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Fruit and Vegetable Intake of Students and Prevalence of Vegetarianism at Lakehead University

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Abstract

Purpose: The purpose of this study was to assess the daily intake levels of fruits and vegetables in a population of post-secondary students at Lakehead University in Thunder Bay, Ontario and to measure the prevalence rate of vegetarianism in this population.

Methods: Food intake, demographic variables and vegetarian status were measured with a survey and food frequency questionnaire (FFQ) filled out by students who ate at the Aramark residence cafeteria of Lakehead University between Sunday February 1st and Saturday February 7th, 2009. Two hundred sixty-seven students participated, of which 197 were on the Aramark meal plan and therefore ate all of their meals at this cafeteria (response rate= 43.5% for this group).

Results: Forty-three percent of the sample was female, with a mean age of 21 ± 3 years of age. Mean intake of fruits and vegetables was 5.0 ± 2.3 servings/day for females and 4.6 ± 2.1 servings/day for males. Females ate significantly more vegetables than males ($p < 0.01$), Caucasians ate more fruits and vegetables than non-Caucasians ($p < 0.01$) and vegetarians ate more fruits and vegetables than non-vegetarians ($p < 0.01$). Within the sample, 6.7% (18/267) self-reported as vegetarian, with the majority being female (14/18) and ovo-lacto vegetarian (13/18).

Conclusions: Fruit and vegetable intake in this population is below recommended levels and below the estimated national average for their age group. Males, non-vegetarians and non-Caucasians are at a particular risk of future health deficits due to insufficient fruit and vegetable intake. The prevalence of vegetarianism among Canadian post-secondary students may be higher than in the rest of Canada.

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Introduction

Proper nutrition is of critical importance in the prevention of disease and maintenance of good health (Shah, 2003). Addressing public health through dietary interventions and nutrition research is a form of primary prevention that has been a cornerstone of research since a surge in popularity in the 1950's (Van Horn et al., 2008). In recent years, nutrition research has turned its focus to fruit and vegetable intake and the health benefits of a vegetarian diet (Sabate, 2003). In 2007, Health Canada released their latest version of the Canada Food Guide, which continued to highlight the importance of fruits and vegetables and showed more support for alternatives to meat (Katamay et al., 2007). However, there is a lack of quantitative research specifically on the nutrition of post-secondary students (Adams & Colner, 2008). Fruit and vegetable intake and the prevalence of vegetarianism in this population are poorly understood, especially in Canada (House & Levy-Milne, 2006).

Objectives

The primary research questions for the current study were: "What are the daily intake levels of fruits and vegetables in the population of students at the residence cafeteria hall at Lakehead University?" and "What is the prevalence rate of vegetarianism in this population?". Secondary research questions were: "What are the gender, ethno-cultural, or other demographic differences (if any) in terms of vegetarianism and fruit and vegetable intake in this population?" and "What are the predictors of fruit and vegetable intake in this population?".

A literature search of PubMed, PsychInfo and CINAHL was undertaken to look for articles published in peer-reviewed journals that were relevant to this research. Search terms included: "fruit and vegetable intake", "vegetarian mortality", "vegetarian student", "diet of post-secondary students", "vegetarian prevalence rates", "vegetarian health", "plant-based diet health", "health benefits of fruit and vegetable intake" and "food frequency questionnaire". Other topics of interest searched for included the mechanisms underlying the health benefits of fruit intake/vegetable intake/vegetarian diets, fruit and vegetable intake among post-secondary students, Canadian fruit and vegetable intake rates, Canadian rates of vegetarianism and survey response rates. Further articles were found by cross-referencing from papers of particular interest.

Daily Food Intake and the Canada Food Guide

Since its inception as "Canada's Official Food Rules" in 1942, the Canada Food Guide (Health Canada, 2007) evolved with nutritional research to promote ideal food choices for Canadians (Katamay et al., 2007). The 2007 version of the Canada Food Guide had four food groups. A balanced diet for females aged 19-30 would consist of eight servings of fruits and vegetables, seven servings of grain products, two servings of dairy and dairy alternatives and two servings of meat and alternatives per day. Recommendations for males aged 19-30 were higher for fruits and vegetables, grain products and meat and alternatives. Males aged 19-30 were advised to eat ten servings of fruits and vegetables, eight servings of grain products, two servings of dairy and alternatives and three servings of meat and alternatives per day. Although the Guide

made no specific mention of vegetarianism, it did provide a general recommendation that meat alternatives be eaten "often" (Health Canada, 2007, p.2).

The American guide (United States Department of Agriculture, 2008) was similar to the Canada Food Guide but consisted of five food groups, with separate groups for fruits and vegetables: grains, vegetables, fruits, meat and beans, and dairy. For adults of either gender, the United States Department of Agriculture (USDA) recommended the equivalent of five servings of vegetables and four servings of fruit (totaling nine servings of fruits and vegetables), five servings of grains, three servings of dairy and two servings of meat and alternatives. (USDA, 2008). This is similar to the Canada Food Guide, but with recommendations for a slightly lower daily intake of grain and a slightly higher daily intake of dairy. In addition to the Canadian and American food guides, the World Health Organization (WHO) released 'Diet, Nutrition and the Prevention of Chronic Disease' in 2003. This did not offer guidelines for intake by food group, however it did provide a few key recommendations. The consumption of fruits and vegetables were considered "vital" (WHO, 2003, p. 23) and the dangers of cholesterol and saturated fats from meat were highlighted. For optimal health, the WHO recommended an increased consumption of fruits, vegetables, legumes, whole grains and nuts.

Definitions of Vegetarianism

'Vegetarianism' is a blanket term for various diets that are plant-based. That is, they exclude meat, fish and fowl. Definitions for variations along the spectrum of plant-based diets have been informal, but generally accepted by researchers. The term 'vegetarian' has been typically used by

researchers to refer to 'ovo-lacto vegetarianism', a diet which excludes meat but includes eggs and dairy products (HealthOn, 2008). 'Ovo-vegetarianism' excludes meat and dairy, but includes eggs, whereas 'lacto-vegetarianism' excludes meat and eggs, while including dairy (HealthOn, 2008). 'Pesco vegetarianism' consists of an ovo-lacto vegetarian diet that includes fish. 'Veganism' refers to a diet that excludes meat, fish, dairy and eggs (HealthOn, 2008). Since the majority of research on plant-based diets has been conducted in reference to an ovo-lacto vegetarian diet, the term 'vegetarian' will refer to ovo-lacto vegetarianism throughout this thesis unless otherwise stated.

In all forms, the focus of a vegetarian diet rests primarily on fruits, vegetables, legumes, grains and nuts, supplemented by eggs and dairy products. The protein in such diets comes primarily from the intake of whole grains, nuts, seeds and legumes. Otherwise, a vegetarian diet conforms to the recommendations in the Canada Food Guide. In fact, the 'meat and alternatives' section of the Canada Food Guide lists multiple sources of meat alternatives such as nuts, seeds and legumes and encourages the consumption of "meat alternatives such as beans, lentils and tofu often" (Katamay et al., 2007, p. 161). Some early research expressed concerns that vegetarian diets were linked to nutrient deficiency (Sanders & Reddy, 1994). Sabate (2003) challenged the idea that vegetarian diets are nutrient-poor by pointing out that "nutrient deficiency is mostly found in vegetarian diets in poorer countries, due to poor nutrient quality and quantity in the diet and in certain (fruitarian, some macrobiotic diets) extreme vegetarian diets." (p. 502S-503S).

Research on the Benefits of Fruits and Vegetables and a Vegetarian Diet

Overview of Research on Fruit and Vegetable Intake and Vegetarianism. Quantitative research on the benefits of vegetarian health began in the early 20th century (Benedict & Roth, 1915) and continued with studies conducted among religious groups whose members did not consume meat. At the same time, the earliest research on the health effects of fruit and vegetable intake was being conducted (Drummond, 1921). This was followed by studies that examined the effects of vegetarianism as well as fruit and vegetable intake on short-term effects such as body-mass index (BMI) and long-term health outcomes such as cancer rates. More recently, research was undertaken on the mechanisms mediating the health effects of fruit and vegetable intake and a vegetarian diet. This section will first outline the early studies and continue with evidence for health benefits, followed by the mechanisms by which fruits and vegetables and a vegetarian diet affect health.

History of Research on Vegetarianism. The first study conducted on vegetarianism examined the relative metabolism of vegetarians (Benedict & Roth, 1915) in a sample drawn from staff of the Battle Creek Sanitarium, a health resort that promoted ovo-lacto vegetarianism. Early research on vegetarianism mortality was conducted on religious groups, for example certain groups of nuns who did not consume meat (Stocks, 1957). After this, migrant studies began to be conducted, followed by cohort studies such as that of the Vegetarian Society of Manchester (Kinlen, Hermon, & Smith, 1983). This cohort study was one of the first to track mortality rates for cardiovascular disease and cancer among vegetarians and found a lower rate of colorectal cancer among vegetarians. After this, a series of important studies were conducted on Seventh-

Day Adventists, a religious group whose members have very similar lifestyle habits in terms of smoking status, alcohol consumption and diet. Although it is not mandatory, the majority of Seventh-Day Adventists eat an ovo-lacto vegetarian diet. For this reason, the rate of vegetarianism has been much higher in this population than in the general population (Phillips & Snowdon, 1985), which has allowed for well-controlled comparisons of disease outcomes within that community. Important studies on vegetarianism include the Health Food Shoppers Study (Burr & Sweetnam, 1982), which recruited several thousand vegetarians and non-vegetarians and tracked their mortality for over 20 years, finding lower mortality due to heart disease for vegetarians. Also, Key et al. (1999) compared the mortality rates for various diseases for over 75,000 vegetarians and non-vegetarians in the United States, finding that vegetarians had lower rates of heart disease.

Health Effects of Fruit and Vegetable Intake and Vegetarianism. In general, research on the long-term health benefits of vegetarianism has focused on cardiovascular disease (CVD) and colorectal and prostate cancer (Burr & Sweetnam, 1982; Kris-Etherton et al., 2002). Short-term health outcomes of particular interest were BMI (Berkow & Barnard, 2006) and serum cholesterol levels (Leitzmann, 2005). Research on the health effects of fruit and vegetable intake has looked at several outcomes, mostly long-term, including breast, prostate and lung cancer as in Gandini, Merzenich, Robertson, & Boyle's review (2000) and cardiovascular disease as in O'Keefe, Gheewala, & O'Keefe's 2008 review.

Long-term Health Outcomes for Fruit & Vegetable Intake & Vegetarianism

Cancer and Fruit and Vegetable Intake. Research on the protective effects of fruit and vegetables against cancer began with comparisons of the rates of colon cancer with the intake of various dietary factors (Burkitt, 1971). Since then, several studies and at least two meta-analyses have demonstrated a link between fruit and vegetable intake and lowered risk of cancer. In a meta-analysis on the effect of diet and other lifestyle interventions on cancer prevention, Demark-Wahnefried, Rock, Patrick, & Byers (2008) investigated various types of food and concluded that an ideally healthy diet for reducing the risk of most cancers consisted primarily of plant-based foods. Their best practice guidelines for family physicians specifically recommended advising patients to eat five or more servings of fruits and vegetables per day as a preventive measure. In the second meta-analysis, consisting of 26 studies, Gandini et al. (2000) detected a relative risk (RR) of 0.75 for breast cancer between groups that consumed high versus low levels of fruits and vegetables. This meta-analysis also specifically noted that yellow-orange and cruciferous vegetables were associated with lower rates of prostate cancer, with an odds ratio (OR) of 0.67 and that lung cancer risks were 21% lower among women with higher fruit and vegetable consumption.

As the evidence for these relationships mounted, local and multi-national estimates of the effect of fruit and vegetable intake on cancer rates began to be explored. The World Cancer Research Fund and American Institute for Cancer Research (WCRF-AICR, 1997) examined the relationship of various dietary constituents to types of cancers. In their estimation, 20% or more of cancer cases worldwide for all adults and children over the age of two, were preventable by

simply eating "substantial and varied amounts of vegetables and fruits". This corresponded to three million or more cases of cancer per year, world-wide (WCRF-AICR, 1997, p. 524).

Cancer and Vegetarianism. The link between a vegetarian diet and cancer rates is a more recent one in the literature and only one review (Fraser, 2009) has been conducted to date. In the first large-scale study found, Burr and Sweetnam (1982) conducted a prospective study over a 20-year period and found an association between vegetarian diets and decreased levels of prostate and colorectal cancer. As Sabate (2003) pointed out, research from the early 1990's onwards showed vegetarians in more developed countries to be relatively healthier than non-vegetarians in terms of multiple health outcomes, including several types of cancer. In addition to preventing cancer, a plant-based diet was found to reduce the recurrence of prostate cancer in a pilot study by Nguyen et al. (2006), which included dietary change in a population of men diagnosed with prostate cancer. Fraser's (2009) review of vegetarianism and health concluded that vegetarians have lower rates of colorectal cancer and although differences in terms of other specific cancers requires more research, vegetarians tend to have lower overall cancer rates than non-vegetarians.

CVD and Fruit and Vegetable Intake. The foundational study on cardiovascular disease and diet was the Framingham Heart Study, a longitudinal study which began in 1948 and which later concluded that there was a 25% reduction in risk for stroke for every three servings of fruits and vegetables eaten daily (Gillman et al. 1995). A few studies and one meta-analysis have been conducted since then and in 2001, Joshipura et al. drew similar conclusions, calculating that there was a 4% reduction in risk of coronary heart disease for each serving of fruits and

vegetables consumed per day. In a review (2003), Hu concluded that a plant-based diet was associated with a decrease in the risk of CVD and stroke. Green, leafy vegetables were found to be most protective against CVD and citrus fruits and cruciferous vegetables were determined to be most protective against stroke. As well, Hu found a dose-response relationship, with a daily intake of eight servings/day resulting in the lowest risk level for CVD. This lead Hu to conclude that "from a public health point of view, an increase in consumption of all types of fruit and vegetables should be encouraged" (Hu, 2003, p.545S). Finally, in their 2003 review of global dietary intake patterns, the WHO recommended that fruits and vegetables should be consumed in the amount of 400-500g per day, in order "to reduce the risk of coronary heart disease, stroke and high blood pressure." (World Health Organization, 2003, p. 89).

CVD and Vegetarianism. Large-scale research on vegetarianism and cardiovascular disease (CVD) was first conducted by Burr and Sweetnam (1982), who noted a significant protective effect of vegetarianism on ischemic heart disease in their prospective mortality study. Several studies have been conducted since, with at least two meta-analyses. In their 1999 review of five large prospective studies from the USA, Key et al. controlled for age and smoking and found that mortality from ischemic heart disease was lower by 26% in vegans, lower by 24% in vegetarians and lower by 20% in occasional meat-eaters, all compared to regular meat-eaters. A greater effect size for vegetarianism was also found in those individuals who had been vegetarian for over five years, indicating a possible temporal relationship between vegetarianism and prevention of CVD. A more recent meta-analysis of vegetarian diets (Fraser, 2009) confirmed

that vegetarian diets were associated with a lower rate of CVD and offered several reasons for this, including lower rates of obesity and lower cholesterol levels.

Other Health Benefits

Other Health Benefits from Fruit and Vegetable Intake. A few other health benefits have been linked to fruit and vegetable intake. A protective effect of fruit and vegetable intake on bone density (New, 2003) has been noted. Plant-based diets that include at least five fruits and vegetables per day were linked with a decreased risk of Parkinson's disease (Gao et al., 2007), with a total risk reduction of 22% attributable to an ideal diet high in fruits and vegetables. Also, Bernstein (2009) reviewed the literature on fruit and vegetable consumption and age-related macular degeneration, concluding that a diet with plentiful and varied fruits and vegetables would significantly decrease the incidence of this disease as well.

Other Short-term Benefits of Vegetarianism. In 2006, Berkow and Barnard noted that 1.2 billion people were estimated to be overweight or obese, worldwide. After reviewing 40 articles, Berkow and Barnard found that the BMI of vegetarians was lower than that of non-vegetarians by anywhere from 3-20%. This effect was consistent in both sexes, across geography and cultural groups. As well, in a joint position paper on vegetarian diets by the American Dietetic Association and the Dieticians of Canada (2003), vegetarians were reported to have lower BMI scores than non-vegetarians as well as lower blood cholesterol levels.

Other Long-term Benefits from Vegetarianism. The position paper of the American Dietetic Association and the Dieticians of Canada (2003) reported lower rates of hypertension, type two

diabetes, osteoporosis, renal disease and dementia among vegetarians. Leitzmann (2005) concurred, adding diverticular disease, gallstones and rheumatoid arthritis to the list of health conditions that may be prevented by a vegetarian diet. Barnard, Scialli, Hurlock & Bertron (2000) found that vegetarian diets have specific benefits for dysmenorrhea. Finally, Spencer, Elon, & Frank (2007) stated that vegetarian diets were associated with lower levels of fibromyalgia.

Mechanisms by which Fruits and Vegetables and a Vegetarian Diet Affect Health

The early research on the health benefits of fruit and vegetable intake and of vegetarianism were built on by subsequent research looking at the mechanisms by which these health benefits were conferred. Studies on this topic have included research on animal models, to allow for randomized clinical trials to determine chemicals of interest and their underlying mechanisms, as well as epidemiological research with humans to examine health and disease outcomes. Several families of chemicals (such as isothiocyanates, psyllium, pectin and monoterpenes) were studied in the literature to assess their protective effects on health. There have been at least three reviews, beginning in 1999 when Hollman, Feskens, & Katan (1999) reviewed the evidence for flavonol, a plant-based antioxidant, as being protective against CVD both among people who have a history of CVD and among the general population. Kris-Etherton et al. (2002) added to this by listing several other flavonoids and carotenoids found in fruits and vegetables which have inhibitory effects on rates of CVD and cancer. Folts (2002) reviewed the evidence for the protective effects of grape juice against low-density lipoprotein (LDL) oxidation, a risk factor for CVD.

Although the World Health Organization (2003) indicated that fruit and vegetable intake reduced the risk of stroke, ischemic heart disease and high blood pressure via the protective effects of dietary fibre, potassium and phytonutrients, they also concluded that the combined health benefits of fruits and vegetables "cannot be ascribed to a single or mix of nutrients and bioactive substances" (WHO, 2003, p. 58). The mechanisms underlying the health benefits of fruit and vegetable intake and a vegetarian diet are complex, but researchers have clearly indicated the need to continue recommending a diet with a variety of fruit and vegetables eaten daily (Kris-Etherton et al., 2002).

Mechanisms Affecting Cancer. Mechanisms underlying both the promotion and prevention of cancer have been found at the macronutrient and micronutrient level and several reviews exist on this topic in the literature. A micronutrient of interest in terms of cancer is lycopene, a carotenoid found mainly in fruits. Clinton (1998) concluded that lycopene in the diet may confer a protective effect against cancers of the colon, rectum, bladder, cervix, prostate, stomach, pharynx and esophagus. In their 2005 review, Shukla and Gupta specified various phytochemicals found in fruits and vegetables which may have anti-carcinogenic properties important in the prevention of prostate cancer. In another review of mechanisms underlying the prevention of both cancer and cardiovascular disease (Kris-Etherton et al., 2002), the authors found an inverse association between the dietary intake of flavonoids, which are phenolic compounds found in plant foods, and cancer risk. The authors concluded with a recommendation for a diet with a variety of whole, plant-based foods such as fruits, vegetables, whole grains, legumes, and nuts.

In terms of macronutrients, saturated fat, a type of fat which is found in animal foods, has been linked with increased risk of cancer. In a review of fat intake and cancer risk, Gerber (2009) concluded that the risk of breast cancer increases with the consumption of animal fat.

Mechanisms Affecting Cardiovascular Disease. Research on cardiovascular disease indicated that there are multiple underlying mechanisms. These include concentration of dietary saturated fat, cholesterol, post-prandial inflammation and obesity.

In a review looking at various risk factors for heart disease, Rajaram (2003) found that plant-based diets were linked to lower blood serum lipid levels, a finding that was confirmed in a review of dietary factors on the prevention of cardiovascular disease (Van Horn et al., 2008). Potential mechanisms included the lowering effects of soy and dietary fibre on LDL levels, the preventative effect of folic acid on endothelial dysfunction and the inhibitory effect of dietary antioxidants on atherosclerosis. Van Horn et al. (2008) made recommendations for a plant-based high-fiber diet with ample intakes of fruits and vegetables to keep blood pressure low and ensure sufficient intake of B-vitamins, thereby decreasing the risk of CVD.

Key, Davey & Appleby (1999) found that vegetarians had a lower plasma concentration of cholesterol than non-vegetarians and suggested that this was an important indicator of ischemic heart disease. This was confirmed in a 2009 review by Fraser, who also concluded that vegetarians had lower rates of CVD due to lower rates of obesity. Finally, O'Keefe et al. (2008) reviewed the chemical basis for post-prandial (after a meal) inflammation from different types of food, a phenomenon that was linked with an increased risk of both CVD and diabetes and

concluded that post-prandial inflammation could be avoided or minimized by eating a plant-based diet.

Daily Intake of Fruits and Vegetables Among Post-Secondary Students

Overview. The diet of post-secondary students is of particular interest because this represents an especially formative period in the development of health-promoting habits (Sanders & Sanders-Gendreau, 2007). According to their 2007 review, which looked at the diet of college students in the United States of America, the years of post-secondary education (typically between the ages of 18-24) are the beginnings of a psychological phase described by Jean Piaget as 'formal operations', indicating a newfound ability for reason, complex thought and executive function (Sanders & Sanders-Gendreau, 2007, p. 410-411). This translates to individuals who are experiencing the ability and freedom to choose their lifestyles for perhaps the first time. Sanders and Sanders-Gendreau (2007) argued that this makes post-secondary students an ideal population in which to address diet. Skemiene, Ustinaviciene, Piesine, & Radisauskas (2007) concurred, finding that this period tends to be associated with newfound financial difficulties and a faster pace of activity, leading to unique dietary concerns for this group of people. Wharton, Adams & Hampl (2008) added to this, stating that because of the relative youth of individuals in this cohort, there is a relatively "large avoidable burden of chronic disease" (p. 579), making this a time for especially efficient dietary interventions.

The earliest and most comprehensive survey research found on the daily intake of fruits and vegetables was based on data from the 1994 Behavioral Risk Factor Surveillance System in the

United States of America (Serdula, Gillespie, Kettel-Khan, & Farris, 2004). This survey reported data from a US national survey of diet (n= 32,257) with correlated variables such as age, tobacco use, and education level. Since this study, a similar study on fruit and vegetable intake was conducted on the general population of Canada (Garriguet, 2007), one smaller study was conducted in Southern Ontario (Traynor, Holowaty, Reid & Gray-Donald, 2006), one survey of high school students in Prince Edward Island (MacLellan, Taylor & Wood, 2008), one survey among American post-secondary students (Spencer, Elon & Frank, 2007) and one among American high-school students (Perry, McGuire, Neumark-Sztainer, & Store, 2002). No studies specifically measured the fruit and vegetable intake of Canadian post-secondary students, however Garriguet (2007) did provide fruit and vegetable intake data for Canadian adults aged 19-30.

Canadian Findings. Although the total enrolment in Canadian universities was 1,047,705 in 2005/2006 (Statistics Canada, 2005), there has been little research on fruit and vegetable intake among Canadian post-secondary students. Garriguet (2007) examined data from the 2004 Canadian Community Health Survey and found that among 19-30 year olds, 60% of females and 45% of males ate less than five servings of fruits and vegetables per day. Mean combined intake of fruits and vegetables was 4.7 servings per day for women and 5.4 for men, with current Canada Food Guide recommendations for intake in this age group being eight servings per day for women and 10 for men. This was the only study that found a higher intake of fruit among men than women. However, this represented an average of 59% of the recommended daily fruit and vegetable intake for women and only 54% of the recommended daily intake for men. Related

to this, Statistics Canada (2002) reported that Canadian women were more likely than Canadian men to make food choices based on preventing disease and/or promoting health.

Traynor et al. (2006) measured fruit and vegetable consumption in a population of adults in Southern Ontario (n= 174) with a validated FFQ based on the Canada Food Guide. They found that the total consumption of fruits and vegetables was 4.6 ± 2.3 servings/day, slightly lower than the Canadian mean overall adult intake of 5.0 servings (Garriguet, 2007) and markedly lower than the Canada Food Guide's recommended intake of eight to ten servings per day (Health Canada, 2007). MacLellan (2008) measured intake of the food groups from the Canada Food Guide among students aged 13 to 15 years of age, in Prince Edward Island. Average combined fruit and vegetable intake was 4.3 ± 2.9 servings per day, also lower than the Canadian average and recommended intake levels.

U.S. Findings. The most recent data on the American national survey (Serdula et al., 2004) was from 2000, when the mean fruit and vegetable intake per day was reported as 3.6 for women and 3.1 for men, for an overall mean of 3.4, substantially lower than the USDA recommended intake of nine servings of fruits and vegetables per day (USDA, 2008). The authors compared the reported daily intake to a level of five servings per day, which is approximately half of the USDA recommended daily intake. They found that the total percentage of Americans aged 18-24 who reported eating at least five servings of fruits and vegetables per day was approximately 22%. In terms of ethno-cultural background, 25% of Non-Hispanic Whites reported eating five or more servings per day, compared to 23% of Non-Hispanic Blacks. Education level was also

associated with fruit and vegetable consumption, with 20% of those who had less than a high school diploma reporting eating at least five servings per day, compared to 29% for those with a college degree. In terms of smoking status, 27% of non-smokers ate five servings of fruits and vegetables per day versus 18% of smokers. Also, 27% of those with a BMI under 25 (normal weight) ate five servings of fruits and vegetables per day, compared to 22% for those with a BMI greater than or equal to 30 (obese).

Perry et al. (2002) looked at a cross-section of students in Minnesota high schools (n= 4,746) and found a total fruit and vegetable consumption of 4.2 servings per day overall, higher than the national average of 3.4 (Serdula et al., 2004), but much lower than the USDA recommended intake of nine fruits and vegetables per day (USDA, 2008) . Total fruit and vegetable consumption was 4.7 servings per day for semi-vegetarians (those who occasionally ate chicken and/or fish) and 5.1 servings per day for ovo-lacto vegetarians. Vegetarians consumed 0.4 more servings of fruit and 0.5 more of vegetables per day than non-vegetarians did. Finally, Spencer et al. (2007) examined fruit and vegetable intake among students attending medical school in the United States. Overall mean fruit and vegetable intake was approximately 2.8 servings per day, lower than the national average of 3.4 (Serdula, 2004). Fruit and vegetable intake for vegetarians was 3.4 servings per day, with a daily intake of 3.5 for vegetarians for health reasons and 3.3 for other vegetarians.

Prevalence of Vegetarianism

Little population prevalence data exist on vegetarianism. Average rates are approximately 2.5- 4.0% within the adult population in North America (American Dietetic Association and

Dieticians of Canada, 2003). Prevalence of vegetarianism was slightly higher among students compared to other adults and significantly higher for females compared to males, across studies.

Canadian Prevalence. Leitzmann (2005) concluded in his paper that a properly balanced vegetarian diet would be healthy for anyone of any age, including post-secondary students. However, despite the wealth of evidence on the health benefits of vegetarianism, there was a lack of literature on the prevalence of vegetarianism from a Canadian perspective. The joint paper of the American Dietetic Association and Dieticians of Canada (2003) estimated that the prevalence of vegetarianism in adults was approximately 4.0% in Canada. They also noted that an increase in the prevalence was expected in the years afterwards. In a population survey in British Columbia, Bedford & Barr (2005) found that 6% of adults in the sample (n= 1817) identified as vegetarian. Within this sample, approximately 9.3% of adults aged 19-30 identified as vegetarian, significantly higher than the national average of 4.0% (American Dietetic Association and Dieticians of Canada, 2003). Although there was insufficient research on this topic to conclude with certainty, the higher prevalence of vegetarianism in this population may have been due to geographic and/or cultural factors particular to British Columbia.

No data were found on the prevalence of vegetarianism in a post-secondary population in Canada. In the only Canadian data found among students, Greene-Finestone, Campbell, Evers & Gutmanis (2008) examined the prevalence of vegetarianism in Grade nine students across Ontario and found it to be 6.5% for females and 1.0% among males, for a overall prevalence of 4.0%. Their comment on the state of research in this field was telling: "in Canada, there has been no systematic evaluation of the diets of vegetarian and omnivore adolescents" (Greene-Finestone

et al., 2008, p.106). Despite the importance of nutritional research in this population, House et al. (2006) reported that there was a relative lack of literature on the diet of post-secondary students. They specifically noted that the literature showed quantitative analysis of student diet only in the USA. The need for more Canadian research on this topic was indicated.

American Prevalence. Data on the prevalence of vegetarianism among adults in the USA came from a joint paper by the American Dietetic Association and Dieticians of Canada (2003) in which the prevalence rate was estimated to be 2.5%, lower than the rate of 4.0% established for Canada. Perry et al. (2002) looked at 4,746 American adolescents in high school, with an approximately equal number of female and male participants and found that 5.8% reported as vegetarian, which was slightly higher than Greene-Finestone et al.'s 2008 rate of 4.0% among Canadian Grade nine students and higher than the estimated national rate of 2.5% (American Dietetic Association and Dieticians of Canada, 2003). Of these vegetarians, 74% were female, which represented a significant gender difference and confirmed the same gender difference found in other studies (Bedford & Barr, 2005; American Dietetic Association and Dieticians of Canada, 2003). In terms of significant differences in ethno-cultural background, Perry et al. found that Asian high-school students were more likely to be vegetarian than either Caucasian or African-American students and that African-American students were the least likely to be vegetarian.

Adams et al. (2008) reported that there was a relative lack of literature on the diet of post-secondary students in the United States. Data on the prevalence of vegetarianism in this population was obtained from Spencer et al. (2007), who sent out surveys to medical students

(n= 1,849) at three different points in the curricula of 16 American medical schools students. Of these, 857 students participated at all three time points. Self-identified 'vegetarian' and 'vegan' status was measured and cross-referenced with self-reports of meat intake on the FFQ. Their study found a self-identified rate of vegetarianism of 7.2% and a rate of 4.0% calculated from those who specifically reported "never eating meat, fish or fowl" (Spencer et al., 2007, p.76). Both of these rates were higher than the national average of 2.5% (American Dietetic Association and Dieticians of Canada, 2003). With an approximately equal number of female and male participants, Spencer et al. found a gender difference similar to that of Bedford & Barr (2005); women were significantly more likely to be vegetarian than men (10% versus 5%, p. 73). Spencer et al. also found a significant racial difference, although it did not correspond directly with Perry et al.'s (2002) findings that Asian students were most likely to be vegetarian and Black students least likely to be vegetarian. Rather, 6.0% of White students self-reported as vegetarian, 7.7% of Hispanic/other students, 8.8% of Black students and 10.3% of Asian students.

Prevalence In Other Developed Countries. Because of the sparseness of data on prevalence rates of vegetarianism in North America, a search for similar data in other developed countries was undertaken, to provide corroboration. Vinnari, Montonen, Harkanen, & Mannisto (2008) recruited 24,393 participants in a nationwide survey in Finland and found a total self-reported prevalence rate of vegetarianism of 3.3%. In their examination of vegetarianism among post-secondary students in Lithuania, Skemiene et al. (2007) looked at first and third-year medical students. Surveys were sent out to 349 students, with the dietary categories of lacto-vegetarian,

ovo-lacto-vegetarian, vegan, not vegetarian and "semi-vegetarian", which was not explicitly defined. They found a total prevalence of 8.7% among the students, with 10.5% of females and 4.1% of males reporting as 'vegetarian', a status which included those who reported as 'semi-vegetarian'. Excluding 'semi-vegetarians' resulted in a total vegetarian prevalence of 3.0%. Women were found to be vegetarian significantly more often than men throughout.

Overview of Study

This study measured the diet of students in the Aramark residence cafeteria at Lakehead University, a buffet-style cafeteria that offers students open and ample access to foods from each of the food groups. This included grains such as bagels, breads, pasta, rice, oatmeal, and cereal, dairy products such as milk, cheese, yoghurt, ice cream, and butter, fruits and vegetables served raw, stir-fried vegetables, fruit desserts and fruit juice, and meat and alternatives such as pork, beef, fish, chicken, soy products, beans and lentils (Aramark, 2008). Members of the Aramark meal plan eat three meals per day at this cafeteria. Other students also occasionally eat some meals at this cafeteria.

Food Frequency Questionnaire

This study used a food frequency questionnaire (FFQ) to anonymously examine post-secondary students' food intake. The FFQ used in this study was an adaptation of the FFQ used by Spencer et al. (2007), modified to include questions about all food groups from the Canada Food Guide, with descriptions of serving sizes derived from the Canada Food Guide. According to Willet and Hu (2007), the FFQ has a low cost, requires relatively little participant burden compared to other forms of dietary report and has a "proven record of construct and predictive validity", even when compared to diet records of up to one week (p.183).

A 24-hr recall was chosen for this study rather than 48-hr (two-day), seven-day, monthly or longer recalls. Due to its relative brevity, this FFQ minimized respondent burden. Spencer, Elon, Hertzberg, Stein, and Frank (2005) pointed out that brief measures such as this represent a

smaller burden on the researcher and respondent and are also easier to analyze than full-length (50+ question) FFQs. Kim and Holowaty (2003) went further, stating that the validity of brief FFQs, "can be applied for dietary interventions in epidemiological studies" (p. 440). In their review of FFQs, Kim and Holowaty (2003) found that studies used a variety of FFQs and examined the validity and reliability of ten separate, brief FFQs. They did not report systematic significant differences in validity or reliability of FFQs with respect to their length, which varied from 24-hr to one-year. Improved validity was reported as stemming from techniques such as the incorporation of portion sizes in the surveys.

The FFQ for this study (Appendix 2) was designed to assess the intake of food groups from the Canada Food Guide (Katamay et al., 2007). Unfortunately, the available literature did not provide an appropriate questionnaire to be used for this population. Although Spencer et al. (2007) examined fruit and vegetable consumption, they measured total fruit and vegetable consumption using a summation of results from 40 separate food and beverage items, which was not possible in a brief FFQ. Also, Spencer et al.'s 2007 survey was administered at three separate time points and their study was part of an earlier study (Frank, 2004). Given that the population for this study had not been approached before and given the length of Spencer et al.'s 2007 FFQ, the FFQ for this study was designed to be shorter, to ensure sufficient participant response rate (Kim & Holowaty, 2003). Traynor et al. (2006) measured only fruit and vegetable consumption as well, but did so with an FFQ by phone interview, not a paper survey. Papadaki, Hondros, Scott & Kapsokefalou (2007) used an FFQ that was self-administered, but once again was too detailed for purposes of this study, using 49 separate measure of food intake. Because this was a

pilot study, the adapted FFQ was simplified in its application. It was not administered at several time points and it did not measure individual food and beverage items within food groups.

The categories chosen for the questionnaire used in the current study reflect the food groups of the Canada Food Guide (Katamay et al., 2007). Baldini, Pasqui, Bordoni, & Maranesi (2007) used nearly the same methodology in dividing their FFQ questions, with the addition of a fifth group for oils and butter. In order to maximize validity (Kim & Holowaty, 2003), serving sizes taken from the Canada Food Guide were defined on the surveys (Appendix 2), which allowed responses to be compared according to the recommended daily intake levels. The inclusion of food groups beyond fruits and vegetables allowed for further analyses of dietary differences between vegetarians and non-vegetarians, by gender, by ethno-cultural background and by membership on the Aramark meal plan. However, the primary focus in terms of food groups was fruits and vegetables and this is justified by Spencer et al., (2007) who noted that the intake of fruits and vegetables correlated higher with estimates of food recall than other food types, justifying their choice to only analyze fruit and vegetable data. The scale for responses was based on Spencer et al. (2007).

Demographics

In addition to the FFQ, this study measured demographic variables found to be important in the literature (Baldini et al., 2007; Papadaki et al., 2007; Skemiene et al., 2007 & Spencer et al., 2007). Body-mass index was calculated from height and weight data. It was expected to be a significant predictor of vegetarianism, as Spencer et al. (2007) found that students with a BMI of

less than 25 (i.e., non-overweight BMI) tended to be vegetarian more often than other students. Baldini et al. (2007) also found that vegetable intake was significantly negatively correlated to BMI. Gender was expected to be a significant predictor of vegetarianism as well, with Spencer et al. (2007) finding that females tend to be vegetarian more often than men. A similar finding by Baldini et al. (2007) showed that female undergraduate students tended to eat more fruits and vegetables than males in a population of Italian and Spanish post-secondary students. Spencer et al. (2005) indicated that there may be a possible skewing effect of pregnant and lactating women and advised that they be analyzed separately.

Ethno-cultural background was found to be an important variable in terms of rates of vegetarianism (Perry et al., 2002; Spencer et al., 2007) and in terms of fruit and vegetable intake (Serdula et al., 2004). It was anticipated that there may be a confounding effect of ethno-cultural background on FFQ results (Dehghan, et al., 2005; Spencer et al., 2007). However, because this was considered a pilot study, the same FFQ was created and administered to all participants regardless of ethno-cultural background. Tobacco use categories were taken from Spencer (2007) who found a significant predictive effect, as students who used tobacco were less likely to be vegetarians than those who had never used tobacco or had ceased using it.

Vegetarianism

The joint paper of the American Dietetic Association and Dieticians of Canada (2003) stated that individual assessment of a self-reported vegetarian was required due to the variability of vegetarian diets. That is, along with questions about food consumption patterns, questions for

self-identification in categories such as "vegetarian", "vegan", were necessary. The literature showed multiple definitions of 'vegetarianism', which vary by the degree of meat and dairy and or eggs excluded. Although ovo-lacto vegetarianism was the most common definition for 'vegetarian', there was no recognized standard in the literature for categorizing types of vegetarianism. Reasons for vegetarianism was measured as in Spencer et al. (2007), with the same categories (Appendix 2). In their study, Spencer et al. found that the most commonly cited reason for being vegetarian was for health reasons and that these vegetarians ate a slightly higher intake of fruits and vegetables than other vegetarians and were less likely to contradict their self-reported vegetarianism by reporting meat intake in the FFQ.

Methods

Participants

The targeted participants were students of Lakehead University, Thunder Bay, who ate one or more meals at the Aramark residence cafeteria at any time during its hours of operation between Sunday February 1st and Saturday February 7th, 2009 and who provided informed consent to participate. The total number of students on the Aramark residence students' meal plan during this time was 453 (Nick Buragina, Aramark Director, personal communication, 2009). These students eat the majority or all of their meals at the Aramark residence cafeteria. An unknown number of students who were not on the meal plan also ate at the residence cafeteria and were included and identified on the survey. Students who ate at this cafeteria were selected for their expected homogeneity in terms of exposure to environmental differences in diet, via a shared eating environment and food options.

Sampling and Projected Response Rates. The expected response rate for the survey was estimated from data on previous self-administered FFQ surveys among post-secondary students, which indicated a response rate of 21% as a reasonable estimate for this survey (Baldini et al., 2007; Spencer et al., 2005). Kielhofner (2006) stated that survey response rates could vary widely and there was "no agreed upon minimum for an acceptable response rate" (p. 105). Czaja and Blair (2004) offered typical response rates for different types of surveys: 45% for mailed surveys, 60% for telephone surveys and 65% or more for face-to-face interviews. Self-administered surveys were not listed however. A response rate of 21% from the population of

453 meal plan students would result in an estimated sample size of 95. Because it was not known how many non-meal plan students eat at the cafeteria, it was not possible to estimate the sample size for this group.

Procedure

Copies of a poster (Appendix 5) were posted outside the entrance of the residence cafeteria next to where students line up to enter as well as on the bulletin board inside the cafeteria. Copies were posted from January 25th until February 7th 2009, advertising the advent of the study period and highlighting the low respondent-burden of the survey. According to Aramark policy, when students enter the cafeteria they must either present their meal plan card to a cafeteria worker to swipe, or pay them in cash in order to enter. At this time students were handed a survey by the researcher and invited to take part in the study. Pencils were available as they entered the cafeteria. It was verbally indicated that surveys were to be filled out once per person. Surveys were stapled with the cover letter (Appendix 3) on top, followed by the consent form (Appendix 4) and then the questionnaire. No envelopes were used. Students completed this survey before, during or after their meal. Completing the survey took between three to five minutes. Students were instructed to drop the completed surveys off in a conspicuous box at the exit of the cafeteria to be collected by the researcher afterwards. Unused surveys left on the tables after meal times were collected by the researcher to be reused.

Measures

The FFQ used in this study (Appendix 2) included six questions, one each for the four food groups of the Canada Food Guide and separate questions for fruit, vegetables, meat and meat alternatives. The questionnaire was inspired by Spencer et al.'s (2007), utilizing the same scale, but did not measure individual food items within fruit and vegetable intake and did not measure food intake at three different time periods. Rather, it was a simplified inventory based on the Canada Food Guide that asked global questions for each food group. Answers for the FFQ used in this study were in categorical rather than in open-ended form. Sierles (2003) indicated that survey questions in categorical form helped to eliminate answers such as "I don't know", which would otherwise be over-represented (p.108). Furthermore, Skemiene et al. (2007) Papadaki et al. (2007) and Spencer et al. (2007) all exclusively used categorical data in the FFQ sections of their surveys. Traynor et al.'s format (2006) allowed them to pose open-ended questions on food consumption because surveys were administered by interviewers trained to follow-up on unclear responses. Inclusion of serving sizes was modeled after Traynor et al. (2006) and the description of the serving sizes were based on those in the Canada Food Guide (Health Canada, 2007).

Fruit Intake. One item was used to measure fruit intake: "How many servings of fruits have you eaten in the past 24 hours? (Circle an answer)". On a separate line below this, serving sizes were defined: "(1 serving = ½ cup (125 g) of fresh / frozen / canned fruit, or one fruit, or 125 ml (½ cup) of fruit juice.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Vegetable Intake. One item was used to measure vegetable intake: "How many servings of vegetables do you typically eat per day? (Circle an answer)". On a separate line below this,

serving sizes were defined: "(1 serving = ½ cup (125 g) of fresh / frozen / canned vegetables, ½ cup (125 g) of cooked vegetables, 1 cup (250 g) of raw leafy vegetables, 125 ml (½ cup) of vegetable soup or 125 ml (½ cup) of vegetable juice.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Grain Intake. One item was used to measure grain intake: "How many servings of grain and grain products do you typically eat per day? (Circle an answer)". On a separate line below this, serving sizes were defined: "(1 serving = 1 slice of bread, ½ a bagel, ½ a pita or tortilla, ¾ cup (175 g) of cereal or oatmeal, ½ cup (125 g) of rice, quinoa or bulgur wheat, etc, or ½ cup (125 g) of pasta.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Meat Intake. One item was used to measure meat intake: "How many servings of meat do you typically eat per day? (Circle an answer)". On a separate line below this, serving sizes were defined: "(1 serving = 75 g / 2.5 oz / ½ cup (125 g) of poultry, cooked fish, shellfish, or lean meat.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Meat Alternatives Intake. One item was used to measure meat alternatives intake: "How many servings of meat alternatives do you typically eat per day? (Circle an answer)". On a separate line below this, serving sizes were defined: "(1 serving = 150g (175 ml or ¾ cup) of tofu, 2 eggs, 30 ml (2 Tbsp.) of peanut or nut butter, ¾ cup (175 g) of cooked legumes (beans, lentils, chick peas, etc), or 60 ml (¼ cup) of shelled nuts or seeds.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Dairy Intake. One item was used to measure dairy intake: "How many servings of dairy products do you typically eat per day? (Circle an answer)". On a separate line below this, serving sizes were defined: "(1 serving = 250 ml (1 cup) of milk / fortified soy milk, 175g (¾ cup) of

yogurt, or 50g (1.5oz) of cheese.)". Below this, a scale of "0, 1, 2, 3, 4, 5, 6 or more" was presented.

Demographics. Demographic variables were included on the survey: gender (male/female), pregnant or lactating status (yes/no), age, tobacco use status (never used tobacco/used tobacco but stopped/using tobacco), home community, height, weight, ethno-cultural background (White or Caucasian/East or Southeast Asian/West Asian or Arab/South Asian/Latin American/Black, Caribbean-Canadian or African-Canadian/North American Aboriginal/Other) and academic department of study (Business Administration/Education/Engineering/Forestry/Graduate Studies/Health and Behavioural Sciences/Northern Ontario School of Medicine/Science and Environmental Studies/Social Sciences and Humanities/Other). Body-Mass Index (BMI) was calculated (Ianelli, 2008) from the height and weight data, according to the formula: BMI = (weight in pounds x 703) / (height in inches)^2. The list of ethno-cultural backgrounds was based on the Canadian Community Health Survey (Beland, 2002). Departments of study were obtained from the Lakehead University website (Lakehead University, 2003). Home community was an exploratory variable included to better describe the population.

Meal Plan. Meal plan questions included: being on the residence students' meal plan (yes/no) and length of time on the residence students' meal plan. These variables were considered important because members of the meal plan eat all of their meals in this cafeteria, whereas other participants do not. The number of participants on the meal plan allowed for the calculation of a response rate for this group.

Vegetarianism. Variables regarding vegetarianism were included on the survey. Type of diet was assessed with a choice between ovo-lacto vegetarian (excludes meat, but includes eggs and

dairy products), lacto-vegetarian (excludes meat and eggs, but includes dairy products), ovo-vegetarian (excludes meat and dairy products, but includes eggs), pesco-vegetarian (excludes meat except for fish, may or may not include eggs or dairy), vegan (excludes meat, excludes dairy products and excludes eggs) and none of the above. Five of these categories were drawn from the literature (Greene-Finestone et al., 2008, Skemiene et al., 2007, Spencer et al., 2007), with the addition of 'pesco-vegetarian' due to evidence of some vegetarians reporting occasional fish or seafood intake (Bedford & Barr, 2005).

Respondents who indicated they were vegetarian were asked to answer additional questions about length of time as a vegetarian (in months and years), having vegetarians in the immediate family (yes/no) and the primary reasons for their dietary choice ("check all that apply": health-related choice/ethical or animal welfare concerns/taste/religious reasons/weight control/other). Length of time as a vegetarian and having vegetarians in the family were not found in the literature; these exploratory variables were included based on the idea that they may offer some predictive value on overall diet.

Ethics

This study received ethical approval from the Lakehead University Ethics Committee. Participants provided informed consent to participate by signing the consent form, after reading the cover letter provided with the survey.

Data Analyses

All gathered data were considered for analysis. Surveys with missing data were included as well. Categorical variables (gender, ethno-cultural background, department of study, pregnant/lactating status, membership on the Aramark meal plan, tobacco use status, type of diet, having vegetarians in the family and reason for diet) were assigned a numerical value to allow for data analysis and then entered into the SPSS Data Builder Program. As the data from each survey were entered, the hard copy was marked to indicate that it was entered. Frequency distributions (for categorical variables) and measures of central tendency (for continuous variables) were run on the data set to check for outlier data, out of range data, missing data and errors in data entry. Data points 3 or more standard deviations from the mean would indicate probable outliers (Freedman, Pisani & Purves, 1979). Errors were corrected and a log of all errors was kept.

Primary Outcomes. To answer the primary research question regarding the daily intake levels of fruits and vegetables in this population, tables of descriptive statistics were compiled for comparison of data by gender, type of diet and ethno-cultural background. To answer the primary research question regarding vegetarianism, a descriptive table was compiled, including the calculated prevalence rate of vegetarianism. Independent t-tests were conducted to detect potential differences in gender, weight and BMI between vegetarians and non-vegetarians. As part of the primary outcomes, one planned forced-entry multiple regression was performed to measure the strength of association of a number of variables on fruit and vegetable intake.

An a priori power analysis for multiple regression was performed using an online calculator (Daniel S. Soper, 2008). For a multiple regression analysis with a confidence level of 95% (or alpha level of 0.05), six independent variables, desired statistical power of 0.8 and anticipated effect size (f^2) of 0.15, the minimum sample size was calculated to be 97. An f^2 value of 0.15 represents a medium effect size and 0.8 was considered the minimum standard for statistical power of a regression analysis (Osborne & Waters, 2002). No f^2 scores were found in diet studies in the literature. Therefore this power analysis was taken on its own as a rough estimate of the necessary sample size for a medium-sized effect. For this expected sample size, the number of independent variables for a multiple regression analysis was limited to six. Regression analyses on fruit and vegetable intake among post-secondary students were not found in the literature. Independent variables were therefore chosen based on significant correlations and/or significant t-test findings in the literature: age (Serdula et al., 2004), tobacco use (smoker versus non-smoker, Palaniappan, 2001; Spencer et al., 2007), type of diet (vegetarian versus non-vegetarian, Spencer et al., 2007), BMI score (Berkow, S.E. & Barnard, 2006; Brunt et al., 2008), gender (Garriguet, 2007; Serdula et al., 2004; Spencer et al., 2007) and ethno-cultural background (Caucasian versus non-Caucasian, Serdula et al., 2004). In order to prevent over-fitting, the number of independent variables was restricted to no more than one per 15 participants in the analysis, based on Babyak (2004). Other steps to avoid over-fitting of the regression model included requiring all variables to have a maximum of 10% missing data and independent variables were required to have tolerance scores > 0.80 in order to prevent collinearity with other variables in the model.

Secondary Outcomes. To supplement the primary outcomes, independent t-tests were conducted to determine whether fruit intake, vegetable intake and fruit and vegetable intake by gender, ethno-cultural background and type of diet were significantly different. This totaled nine analyses and therefore the decision was made to make a Bonferroni adjustment to control family-wide Type I error (Sankoh, Huque & Dubey, 1997). With nine analyses and a mean correlation of 0.73 between outcome variables, a corrected alpha of 0.027 was set as the alpha for each test of the secondary outcomes (SISA, 1998).

Exploratory Outcomes. This study conducted a number of exploratory analyses. Independent t-tests were conducted to determine whether the intake of grains, dairy, meat and alternatives, meat alternatives and meat by gender, ethno-cultural background and type of diet were significantly different. T-tests were also conducted to determine if food intake of any of the food groups by membership on the meal plan were significantly different. As well, bivariate correlations were calculated between all of the dependent and independent variables of the regression models and a table of bivariate correlations was compiled. Three post-hoc regression analyses were also conducted to further understand the data build on the results from the primary outcome regression. Two of the post-hoc analyses were variations on the original regression analysis and the third post-hoc explored two additional variables.

The first post-hoc regression analysis was a forced-entry analysis that kept the same independent variables as the planned regression analysis and changed the dependent variable to vegetable intake, because fruit intake appeared to be relatively unchanging across gender and ethno-cultural background, two of the strongest expected independent variables in the model.

The second post-hoc regression was a hierarchical regression analysis with the same variables as the first post-hoc, but with the six independent variables entered on three steps. The independent variables of BMI, ethno-cultural background, gender and age were entered in the first step of analysis, as they were expected to be especially relevant predictors of vegetable intake (Serdula et al., 2004; Skemiene et al., 2007; Spencer et al., 2007). Type of diet was also expected to be a strong predictor of vegetable intake (Spencer et al., 2007), however it was entered in the second step in case it was overlapping with some of the variance in vegetable intake supplied by the gender variable. Tobacco use status was expected to be a predictor of vegetable intake (Palaniappan, 2001; Spencer et al., 2007), however it was not expected to be as strong a predictor as the other independent variables so it was entered in the third step. The third post-hoc regression analysis was a forced-entry regression that kept the same variables as the original primary outcome regression analysis and added two independent variables: main reason for diet (health-reasons versus other reasons, Spencer et al., 2007) and having vegetarians in the family, which was an exploratory variable added because it was believed that it may help to predict fruit and vegetable intake. Fruit and vegetable intake was chosen as the dependent variable instead of vegetable intake to stay consistent with the original objectives of the study and to build on the primary outcome regression.

Adding up all of the exploratory t-tests, regression analyses and each correlation analysis in the 8x8 model, a total of 62 exploratory analyses were conducted. Because of this, it is possible that the family-wide Type I error for the exploratory analyses was increased. These analyses were included to increase the understanding of relationships between variables relating to food

intake and were considered exploratory only. Their results must therefore be treated with caution.

Results

Response Rate

A total of 267 students filled out surveys. Of the 453 students on the meal plan, 197 participated in this study (Table 1). This was a response rate of approximately 43%. The response rate for other students was not known, because the total number of non-meal plan students who ate at this cafeteria was unknown. Also, the total number of surveys distributed was not tracked, so the overall response rate could not calculated.

Participants

Slightly more males than females participated (Table 1). The mean age of the sample was 21 ± 3 years. Excluding missing values (8/267), 24% of participants (62/259) came from communities in North-Western Ontario as defined by the North-West Local Health Integration Network (LHIN), where Lakehead University is located. The majority, 76% (197/259) came from other communities in Ontario, Canada or internationally. In terms of ethno-cultural background, 84% of the sample self-identified as "White or Caucasian". Students were drawn from a variety of faculties, with students from education the most common discipline (30%). The mean BMI of participants was 24 ± 4 and 8% were current smokers (N = 20).

Table 1. *Demographics*

Variables	All N = 267	Vegetarian N = 18	Non-vegetarian N = 249
Female, *% (n)*	43% (116)	78% (14)**	41% (102)**
Age[1], *Mean ± SD, (Range)*	21 ± 3 (18-37)	20 ± 2 (18-28)	21 ± 4 (18-37)
Height (inches)[2], *Mean ± SD, (Range)*	69 ± 4 (54-79)	67 ± 3 (62-72)	69 ± 4 (54-79)
Female	66 ± 3 (54-73)	66 ± 2 (62-69)	66 ± 3 (54-73)
Male	71 ± 3 (57-79)	70 ± 1 (69-72)	71 ± 3 (57-79)
Weight (pounds)[3], *Mean ± SD, (Range)*	164 ± 37 (100-300)	140 ± 29 (138)**	166 ± 38 (195)**
Female	145 ± 30 (100-300)	131 ± 15 (100-155)	147 ± 31 (105-300)
Male	177 ± 36 (125-300)	169 ± 47 (135-238)	178 ± 36 (125-300)
Body-Mass Index (BMI)†[4], *Mean ± SD, (Range)*	24 ± 4 (16-39)	22 ± 4 (16)*	25 ± 4 (18-39)*
Female	24 ± 4 (16-32)	21 ± 3 (16-27)	24 ± 5 (20-32)
Male	25 ± 4 (18-39)	24 ± 6 (20-32)	25 ± 4 (18-39)
Tobacco Use, *% (n)*			
Current smoker	8% (20)	0% (0)	8% (20)
On the Aramark Meal Plan[1], *% (n)*	74% (197)	83% (15)	68% (182)
Home Community[5 6], *% (n)*			
Thunder Bay	5% (14)	6% (1)	5% (13)
Other in North-West LHIN	19% (48)	6% (1)	20% (47)
Not in North-West LHIN	76% (197)	89% (16)	75% (181)
Ethnic Background[6], *% (n)*			
White or Caucasian	80% (215)	94% (17)	80% (198)
East or Southeast Asian	6% (15)	0% (0)	6% (15)
Multiple ethnicities/cultural backgrounds	4% (10)	0% (0)	4% (10)
Latin American	3% (9)	0% (0)	4% (9)
Black, Caribbean- or African-Canadian	3% (7)	0% (0)	3% (7)
West Asian or Arab	2% (5)	6% (1)	2% (4)
South Asian	1% (2)	0% (0)	1% (2)
North American Aboriginal	1% (2)	0% (0)	1% (2)
Other	1% (2)	0% (0)	1% (2)
Faculties of Study[1], *% (n)*			
Education	30% (79)	39% (7)	29% (72)
Engineering	15% (39)	17% (3)	14% (36)
Other	14% (37)	11% (2)	14% (35)
Social Sciences & Humanities	13% (34)	17% (3)	12% (31)
Science & Environmental Studies	11% (29)	6% (1)	11% (28)
Business Administration	8% (20)	0% (0)	8% (20)
Health & Behavioural Sciences	8% (20)	6% (1)	8% (19)
Forestry	3% (8)	6% (1)	3% (7)

* p < 0 05, ** p < 0 01

[1] N = 266 for these variables [2] N = 265 for this variable [3] N = 252 for this variable [4] N = 250 for this variable [5] N = 259 for this variable

[6] Due to rounding, percentages may not sum to 100%

† Body-Mass Index is calculated according to the formula BMI = (weight in pounds x 703) / (height in inches)^2

Vegetarianism

Approximately 7% of the sample (18/267) self-reported as vegetarian. Although the sample size was too small to test this statistically, there were more female vegetarians (78%, 14/18) than males, compared to 43% (116/267) of the entire sample being female. The average age of vegetarians in this sample was 20 ± 2 years (Table 1). None of the vegetarians were smokers and demographic data tended to be similar to the overall sample, with the notable exception of weight and body-mass index (BMI). Overall mean weight for vegetarians was 140 ± 29 pounds, significantly lower ($p < 0.01$) than 166 ± 38, the mean weight of non-vegetarians (Table 1). Mean BMI for vegetarians was 22 ± 4, significantly lower than the mean BMI score for non-vegetarians of 25 ± 4 ($p < 0.05$). Comparisons of weight and BMI between vegetarians and non-vegetarians were biased however, as weight and BMI were not controlled for gender and 78% (14/18) of vegetarians were female.

Of the 18 vegetarians in the sample, the majority (13) were ovo-lacto vegetarians, three were pesco-vegetarians and two were vegans (Table 2). The mean length of time as a vegetarian was 22 ± 27 months and reasons for vegetarianism were varied: of the reasons provided by the 18 vegetarian participants, the two most prevalent were ethical/animal welfare concerns, representing 27% of responses and taste and health-related reasons, representing 19% of responses. Of these vegetarians, 28% reported having vegetarians in their family.

Table 2. *Vegetarian Diets, Reasons for Diet and Vegetarians in the Family, by Gender*

Variables	Total, N=18		Female, N=14		Male, N=4	
	%	n	%	n	%	n
Ovo-lacto vegetarianism, *% (n)*	72%	13	79%	11	50%	2
Pesco-vegetarianism	17%	3	14%	2	25%	1
Vegan	11%	2	7%	1	25%	1
Ovo-vegetarianism	0%	0	0%	0	0%	0
Lacto-vegetarianism	0%	0	0%	0	0%	0
Reasons for diet[1]						
Ethical/animal welfare concerns	27%	7	33%	7	0%	0
Multiple reasons for diet	28%	5	29%	4	25%	1
Health, ethical and taste	6%	1	7%	1	0%	0
Health, ethical and other	6%	1	7%	1	0%	0
Health, taste and weight control	6%	1	7%	1	0%	0
Health and weight control	6%	1	0%	0	25%	0
Taste and religious reasons	6%	1	7%	1	0%	0
Taste	19%	5	19%	4	20%	1
Health-related choice	19%	5	19%	4	20%	1
Other[2]	15%	4	14%	3	20%	1
Religious reasons	8%	2	5%	1	20%	1
Weight control	8%	2	5%	1	20%	1
No reason given	4%	1	5%	1	0%	0
Vegetarians in the family[3]	28%	5	29%	4	25%	1

[1] n for this section is greater than 18 and percentages do not add to 100%, as each of the multiple reasons for diet were tallied separately

[2] Two of the four participants who listed 'other', specified 'environmental' as their reason for diet Two others listed no reason

[3] N = 17 for this variable N = 3 for males for this variable

Daily Intake of the Food Groups

The overall consumption of combined fruits and vegetables had a mean of 4.8 ± 2.2 servings per day (Table 3). From this, approximately 2.6 servings were of vegetables and 2.1 servings were of fruit. The mean intake of grains was 3.6 ± 1.4 servings. Mean dairy intake was 2.9 ± 1.6 servings. Mean intake of meat and meat alternatives was 3.9 ± 2.1 servings, comprised of approximately 2.4 servings of meat and 1.6 servings of meat alternatives.

Daily Food Intake by Gender. Food intake was significantly different between the genders for three food groups, vegetables, meat and alternatives and meat (Table 3). Females consumed significantly more vegetables than males, $t(265)= 2.66$, $p= 0.008$ and males consumed significantly more meat and alternatives, $t(264)= 5.10$, $p= 0.003$ and significantly more meat, $t(264)= 6.37$, $p< 0.001$ than females. Of the females in the sample, 44% reported consuming less than 5 servings of fruits and vegetables per day, as did 54% of males.

Table 3. *Mean Servings per Day of Food Groups by Gender*

Food Groups	All, N = 267 M ± SD (Range) [Mode]	Female, N = 116 M ± SD (Range) [Mode]	Male, N = 151 M ± SD (Range) [Mode]
Fruits & Vegetables	4.8 ± 2.2 (0-12) [4]	5.0 ± 2.3 (0-12) [5]	4.6 ± 2.1 (0-12) [4]
Fruits	2.1 ± 1.3 (0-6) [2]	2.2 ± 1.4 (0-6) [1, 2]	2.1 ± 1.3 (0-6) [2]
Vegetables	2.6 ± 1.3 (0-6) [3]	2.9 ± 1.4 (0-6) [3]*	2.5 ± 1.2 (0-6) [2]*
Grains	3.6 ± 1.4 (0-6) [4]	3.7 ± 1.3 (1-6) [4]	3.6 ± 1.4 (0-6) [3][1]
Dairy	2.9 ± 1.6 (0-6) [3]	2.9 ± 1.5 (0-6) [2]	3.0 ± 1.7 (0-6) [1][1]
Meat & Meat alternatives	3.9 ± 2.1 (0-12) [4]	3.2 ± 1.6 (0-8) [4]**[2]	4.5 ± 2.2 (0-12) [3]**
Meat	2.4 ± 1.4 (0-6) [2]	1.8 ± 1.2 (0-6) [2]**[2]	2.8 ± 1.4 (0-6) [2]**
Meat alternatives	1.6 ± 1.1 (0-6) [1]	1.4 ± 1.0 (0-5) [1]	1.7 ± 1.2 (0-6) [1]

* $p < 0.01$.
** $p < 0.001$.
[1] N = 150 for these variables.
[2] N = 115 for these variables.

Daily Food Intake by Meal-plan Participants and Other Students. Food intake was significantly different between students on the meal plan and those not on the meal plan for one food group, dairy (Table 4). Meal plan students ate significantly more dairy than non-meal plan students, $t(263)= 3.68$, $p< 0.001$.

Table 4 *Mean Servings per Day of Food Groups by Membership on the Aramark Meal Plan*

Food Groups	On the Meal Plan, N = 197 M ± SD (Range) [Mode]	Not on the Meal Plan, N = 69 M ± SD (Range) [Mode]
Fruits & Vegetables	4 9 ± 2 2 (0-12) [5]	4 4 ± 2 4 (1-12) [4]
Fruits	2 2 ± 1 3 (0-6) [2]	2 0 ± 1 4 (0-6) [2]
Vegetables	2 7 ± 1 3 (0-6) [3]	2 4 ± 1 2 (0-6) [3]
Grains	3 7 ± 1 3 (1-6) [4][1]	3 4 ± 1 4 (0-6) [4]
Dairy	3 2 ± 1 6 (0-6) [3]*[1]	2 3 ± 1 4 (0-6) [3]*
Meat & Meat alternatives	3 9 ± 2 1 (0-12) [3]	3 9 ± 1 8 (0-12) [3][2]
Meat	2 4 ± 1 4 (0-6) [2]	2 4 ± 1 3 (0-6) [2][2]
Meat alternatives	1 6 ± 1 2 (0-6) [1]	1 5 ± 1 0 (0-6) [1]

* $p < 0\ 001$
[1] N = 196 for these variables
[2] N = 68 for these variables

Daily Food Intake by Ethno-cultural Background Food intake was significantly different between Caucasians and non-Caucasians for four food groups, vegetables, fruits and vegetables, grains and dairy (Table 5) Caucasians ate significantly more vegetables $t(265)= 3\ 19$, $p= 0\ 02$, fruits and vegetables $t(265)= 2\ 59$, $p= 0\ 01$, grain $t(264)= 4\ 81$, $p< 0\ 001$ and dairy $t(264)= 2\ 82$, $p= 0\ 005$ than non-Caucasians

Table 5 *Mean Servings per Day of Food Groups by Ethno-cultural Background*

Food Groups	Caucasian, N = 225 M ± SD (Range) [Mode]	Non-Caucasian, N = 42 M ± SD (Range) [Mode]
Fruits & Vegetables	4 9 ± 2 2 (1-12) [4, 5]*	4 4 ± 2 3 (0-9) [4]*
Fruits	2 2 ± 1 3 (0-6) [2]	1 9 ± 1 4 (0-5) [2]
Vegetables	2 7 ± 1 3 (0-6) [3]*	2 1 ± 1 2 (0-4) [1, 2]*
Grains	3 8 ± 1 3 (1-6) [4]**	2 7 ± 1 3 (0-6) [2]**[2]
Dairy	3 1 ± 1 6 (0-6) [3]*[1]	2 3 ± 1 7 (0-6) [1]*
Meat & Meat alternatives	3 9 ± 2 0 (0-12) [4][1]	4 2 ± 2 2 (0-9) [3]
Meat	2 4 ± 1 4 (0-6) [2][1]	2 4 ± 1 4 (0-5) [2]
Meat alternatives	1 5 ± 1 1 (0-6) [1]	1 8 ± 1 2 (0-4) [1]

* $p < 0\ 01$
** $p < 0\ 001$
[1] N = 224 for these variables
[2] N = 41 for this variable

Daily Food Intake By Type of Diet. Food intake was significantly different between vegetarians and non-vegetarians for three food groups, vegetables, meat and meat and alternatives (Table 6). Vegetarians ate significantly more vegetables than non-vegetarians $t(265)= 2.62$, $p= 0.009$. Non-vegetarians ate significantly more meat than vegetarians $t(264)= 5.65$, $p< 0.001$ and significantly more meat and meat alternatives $t(264)= 4.09$, $p< 0.001$.

Table 6. *Mean Servings per Day of Food Groups by Type of Diet*

Food Groups	Vegetarian, N = 18 M ± SD (Range) [Mode]	Non-vegetarian, N = 249 M ± SD (Range) [Mode]
Fruits and Vegetables	5.8 ± 2.0 (3-8) [3, 4, 6]	4.7 ± 2.2 (0-12) [4, 5]
Fruits	2.4 ± 1.5 (0-6) [2]	2.1 ± 1.3 (0-6) [2]
Vegetables	3.4 ± 1.4 (1-6) [3]*	2.6 ± 1.2 (0-6) [3]*
Grains	3.2 ± 1.2 (1-5) [4]	3.6 ± 1.4 (0-6) [4][1]
Dairy	2.6 ± 1.4 (0-5) [4]	3.0 ± 1.6 (0-6) [2, 3][1]
Meat and Meat alternatives	2.1 ± 1.4 (0-6) [1]**	4.1 ± 2.0 (0-12) [4]**[1]
Meat	0.7 ± 1.1 (0-3) [0]**[2]	2.5 ± 1.3 (0-6) [2]**[1]
Meat alternatives	1.4 ± 0.8 (0-3) [1]	1.6 ± 1.2 (0-6) [1]

* p < 0 01
** p < 0 001
[1] N= 248 for these variables
[2] n b In terms of meat intake, six of the 18 vegetarians in the sample reported eating one or more servings of meat per day, which runs contrary to the definition of vegetarianism This may have been partly due to fish intake However, only three of the 18 reported as pesco-vegetarians

Correlations

Bivariate correlations were calculated between all of the dependent and independent variables of the regression models (Table 7). Fruit and vegetable intake significantly correlated with type of diet, ethno-cultural background, reason for diet and vegetarians in the family, with higher fruit and vegetable intake for vegetarian diets, Caucasian ethnicity, choosing a diet for health reasons and having vegetarians in the family. Vegetable intake significantly correlated with gender,

ethno-cultural background, reason for diet and vegetarians in the family, with higher vegetable intake for the female gender, Caucasian ethnicity, choosing a diet for health reasons and having vegetarians in the family. Gender correlated significantly with type of diet, ethno-cultural background, tobacco use and BMI, with being female associated with having a vegetarian diet, Caucasian ethnicity, lower tobacco use and lower BMI scores. Age was significantly correlated with gender, ethno-cultural background, BMI and vegetarians in the family, with increased age associated with the male gender, non-Caucasian ethnicities, higher BMI scores and not having vegetarians in the family. Vegetarian diets significantly correlated with vegetarians in the family and BMI, with vegetarianism increased with having vegetarians in the family and lower BMI scores.

Table 7 *Table of Correlations*

		Veg Intake	Fruit &Veg Intake	Age	Gender	Tob Use	Type of Diet	BMI	Ethno-Cultural Bckgrd	Family Veg [1]	Reason For Diet[1]
Vegetable Intake	Pearson Correlation	1									
	Significance (2-tailed)	-									
	N	267									
Fruit & Vegetable Intake	Pearson Correlation	850**	1								
	Sig (2-tailed)	< 001	-								
	N	267	267								
Age	Pearson Correlation	- 015	- 041	1							
	Sig (2-tailed)	811	508	-							
	N	266	266	266							
Gender	Correlation	161**	102	300	1						
	Sig (2-tailed)	008	097	< 001	-						
	N	267	267	266	267						
Tobacco Use	Correlation	- 053	- 002	110	- 135*	1					
	Sig (2-tailed)	389	974	074	028	-					
	N	267	267	266	267	267					
Type of Diet	Correlation	- 159	- 122*	054	- 186**	077	1				
	Sig (2-tailed)	009	047	384	002	213	-				
	N	267	267	266	267	267	267				
BMI	Correlation	015	- 008	148*	- 128*	087	139*	1			
	Sig (2-tailed)	813	899	019	044	168	028	-			
	N	250	250	249	250	250	250	250			
Ethno-Cultural Backgrd	Correlation	- 192**	- 157*	191**	- 171**	- 006	075	013	1		
	Sig (2-tailed)	002	010	002	005	926	221	841	-		
	N	267	267	266	267	267	267	250	267		
Family Veg [1]	Correlation	- 173*	- 233*	178*	- 011	041	184	- 129	- 078	1	
	Sig (2-tailed)	042	006	036	898	627	030	143	362	-	
	N	140	140	139	140	140	140	131	140	140	
Reason For Diet[1]	Correlation	- 233*	- 287*	- 148	- 063	091	009	182	042	- 164	1
	Sig (2-tailed)	026	006	165	554	389	933	095	693	152	-
	N	91	91	90	91	91	91	85	91	78	91

* Correlation is significant at the 0 05 level (2-tailed)

** Correlation is significant at the 0 01 level (2-tailed)

[1] Sample sizes for these variables were very low, with 48%- 71% missing data, as these questions on the survey were interpreted by many to be intended only for vegetarians and therefore left blank by many non-vegetarians

Predictors of Fruit and Vegetable Intake

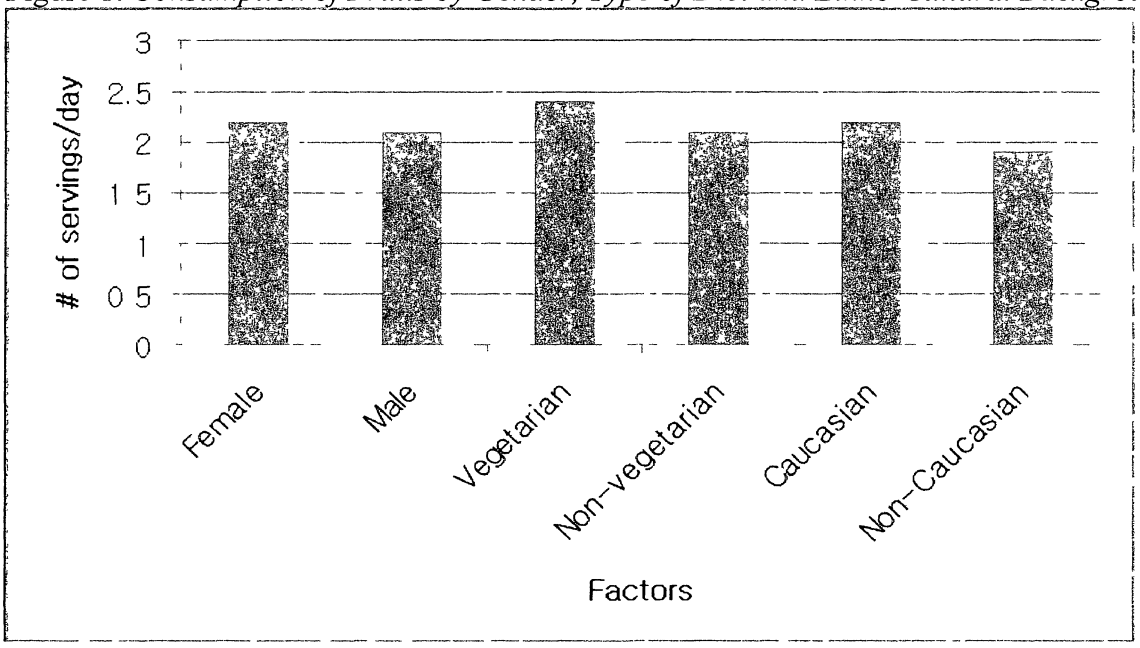
A Priori Regression Analysis of Fruit and Vegetable Intake. A standard forced-entry multiple regression analysis was conducted, with fruit and vegetable combined intake as the dependent variable. The independent variables were age, gender, tobacco use (smoker and non-smoker), type of diet (vegetarian and non-vegetarian), BMI score and ethno-cultural background (Caucasian and non-Caucasian). Six percent (17/267) of participants were excluded due to missing data on one or more independent variables; therefore 250 participants were included in the model. Fruit and vegetable intake was scored by combining the total daily fruit intake and daily vegetable intakes from the survey, resulting in a possible range of intake scores from zero to twelve combined fruit and vegetable servings per day. Despite the statistically significant bivariate correlations, the regression model was not significant, with $F_{6,242} = 1.684$, $p = 0.126$.

Post-hoc Forced-Entry Regression Analysis of Vegetable Intake. A post-hoc forced-entry regression analysis was performed as an exploratory analysis, with the same independent variables as the planned regression analysis (Table 8). The dependent variable was vegetable intake only, because fruit intake (Figure 1) was found to not vary significantly by gender (Table 3) or by type of diet (Table 6). Seven percent (19/267) of participants were excluded due to missing data; 248 participants were included in the model. This model was significant, $F_{6,242}= 2.643$, $p= .017$. In this analysis $R= .248$ and $R^2= .038$, indicating that approximately 3.8% of the variability within vegetable intake was accounted for by the independent variables. Only ethno-cultural background was significant ($\beta = -0.166$, $t_{242}= -2.589$, $p < 0.01$), with a higher mean daily intake of vegetables among Caucasians (2.74 ± 1.27) than non-Caucasians (2.07 ± 1.18).

Table 8. *First Post-Hoc Regression Analysis of Vegetable Intake*

	B	Standard Error	Beta	t	Sig.	R	Adjusted R^2
						.248	.038
(Constant)	2.386	.718		3.324	.001		
Age	.021	.024	.058	.871	.385		
Gender	.314	.175	.120	1.795	.074		
Ethno-Cultural Background	-.589	.227	-.166	-2.589	.010		
BMI	.011	.019	.037	.578	.564		
Current Diet	-.534	.335	-.102	-1.593	.112		
Tobacco Use	-.060	.315	-.012	-.190	.850		

Figure 1. *Consumption of Fruits by Gender, Type of Diet and Ethno-Cultural Background*



Post-hoc Hierarchical Regression Analysis. A second post-hoc, hierarchical regression analysis was performed which had the same variables as the first post-hoc regression, introduced

in three steps. The three-step regression was performed (Table 9) with BMI, ethno-cultural background, gender and age introduced as independent variables in the first step of analysis. A second step added type of diet as a predictor and a third step added tobacco use status. Six percent (18/267) of participants were excluded due to missing data; 249 participants were included in the model. Only the first step created a significant model, the other two steps were not significant. The first model was significant with $F_{4,244} = 3.304$, $p = 0.012$. In this analysis, $R = .227$ and adjusted $R^2 = .036$, indicating that approximately 3.6% of the variability within vegetable intake was accounted for by the independent variables. Two of the four variables on the first step were significant: gender and ethno-cultural background. The effect of gender was significant ($\beta = 0.138$, $t_{244} = 2.10$, $p < 0.05$), with a lower mean daily intake of vegetables among males (2.46 ± 1.18) than females (2.87 ± 1.35). The effect of ethno-cultural background was significant ($\beta = -0.170$, $t_{244} = -2.65$, $p < 0.01$), with a higher mean daily intake of vegetables among Caucasians (2.74 ± 1.27) than non-Caucasians (2.07 ± 1.18).

Table 9. *Second Post-Hoc Regression: Hierarchical Analysis of Vegetable Intake*

	B	Standard Error	Beta	t	Sig.	R	Adjusted R^2	Significant F Change
Step 1						.227	.036	.012
(Constant)	1.949	.660		2.954	.003			
Age	.022	.024	.059	.892	.373			
Gender	.362	.172	.138	2.101	.037			
Ethnicity	-.602	.227	-.170	-2.648	.009			
BMI	.007	.019	.024	.376	.707			
Step 2						.248	.042	.110
(Constant)	2.397	.714		3.356	.001			
Age	.021	.024	.057	.859	.391			
Gender	.317	.174	.121	1.825	.069			
Ethnicity	-.587	.227	-.166	-2.589	.010			
BMI	.011	.019	.036	.569	.570			
Diet type	-.537	.334	-.102	-1.606	.110			
Step 3						.248	.038	.850
(Constant)	2.386	.718		3.324	.001			
Age	.021	.024	.058	.871	.385			
Gender	.314	.175	.120	1.795	.074			
Ethnicity	-.589	.227	-.166	-2.589	.010			
BMI	.011	.019	.037	.578	.564			
Diet type	-.534	.335	-.102	-1.593	.112			
Tobacco Use	-.060	.315	-.012	-.190	.850			

Final Post-hoc Exploratory Regression Analysis. A final regression analysis was conducted (Table 10) with the same dependent and independent variables as the planned, primary outcome analysis and two added independent variables: 'having vegetarians in the family' (yes/no) and 'main reason for diet'. This exploratory analysis had 195/267 or 73% of participants excluded due to missing data on the variables of 'reasons for diet' and 'having vegetarians in the family'.

Due to the format of these questions, many subjects interpreted them as intended only for vegetarians and left them blank. Only 72 participants were included in the model and therefore these results must be treated with caution, as overfitting may have occurred.

The model was significant, with $F_{8,63} = 2.45$, $p = 0.022$. In this analysis, $R = 0.487$ and $R^2 = 0.237$, indicating that approximately 23.7% of the variability within fruit and vegetable intake was accounted for by the independent variables. Two of the variables were significant: having vegetarians in the family and ethno-cultural background. The effect of having vegetarians in the family was significant ($\beta = -2.519$, $t_{63} = -3.20$, $p < .01$), with a higher mean daily fruit and vegetable intake for those with vegetarians in the family (6.5 ± 2.0) than for those who did not have vegetarians in the family (4.9 ± 2.4). The effect of ethno-cultural background was also significant ($\beta = -2.397$, $t_{63} = -3.119$, $p < .01$), with a higher mean daily fruit and vegetable intake for Caucasians (4.9 ± 2.2) than for non-Caucasians (4.0 ± 2.3).

Table 10. *Third Post-Hoc Regression Analysis of Vegetable Intake*

	B	Standard Error	Beta	t	Sig.	R	Adjusted R^2
						.487	.237
(Constant)	7.214	2.622		2.752	.008		
Age	.080	.092	.104	.866	.390		
Gender	.660	.656	.127	1.007	.318		
Ethno-Cultural Background	-2.397	.769	-.374	-3.119	.003		
BMI	-.045	.066	-.078	-.679	.503		
Current Diet	.218	.814	.033	.267	.790		
Tobacco Use	.746	1.009	.085	.739	.463		
Vegetarians in the Family	-2.519	.946	-.320	-2.662	.010		
Reason for Diet	-.140	.141	-.116	-.991	.325		

Discussion

Overview

This study was designed to address gaps in Canadian data by assessing fruit and vegetable intake by gender, ethno-cultural background and type of diet and by calculating the prevalence of vegetarianism among post-secondary students at Lakehead University. The mean fruit and vegetable intake in this population was 4.8 servings per day overall, 5.0 for females and 4.6 for males, 4.9 for Caucasians and 4.4 for non-Caucasians and 5.8 for vegetarians and 4.7 for non-vegetarians. Except for the intake for vegetarians, these were all lower intake rates than the Canadian average of 5.1 servings per day for this cohort (Garriguet, 2007). Differences in fruit and vegetable intake were as expected by ethno-cultural background and type of diet but different than expected in terms of gender. The mean intake of fruits and vegetables was lower than the recommended daily intake levels of the Canada Food Guide for all sub-groups in this study. The prevalence of vegetarianism was 7% in this study's sample, with the majority of these being female and ovo-lacto-vegetarians. In a forced-entry regression analysis, the independent variables of age, gender, tobacco use, type of diet, BMI and ethno-cultural background did not significantly predict fruit and vegetable intake. These variables did predict vegetable intake in two exploratory analyses, however these models had weak predictive value, accounting for less than 4% of the variability of vegetable intake. A final exploratory model included having vegetarians in the family and reason for diet and significantly predicted 23.7% of the variability in fruit and vegetable intake, although results from this model were considered speculative.

The response rate of 43% for students on the Aramark meal plan was higher than expected for a survey of this type with no remuneration (Baldini et al., 2007; Czaja & Blair, 2004; Spencer et al., 2005). The sample size of 197 students on the meal plan was more than double the expected response rate of 21% (Baldini et al., 2007; Spencer et al., 2005). This fairly high response rate was likely due to the relatively low participant burden of this type of brief questionnaire (Spencer et al., 2005; Willet & Hu, 2007), which was offered and completed during meal times in the cafeteria when participants had ample time and opportunity to fill out a brief survey. Also, the researcher actively handed out surveys to potential participants, which did not require participants to seek out surveys on their own. This response rate indicated that the results obtained from members of the meal plan may be representative of that population as a whole. The overall response rate was unavailable however, as neither the University nor the Aramark company tracked how many students ate at this cafeteria but were not on the meal plan. To calculate the overall response rate, it was also necessary to know the total number of surveys distributed and this was not tracked. Despite the lack of an overall response rate, the results from this study were still considered valid. Given the high response rate for those on the meal plan, it was likely that results from this survey were still generalizable to its population.

Daily Intake of Food Groups

The intake of fruits and vegetables in this study was close to the Ontario average and slightly lower than the Canadian national average. The average participant in this study did not meet Canada Food Guide daily intake recommendations for fruits and vegetables. Although there were no specific data in the literature on combined fruit and vegetable intake among Canadian post-

secondary students, the overall fruit and vegetable intake in this study (4.8 servings per day) was similar to Traynor et al.'s (2006) result of 4.6 servings per day from a sample of adults in Southern Ontario. This suggests that the fruit and vegetable consumption in this population may be at or near the average in Ontario. The overall fruit and vegetable intake in this study was also comparable to but slightly lower than the national average fruit and vegetable intake of 5.0 servings per day for adults aged 19-30 (Garriguet, 2007). Intake for females (5.0 servings/day) was similar to or slightly higher than the national average of 4.7 for females, but lower for males (4.6 servings/day) compared to the average of 5.4 for males in Canada, among adults aged 19-30 (Garriguet, 2007). This national survey of food intake (Garriguet, 2007) found that fruit and vegetable intake was higher for men than for women. The opposite was seen in this study, with females reporting a higher intake of fruits and vegetables than men and a significantly higher intake of vegetables. This is intriguing and suggests that the gender difference in fruit and vegetable intake may be reversed among post-secondary students in this population, as compared to nationally among adults aged 19-30.

The overall fruit and vegetable consumption in this study (4.8 servings/day) indicated that for both genders, most of the sample was not meeting the recommended fruit and vegetable intake of eight to ten servings per day put forth in the Canada Food Guide (Katamay et al., 2007). For both females and males in this study, the average intake of fruits and vegetables was at least three servings below Canada Food Guide recommendations. In contrast to Garriguet's (2007) finding that 60% of Canadian females and 45% of Canadian males aged 19-30 ate less than five servings of fruit and vegetable per day, less females (44%) than males (54%) in this sample reported

eating less than five servings of fruits and vegetables per day. Again, it appears that this population has the opposite gender difference in fruit and vegetable intake as the national data. It is not clear why this may be the case, either because of the open-access cafeteria system, by virtue of being post-secondary students or for other reasons. The literature on this topic was scarce, however Traynor et al. (2006) found no significant gender difference in fruit and vegetable intake among adults in Ontario. It may be that gender differences in fruit and vegetable intake vary by region across Canada. Males in this population appear to be especially at risk for inadequate fruit and vegetable consumption, which could increase their long-term risk of heart disease, cancer and other health conditions (Hu, 2003; O'Keefe et al., 2008; Park et al., 2007; Rajaram, 2003).

The respondents' reports of the intake of dairy and meat and alternatives were higher than the national average and daily intake of grain was much lower than the national average (Garriguet, 2007) as well as compared to recommendations from the Canada Food Guide for adults aged 19-30 (Health Canada, 2007). Although comparisons of food groups other than fruits and vegetables are possible, only Garriguet (2007) measured all of the food groups of the Canada Food Guide. Also, Spencer et al. (2007) noted that fruits and vegetables correlated higher with estimates of food recall than other food types, justifying their choice to only analyze fruit and vegetable data. Therefore the comparisons of food intake in this study from food groups other than fruits and vegetables should be treated with caution. The consumption of dairy by the sample in this study (2.9 servings/day) was higher than the national average of 1.7 (Garriguet, 2007) and higher than the recommended intake of two servings per day. Grain consumption in this sample (3.6

servings/day) was well below the national average of 6.3 (Garriguet, 2007) as well as the recommended intake of seven to eight servings per day. This was a very large difference and may have been partly due to the fact that the national survey used a multi-step methodology to maximize recollection of food consumption, as well as the use of a scale on this FFQ with a maximum value of "six or more servings per day". Meat consumption in this sample (3.9 servings/day), was higher than the national average of 2.8. The consumption of meat and alternatives was 1.2 servings more per day than Canada Food Guide recommendations for females and 1.5 servings more for males. This may be a concern since long-term excess meat intake has been linked to an increased risk of heart disease and obesity (O'Keefe et al., 2008).

This study appears to be the first to offer data on fruit and vegetable intake and ethno-cultural background among Canadian post-secondary students. Because 84% of the sample was Caucasian, it was not possible to compare across non-Caucasian ethno-cultural groups. This study did find significant differences between Caucasians and non-Caucasians, with Caucasians (4.9 servings/day) eating more fruits and vegetables than non-Caucasians (4.4 servings/day). Little research has been conducted on this topic from a Canadian perspective, meaning that ethno-cultural groupings in the literature may not be relevant in the context of this research. Caucasians were found to eat more fruits and vegetables than non-Caucasians in this population. This was somewhat similar to Serdula et al.'s (2004) findings with regards to ethno-cultural background, in that Serdula et al. (2004) reported a greater fruit and vegetable intake among Caucasian Americans than Black Americans. However, these data were from the United States and did not have the same reference groups as this study, which grouped all East or Southeast

Asian, West Asian or Arab, South Asian, Latin American, Black, Caribbean-Canadian, African-Canadian and North American Aboriginal into 'non-Caucasian' (n= 42), for comparison with Caucasians (n= 225). Although baseline data may not exist for the comparison of ethno-cultural intake rates, this study's findings suggest that non-Caucasians in this population are particularly likely to be below Canada Food Guide recommended daily fruit and vegetable intake levels.

Students on the meal plan showed a significant difference in consumption versus those not on the meal plan only in terms of the intake of dairy products. Students on the meal plan ate more dairy (3.2 servings/day) than other students (2.3 servings/day). Given the menu at the Aramark cafeteria, this may be due to the access to pizza, ice cream and milk at every meal in this location. The intake of fruits and vegetables was greater among those on the meal plan, but the difference was not statistically significant.

Vegetarians in this study ate more total fruits and vegetables (5.8 servings/day) than non-vegetarians (4.7 servings/day) and this was expected (Perry et al., 2004; Spencer et al. 2007), especially given that vegetarians in this age group tend to be more health-conscious than younger adolescent vegetarians (Greene-Finestone et al., 2008). However, only vegetable intake (3.4 servings/day) was found to be significantly greater among vegetarians than non-vegetarians (2.6 servings/day). The lack of a significantly higher intake of fruits among vegetarians is surprising and runs counter to the evidence in the literature (Perry et al., 2002; Spencer et al. 2007). This may be due to the regular, readily-available access to food of all kinds in this cafeteria. That is, fruit intake among non-vegetarians in this sample may be relatively increased due to open, regular access to fruits in the cafeteria. Also, with only 18 vegetarians in the sample, there may

not have been enough statistical power to find an existing significant difference in fruit intake by type of diet. The level of total fruit and vegetable intake of vegetarians in this study (5.8 servings/day) was higher than the national average of 5.0 and closer than any other sub-group to the recommendation of eight to ten servings of fruits and vegetables per day in the Canada Food Guide (Health Canada, 2007). Vegetarians also ate a great deal less meat and alternatives (2.1 servings/day) than non-vegetarians (4.1 servings/day). Vegetarians in the sample were more likely to be near or below the recommended two to three servings of meat and meat alternatives per day than non-vegetarians, who were more likely to be near or above the recommended daily intake. These non-vegetarians appear to be at risk of excessive consumption of meat and meat alternatives, which once again is associated with negative long-term health outcomes such as obesity, heart disease and cancer (Katamay et al., 2007; O'Keefe et al., 2008).

Vegetarianism

The prevalence rate of 7% for vegetarianism in this study was similar to but slightly higher than prevalence rates from the literature, which varied from 4.0% for Canada as a whole (American Dietetic Association and Dieticians of Canada, 2003) to 6.0% among adults in British Columbia (Bedford & Barr, 2005). This may have been due to a recent increase in vegetarianism, as it was pointed out in 2003 that the prevalence of vegetarianism appeared to be increasing (American Dietetic Association and Dieticians of Canada, 2003). As well, the sample of university students in this study could simply have a higher prevalence of vegetarianism than the general population. Evidence exists indicating that the rate of vegetarianism may be higher among post-secondary students than among other adults (Spencer et al., 2007). There was a large

gender difference in terms of vegetarian diet, with about three quarters of the vegetarians in this sample (14/18) being female. This exact proportion may not be appropriate for direct comparison to gender ratios within the literature, as the absolute number of vegetarians in the sample was relatively low, reducing the generalizability of descriptive statistics and making inferential statistics on vegetarians impossible in this study. However, the higher rate of vegetarianism among females was expected; this was consistently found across several studies on vegetarianism (Bedford & Barr, 2005; Greene-Finestone et al., 2008; Skemiene et al., 2007; Spencer et al., 2007) and was now confirmed among Canadian post-secondary students, representing an extension of previous research. Also as expected was the lower BMI among vegetarians (Spencer et al., 2007) although again, comparisons between vegetarians and non-vegetarians were not corrected for gender.

The inclusion of six categories for vegetarianism provided a better understanding of vegetarianism and its types, while still allowing for vegetarianism data to be compared to other studies by combining groups. Studies on vegetarianism in the literature did not all agree on categories for types of vegetarianism. It was consistently found that the majority of vegetarians were ovo-lacto vegetarian (Bedford & Barr, 2005; Greene-Finestone et al., 2008; Spencer et al., 2007), as were 72% of the vegetarians in this study. Perhaps because of this, some studies used "vegetarian" and "ovo-lacto vegetarian" interchangeably (Bedford & Barr, 2005; Spencer et al., 2007). This study found that some individuals reported as vegan or pesco-vegetarian, which justified the inclusion of these categories, especially given that research has indicated that some of the health benefits of a vegan diet exceed those of ovo-lacto vegetarian diets (Key et al.,

1999). In the interests of being thorough and classifying participants with possible food allergies, this study's questionnaire allowed participants to identify as ovo-vegetarian or lacto-vegetarian, however no participants identified in either of these groups. This suggests that other than vegans, there is perhaps not a large percentage of vegetarians who eat a diet less restrictive than ovo-lacto vegetarianism. Finally, this study confirmed that the most popular reason for vegetarianism among university-aged individuals was for health reasons. As Greene-Finestone (2008) pointed out, university-aged vegetarians have tended to be more health-conscious than younger vegetarians.

Predictors of Fruit and Vegetable Intake

This study's regression analyses helped to elucidate the prediction of fruit and vegetable intake and of vegetable intake, given that there were no regression analyses on these in the literature. The primary outcome regression analysis was not significant, suggesting that fruit intake and vegetable intake in this population were differently affected by the independent variables. Running this regression with vegetable intake as the dependent variable gave a significant result, which confirmed that vegetable intake appeared to be predicted by the independent variables to a greater degree than fruit intake. Running the regression analysis again hierarchically was only significant for the first step, illustrating that BMI, ethno-cultural background, gender and age were the most salient predictors of vegetable intake in this population. Caucasian ethno-cultural background and female gender significantly predicted increased vegetable intake, in agreement with correlative data from Spencer et al. (2007). Results from the final exploratory regression should be treated with caution, but may indicate that having

vegetarians in the family was a significant predictor of fruit and vegetable intake. The only independent variable that was found to be significant in all of the exploratory analyses was ethno-cultural background, indicating that this may be a central predictor of vegetable intake.

Excluding the final model, in which overfitting may have occurred, none of these models predicted more than 4% of total fruit and vegetable or vegetable intake. It seems that although these predictors may have underpinned food consumption in this sample, there were other factors that accounted for a great deal more of the variability in fruit and vegetable and vegetable intake. Some of this could have been due to the open and constant access to fruits and vegetables in this cafeteria, which may have significantly affected the food choices of the students who ate there. In other words, the expected and typical predictors of fruit and vegetable intake and of vegetable intake may have been significantly less powerful as predictors in the Aramark cafeteria, because fruits and vegetables were much more easily available in this type of environment than is usually the case. Differences between the prediction of fruit intake and vegetable intake may have been due to the daily displays of fruit on stands inside the cafeteria, a phenomenon that was not found with vegetables.

Correlations

This study had a number of significant zero-order correlations between variables that were not found to be significant predictors of fruit and vegetable intake or vegetable intake. For example, reason for diet and type of diet were significantly correlated to fruit and vegetable intake ($p < .05$) and gender was significantly correlated to vegetable intake ($p < .01$), although none of these

variables were significant predictors in any of the regression analyses. This raised the possibility that the relationship between these variables was more complicated than simple correlations. This would be especially important in the case of multiple regression analyses, as undertaken in this study, where care must be applied to take into account how the independent variables interact together. It is possible that some of the variability in the dependent variables (fruit and vegetable intake and vegetable intake) was shared between more than one of the independent variables.

Limitations of the Study

Several limitations are noted for this study. Because the total number of students not on the meal plan who eat at the Aramark cafeteria was unknown, it was not possible to accurately calculate the overall response rate. The difficulties of measuring response rate (some surveys were completed during the meal period, others were returned completed on later days, some were taken away and not returned and other unused surveys were left behind and re-used) meant that although the researcher stated that surveys were to be filled out only once per person, it was possible that some students may have filled out the survey more than once. Close inspection of the completed surveys during data entry revealed that this was unlikely within this study, however this remains a limitation. Also, the total number of distributed surveys was not tracked. This should be considered a limitation, as these data would have allowed the calculation of a response rate from among all the students who were asked to participate. The response rate from students on the meal plan was relatively high (43%), so data from this study were still considered to have validity for that population, but ultimately the representativeness of the sample to the

population it was drawn from could not be established. Similarly, results from this survey may only be applicable to other post-secondary populations and in the context of open-access cafeterias.

This study did not replicate an existing FFQ with established validity and reliability. This was due to the fact that no FFQs were found in the literature that were brief, low in respondent burden and still examined intake of the food groups from the Canada Food Guide. The use of 24-hr FFQs of this kind was supported in the literature (Kim & Holowaty, 2003) and some 24-hr FFQs on fruit and vegetable intake were found (Spencer et al., 2007; Traynor et al., 2006). However, because of the limitations of this pilot study, unlike some of the 24-hr FFQs in the literature, this survey was not administered at separate time points and averaged. As well, multiple food items were not measured within each food group. Because of this, the survey used in this study did not have an established reliability or validity and was not tested for its reliability and validity to the population of students who eat at the Aramark cafeteria or to students at Lakehead University. This should be considered a limitation, although the FFQ used in this study did conform to recommendations on brief FFQs (Kim & Holowaty, 2003) and was modeled after existing, validated surveys in terms of the scale and the inclusion of serving sizes (Spencer et al., 2007; Traynor et al., 2006). Also, although it was not part of this FFQ and was not generally incorporated into FFQs by other researchers, the inclusion of pictures of serving sizes would possibly have increased the accuracy of food intake reports. In terms of the scale for questions, this FFQ followed the scale of zero to "six or more" servings of each food group per day (Spencer, 2007). However, given that the Canada Food Guide recommended seven to eight

servings of grain products per day, a scale with a higher maximum value would have been useful.

Another limitation was the missing data for the questions about vegetarians in the family (48% missing data) and reasons for the participants' diet (66% missing data). Due to the wording of these questions, it was likely that they were misunderstood by many as being intended only for those who had vegetarian diets, and were therefore left blank by many non-vegetarians. This limited the statistical power of regression analyses and other inferential data involving these variables. In the same way, the small number of vegetarians in the sample limited the types of analyses that could be run on that sub-group. It was also possible that the small number of vegetarians in the sample (18/267) led to non-significant results for 'type of diet' as a predictor within the study's regression analyses. Similarly, the small number of non-Caucasians in the sample (42/267) allowed for comparisons between Caucasians and non-Caucasians, but did not allow for comparisons between any particular non-Caucasian groups. It was possible that not leaving a blank space in front of 'Other' under the reasons for diet may have prevented the listing of specific other reasons for participant diet. Finally, as with any self-reported result, there may have been an over-representing of healthy behaviour (Spencer et al., 2007).

Relevance to Public Health

Previous studies have indicated that increased fruit and vegetable intake was linked to improved long-term and short-term health outcomes. This included lower rates of breast, colorectal, prostate and other forms of cancer (Demark-Wahnefried et al., 2008; Gandini et al.,

2000), lower rates of cardiovascular disease and stroke (Hu, 2003; O'Keefe et al., 2008), improved bone density (New, 2003) and lower rates of Parkinson's disease (Gao et al., 2007). Vegetarian diets have also been linked to improved health outcomes, including lower rates of prostate and colorectal cancer (Burr & Sweetnam, 1982; Fraser, 2009), lower rates of cardiovascular disease (Fraser, 2009) and lower rates of hypertension, type two diabetes, osteoporosis, renal disease and dementia (American Dietetic Association and the Dieticians of Canada, 2003). Several mechanisms have been indicated for these effects and it is evident from the literature that fruit and vegetable intake and vegetarian diets play important roles in the prevention of disease and maintenance of good health. The current study examined fruit and vegetable intake and vegetarianism specifically among post-secondary students, a population that has been categorized as ideal for dietary interventions (Sanders & Sanders-Gendreau, 2007; Wharton et al., 2008). In addition, the diet of post-secondary students has been relatively under-examined (House et al., 2006). The current study attempted to add to the knowledge base regarding diet and the future health of post-secondary students, within a Canadian context.

Future Directions

The results from this study suggested that post-secondary students may have the opposite gender difference in fruit and vegetable intake as other Canadian adults aged 19-30, a result which should be investigated further. As well, differences in fruit and vegetable intake and vegetable intake by ethno-cultural background were found for the first time in this demographic, justifying further research on this topic. Non-significant differences in fruit intake should be explored further as well. Males, non-vegetarians and non-Caucasians appeared to be the least

likely to meet Canada Food Guide recommendations for fruit and vegetable intake. Males and non-vegetarians also appeared to be at a particular risk for consuming an excess of meat. More research is required to understand the particulars of these populations and future public health interventions could be targeted at these high-risk groups.

Researchers on vegetarianism in Canada should expect the prevalence of vegetarianism to be around 7% for post-secondary students and plan their recruitment accordingly. Going forward, larger samples of vegetarians are needed for inferential statistics on this population. Responses by pesco-vegetarians in this sample demonstrated the need for researchers to include this category on future surveys of vegetarians to describe fish-eaters who may or may not eat eggs and/or dairy. Future research could extend this and also include the category of 'ovo-lacto-pesco vegetarianism', which would classify diets that include fish and do specifically include eggs and dairy products. Finally, it was noted that vegetarians other than pesco-vegetarians reported meat intake in this study. This may be because, anecdotally, some individuals self-report as 'vegetarian' simply because they do not eat red meat. There may therefore be value in future research asking about fish, poultry and red meat intake with separate questions in order to better understand these variations.

Nutrition research to date has tended to not assess the predictors of fruit and vegetable intake, focusing instead on correlates or t-tests. The regression results of this study have provided a foundation for further regression analyses on fruit and/or vegetable intake among post-secondary student populations. Researchers undertaking regression analyses on fruit and/or vegetable intake should exercise caution in the selection of their variables, as the true relationship between these

variables is likely more complicated than the correlation data indicates. It is possible that predictors of food intake may be different for those who eat in open-access buffet-style cafeterias than for the general student population; this bears further investigation. Given that a lack of choice for healthy options on campus is a commonly cited barrier to healthy eating (House et al., 2006), investigating methods for delivering healthy food options to students remains an important priority for ideal nutrition among post-secondary students. Future research could focus on better understanding the relationship between what foods are offered on meal plans, how they are presented and the actual intake of participants on these meal plans.

Conclusion

This study demonstrated that fruit and vegetable intake among post-secondary students may be below recommended levels as well as below the estimated national average for this age group. Given the lack of research on fruit and vegetable intake, vegetarian status and the predictors of fruit and vegetable intake of post-secondary students in Canada, the current study represents a foundation for future research on these topics. Male post-secondary students, non-vegetarians and non-Caucasians were identified as being at a potentially increased risk of future health deficits due to insufficient fruit and vegetable intake. As well, valuable data was added on the prevalence of vegetarianism among Canadian post-secondary students, a population which may exhibit higher rates of vegetarianism than the rest of Canada. The use of specific categories for types of vegetarianism was justified; future research on this subject can incorporate these categories to allow for a more subtle understanding of different types of diets. This study's summary of existing research on fruit and vegetable intake and vegetarian prevalence has

demonstrated that there is a need to standardize the comparison groups, definitions and survey methodology for research on these topics, as they are currently inconsistent and not easily comparable. It is hoped that Canadian public health research, nutritional awareness campaigns and dietary interventions will make use of findings such as these in order to best ensure the long-term health of Canadians.

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Appendix 1:

Table 2.
Response Rates for FFQs by Post-Secondary Students

Reference	Total Population	Number of Respondents	Response Rate	Notes
Papadaki et al. (2007)	Not provided	84	Insufficient Data	The total population of students was not provided.
Baldini et al. (2007)	Approx. 1000	210	Approx. 21%	Baldini et al. estimate that "about a thousand students were contacted" (p. 2).
Spencer et al. (2005)	333	71	21%	
Skemiene et al. (2007)	Not provided	349	Insufficient Data	The total population of students was not provided.

Appendix 2:
Diet and Vegetarianism:

Part 1: This is a voluntary survey looking at student food consumption. Please answer all the questions below as best you can.

1) How many servings of fruits have you eaten in the past 24 hours? (Circle an answer)

(1 serving = ½ cup (125 g) of fresh / frozen / canned fruit, or one fruit, or 125 ml (½ cup) of fruit juice.)

0 1 2 3 4 5 6 or more

2) How many servings of vegetables do you typically eat per day? (Circle an answer)

(1 serving = ½ cup (125 g) of fresh / frozen / canned vegetables, ½ cup (125 g) of cooked vegetables, 1 cup (250 g) of raw leafy vegetables, 125 ml (½ cup) of vegetable soup or 125 ml (½ cup) of vegetable juice.)

0 1 2 3 4 5 6 or more

3) How many servings of grain and grain products do you typically eat per day?

(1 serving = 1 slice of bread, ½ a bagel, ½ a pita or tortilla, ¾ cup (175 g) of cereal or oatmeal, ½ cup (125 g) of rice, quinoa or bulgur wheat, etc, or ½ cup (125 g) of pasta.)

0 1 2 3 4 5 6 or more

4) How many servings of meat do you typically eat per day?

(1 serving = 75 g / 2.5 oz / ½ cup (125 g) of poultry, cooked fish, shellfish, or lean meat.)

0 1 2 3 4 5 6 or more

5) How many servings of meat alternatives do you typically eat per day?

(1 serving = 150g (175 ml or ¾ cup) of tofu, 2 eggs, 30 ml (2 Tbsp.) of peanut or nut butter,

¾ cup (175 g) of cooked legumes (beans, lentils, chick peas, etc), or 60 ml (¼ cup) of shelled nuts or seeds.)

0 1 2 3 4 5 6 or more

6) How many servings of dairy products do you typically eat per day?

(1 serving = 250 ml (1 cup) of milk / fortified soy milk, 175g (¾ cup) of yogurt, or 50g (1.5oz) of cheese.)

0 1 2 3 4 5 6 or more

Part 2: This study is looking at how demographics such as age, sex and cultural background may be related to diet. Therefore, please answer the following questions.

1 a) You are: _____ male female _____

1 b) If you are female, are you pregnant or lactating?: _____Yes No _____

2) Are you on the Aramark student meal plan?: _____Yes No _____

3) For how many years (including this one) have you been on the residence meal plan?: _____

4) Your age in years: _____

5) Your tobacco use status: (Check which applies)

☐ Never used tobacco ☐ Used tobacco but stopped ☐ Using tobacco

6) Your home community (where you are from): _____

7) Your cultural or ethnic background: (Check all that apply)

☐ White or Caucasian ☐ East or Southeast Asian ☐ West Asian or Arab ☐ South Asian

☐ Latin American ☐ Black, Caribbean-Canadian or African-Canadian

☐ North American Aboriginal ☐ Other

8) Your academic department of study: (Check which applies)

☐ Business Administration ☐ Education ☐ Engineering ☐ Forestry ☐ Graduate Studies

☐ Health and Behavioural Sciences ☐ Northern Ontario School of Medicine

☐ Science and Environmental Studies ☐ Social Sciences and Humanities ☐ Other

9) Please state your height: _____feet inches_____ OR ____cm.

10) Please state your weight: _____lbs OR _____kg.

11) Please check off which, of the following best describes your current diet:

☐ Ovo-lacto vegetarian (excludes meat, but includes eggs and dairy products)

☐ Lacto-vegetarian (excludes meat and eggs, but includes dairy products)

☐ Ovo-vegetarian (excludes meat and dairy products, but includes eggs)

☐ Pesco-vegetarian (excludes meat except for fish, may or may not include eggs or dairy)

☐ Vegan (excludes meat, excludes dairy products and excludes eggs)

☐ None of the above

12) If you checked off any of the vegetarian or vegan options in the last question, please state:

a) For approximately how long you have been vegetarian/vegan: _____ years months_____

b) Is anyone in your immediate family (parents and siblings) vegetarian or vegan?:

___Yes No___

c) What was your primary reason for this dietary choice?: (Check all that apply)

☐ Health-related choice ☐ Ethical/animal welfare concerns ☐ Taste

☐ Religious reasons ☐ Weight control ☐ Other

Appendix 3:

Diet and Vegetarianism:

Dear Lakehead University student,

My name is Sam Kooshesh and I am a student at Lakehead University in the Masters of Public Health Program. I am conducting a thesis study on student diet here at Lakehead. With the approval of Aramark, I am inviting you to fill out a brief survey for a study entitled "Diet and Vegetarianism Among Lakehead University Students".

The purpose of this survey is to measure the daily food intake patterns of Lakehead students at the residence cafeteria, as well as the frequency of vegetarianism. As a student eating here, you are eligible to fill out the brief survey. You will be asked to estimate your daily intake of various types of food using a food frequency questionnaire. You will also be asked about vegetarianism, as well as basic demographic data about yourself. The survey is brief and will likely take less than 5 minutes of your time.

There is no anticipated risk to you if you choose to take part. Your participation is entirely voluntary and you may refuse to participate with no penalty. At any time you may choose not to answer one or more of the questions asked in the survey. Although there is no direct benefit to you, the information you provide will help researchers to better understand the diet of university students.

Any information you provide will be coded and made anonymous, and used only for the purposes of this study. In keeping with Lakehead University policy, all data from this study will be stored at Lakehead University for five (5) years. However, the findings of this project are available to you at your request once the study is completed. The survey is not labeled in any way that allows you to be identified. Neither your name nor any other identifying information will be revealed in any published materials.

If you have any questions or concerns, or would like to access a final copy of the results of this survey, please do not hesitate to contact me at hkooshes@lakeheadu.ca. You can reach the supervisor for this study, Dr. Patricia Smith at Patricia.Smith@normed.ca, and Lakehead University's Research Ethics Board at 343-8283.

This cover letter is yours to keep if you volunteer to fill out the survey.

Thank you very much for your assistance.

Sincerely,

Sam Kooshesh, MPH student

Appendix 4:
Consent Form:

As a potential participant, your signature is necessary and indicates that you are a participant for the survey study entitled "Diet and Vegetarianism Among Lakehead University Students". Your signature on this sheet indicates that you understand the following:

1. You are a volunteer and can withdraw from the study at any time.
2. You have read and understand the attached cover letter for the study.
3. The data you provide will be securely stored at Lakehead University for five (5) years.
4. You will have access to the final results of this study, if you request it, following the completion of the study.
5. You will not be named, or identified in any way in any materials published as a result of this study.
6. There is no anticipated risk of physical or psychological harm and there is no direct benefit to you from participating.
7. You are at least 18 years of age and therefore able to consent to participate.

Signature of Participant Date

If you choose to fill out the survey, please leave this sheet attached. Thank you,

Sam Kooshesh
hkooshes@lakeheadu.ca