1696.0
Protein	105.9^{a}	77.6-134.1	21.13%	78.9^{b}	53.2-97.9	15.61%	122.3^{a}	103.0-138.6	24.29%	10%-35%	19-30			46.0	ND	73.0
g/day	± 16.8			± 17			± 11.5				31-50			46.0	ND	76.0
											51-70			46.0	ND	72.0
Carbohydrate	275.9	214.3-328.7	55.08%	298.5^{a}	228.0-335.4	59.11%	238.4^{b}	192.1-279.7	47.34%	45%-65%	19-30		100.0	130.0	ND	247.0
g/day	± 41.1			± 38.8			± 26.1				31-50		100.0	130.0	ND	225.0
											51-70		100.0	130.0	ND	211.0
Fat (total)	65.7	45.5-95.5	29.49%	66.7	56.8-96.4	29.73%	70.9	58.9-86.8	31.68%	20%-35%	19-30	ND			ND	67.0
g/day	± 19.7			± 14.7			± 10				31-50	ND			ND	69.0
											51-70	ND			ND	62.0
Saturated Fat	17.6^{a}	11.7-31.6		10.9^{b}	8.5-16.4		17.1^{a}	11.7-20.5			19-30					22.4
g/day	± 7.3			± 2.9			± 3.2				31-50					22.5
											51-70					19.8
Omega 3	1.3^{b}	1.1-1.6		2.2	0.8-4.7		3^{a}	1.2-4.4			19-30	1.1			ND	1.6
g/day	± 0.2			± 1.4			± 1.1				31-50	1.1			ND	1.8
											51-70	1.1			ND	1.7
Omega 6	6.1^{b}	3.3-8.8		11.4^{a}	7.3-16.3		14.8^{a}	10.5-20.6			19-30	12.0			ND	9.4
g/day	± 1.7			± 3.2			± 4.2				31-50	12.0			ND	9.8
											51-70	11.0			ND	9.0
Trans Fat	0.5^{a}	0.0-0.9		0^{b}	0-0.1		0.3	0.1-0.8			19-30					
g/day	± 0.3			± 0			± 0.2				31-50					
											51-70					

Table 3.5: Macronutrient Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Men Intakes. Health Canada, Dietary Reference Intakes Tables. 2006

ND= not determinable

	No Harm		Vegan		Omnivore							
	Average ± SD	Range	Average ± SD	Range	Average ± SD	Range	Age	AI	EAR	RDA	UL	Canada Average
Sodium	1814.2	1183.1-2295.0	2080.1	1010.1-3170.2	2086.6	1259.8-2962.9	19-30	1500.0			2300.0	4083.0
mg/day	± 363.4		± 703.4		± 557.7		31-50	1500.0			2300.0	3634.0
							51-70	1300.0			2300.0	3345.0
Calcium	2197.3[a]	1698.7-2879.2	1006.8[b]	855.1-1221.3	1323.6[b]	1172.4-1482.4	19-30		800.0	1000.0	2500.0	1107.0
mg/day	± 434.1		± 154.4		± 116.4		31-50		800.0	1000.0	2500.0	938.0
							51-70		1000.0	1200.0	2000.0	832.0
Iodine	44.2	14.2-66.2	19.4	12.2-34.8	61.8	14.6-90.6	19-30		95.0	150.0	1100.0	
µg/day	± 16.2		± 9.5		± 30.5		31-50		95.0	150.0	1100.0	
							51-70		95.0	150.0	1100.0	
Iron	13[b]	10.0-16.9	24.9[a]	20.3-33.6	15.3[b]	11.0-18.6	19-30		6.0	8.0	45.0	17.6
mg/day	± 2.8		± 4.7		± 2.9		31-50		6.0	8.0	45.0	16.7
							51-70		6.0	8.0	45.0	15.1
Magnesium	438.5	373.2-507.6	487.1	406.7-613.2	453.7	400.3-509.0	19-30		330.0	400.0	350.0	380.0
mg/day	± 44.8		± 76.9		± 40.6		31-50		350.0	420.0	350.0	372.0
							51-70		350.0	420.0	350.0	353.0
Manganese	5.2[b]	3.2-8.9	8[a]	4.4-10.5	5.3[b]	4.0-6.5	19-30	2.3			11.0	
mg/day	± 2		± 1.8		± 1		31-50	2.3			11.0	
							51-70	2.3			11.0	
Phosphorus	1900.4[a]	1390.5-2383.7	1195[b]	886.1-1439.5	2118.8[a]	1886.3-2348.8	19-30		580.0	700.0	4000.0	1659.0
mg/day	± 297.8		± 192.3		± 183		31-50		580.0	700.0	4000.0	1560.0
							51-70		580.0	700.0	4000.0	1417.0
Selenium	71[b]	42.4-85.4	61.1[b]	40.8-71.2	159.2[a]	65.0-221.2	19-30		45.0	55.0	400.0	
µg/day	± 14.4		± 10.5		± 52.9		31-50		45.0	55.0	400.0	
							51-70		45.0	55.0	400.0	
Zinc	11.0	8.4-13.2	9.7[b]	7.4-11.4	12.2[a]	10.0-14.5	19-30		9.4	11.0	40.0	14.2
mg/day	± 1.5		± 1.4		± 1.5		31-50		9.4	11.0	40.0	13.9
							51-70		9.4	11.0	40.0	12.2
Potassium	6643.7[a]	5274.6-7481.8	5144.3[b]	4073.0-6286.5	4829.4[b]	3834.5-5563.2	19-30	4700.0			ND	3552.0
mg/day	± 744.3		± 830.6		± 695.9		31-50	4700.0			ND	3534.0
							51-70	4700.0			ND	3403.0

Table 3.6: Mineral Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Men Intakes. Health Canada, Dietary Reference Intakes Tables. 2006

ND= not determinable

	No Harm		Vegan		Omnivore							
	Average ± SD	Range	Average ± SD	Range	Average ± SD	Range	Age	AI	EAR	RDA	UL	Canada Average
Vitamin A	9832.0	8827.5-11368.2	9993.1	5497.2-15433.0	8592.7	3708.7-16742.4	19-30		2083.0	3000.0	10000.0	2341.0
IU/day	± 853.6		± 3286.9		± 5526.2		31-50		2083.0	3000.0	10000.0	2404.3
							51-70		2083.0	3000.0	10000.0	2803.9
Vitamin C	335.1	201.9-564.7	261.2	77.9-465.5	275.1	156.4-445.2	19-30		75.0	90.0	2000.0	158.0
mg/day	± 118		± 149.4		± 100		31-50		75.0	90.0	2000.0	127.0
							51-70		75.0	90.0	2000.0	131.0
Vitamin D	221.9^{b}	124.6-395.0	2286.3^{a}	941.4-3765.6	663.1^{b}	203.9-1103.1	19-30		400.0	600.0	4000.0	236.0
IU/day	± 91.5		± 1067.4		± 436		31-50		400.0	600.0	4000.0	232.0
							51-70		400.0	600.0	4000.0	7.1
Vitamin E	23.6^{a}	20.1-27.3	14.8^{b}	12.3-17.1	15.5^{b}	12.9-17.7	19-30		12.0	15.0	1000.0	
mg/day	± 2.7		± 1.7		± 1.6		31-50		12.0	15.0	1000.0	
							51-70		12.0	15.0	1000.0	
Vitamin K	162.0	106.8-212.6	227.6	111.6-429.3	198.6	77.9-402.2	19-30	120.0			ND	
µg/day	± 33.5		± 113.2		± 116		31-50	120.0			ND	
							51-70	120.0			ND	
Thiamin	1^{b}	1.0-1.2	3.9^{a}	1.3-6.1	1.7^{b}	1.4-2.0	19-30		1.0	1.2	ND	2.1
mg/day	± 0.1		± 2		± 0.2		31-50		1.0	1.2	ND	2.0
							51-70		1.0	1.2	ND	1.9
Riboflavin	3^{b}	2.5-3.7	4.5^{a}	2.0-6.3	2.5^{b}	2.0-3.6	19-30		1.1	1.3	ND	2.4
mg/day	± 0.4		± 1.8		± 0.5		31-50		1.1	1.3	ND	2.2
							51-70		1.1	1.3	ND	2.0
Niacin	15.4^{b}	11.6-20.0	34.3^{a}	22.0-50.7	35.1^{a}	25.2-42.8	19-30		12.0	16.0	35.0	49.7
mg/day	± 2.6		± 11.5		± 5.9		31-50		12.0	16.0	35.0	48.4
							51-70		12.0	16.0	35.0	43.9
Vitamin B6	3.0	2.6-3.5	4.1	2.1-5.9	3.9	3.1-4.7	19-30		1.1	1.3	100.0	2.3
mg/day	± 0.4		± 1.7		± 0.5		31-50		1.1	1.3	100.0	2.2
							51-70		1.4	1.7	100.0	2.1
Vitamin B12	7.7^{a}	5.5-9.4	4.7^{b}	1.6-7.6	5.3^{b}	2.9-7.9	19-30		2.0	2.4	ND	5.4
µg/day	± 1.3		± 2.5		± 1.6		31-50		2.0	2.4	ND	5.3
							51-70		2.0	2.4	ND	4.9
Pantothenic acid	6.7^{b}	4.9-8.2	8.4	5.4-10.3	9.4^{a}	7.5-11.1	19-30	5.0			ND	
mg/day	± 1.2		± 2		± 1.3		31-50	5.0			ND	
							51-70	5.0			ND	
Biotin	22^{b}	14.3-33.9	32.4	15.1-77.3	46.6^{a}	32.8-58.2	19-30	30.0			ND	
µg/day	± 7.1		± 20.8		± 9.1		31-50	30.0			ND	
							51-70	30.0			ND	
Folate	465.8^{b}	349.6-534.1	910.2^{a}	515.3-1229.9	460.2^{b}	322.4-569.8	19-30		320.0	400.0	1000.0	587.0
µg/day	± 64.5		± 278.3		± 93.9		31-50		320.0	400.0	1000.0	528.0
							51-70		320.0	400.0	1000.0	485.0

Table 3.7: Vitamin Averages for No Harm, Vegan and Omnivore Meal Plans Compared to DRIs Recommendations and Average Canadian Men Intakes. Health Canada, Dietary Reference Intakes Tables. 2006

ND= not determinable

	Carbohydrates			Protein			Fat		
No Harm	Banana	Apple	Orange	Egg	Yogurt	Milk	Olive Oil	Butter	Avocado
Kg CO2 eq	0.4	0.5	0.3	5.5	1.8	1.0	0.6	7.6	0.6
Vegan	Banana	Bread	Potato	Almond	Cashew	Canned Beans	Olive Oil	Avocado	Peanut Butter
Kg CO2 eq	0.4	0.7	0.0	1.6	8.3	1.3	0.6	0.6	1.8
Omnivore	Banana	Bread	Potato	Chicken	Beef	Pork	Olive Oil	Butter	Peanut Butter
Kg CO2 eq	0.4	0.7	0.0	2.6	22.3	3.7	0.6	7.6	1.8

Table 3.8: Kg of CO2 eq per 1 Kg of Selected Foods for Each Diet

	Carbohydrates			Protein			Fat		
No Harm	Banana	Apple	Orange	Egg	Yogurt	Milk	Olive Oil	Butter	Avocado
Kg CO2 eq	0.5	1.0	0.6	1.7	1.2	0.8	0.0	0.5	0.2
Vegan	Banana	Bread	Potato	Almond	Cashew	Canned Beans	Olive Oil	Avocado	Peanut Butter
Kg CO2 eq	0.5	0.3	0.0	0.1	0.6	0.6	0.0	0.2	0.1
Omnivore	Banana	Bread	Potato	Chicken	Beef	Pork	Olive Oil	Butter	Peanut Butter
Kg CO2 eq	0.5	0.3	0.0	0.9	3.1	0.4	0.0	0.5	0.1

Table 3.9: Kg of CO2 eq per Total Diet Kcal Women

	Carbohydrates			Protein			Fat		
No Harm	Banana	Apple	Orange	Egg	Yogurt	Milk	Olive Oil	Butter	Avocado
Kg CO2 eq	0.5	1.1	0.7	1.9	1.3	0.9	0.0	0.6	0.2
Vegan	Banana	Bread	Potato	Almond	Cashew	Canned Beans	Olive Oil	Avocado	Peanut Butter
Kg CO2 eq	0.5	0.3	0.1	0.1	0.7	0.6	0.0	0.1	0.2
Omnivore	Banana	Bread	Potato	Chicken	Beef	Pork	Olive Oil	Butter	Peanut Butter
Kg CO2 eq	0.5	0.3	0.1	1.0	3.4	0.4	0.0	0.6	0.2

Table 3.10: Kg of CO2 eq per Kcal Men

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