A Cross-Sectional Analysis of Student Fruit and Vegetable Consumption at the University of Ontario Institute of Technology

by

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An oral defense of this thesis took place on January 07, 2020 in front of the following examining committee:

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Chair of Examining Committee	Dr. Manon Lemonde
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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

ABSTRACT

Access to nutritious food is imperative for maintaining overall health. Fruits and vegetables are foods that are nutrient rich, and consumption of these foods is related to positive health outcomes. The purpose of this study was to determine fruit and vegetable consumption for students in the Faculty of Health Sciences at the University of Ontario Institute of Technology and what food retailers they frequent. The study found that students reported a daily fruit and vegetable consumption lower than the minimum daily amount recommended by Canada's Food Guide. Students were also shown to frequent sit-down food retailers that offered diverse dietary options (low-sodium, gluten-free, and vegetarian). There was an association between students who visited stores that offered fewer options and increased consumption of potatoes. Low consumption of fruit and vegetables can lead to health complications, such as increased risk for cardiovascular disease and cancer, and should be addressed to reduce risk.

Keywords: Fruit and vegetable consumption; cross-sectional; university students; Canada's Food Guide

AUTHOR'S DECLARATION

I hereby declare that this thesis consists of original work of which I have authored. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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_____ Abigail Graham

STATEMENT OF CONTRIBUTIONS

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication. I have used standard referencing practices to acknowledge ideas, research techniques, or other materials that belong to others. Furthermore, I hereby certify that I am the sole source of the creative works and/or inventive knowledge described in this thesis.

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DEDICATION

I would like to dedicate this work to my Lord Jesus Christ, because it was by His grace this was completed.

1 Corinthians 15:57

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ANOVA	Analysis of Variance
CCHS	Canadian Community Health Survey
CFG	Canada's Food Guide
DGV	Dark Green Vegetable
FHS	Faculty of Health Sciences
FJ	Fruit Juice
FVC	Fruit and Vegetable Consumption
OR	Orange Vegetable
OV	Other Vegetable
SPSS	Statistical Package for the Social Sciences
Ontario Tech University	University of Ontario Institute of Technology

SYMBOLS

α	Significance level
Δ	Difference between sample and population mean
Z_α	z-value for
Z_β	z-value for β

Chapter 1: Introduction

1.1 Research Context

Low fruit and vegetable consumption are associated with cardiovascular disease, cardiovascular mortality, non-cardiovascular mortality, and total mortality (Miller *et al.*, 2017). An estimation on the Global Burden of Disease in 2017 attributes 1-4 million deaths and 41-92 disability-adjusted-life-years to low intake of fruit alone (GBD 2017 Diet Collaborators, 2019). Canadians are eating fewer servings of fruits and vegetables than the recommended minimum (Azagba & Sharaf, 2011; Black & Billette, 2013 Krueger, Koot, & Andres, 2017). Increasing fruit and vegetable servings was associated with reduced risk of chronic diseases such as, type-2 diabetes, cardiovascular disease, and cancer and an estimated reduction in health spending (Ekwaru *et al.*, 2016).

National food intake guidelines, such as the 2011 version of Canada's Food Guide (CFG), aim to simplify what food types need to be consumed and in what quantity they should be consumed to support a healthy lifestyle and prevent chronic health conditions (Health Canada, 2011). Data from the Canadian Community Health Survey (CCHS) showed that only 29% of Canadians met the minimum daily number of suggested servings of fruits and vegetables (So, McLaren, & Currie, 2017). Fruit and vegetable consumption are a Canadian chronic disease indicator and can be used to predict different health outcomes (Public Health Agency of Canada, 2017). Fewer than 20% of Canadians age 15 – 35+ consume the number of servings of fruits and vegetables suggested by the 2011 version of Canada's Food Guide (Krueger, Koot, & Andres, 2017). Studies have also shown that university students, do not consume the daily recommended number of fruits and vegetable servings (Boucher, Gagne, & Cote, 2013; Tomasone, Meikle, & Bray, 2015). Students attending academic institutions with fewer than 20,000 students were associated with a

higher proportion of students consuming less than five servings of fruits and vegetables *per* day, as compared to those attending larger institutions (Kwan, Faulkner, Arbour-Nicitopoulos, & Cairney, 2013).

Access to fruit and vegetables can be impacted by the physical environment (Story, Kaphingst, Robinson-Obrien, & Glanz, 2008). Fruit and vegetable access have many different aspects. One aspect of access is the accessibility/distance to food retailers and the types of food retailers (Usher, 2015). Food retailers are often classified into separate groups dependent on the types of foods the stores offer to consumers, such as stores and fast food outlets (Sadler, Gilliland, & Arku, 2011). The food offered at these types of sources can vary greatly in respects to the nutritional content of the food (Sadler, Gilliland, & Arku, 2011).

Food retailer visits can be affected by whether a retailer provides customers with foods of their choice (Clarke *et al.*, 2004; Jackson *et al.*, 2006). Choice can determine what types of foods are consumed, as personal preferences can influence what food is selected regardless of nutritional content (Jackson *et al.*, 2006). Some food preferences can lead to desirable eating habits, such as an increase in fruit and vegetable consumption. Access to produce can increase fruit and vegetable consumption (Usher, 2015). Gluten-free options have been associated with eating more fruits and vegetables, as gluten-eliminating diets tend to replace consumption of other food groups with high intake of fruits and vegetables (Christopher *et al.*, 2017). Additionally, not surprisingly, vegetarian diets have also been associated with an increased consumption of plant-based foods (Miles *et al.*, 2019). Consuming foods with low-sodium levels is also associated with increased consumption of fruits and vegetables (Wilson, Nghiem, & Foster, 2013). These food choices have the potential to positively improve fruit and vegetable intake and thus impact health. As food retailer type and food options can impact food retailer visits it is important to understand

both the type of retailer and the options that are offered when examining the physical environment (Sadler, Gilliland, & Arku, 2011).

The University of Ontario Institute of Technology (Ontario Tech University) is a university with commuters comprising a large proportion of the student body (Provost's Advisory Committee on Integrated Planning, 2016). There are approximately 10,000 students enrolled in the university (Office of the Registrar, 2018). The area surrounding the north location of the university has a small number of food retailers (Frech, Graham, & Hamel, 2016). Before the completion of this study there was no data concerning the fruit and vegetable consumption of students at Ontario Tech University. Previous to this study there was no information on what types of food retailers students are obtaining food from, and if available food options impact students' choice to visit retailers. It was also unknown if there was an association between food retailer visits and fruit and vegetable consumption.

1.2 Thesis Objectives

The purpose of this study is to determine the fruit and vegetable consumption, what type of food retailers are visited, and if there are associations between visits to food retailers and consumption of fruit and vegetables of Ontario Tech University students enrolled in the Faculty of Health Sciences (FHS).

Hypothesis 1: Students in the FHS at Ontario Tech University do not consume the recommended number of fruits and vegetables, from the 2011 CGF.

Hypothesis 2: Students in the FHS at Ontario Tech University students are more likely to visit high option retailers than low option retailers; for options linked to increased fruit and vegetable consumption (low-sodium, gluten-free, vegetarian, fresh produce availability).

In order to test these hypotheses, this study determined the fruit and vegetable consumption among second year FHS students and assessed which of the food retailers students obtained their food from.

Four specific objectives were identified for this thesis:

I. To assess the fruit and vegetable consumption of second year FHS students at Ontario Tech University.
II. To assess which type of food retailers students visit (Bars, Bakeries, Takeaways, Sit-down, and Stores that provide produce, gluten-free, low-sodium, and/or vegetarian options).
III. To examine associations between fruit and vegetable consumption and food retailer visits.
IV. To examine associations between demographic variables and fruit and vegetable consumption and food retailer visits.

1.3 Thesis Overview

The purpose of this thesis was to examine the fruit and vegetable consumption of second year students in the FHS at Ontario Tech University. The current chapter introduces the topic and outlines the objectives of the thesis. Chapter Two provides a literature review on diet, health, and wellness, food consumption, and factors impacting dietary intake. Chapter Three details the methodology used in conducting the cross-sectional analysis and the statistical methods used to analyze the data. Chapter Four provides the collected results and the analysis of the results. Chapter Five provides a summary of the results and puts them into perspective by providing a future direction for this area of study.

Chapter 2: Background

2.1. Diet, Health, and Wellness

Poor diet quality can lead to the development of chronic diseases. Globally, in 2017 alone, approximately 11 million deaths and the loss of 255 million life-years were attributed to poor dietary intake (GBD 2017 Diet Collaborators, 2019). In Canada, the 2019 version of Canada's Food Guide provides recommendations for making healthy food choices, eating habits, resources, recipes, and tips for healthy eating (Health Canada, 2019). The former versions of the food guide provided Canadians with the number of recommended daily servings of different food groups (Health Canada, 2011). The current food guide does not contain information on recommended servings per day; however, there are plans to release this information in a format that is easily accessible to Canadians in the near future (Canada's Dietary Guidelines, 2019).

There is an increased rate of mortality in Canadians associated with consuming fewer than five servings of fruit and vegetables *per* day (Sanmartin *et al.*, 2016). Increasing fruit and vegetable servings was associated with reduced risk of chronic diseases such as, type-2 diabetes, cardiovascular disease, and cancer with an estimated reduction of $9.2 billion dollars in health for a single serving increase (Ekwaru *et al.*, 2016).

2.1.1. Fruit and vegetable consumption: adherence and health impacts.

The Canadian Community Health Survey (CCHS) was developed in 2000 to gather information on health determinants, status, and system utilization (Health Canada, 2017). The survey focuses on perceptions of health, both mental and physical, health service utilization, and behaviours concerning activity level, alcohol consumption, fruit and vegetable consumption, and smoking and is conducted annually (Statistics Canada, 2018).

One surveillance module asks about fruit and vegetable consumption and divides consumption into six categories: fruit juices, fruit, dark green vegetables, orange-coloured vegetables, potatoes, and other vegetables (Statistics Canada, 2019). The section on fruit and vegetable consumption from the CCHS is an intake measure that has been studied in the general population repeatedly (Hosseini, Whiting, & Vatanparast, 2019; Garriguet, 2008a; Garriguet, 2008b; Nishi, Jessri, & L'Abbe, 2018; Health Canada, 2017; Statistics Canada, 2018; Wahi, Boyle, Morrison, & Georgiades, 2014).

2.2.1.1. Adherence to recommended fruit and vegetable consumption.

Nonadherence with the 2011 CFG recommendations was associated with an increased likelihood of obesity (OR 1.41) as compared to those that adhere to the guidelines [95% Confidence Interval: 1.17–1.71] (Jessri, Ng, & L'Abbe, 2017). According to analysis of data from the CCHS, there was a slight reduction in fruit and vegetable consumption from 2007 to 2014 and average consumption of fruits and vegetables was most recently found to be fewer than five servings *per* day (Colapinto, Graham, & St-Pierre, 2018). Canadians from age 18-79 with low-high incomes on average failed to meet the recommended daily minimum number of fruits and vegetables (Hosseini, Whiting, & Vatanparast, 2019). Adequate fruit and vegetable intake can affect the health of individuals and consuming less than the recommended number of foods has led to over thirteen-billion dollars, in a single year, for the Canadian health care system, in direct and indirect costs (Lieffers, Ekwarum, Ohinmaa, & Veugelers, 2018).

2.2.1.2. Body Mass Index.

Body Mass Index (BMI) is the ratio of weight-to-height and can be used to represent overweight and obese individuals (Health Canada, 2019, November 25). Individuals that have a higher BMI in their early life have been shown to have health complications such as

diabetes and cardiovascular disease, later in life (Ryu & Bartfeld, 2012). CCHS data showed an inverse association between fruit and vegetable consumption and BMI (So, McLaren, & Currie, 2017). Another study found a significant negative association between fruit and vegetable consumption and BMI in immigrant and non-immigrant Canadian youths (Wahi, Boyle, Morrison, & Georgiades, 2014). Meeting the servings of fruits and vegetables suggested by Canada's Food Guide (seven servings *per* day) is associated with a reduction in BMI and a reduction in overall health complications associated with a higher BMI (So, McLaren, & Currie, 2017). In Canada, an association between increased BMI and the consumption of fewer than five servings of fruits and vegetables *per* day was established (Dehghan, Akhtar-Danesh, & Merchant, 2011). Fruit and vegetable consumption are associated with reduced risk of cardiovascular disease and low consumption has been globally linked to increased deaths by cardiovascular disease (GBD 2017 Diet Collaborators, 2019; Ekwaru *et al*., 2016).

2.2.1.3. Mental health.

General mental health and well being is been associated with higher fruit and vegetable consumption across different countries including Canada (Warner, Frye, Morrell, & Carey, 2016). Increased fruit and vegetable consumption are also protectively associated with depression (Saghafian *et al*., 2018). When adjusted for socioeconomic standing, associations were still found between fruit and vegetable intake and positive mental health (Huang *et al*., 2016). This finding supports the current recommendation of increasing fruit and vegetable intake to improve mental health. In Canadian immigrants, fruit and vegetable consumption provided a protective association with mental health outcomes, namely mood and/or anxiety disorder, distress, and good self-rated mental health (Emerson & Carbert, 2018). Increased fruit and vegetable consumption are associated with inverse rates of

depression, suffering from mental distress, mood disorders, and poor mental-health outcomes (McMartin, Jacka, & Coleman, 2013).

2.2.1.4. Cancer and other complications.

There are associations between low fruit and vegetable consumption and increased incidents of colorectal cancers. An increase in consumption of fruits and vegetables could potentially prevent more than 30,000 cases of colorectal cancer by 2042 in Canada alone (Poirier *et al.*, 2019). Other incidents of cancers such as bladder, breast, esophageal, liver, lung, pancreatic, ovary, and stomach cancers were also associated with low consumption of fruits and vegetables (Poirier *et al.*, 2019). Higher vegetable intake was associated with a lower overall risk of breast cancer (Emaus *et al.*, 2016). Increased fruit intake of 100 g/day was associated with lower rates of esophageal, mouth, pharynx, and larynx cancer and increased vegetable intake of 100 g/day associated with a reduction of renal cell cancer and non-Hodgkin lymphoma (Yip, Chan, & Fielding, 2019).

A systematic review showed that overall there is an association between low fruit and vegetable consumption and severity of asthma; additionally, low consumption is associated with a prevalence of wheezing (Hosseini, Berthon, Wark, & Wood, 2017). Erectile dysfunction, which can be related to heart condition and overall fitness was negatively associated with increased fruit and vegetable consumption, with a 10% risk reduction for each additional daily serving of fruit or vegetable consumed (Wang, Dai, Wang, & Morrison, 2013). Potential health complications aid in justifying the need for a study determining if students are meeting the recommended number of daily fruit and vegetable servings.

2.2. Eating Habits of Post-Secondary Students

One study of eight universities in the United States of America found that freshmen were consuming relatively low amounts of fruits and vegetables and this amount tended to

decrease through the academic year, in part due to lack of knowledge surrounding health benefits and partially due to access constraint, such as distance to, availability of, and the cost of fruits and vegetables (Vilaro *et al.*, 2018). Students attending university in Alberta and enrolled in a nutrition course were also found to consume fewer fruits and vegetables than the suggested daily minimum (Frechlich, Eller, Parnell, Fung, & Reimer, 2017). According to Statistics Canada, the majority of Canadians aged 18-34 consume fruit and vegetables fewer than five times *per* day, with 24.4% of males and 36.4% of females consuming fruit and/or vegetables more than five times *per* day (2017). A significant decrease in the consumption of vegetables, green salad, and fruit during the first year of university, as compared to consumption before beginning higher education has been previously seen (Beaudry, Ludwa, Thomas, Ward, Falk, & Josse, 2019). For students reporting influencers, such as lifestyle, healthy eating knowledge, budget constraints, family, friends, and media; servings for fruits and vegetables were below the recommendations of the 2007 version of Canada's Food Guide (Mann & Blotnicky, 2016). Less than a quarter of surveyed students ate at least five servings per day with 27% and 12% consuming no orange/red and green vegetables respectively (Mann & Blotnicky, 2016). It is important to determine if students at Ontario Tech University, a highly commuter based institution, are consuming fewer servings of fruits and vegetables than the 2011 CFG recommendations *per* day or if they are meeting the recommended daily minimum, as lower consumption of fruits and vegetables could lead to some of the health complications previously mentioned.

Studies have shown that students are not likely to cook their own food but are rather more likely to eat out (Courtney, Majowicz., & Dubin, 2016). This behaviour is not linked to the students' inability to prepare their own meals but is instead related to either lack of time associated with preparing food, accessing ingredients, or other obstacles (Courtney,

Majowicz., & Dubin, 2016). Time can be a constraining factor when it comes to food preparation. It can prevent students from preparing healthy meals for themselves and instead necessitate a reliance on pre-prepared foods or food from restaurants, depending on what restaurants offer in the area. This could mean that students are eating a diet that consists of fast food and highly processed packaged foods. These behaviours are associated with low consumption of fruits and vegetables (Barnes. French, Mitchell, & Wolfson, 2016). These factors highlight how interactions with the differing types of food sources could impact health based on the types of foods that are being selected for intake. It is important to consider what factors are impacting fruit and vegetable intake.

2.3. Factors Impacting Dietary Intake: An Overview.

There are many factors that can influence dietary intake. One theoretical framework that deals with this is the Ecological framework of the influences on what people eat (Figure 2.1) and it divides influential factors into four main categories: Macro Level, Physical Environments, Social Environments, and Individual Factors (Story, Kaphingst, Robinson-Obrien, & Glanz, 2008). Factors impacting dietary intake include the physical environment, which includes access and availability (Story, Kaphingst, Robinson-Obrien, & Glanz, 2008). The Physical Environment and Individual Factors are framework levels that are of interest.

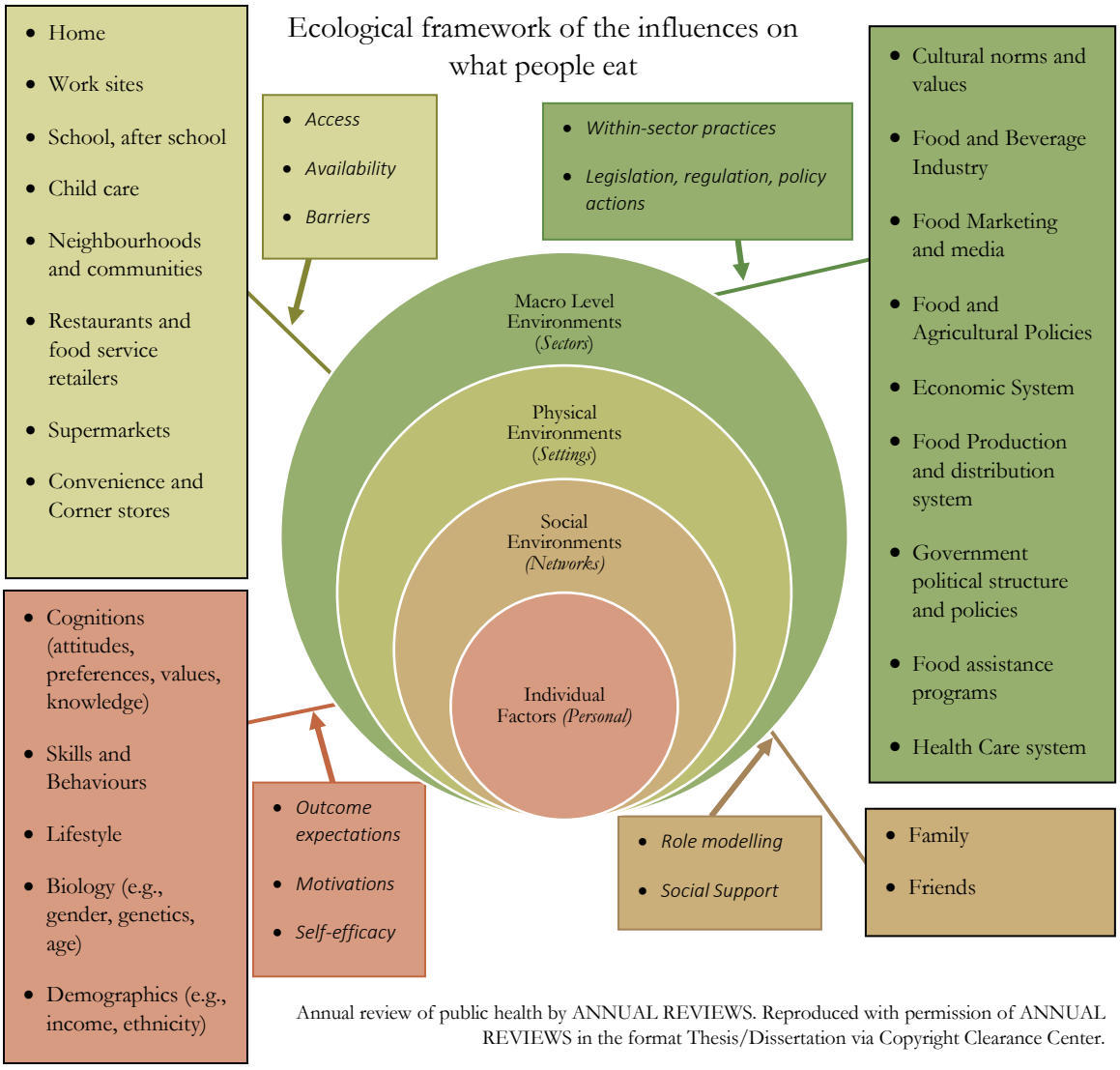

Figure 2.1. Ecological framework of the influences on what people eat. Figure taken from Story, Kaphingst, Robinson-Obrien, & Glanz, 2008 (Appendix A).

2.3.1. Factors impacting dietary intake: physical environment.

An ecological framework emphasizes the relationships and associations between nutritional intake and factors in the physical environment (Story *et al.,* 2008). Some of the strongest factors in the physical environment that relate to food intake are food availability,

whether the food is present, and food accessibility, and whether the food is in a location that facilitates consumption (Story *et al.,* 2008).

In regard to food access, food insecurity can be defined as follows:

[It] "exists within a household when one or more members do not have access to the variety or quantity of food that they need due to lack of money" (Roshanafshar & Hawkins, 2015, p.3). In Canada, the number of households that face food insecurity is approximately 1.1 million (Roshanafshar & Hawkins, 2015). Low socioeconomic status is often associated with food insecurity as individuals with of low socioeconomic status are more likely to report food insecurity than those with a higher socioeconomic standing, with over 50% of individuals that report food insecurity also reporting a reliance on social assistance (De Schutter, 2012). Low income is considered a barrier to food access and is often not mitigated by social assistance, with those living on social assistance having to make choices between paying necessities such as: utilities, rent, and food (Kirkpatrick & Tarasuk, 2009).

One factor concerning food insecurity is the ability to access food. A food desert(s) is a conceptual framework that deals with this issue. A food desert is an area with no or low access to food of insufficient quantity or quality (Smoyer-Tomic, Spence, & Amrhein, 2006). Food deserts are often urban and poor areas where low access levels can be exacerbated due to lack of available transportation (Smoyer-Tomic, Spence, & Amrhein, 2006).

Food insecurity in students at post-secondary institutes is an issue that is prevalent in Canadian institutions, with an estimated 40% of students reporting food insecurity as compared to the estimated 8.3% of households that report food insecurity (Silverthorn, 2016). Students also report having to make choices between paying for necessities, such as utilities, rent, and food, with the added burden of tuition, and have reported increased inability to study and reduced ability to maintain overall wellbeing (Silverthorn, 2016).

Students have reported an increase in the use of food hampers, but the quality of the food in the hampers requires the hampers to be supplemented with fresh dairy, meat, and produce (Jessri, Abedi, Wong, & Eslamian, 2014).

The availability of foods that contribute positively towards health from food retailers is a contributor to eating patterns (Story *et al.,* 2008). This framework suggests that: "Key categories of food sources in neighborhoods include stores and restaurants. It is useful to distinguish where people get food and what type of food they can get within those establishments." (Story, *et al.,* 2008, p. 265). To determine where food is being obtained by students in the FHS at Ontario Tech University and what type of food these students are obtaining is one step in understanding what role the physical environment plays in food intake, specifically in the intake of fruits and vegetables.

Understanding the components of the physical environment, such as restaurants, food service retailers, convenience stores, and supermarkets assists in establishing associations between the environment and food intake (Story *et al.,* 2008). When an area has fewer than ten suitable food sources/retailers the area can be classified as a "Food Desert" and can be either within a defined area or within a specified distance from a place (Walker, Keane, & Burke 2010). Food Deserts can be absolute or relative based on if foods offered are healthy or non-healthy food or other factors (Apparicio, Cloutier, & Shearmur, 2007; Larsen, & Gilliland, 2008; Luan, Law, & Quick, 2015; Sadler, Gilliland, & Arku, 2011). For relative food deserts, classification can be based on the type of store, whether it is a grocery store, fast food restaurant, a full-service restaurant, or convenience store or based on the types of food that are offered (Luan, Law, & Quick, 2015).

Some studies have shown that having access to food retailers that provide fresh produce will increase consumption of fruits and vegetables (Usher, 2015). Dining out at fast

foods restaurants and full-service restaurants has been linked to an increase in consumption of calories, cholesterol, fat, and sodium (An, 2016). There is also an association with fast food restaurants and increased BMI, lower total vegetable consumption, and reduced intake of nutrients such as magnesium and potassium (Barnes. French, Mitchell, & Wolfson, 2016). Living in close proximity to convenience stores and fast food retailers is linked to low quality diets in adolescents (He *et al*., 2012). Highly processed foods were found to be nutritionally inferior to unprocessed foods and were also found to have higher carbohydrates, fats, and sugars (Moubarac, Batal, Louzada, Steele, & Monteiro, 2016). Therefore, determining the types of retailers in an area can lead to an increased understanding of the physical environment (Sadler, Gilliland, & Arku, 2011).

The type of retailer is not the only factor that affects whether costumers will patronize a food retailer (Sadler, Gilliland, & Arku, 2011). If a food retailer does not provide customers with foods that are preference-based, customers may travel to other retailers that will provide them with foods of their choosing (Clarke *et al*., 2006; Jackson *et al*., 2006). There are certain dietary choices, such as low-sodium diets, gluten-free diets, and vegetarian diets that are associated with an increase in fruit and vegetable consumption. In one study it was found that participants were more likely to choose stores that had more food choices available than stores located closer to the participants homes (Hillier, Smith, Whiteman, & Chrisinger, 2017).

Gluten-free options have become more prevalent and one study found that 13% of young adults placed value on sources that offered gluten-free options and showed an association with eating more fruits and vegetables and consuming gluten-free foods (Christopher *et al*., 2017). As compared to individuals that did not value a gluten-free diet, those that placed value on obtaining gluten-free foods were found to consume about 1 more

daily serving each of fruit and vegetables (Christopher *et al.*, 2017). Consumption of a gluten-free diet or adherence to partial gluten avoidance, was associated with an increased consumption of fruits and vegetables (Perrin, Alles, Buscail, Ravel, Hereberg, Julia, & Kessse-Guyot, 2019). Those that partially avoided gluten and those that adhered to a gluten free diet had ORs of 1.1 and 1.4 for fruit consumption and 1.2 and 1.4 for vegetable consumption compared to those that were non-avoiders (Perrin, *et al.,* 2019).

Vegetarian diets, as compared to non-vegetarian diets, are associated with an increase of phytochemicals present in urine, which is associated with increased consumption of plant foods (Miles, *et al.*., 2019). This implies that a vegetarian diet is associated with increased consumption of fruits and vegetables. An increase in fruit and vegetable consumption is associated with access to produce (Usher, 2015). Some association is known to occur between the lowering of sodium in a diet and the increase of fruit and vegetable consumption (Wilson, Nghiem, & Foster, 2013).

There are positive associations between the consumption of fruits and vegetables and diets that provided, low-sodium options, gluten-free options, vegetarian options, and produce. Therefore, these measures where chosen to be used when determining associations between food retailers and fruit and vegetable consumption. As the type of retailers and options offered can impact health and food intake. This study is concerned with how students interact with the retailer type and option availability surrounding the university.

The area surrounding Ontario Tech University has been identified as a food desert based on a 5km/hour. 10-minute walking zone with fewer than 10 food sources (Frech, Graham, & Hamel, 2015). Food sources on campus can have inconsistent menu items and have variable hours throughout the academic year and were not included in the analysis of the food landscape (Frech, Graham, & Hamel, 2015). Within a 10-minute walk of the

university there were fewer than ten retailers. Within a 30-minute walking and busing travel distance of the university only 13.3% of the sources can be reached in a 10-minute walk and 20% of retailers do not provide produce, vegetarian options, low-sodium options, or gluten-free options. Having items that promote healthy behaviours such as the reduction of sodium and increase in fruit and vegetable consumption can lead to an increase in fruits and vegetable consumption (Usher, 2015). One study found that fast-food chains have changed their menus to provide more nutritious items, items that are lower in sodium and saturated fats to cater to customer preference (Hobin *et al.*, 2013). It is important to understand what food retailers are within a reasonable walking distance of the university, if the retailers are being frequented by students, and how this affects food access. Food availability and accessibility are emphasized as key to understanding associations between the physical environment and food intake patterns (Story *et al.,* 2008).

Within a 10-minute walk of the Ontario Tech University north location there were fewer than ten food retailers. Sources within a 30-minute travel distance, by walking or busing from the institute, were examined to determine how many of the retailers supplied food items that provide the four criteria. Food retailers were also classified as bars, bakeries, takeaways, retailers with available seating, and stores (Frech, Graham, & Hamel, 2016).

The food supplied by retailers surrounding the school were either too great a distance from the school or did not provide enough of the specific dietary options (Figure 2.2; Figure 2.3). This figure shows that 20% of retailers in a 30-minute travel distance do not provide produce, vegetarian options, low-sodium options, or gluten-free options (Frech, Graham, & Hamel, 2016). This emphasizes the importance of understanding what food sources students are purchasing food from, as it could affect fruit and vegetable consumption, which could impact health.

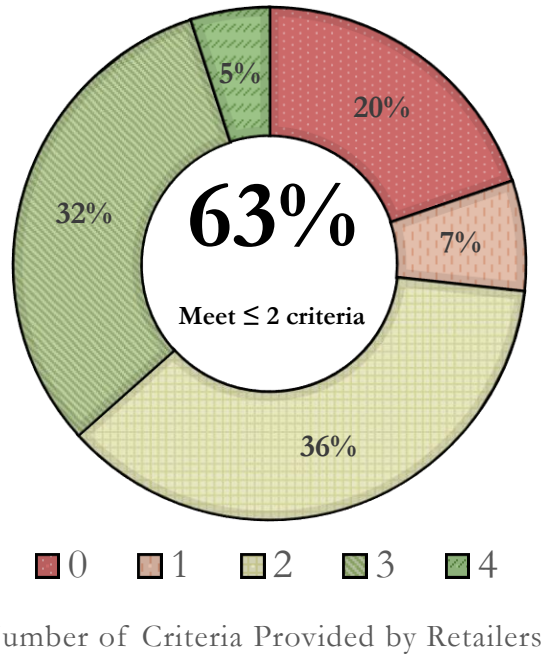

Figure 2.2: Restaurants in a 30-minute travel distance from Ontario Tech University north location. The number indicates the percentage of stores that provide 0, 1, 2, 3, or 4 of the following options: produce, vegetarian options, low sodium options, or gluten free options. This figure shows that while they may provide other options the majority of retailers do not provide multiple of these specific options that are related to increased fruit and vegetable consumption (Frech, Graham, & Hamel, 2016).

This study indicated that there fewer than 10 within the 10-minute travel zone and that the retailers within a 30-minute distance of the university failed to provide for specific dietary constraints, meaning that the food retailers present did not provide food that met the four options.

Sources: Navteq: Roads, Rails, Parks-2012; OBM: Buildings, Railroads, Airports-2012; F. G. H. Solutions: Food retailers, Bus Routes, Bus Stops -2016.

Figure 2.3: Map showing location of restaurants in a 30-minute travel distance from Ontario Tech University north location. The number indicates the number of options that retailers provide: 0, 1, 2, 3, or 4 of the following options: produce, vegetarian options, low sodium options, or gluten-free.

2.3.2. Factors impacting dietary intake: individual factors.

Individual factors, such as biology (age and gender), demographics (ethnicity), lifestyle (program of enrollment and access to a car) can have an impact on fruit and vegetable consumption and are factors in ecological framework that are part of understanding food intake patterns (Story, Kaphingst, Robinson-Obrien, & Glanz, 2008). In Canada, in 2013, those aged 15-80+ averaged a consumption rate of less than 5 servings *per* day (Krueger, Koot, & Andres, 2017). Females were shown to have a higher consumption

rate than their male counterparts; however, both groups still averaged less than 5 servings *per* day (Krueger, Koot, & Andres, 2017). Data from the CCHS showed that there was a significant gender-based difference for fruit and vegetable consumption for those 18 and older with women having an average total fruit and vegetable consumption of 4.39 as compared to the 3.47 seen in males (Clary, Ramos, Shareck, & Kestens, 2015).

The proportion of Aboriginal, Chinese, and Southeast Asian Canadians that consume five or more servings daily, of fruit and vegetables were significantly lower than the proportions of other ethnic groups and had the highest likelihood of developing long-term diseases (Quadir, & Akhtar-Danesh, 2010). There is an association between socioeconomic status and fruit consumption and the odds of eating ≥3 portions of vegetables increased with higher socioeconomic standing, which can include access to a car (Ball *et al.*, 2015). Students studying science and health sciences typically have better food handling and food based knowledge, as compared to non-science students (Courtney, Majowicz., & Dubin, 2016). Students taking health-related studies reported higher fruit and vegetable consumption than those enrolled in technical studies (Bogerd, Maas, Seidell, & Dijkstra, 2018). When considering the characteristics of the FHS it is worth noting that 78.7% of the population is between 18-24 years old and 78.7% is female (Office of the Registrar, 2018). Enrollment by program data for the FHS showed following: Health Sciences (32.8%), Kinesiology (26.2%), Medical Laboratory Science (13.1%), and Nursing (27.9%) (Office of the Registrar, 2018). Understanding the biology, demographics, and lifestyle of students in the faculty is important, as these factors can impact fruit and vegetable consumption, which can in turn impact student health.

2.4 Summary and Knowledge Gaps

Healthy eating is critical for health and wellbeing. Globally, poor dietary intakes are associated with increased morbidity and mortality (GBD 2017 Diet Collaborators, 2019). Lack of adequate fruit and vegetable intake can lead to health problems both in the short and long term. Eating habits can vary dependent on the population. Students of post-secondary institutions tend to eat out rather then prepare their own food (Silverthorn, 2016). Lack of food preparation can be due to lack of time, access to high quality food, access to sufficient quantity of food, or other food related skills (Larson, Perry, Story, & Neumark-Sztainer, 2006). There is minimal data on the dietary intake of Canadian university students in a growing sub-urban area. Assuring students have sufficient food of both high quality and quantity is important for assuring overall student health.

Assuring that the recommendations in Canada's Food Guide are being met is of interest, as meeting the recommendations in the guidelines can provide better health outcomes. To determine if recommendations set out by guidelines are being met, the fruit and vegetable intake of individuals must be determined. The CCHS uses Fruit and Vegetable Consumption (FVC) as an indicator of health status and can be considered appropriate for determining health quality (Health Canada, 2017). The student body of Ontario Tech University tends to commute from Toronto and other GTA location, which is a culturally diverse region and the home of many new immigrants (Nakamura & Donnelly, 2017). Variations in ethnicity and culture can impact food intake through variances in attitudes, preferences, values, and knowledge (Story *et al.,* 2008).

While studies have been completed on other institutions, Ontario Tech University is located in a growing sub-urban area, the student body is comprised primarily of commuters, and the majority of food retailers are located outside of a 10-minute walking distance from

the university. These unique features make evaluation regarding the fruit and vegetable consumption of students at Ontario Tech University a knowledge gap that this study attempts to provide insight into. The aim of this study is to quantify the fruit and vegetable intake of students and to determine if they are meeting the recommendations set out by the 2011 version of Canada's Food Guide and to examine what food retailers students are using to obtain food.

Chapter 3: Methodology

3.1. Design

The ecological framework of the influences on what people eat includes individual-level factors such as: biological and demographic factors (Story, *et al.,* 2008). The framework also includes physical environment level factors or where people obtain food such as: restaurants and supermarkets (Story, *et al.,* 2008). These framework levels interact to impact food intake behaviors and should be examined to better understand food intake and eating patterns (Story, *et al.,* 2008). To study the dietary components at an individual level and certain aspects of the environment, a cross-sectional survey was chosen. A cross-sectional survey is a descriptive study and is defined as "A random cross-section of a population or cohort performed at one particular time point" (Bowling, 2010). Cross-sectional surveys are cost effective and relatively easy to implement. They allow for the collection of information from a large audience and can provide results over a relatively short period of time.

Ontario Tech University has a total student enrolment of just over 10,000 with 9,400 undergraduate students. This body of students represents 6.25% of the Oshawa population (Benham, 2018). Most students commute from the Greater Toronto Area and Toronto (Provost's Advisory Committee on Integrated Planning, 2016). The enrolment of students by faculty can be seen in Figure 3.1.

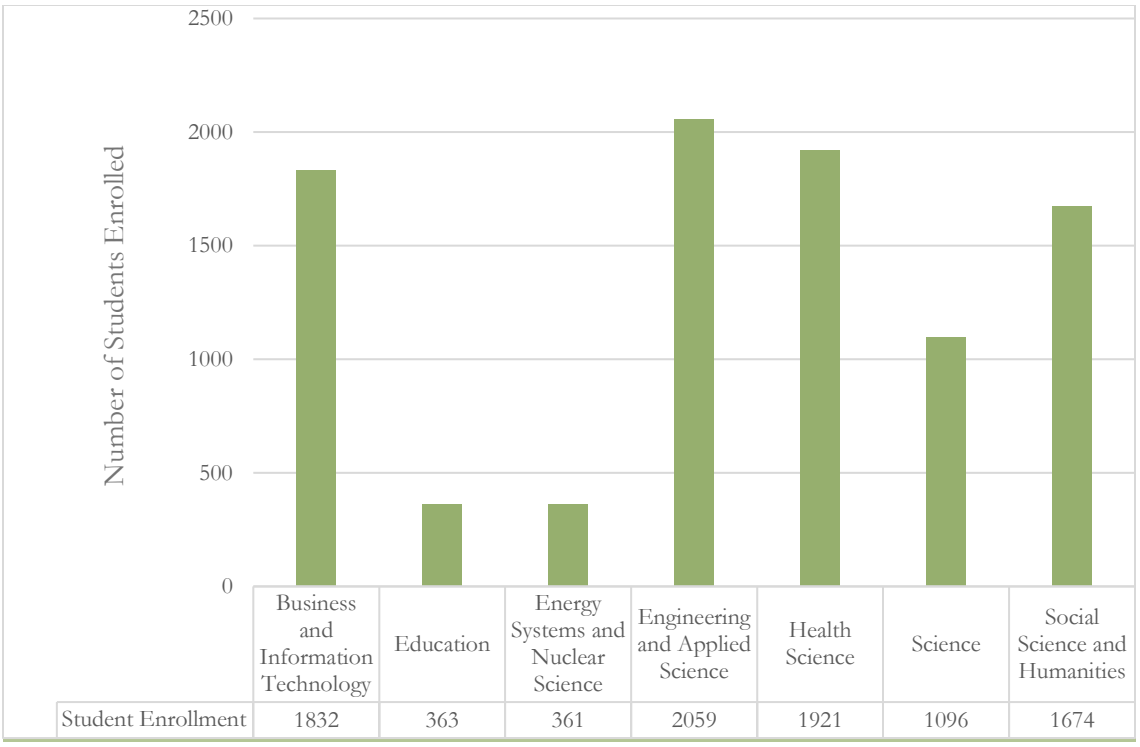

Figure 3.1: University of Ontario Institute of Technology Student Enrollment for 2017 – 2018. Enrollment displayed based on the faculty that students are enrolled in (Provost's Advisory Committee on Integrated Planning, 2016).

The food landscape surrounding the north location of the institution has been shown to be a food desert (Frech, Graham, and Hamel, 2016). Understanding how students in the FHS interact with the food retailer landscape can aid defining where students are obtaining food, and if the landscape is impacting fruit and vegetable consumption. It can also aid in the understanding of how students of the FHS compare to the population in general when it comes to factors, such as consumption of specific food groups through the adaptation of questions from pre-existing surveys.

In comparison to other Ontario universities, Ontario Tech University has a relatively low enrollment and the student body tends to commute from Toronto and the GTA or live

locally off campus (Office of the Registrar, 2018). A large proportion of the population of Toronto, York Region, and Durham Region are immigrants, 50.5%, 48.2%, and 24.1% respectively (Region of Durham, 2018).

Of the student body, the Faculty of Health Sciences (FHS) is one of the largest faculties. Past research has shown that students from science and health science faculties tend to possess greater food related knowledge (Courtney, Majowicz., & Dubin, 2016). The faculty is also large enough that given a standard recruitment rate, a sufficient number of participants should be ensured. Therefore, recruitment of students took place from the FHS.

To assess the FV intakes of students in the Ontario Tech University FHS, a cross-sectional survey of fruit and vegetable consumption and food retailer access was conducted. Second-year students in the FHS were selected for the study. We excluded first year students as they may not have had sufficient time to become familiar with the food retailers surrounding the campus and could potentially be in residence, and students in residence are required to purchase a food plan, which provides food on campus. Third-and fourth-year students were also excluded because they have a lower enrollment compared to second-year students. Descriptive methods were utilized to determine prevalence and associations of FV consumption and food acquisition were also determined.

3.2. Ethics, Recruitment, and Data Collection

The Ontario Tech University Research Ethics Board/Animal Care Committee approved the work in this thesis under REB #14498 (Appendix B). Recruitment occurred through an email sent out through Ontario Tech University's Office of the Registrar (Appendix C). The recruitment email was sent to 507 second-year students enrolled in the FHS. The recruitment email invited students to participate in an online questionnaire

through a link supplied in the email. The recruitment emails were sent out November 21, 2017 and March 13, 2018.

The questionnaire was comprised of a consent form (Appendix D) and four pages of questions (Appendix E). The questionnaire was administered online and hosted through Qualtrics, which supplies online secure data collection and storage (Qualtrics, n.d.). One week after each of the recruitment emails were sent, the results were downloaded from the Qualtrics servers. Downloaded data was stored on a password-protected Universal Serial Bus Drive.

The collected data was analyzed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 25. The first step was to combine the data from the two surveys. For the second step, incomplete survey results were removed. The third step involved the removal of extreme outliers. The interquartile range was determined for all FVC questions. Values that were greater than three times the interquartile range for any of the categories were removed. The remaining completed surveys were included in the analysis. The survey allowed participants to create a personalized 6-digit code based on their name and date of birth. The use of the partial name and their birthdate created a unique code that was used to identify duplicate responses as they remained consistent. This code was used to ensure that the same participant did not fill out the survey multiple times. If a participant had filled the survey out multiple times the survey from November was kept and the March survey was removed from analysis.

3.2.1. Sample size and inclusion/exclusion criteria.

For determining sample size, the sample size calculation was taken from Norman and Streiner (2014) and is as follows:

$$n = \left[\frac{(Z_\alpha + Z_\beta)s}{\Delta}\right]^2$$

Where

$n = sample\ size$

$s = standard\ deviation\ of\ the\ population$

$\Delta = difference\ between\ sample\ and\ population\ mean$

$Z_\alpha = z - value\ for\ \alpha\ (1.96)$

$Z_\beta = z - value\ for\ \beta\ (1.28)$ (Norman & Streiner, 2014)

The Canadian population has a mean daily consumption of fruits and vegetables of 4.95 with a standard deviation of 2.72 (Azagba & Sharaf, 2011). Based on the assumption that the student population has a lower fruit and vegetable consumption, a mean of 3.5 was selected for the sample value. Thus, making the difference between sample and population means equal to 1.45. Using the equation, a sample size of 36.9 or 37 individuals was calculated.

The inclusion/exclusion criteria for this study is based on the age of the participants. All responses from individuals over the age of 18 were included in the study. The consent form (Appendix D) required respondents to confirm their age before allowing them to participate in the study. All incomplete surveys were also excluded from analysis.

3.2.2. Collection of the primary outcome: FVC.

The questions concerning FVC were obtained from the CCHS Rapid Response 2016 FVC section of the survey (Statistics Canada, 2017). There were six questions pertaining to the consumption of Fruit Juice (FJ), Fruit, Dark Green Vegetables (DGV), ORange vegetables (OR), Potatoes, and Other Vegetables (OV) at daily, weekly, and monthly rates (Appendix C). Total FVC was determined by combining Fruit, DGV, OR, OV, Potatoes, and FJ. This is the method of calculating Total FVC used by Statistics Canada (Colapinto, Graham, & St-Pierre, 2018).

The FVC questions that were adopted from the CCHS had a range of input that included a minimum response value of 0 and a maximum of 300. The FVC was reported at a daily, weekly, or monthly rate. In order to make these reports comparable the daily FVC was also determined according to the reported weekly and monthly consumption. The daily rate was calculated based on a seven-day week and a thirty-day month. For example, if an individual reported eating 21 servings of fruit in a week, this would be calculated as 3 daily servings and 90 servings of fruit in a month would similarly calculate to 3 daily servings.

3.2.3. Collection of the secondary outcome: food retailer visits.

This section of the survey contained information on the frequency and type of food retailers being accessed by participants. The food retailers were grouped according to the number of dietary characteristics associated with increased fruit and vegetable consumption that food retailers provided and the type of food retailer (Table 3.1), as these options are associated with fruit and vegetable consumption (Christopher *et al*., 2017; Miles, *et al*.., 2019; Usher, 2015; Wilson, Nghiem, & Foster, 2013). Data pertaining to options provided by retailers and retailer type, were updated in September of 2017 to reflect the locations and options that were available. The retailer type and available option type were

based on information obtained from the retailers, either through phone conversation with the retailer or through information provided on the retailers' websites. Food retailers were classified based on how many of the options (vegetarian, low-sodium, gluten-free, & produce) they offered and what type of retailer they were (bar, bakery, takeaway, with available seating, & stores). Food retailer access was recorded as Daily 1+, Daily 1, Weekly 5-6, Weekly 3-4, Weekly 1-2, monthly 2-3, Monthly 1 or less, and Never.

Table 3.1: Food retailer categorization for food intake questionnaire

Type of Food Retailer	Number of Options*	Retailer Names
Sit-down restaurant	0 -1	Mary Browns Famous Fried Chicken, Kentucky Fried Chicken, Double Apple Café, Skywalk Café, Halibut House, British Style Fish and Chips, Churchill's Fish and Chips
Bakeries	0 -1	Crown Valley Bakery, Taunton Bakery
Bars	0 -1	The Crooked Uncle, T. Williams Pub and Grill, The Players Bench
Takeaway restaurant	0 -1	King Pita, Ming's Kitchen, Tybah's Kebab, Sinatra's Italian Sandwiches
Stores	2	Shoppers Drug Mart, Glover's Milk, El-Madina Grocery Store
Sit-down restaurant	2	Buster Rhino's, La Pizza & Pasta, Chef Tommy's Authentic Greek, Simcoe Blues & Jazz, Golden Gate Buffet, Momma's Family Restaurant, The Waltzing Weasel
Takeaway restaurant	2	Kip's Flaming Burger's, Malinee's Thai House, Bang Bang Burrito, Double Double Pizza and Chicken, Square Boy, Pizza Hut, Pizzaville, Taco Bell, Dairy Queen, Harvey's, Arby's, Pizza Pizza
Sit-down restaurant	3	Kotsy's, Tokushima Sushi, Mandarin Restaurant, Rainbow Sushi, Aunt Audry's Favorites, Whimpy's Diner, St. Louis Bar and Grill
Takeaway restaurant	3	Subway, McCoy Burger Company, Pizza Express, Coffee Culture, Tim Hortons, Pizza Nova, Quiznos Sub, Burger King
Store.	3	Giant Tiger
Store providing produce.	4	Fresh Co., No Frills, Metro

* Options associated with increased fruit and vegetable consumption (low-sodium, gluten-free, vegetarian, and produce available). On campus food options were not included due to variability of hours of operation and options offered.

3.2.4. Collection of sample characteristics.

Demographics considered included age, ethnicity, gender, program of study, and car ownership. Participants were required to be a minimum of 18 years old. Individuals under 18 are not legally considered to be adults in Canada and may not have full agency over food choices and consumption patterns. The options listed for participants to select from were as follows: 18 – 24; 25 – 34; 35 – 44; 45 – 54; 55 – 64; 65 – 74; 75 years or older.

Ethnicity in the CCHS is extensive and provides many categories that can make completion time consuming. It was decided that the categories used by the United States Census Bureau would be used for this study, as they are not as numerous, but still allow for a form of differentiation (U.S. Census Bureau, 2017). The categories were as follows: White; Hispanic or Latino; Black or African American; Indigenous People; Asian / Pacific Islander; Other.

Gender allowed the participants to identify as male, female, or other (Government of Canada, 2019). Program of study provided the participants the options that correspond to the four majors that are offered in the FHS at Ontario Tech University: Bachelor of Health Science (Honours); Kinesiology; Bachelor of Health Science (Honours) in Medical Laboratory Science; and Bachelor of Science (Honours) in Nursing. The car ownership question was a yes or no response.

3.3. Data Characterization and Analysis

Analysis of the data was carried out to characterize the primary and secondary outcomes, as well as the sample characteristics. Analysis was conducted for the associations between the primary outcome and sample characteristics, the primary and secondary outcomes, and the secondary outcome and the sample characteristics. For all statistical tests of significance, a p-value of 0.05 was selected as a cut-off value (Parab & Bhalerao, 2010). In the case where multiple comparisons exist the Bonferroni correction was used as per Norman and Streiner (2014).

$$p = (\alpha/m)$$

Where

$\alpha = 0.05$

$m = number\ of\ comparisson\ groups$ (Norman & Streiner, 2014)

3.3.1. Data characterization: FVC.

For the characteristics of the primary outcome, Mean, standard deviation, and the 95% confidence interval were determined for FVC. The six variables FJ, Fruit, DGV, OR, Potatoes, and OV were determined based on reported daily, weekly, and monthly values. As mentioned previously total FVC was determined by combining the Fruit, DGV, OR, and OV. For all six of variables, responses that were extreme statistical outliers were removed from the study. Extreme statistical outliers were any values found to be three times larger than the inner quartile range of the continuous data categories (Norman and Streiner, 2014). The proportion of respondents that ate at least one serving of dark green vegetables, at least one serving of orange vegetables, and at least seven total servings of fruits and vegetables was calculated and compared to the number of suggested servings of fruits and vegetables (7

servings per day, based on the recommended minimum from the 2007 CFG for adult women).

3.3.2. Data characterization: food retailer visits.

For the characteristics of the food retailer visit data, frequencies were determined. A Chi-square goodness of fit test was used to determine if there was a significant difference in the frequency of the answers to the food retail visit questions. The visit frequency was determined based on the type of store and the number of options (associated with an increase in fruit and vegetable intake) a store provided. Additionally, visit frequency was determined based on whether a retailer was a store, sit-down, or takeaway restaurant regardless of the number of options the retailer provides.

3.3.3. Data characterization: sample characteristics.

For the characteristics of the sample, frequencies were determined for the discrete data from the surveys. This includes demographic data. A Chi-square goodness of fit test was used to determine if there were significant differences within the parameters of age, ethnicity, gender, program, or car ownership (Appendix E, Page 1). A p-value of 0.05 was selected as a cut-off value, as this is a standard cut-off value (Parab & Bhalerao, 2010).

3.3.4. Data analysis: FVC and sample characteristics.

To compare fruit and vegetable consumption to ethnicity and gender, the original data was unsuitable, due to the data having too few counts to perform between group analysis. Categories were combined (Ethnicity: white/non-white, Gender: female/non-female) and differences were evaluated using an independent t-test. The independent t-test was also used for car access (Yes/No) as there were only two possible answers. One-way ANOVA tests were used to compare FVC for age and program. For categories with significant ANOVA results a *post-hoc* test was used to determine specifically where the

differences were. The *post-hoc* test selected was the Tukey's Honest Significant Difference Test.

3.3.5. Data analysis: FVC and food retailer visits.

For the food retailer visits, zero and one option bakeries and bars were not suitable for the independent t-test. The remaining food retailer visit frequency categories were reduced to visits/did not visit. The associations between food retailer visits and FVC were established using the independent t-test

Chapter 4: Results and Analysis

4.1 General Demographics of the Study Sample

Surveys were circulated to 507 students in the FHS of Ontario Tech University. A total of 100 participants submitted a survey response (initial response rate of 19.7%). Duplicate responses (n=5), incomplete responses (n=31), and statistical outliers (n=3) were removed from the dataset, which reduced the number of participants in analysis to 61 participants (Figure 4.1). This corresponds to a 12.6% response rate for surveys used for analysis. Participant characteristics are reported in Table 4.1. Most respondents were ages 18-24 years of age and female (78.7%).

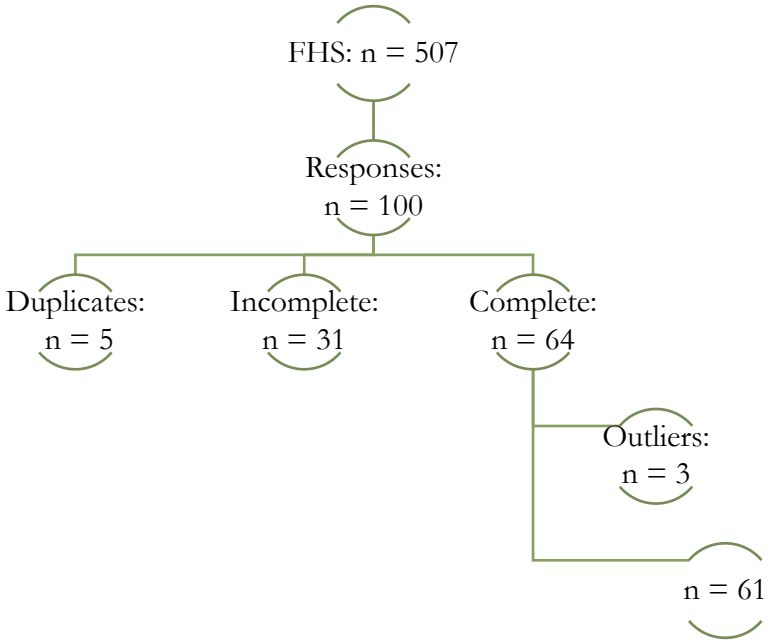

Figure 4.1 Participant recruitment and participation in the study. The initial recruitment emails were sent to 507 students. 100 students responded to the survey. After removal of duplicate respondents and partial complete results there were 64 surveys. Statistical outliers were removed from the group leaving 61 surveys to proceed to further analysis.

Table 4.1. Sample demographics.

Demographic Data	*n* (%)	*p-value*
Age		p<0.001
18 – 24	48 (78.7)	
25 – 34	8 (13.1)	
35 – 44	5 (8.2)	
Ethnicity/Race		p<0.001
White	32 (52.5)	
Hispanic or Latino	1 (1.6)	
Black or African American	5 (8.2)	
Asian / Pacific Islander	18 (29.5)	
Other	5 (8.2)	
Gender		p<0.001
Male	12 (19.7)	
Female	48 (78.7)	
Other	1 (1.6)	
Program		0.213
Health Science	20 (32.8)	
Kinesiology	16 (26.2)	
Medical Laboratory Science	8 (13.1)	
Nursing	17 (27.9)	
Access to car		0.478
Yes	26 (42.6)	
No	35 (57.4)	

4.2 Fruit and Vegetable Consumption

The mean and 95% confidence interval for each of the six categories: FJ (0.35, [0.23, 0.46]), Fruit (1.15, [096, 1.33]), DGV (1.38, [1.15, 1.60]), OR (0.83, [0.64, 1.03]), Potato (0.56, [0.43, 0.70]), and OV (0.84, [0.69, 0.99]) were recorded (Table 4.2). The total estimated consumption of fruits and vegetables was lower than the recommended daily servings in the 2011 version of CFG. The mean total FVC was found to be 4.76 (Table 4.2) and the proportion of students that consumed fruits and vegetables seven or more times per day was found to be 24.6% (Figure 4.2). For dark green and orange vegetables, the means were 1.38 and 0.83 respectively (Table 4.2) and the proportions of students that consumed green and orange vegetables once or more during a day were 65.5% and 49.2% respectively (Figure 4.2).

Table 4.2. Daily Fruit and Vegetable Consumption by Category.

					95% C.I.	
	Mean	**SD**	**Min**	**Max**	Upper	Lower
Fruit Juice	0.35	0.46	0.00	1.74	0.46	0.23
Fruit	1.15	0.75	0.00	3.33	1.33	0.96
Dark Green Vegetables	1.38	0.89	0.00	3.62	1.60	1.15
Orange Vegetables	0.83	0.78	0.00	2.93	1.03	0.64
Potatoes	0.56	0.53	0.00	2.00	0.70	0.43
Other Vegetables	0.84	0.60	0.00	2.50	0.99	0.69
Total FVC	4.76	2.40	0.00	10.13	5.36*	4.15

*Upper 95% C.I. is lower than the minimum recommended number of daily servings (8-10 for males and 7-8 for females aged 18-50). SD = Standard Deviation

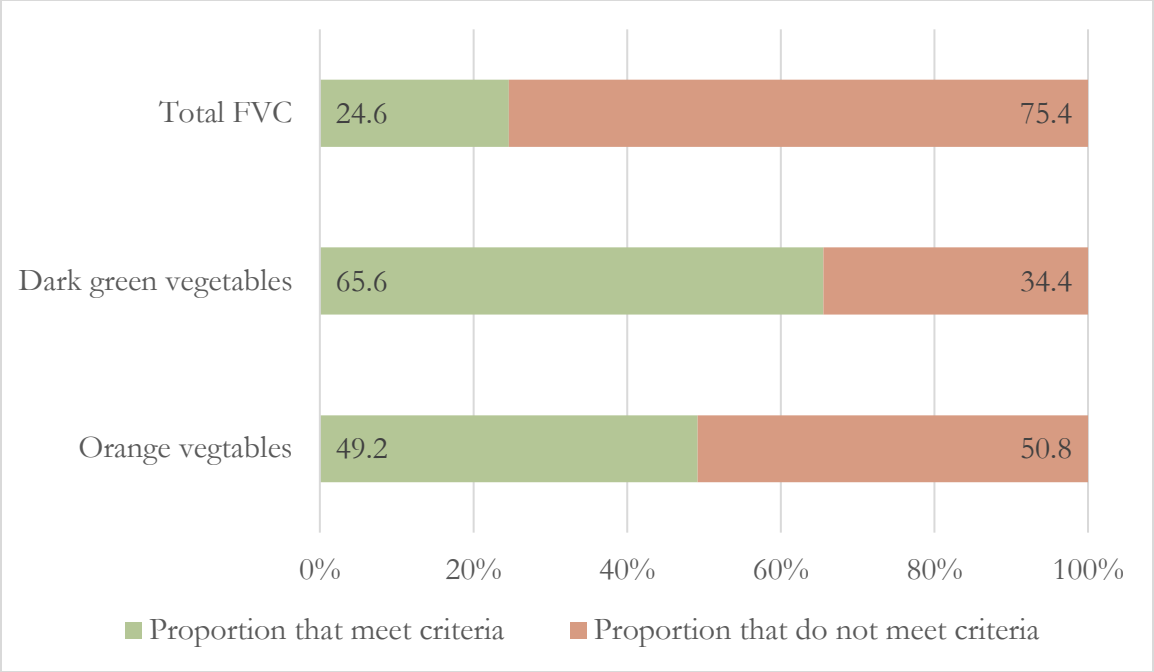

Figure 4.2. Proportion of students that meet minimum recommended daily intake from CFG. Where the criteria are at least one serving of dark green vegetables, one serving of orange vegetables, and a minimum total of 7 servings *per* day (Health Canada, 2011).

4.3. Fruit & Vegetable Consumption Comparisons based on Sample Characteristics and Food Retailer Visits

Comparisons between the categories of demographics, FVC, and food retailer visits were conducted. Comparisons between the following: demographic data and FVC; demographic data and food retailer visits; and FVC and food retailer visits were also conducted.

Between group comparisons for Age & FVC (Table 4.3), Ethnicity & FVC (Table 4.4), Gender (Table 4.5), Program & FVC (Table 4.6) and Car Access & FVC (Table 4.7) were recorded. No significant associations were found between age and FVC (Table 4.3). Ethnicity and fruit juice consumption ($p=0.0211$) and ethnicity and potato consumption

(p=0.0132) were found to be significant, while ethnicity and other categories of FVC were not found to have any significant associations (Table 4.4). For gender, there were significant associations between female and non-females for fruit juice consumption (p=0.0398) and orange vegetable consumption (p=0.0450), while other categories of FVC were not found to have any significant associations with gender (Table 4.5). No significant associations were seen for program of enrolment and fruit and vegetable consumption (Table 4.6). For car access and potatoes (p=0.0033), car access and other vegetables (p=0.0374), and car access and total vegetable consumption (p=0.0162) significant associations were seen (Table 4.7). Car access and other categories of fruit and vegetable consumption were not significant (Table 4.7).

Table 4.3. Comparisons between FVC & Age.

	Mean Daily Intake of FV			
	18-24 years Mean ± SD	**25-34 years** Mean ± SD	**35-44 years** Mean ± SD	P Value
Fruit Juice	0.34 ± 0.44	0.44 ± 0.62	0.22 ± 0.44	0.7189
Fruit	1.14 ± 0.80	1.06 ± 0.62	1.28 ± 0.44	0.8817
Dark Green Vegetables	1.40 ± 0.84	1.04 ± 0.68	1.70 ± 0.91	0.4030
Orange Vegetables	0.83 ± 0.73	0.49 ± 0.65	1.44 ± 1.15	0.0976
Potatoes	0.57 ± 0.56	0.54 ±0.47	0.54 ± 0.43	0.9839
Other Vegetables	0.90 ± 0.63	0.60 ± 0.45	0.68 ±0.43	0.3675
Total FVC	4.84 ± 2.49	3.73 ± 1.79	5.62 ± 2.16	0.3416

SD = Standard deviation

Between group comparisons conducted using a one-way analysis of variance.

Critical p-value = $\alpha/m = 0.05/3 = 0.017$

Table 4.4. Comparisons between FVC & Ethnicity.

	Mean Daily Intake of FV		P Value
	White Mean ± SD	**Non-White** Mean ± SD	
Fruit Juice	0.46 ± 0.26	0.22 ± 0.14	0.0211
Fruit	1.10 ± 0.58	1.20 ± 0.56	0.2971
Dark Green Vegetables	1.33 ± 0.95	1.43 ± 0.65	0.3234
Orange Vegetables	0.78 ± 0.51	0.89 ± 0.72	0.2825
Potatoes	0.42 ± 0.19	0.72 ±0.35	0.0132
Other Vegetables	0.86 ± 0.38	0.82 ± 0.36	0.4017
Total FVC	4.48 ± 5.28	5.06 ± 6.29	0.1725

SD = Standard deviation

Between group comparisons conducted using an independent t-test.

Table 4.5. Comparisons between FVC & Gender.

	Mean Daily Intake of FV		P Value
	Female Mean ± SD	**Non-Female** Mean ± SD	
Fruit Juice	0.30 ± 0.18	0.55 ± 0.30	0.0398
Fruit	1.21 ± 0.63	0.90 ± 0.25	0.0958
Dark Green Vegetables	1.40 ± 0.82	1.31 ± 0.74	0.3770
Orange Vegetables	0.74 ± 0.60	1.15 ± 0.74	0.0450
Potatoes	0.58 ± 0.33	0.51 ±0.11	0.3356
Other Vegetables	0.87 ± 0.73	0.39 ± 0.29	0.2260
Total FVC	4.80 ± 6.65	4.60 ± 2.66	0.3970

SD = Standard deviation

Between group comparisons conducted using an independent t-test.

Table 4.6. Comparisons between FVC & Program.

	Mean Daily Intake of FV				
	Health Science Mean ± SD	**Kinesiology** Mean ± SD	**Med Lab** Mean ± SD	**Nursing** Mean ± SD	P Value
Fruit Juice	0.39 ± 0.50	0.43 ± 0.43	0.06 ± 0.09	0.36 ± 0.52	0.2923
Fruit	1.10 ± 0.82	1.23 ± 0.77	1.01 ± 0.54	1.19 ± 0.78	0.8960
Dark Green Vegetables	1.13 ± 0.81	1.54 ± 0.78	1.41 ± 0.78	1.49 ± 1.11	0.5092
Orange Vegetables	0.78 ± 0.70	1.07 ± 0.79	1.22 ± 0.94	0.48 ± 0.33	0.0663
Potatoes	0.58 ± 0.58	0.57 ±0.44	0.81 ± 0.61	0.42 ± 0.50	0.3877
Other Vegetables	0.87 ± 0.66	0.92 ± 0.56	0.96 ±0.67	0.67 ±0.60	0.5832
Total FVC	4.47 ± 2.49	5.32 ± 2.49	5.43 ± 1.79	4.24 ± 2.16	0.4717

SD = Standard deviation

Between group comparisons conducted using a one-way analysis of variance.

Critical p-value = $\alpha/m = 0.05/4 = 0.0125$

Table 4.7. Comparisons between FVC & Car Access.

	Mean Daily Intake of FV		P Value
	Car Access Mean ± SD	**No Car Access** Mean ± SD	
Fruit Juice	0.43 ± 0.22	0.29 ± 0.21	0.1236
Fruit	1.04 ± 0.63	1.22 ± 0.51	0.1737
Dark Green Vegetables	1.21 ± 0.97	1.50 ± 0.65	0.1052
Orange Vegetables	0.72 ± 0.54	0.92 ± 0.65	0.1625
Potatoes	0.35 ± 0.17	0.72 ±0.32	0.0033
Other Vegetables	0.68 ± 0.33	0.96 ± 0.37	0.0374
Total FVC	4.00 ± 5.32	5.02 ± 5.70	0.0162

SD = Standard deviation

Between group comparisons conducted using an independent t-test.

4.4 Food Retailer Visits

The frequency in which respondents visited food retailers was recorded (Table 4.8). The food retailers were separated according to the number of options associated with increased fruit and vegetable intake they provided (low-sodium, gluten-free, vegetarian, and produce). It was found that 0-1 option retailers (bakeries, bars, sit-down retailers, and takeaways) were most frequently visited "Never" ($n=59$, $p < 0.001$; $n=59$, $p < 0.001$; $n=41$, $p = 0.031$; $n=53$, $p < 0.001$). Responses to visits to 2 option stores were not significant ($p = 0.183$), 2 option sit-down retailers were never visited, and 2 option takeaways were visited Monthly 1-2 times and Never ($n=13$, $p < 0.001$, $n=16$, $p = 0.086$). 3 option stores and takeaway retailers were most frequently visited "Never" ($n=56$, $p < 0.001$; $n=36$, $p < 0.001$). Responses to visits to 3 option sit-downs occurred with non-different probability ($p = 0.149$). Supermarkets (stores selling produce) were most commonly visited Weekly 1-2 ($n=20$, $p < 0.001$). Generally, students do not eat out.

Table 4.8. Frequency of visits to food retailers providing different dietary options (Gluten free, vegetarian, low sodium, and produce).

	Food retailer type and option frequency of visits							
	Daily	**Weekly 5-6**	**Weekly 3-4**	**Weekly 1-2**	**Monthly 2-3**	**Monthly 1-2**	**Never**	P Value*
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
0-1 Bakeries	1 (1.6)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.6)	59 (96.7)	p<0.001
0-1 Bars	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (3.3)	59 (96.7)	p<0.001
0-1 Sit-downs	1 (1.6)	0 (0)	1 (1.6)	2 (3.3)	5 (8.2)	11 (18.0)	41 (68.9)	p<0.001
0-1 Takeaways	0 (0)	0 (0)	1 (1.6)	0 (0)	3 (4.9)	4 (6.6)	53 (86.9)	p<0.001
2 Stores	2 (3.3)	0 (0)	2 (3.3)	12 (19.6)	14 (23.0)	15 (24.6)	16 (26.2)	p = 0.183
2 Sit-downs	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.6)	4 (6.6)	56 (91.8)	p<0.001
2 Takeaways	1 (1.6)	0 (0)	2 (3.3)	11 (18.0)	11 (18.0)	13 (21.3)	16 (26.2)	p<0.001
3 Stores	0 (0)	0 (0)	1 (1.6)	0 (0)	1 (1.6)	3 (4.9)	56 (91.8)	p<0.001
3 Sit-downs	5 (8.2)	7 (11.5)	15 (24.6)	9 (14.8)	11 (18.0)	9 (14.8)	5 (8.2)	p = 0.149
3 Takeaways	0 (0)	0 (0)	1 (1.6)	1 (1.6)	10 (16.4)	13 (21.3)	36 (59.0)	p<0.001
Supermarkets	3 (6.5)	1 (1.6)	5 (10.9)	20 (28.3)	12 (21.7)	7 (13.0)	13 (19.6)	p<0.001

* Count is less than five; therefore, results cannot be considered significant.

Table 4.8. Continued: Frequency of visits to food retailers providing different dietary options (Gluten free, vegetarian, low sodium, and produce).

	Food retailer type and option frequency of visits							P Value*
	Daily n (%)	**Weekly 5-6** n (%)	**Weekly 3-4** n (%)	**Weekly 1-2** n (%)	**Monthly 2-3** n (%)	**Monthly 1-2** n (%)	**Never** n (%)	
All Stores	5 (8.2)	1 (1.6)	6 (9.8)	25 (41.0)	13 (21.3)	8 (13.1)	3 (4.9)	p<0.001
All Sit-downs	6 (9.8)	7 (11.5)	15 (24.6)	8 (13.1)	13 (21.3)	8 (13.1)	4 (6.6)	0.571
All Takeaways	1 (1.6)	0 (0)	2 (3.3)	12 (19.7)	17 (27.9)	18 (29.5)	11 (18.0)	p<0.001

Critical p-value = $\alpha/m = 0.05/7 = 0.007$

The majority of students never visit 3 option stores (92%), 3 option takeaways (59%), 2 option sit-downs (92%), and all 0-1 option retailers (87%, 98%, 97%, & 67%). The majority of students do visit the supermarkets (79%), 3 option sit-downs (92%), 2 options takeaways (70%), and 2 option stores (74%) (Figure 4.3). Locations of the types of retailers offering different options were recorded (Figure 4.4; Figure 4.5; Figure 4.6; & Figure 4.7).

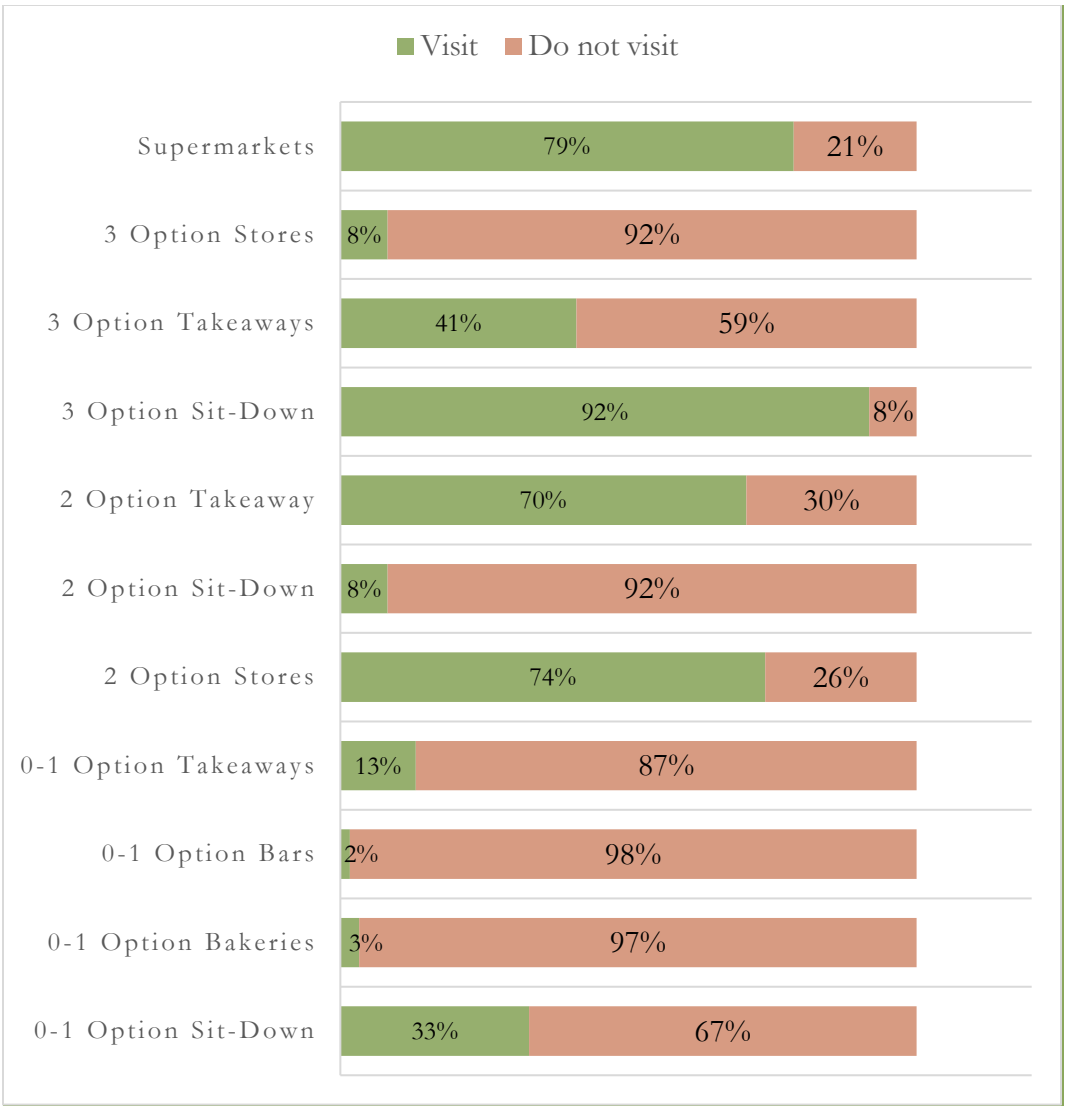

Figure 4.3. Percentage of food retailers that are visited and not visited by FHS students. Options that sources offer are gluten-free, low-sodium, vegetarian, and produce.

Sources: Navteq: Roads, Rails, Parks-2012; OBM: Buildings, Railroads, Airports-2012; F. G. H. Solutions: Food retailers, Bus Routes, Bus Stops -2016, Created using QGIS Desktop 3.4.2.

Figure 4.4. Food retailers that offer 0-1 options. Options that sources offer are gluten-free, low-sodium, vegetarian, and produce.

Sources: Navteq: Roads, Rails, Parks-2012; OBM: Buildings, Railroads, Airports-2012; F. G. H. Solutions: Food retailers, Bus Routes, Bus Stops -2016, Created using QGIS Desktop 3.4.2.

Figure 4.5. Food retailers that offer 2 options. Options that sources offer are gluten-free, low-sodium, vegetarian, and produce

Sources: Navteq: Roads, Rails, Parks-2012; OBM: Buildings, Railroads, Airports-2012; F. G. H. Solutions: Food retailers, Bus Routes, Bus Stops -2016, Created using QGIS Desktop 3.4.2.

Figure 4.6. Food retailers that offer 3 options. Options that sources offer are gluten-free, low-sodium, vegetarian, and produce.

Sources: Navteq: Roads, Rails, Parks-2012; OBM: Buildings, Railroads, Airports-2012; F. G. H. Solutions: Food retailers, Bus Routes, Bus Stops -2016, Created using QGIS Desktop 3.4.2.

Figure 4.7. Food retailers that sell fresh produce. Options that sources offer are gluten-free, low-sodium, vegetarian, and produce.

For associations between FVC and food retailer visits, due to the distribution of the data, zero and one option bakeries and bars were not suitable for the independent t-test. The remaining food retailer visit associations with FVC were found using the independent t-test. The results were recorded for FVC and 0-1 option retailers (Table 4.9), 2 option retailers (Table 4.10), 3 option retailers (Table 4.11) and retailers selling produce (Table 4.12). For 0-1 option takeaways and fruit consumption ($p=0.0306$), and 0-1 option sit-downs ($p=0.0185$) significant associations were seen, while all other types of retailers offering 0-1 options and categories of fruit and vegetable consumption were found not to be significant (Table 4.9). For stores offering 2 options there was a significant association in potato consumption ($p=0.0132$), while all other associations between 2-option retailers and categories of fruit and vegetable consumption were not significant (Table 4.10). For stores offering 3 options there was a significant association in potato consumption ($p=0.0144$), while all other differences between 3-option retailers and categories of fruit and vegetable consumption were not significant (Table 4.11). There were no significant associations between fruit and vegetable consumption and visits to retailers that offered produce (Table 4.12).

Table 4.9. Associations between FVC and 0-1 option retailers.

	Mean Daily Intake of FV				
	Visit Sit-down		**Visit Takeaway**		P Value*
	Yes (n=20)	**No (n=41)**	**Yes (n=8)**	**No (n=53)**	Sit-down Takeaway
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Fruit Juice	0.39 ± 0.31	0.33 ± 0.17	0.40 ± 0.21	0.34 ± 0.22	0.2965 0.3595
Fruit	1.12 ± 0.67	1.16 ± 0.52	0.68 ± 0.12	1.22 ± 0.59	0.2965 0.0306
Dark Green Vegetables	1.32 ± 0.93	1.41 ± 0.75	1.03 ± 0.69	1.43 ± 0.80	0.3673 0.1202
Orange Vegetables	0.72 ± 0.66	0.88 ± 0.59	0.97 ± 0.54	0.81 ± 0.62	0.2255 0.2993
Potatoes	0.36 ± 0.21	0.66 ±0.29	0.85 ± 0.50	0.52 ± 0.24	0.0185 0.0501
Other Vegetables	0.75 ± 0.29	0.88 ± 0.40	0.82 ±0.28	0.84 ±0.38	0.2041 0.4729
Total FVC	4.27 ± 5.36	4.99 ± 5.90	4.36 ± 4.36	4.82 ± 6.02	0.1346 0.3092

SD = Standard deviation

Between group comparisons conducted using an independent t-test.

Table 4.10. Associations between FVC and 2 option retailers.

	Mean Daily Intake of FV						P Value*
	Visit Store		**Visit Sit-down**		**Visit Takeaway**		Store Sit-down Takeaway
	Yes (n=45) Mean ± SD	**No (n=16)** Mean ± SD	**Yes (n=5)** Mean ± SD	**No (n=56)** Mean ± SD	**Yes (n=43)** Mean ± SD	**No (n=18)** Mean ± SD	
Fruit Juice	0.34 ± 0.20	0.33 ± 0.17	0.45 ± 0.33	0.34 ± 0.21	0.38 ± 0.21	0.28 ± 0.22	0.4280 0.3095 0.2336
Fruit	1.21 ± 0.59	0.97 ± 0.46	0.63 ± 0.30	1.19 ± 0.56	0.38 ± 0.28	0.28 ± 0.22	0.1333 0.0556 0.1134
Dark Green Vegetables	1.41 ± 0.68	1.28 ± 1.16	1.25 ± 0.77	1.39 ± 0.81	1.48 ± 0.83	1.22 ± 0.66	0.3055 0.3751 0.0778
Orange Vegetables	0.65 ± 0.31	0.31 ± 0.14	0.73 ± 0.27	0.55 ± 0.28	0.60 ± 0.31	0.48 ± 0.22	0.0982 0.4415 0.1746
Potatoes	0.36 ± 0.21	0.66 ±0.29	0.85 ± 0.50	0.52 ± 0.24	0.85 ± 0.50	0.52 ± 0.24	0.0132 0.2313 0.2284
Other Vegetables	0.85 ± 0.36	0.80 ± 0.41	0.58 ± 0.14	0.86 ± 0.38	0.84 ± 0.82	0.82 ± 0.53	0.3805 0.1630 0.4507
Total FVC	5.03 ± 5.52	3.97 ± 5.92	4.08 ± 4.82	4.78 ± 5.88	5.04 ± 5.67	4.08 ± 5.60	0.0640 0.2584 0.0795

SD = Standard deviation, between group comparisons conducted using an independent t-test.

Table 4.11. Associations between FVC and 3 option retailers.

	Mean Daily Intake of FV						P Value*
	Visit Store		**Visit Sit-down**		**Visit Takeaway**		Store Sit-down Takeaway
	Yes (n=5) Mean ± SD	**No (n=56)** Mean ± SD	**Yes (n=25)** Mean ± SD	**No (n=53)** Mean ± SD	**Yes (n=56)** Mean ± SD	**No (n=5)** Mean ± SD	
Fruit Juice	0.41 ± 0.217	0.34 ± 0.22	0.37 ± 0.16	0.33 ± 0.19	0.35 ± 0.19	0.36 ± 0.54	0.3788 0.4088 0.4778
Fruit	1.20 ± 0.31	1.14 ± 0.59	1.08 ± 0.67	1.19 ± 0.50	1.13 ± 0.60	1.27 ± 0.19	0.4363 0.2728 0.3497
Dark Green Vegetables	1.68 ± 0.68	1.35 ± 0.82	1.41 ± 0.83	1.35 ± 0.80	1.36 ± 0.81	1.56 ± 0.70	0.2147 0.4057 0.3232
Orange Vegetables	1.35 ± 0.99	0.78 ± 0.56	0.79 ± 0.49	0.86 ± 0.70	0.87 ± 0.61	0.39 ± 0.33	0.0560 0.3735 0.0930
Potatoes	1.06 ± 0.36	0.66 ±0.29	0.59 ± 0.33	0.54 ± 0.25	0.57 ± 0.29	0.50 ± 0.20	0.0144 0.3731 0.3888
Other Vegetables	0.68 ± 0.25	0.85 ± 0.38	0.78 ± 0.32	0.88 ± 0.40	0.80 ± 0.36	1.26 ± 0.25	0.2759 0.2516 0.0500
Total FVC	5.03 ± 5.52	4.74 ± 6.17	4.98 ± 1.32	4.64 ± 4.83	5.97 ± 5.01	4.65 ± 5.76	0.4160 0.3816 0.1203

SD = Standard deviation, between group comparisons conducted using an independent t-test.

Table 4.12. Associations between FVC and Supermarkets.

	Mean Daily Intake of FV		P Value*
	Yes (n=48) Mean ± SD	**No (n=13)** Mean ± SD	
Fruit Juice	0.35 ± 0.19	0.35 ± 0.31	0.4943
Fruit	1.08 ± 0.56	1.39 ± 0.53	0.0920
Dark Green Vegetables	1.33 ± 0.84	1.54 ± 0.64	0.2376
Orange Vegetables	0.86 ± 0.64	0.72 ± 0.51	0.2950
Potatoes	0.61 ± 0.31	0.40 ±0.15	0.1064
Other Vegetables	0.79 ± 0.40	1.00 ± 0.21	0.1408
Total FVC	4.67 ± 6.65	5.05 ± 2.60	0.3089

SD = Standard deviation

Between group comparisons conducted using an independent t-test.

Chapter 5: Discussion and Conclusions

5.1 Discussion

The purpose of this study was to determine the fruit and vegetable consumption of second-year students in the FHS at Ontario Tech University and what food retailers students visit. From the results of this study the three main findings are as follows:

1. The estimated consumption of fruit and vegetables does not meet the minimum recommendations of the 2011 version of Canada's Food Guide.
2. Students, with the exception of visits to 2-option takeaways, 2-option stores, and 3-option sit-downs, generally, do not eat out.
3. There are some ethnicity and gender-based differences in the consumption of fruits and vegetables.

The area surrounding Ontario Tech University and associations of fruit and vegetable consumption with food retailer visits are of interest, as it is important to determine where students are obtaining food to aid in determining what role the type of food retailer plays in fruit and vegetable consumption. Studies have shown that undergraduate university and college students tend not to prepare their own meals (Courtney, Majowicz., & Dubin, 2016; Wiggers *et al.*, 2018). This places importance on understanding where students are obtaining food, as food retailers may not provide options that allow students to consume adequate foods, such as fruits and vegetables. Understanding what students are eating is also important as there are associations between FVC and cognitive function (Cohen, Ardern, & Baker, 2016). Cognitive function is an important part of succeeding as a post-secondary student.

To produce data that is generalizable to the population of post-secondary students overall, it is necessary to obtain a sample that provides an accurate representation of the

population being studied. For the demographics of the study sample the findings showed the enrollment was varied between Health Science (32.8%), Kinesiology (26.2%), Medical Laboratory Science (13.1%), and Nursing (27.9%). The population was largely young, 18-24 (78.7%) and female (78.7%). Fewer than 20% of Canadians age 15 – 35+ consume the number of servings of fruits and vegetables suggested by CFG (Krueger, Koot, & Andres, 2017). This is similar to the reported age (80.7% Age 24 and under), gender (74% female enrollment for 2016-2017), and program enrollment reported for between Health Science (28.0%), Kinesiology (26.4%), Medical Laboratory Science (8.8%), and Nursing (37.9%) reported by the university (Office of the Registrar, 2018). This would suggest that, although the sample is small it is a fair representation of the faculty and can be used towards understanding the population eating behaviours, habits, and patterns.

The area surrounding the north location of the university has been identified as a food desert, due to the lack of retailers surrounding the institute (Frech, Graham, & Hamel, 2015). This can make food acquisition difficult. Areas with a higher density of takeaway restaurants are related to higher prevalence of obesity (Polsky, Moineddin, Dunn, Glazier, & Booth, 2016). It is important to remember that in the area surrounding the university 64% of food retailers are fast food restaurants (Frech, Graham, and Hamel, 2016). The majority of students visit 2-option takeaways. This means that the food that is available could lead to excess weight gain, which in turn can affect overall student health.

Understanding what students are eating is a key part of ensuring that students are maintaining healthy eating habits suggested by dietary guidelines (Playdon *et al.*, 2017). It is important to determine the adequacy of fruit and vegetable intake. Higher intake of fruits and vegetables is associated with lower BMI, which in turn is associated with better health outcomes (Azagba, & Sharaf, 2012). It is important to ensure that recommended daily levels

are met at both an individual and societal level. According to the estimated intake, students are not meeting these recommendations, which could put their overall health and wellbeing at risk.

The number of times students reported daily eating fruits and vegetables was fewer than five, which is similar to other studies regarding Canadian university students, as they reported consuming fewer than five servings per day (Beaudry *et al.,* 2019, Mann & Blotnicky, 2016). These consumption patterns are associated with an increased body weight, which could lead to health complications in later life (Beaudry *et al.,* 2019).

For estimated daily consumption; dark green vegetables, fruit, and orange vegetables have the highest means and other vegetables, potatoes, and fruit juice have lower reported means. Non-female students reported significantly higher consumption of orange vegetables. This result is dissimilar to those seen from a study by Slater and Mudryi (2018), where it was reported that Canadians are aware that they should be consuming dark green vegetables but are not aware that orange vegetables should be consumed daily. This would indicate that there are students in the faculty which have some knowledge on what types of vegetables should be eaten, but that there could be a gender-based difference of knowledge.

There is a negative relationship between reported times fruit juice is consumed and socioeconomic status (Shupler & Raine, 2017). Some studies have found that fruit juice tends to be consumed in larger quantities to increase fruit and vegetable intake and to meet recommended daily totals of fruit and vegetable servings (Black & Billette, 2013). Fruit juice is no longer considered a source of fruit, it is now categorized as a sugary drink (Health Canada, 2019). The students in this study reported a lower level of fruit juice consumption, consistent with consumption seen from individuals of a lower socioeconomic status. This does not necessarily indicate the socioeconomic standing students in the study, as other

factors could be contributing to lower fruit juice intake, such as increased education or availability (Hiza, Casavale, Guenther, & Davis, 2013). Fruit juice is no longer counted towards total fruit and vegetable consumption (Wang, Dai, Wang, & Morrison, 2013). This could in part explain low intake of fruit juice, as consumption is no longer being recommended. For this study non-white and female students drink significantly lower amounts of fruit juice as compared to their white non-female counterparts. A study by Drewnowski and Reham found that non-white individuals in lower socioeconomic households consume less fruit juice as compared to their white counterparts, while those of higher socioeconomic status also consume less than those of lower standing (2015). Differences between binary genders showed that females drank less fruit juice than their male counterparts (Drewnowski & Rehm, 2015). As the FHS students that are consuming less fruit juice are non-white, female, the results are not unexpected; however, it is important to note that this portion of the sample was relatively small, and the results could be affected by this.

In the current study, those that did not have car access consumed more potatoes, other vegetables, and total vegetables as compared to those who did. Those without car access may be consuming more total vegetables, but they are not consuming significantly more of the dark green vegetables and orange vegetables, as recommended by the food guide. This indicates that while they are consuming a greater quantity of fruits and vegetables, they may not be consuming a higher quality of fruits and vegetables. Consumption of fruit and vegetable type could be related to the food provided by sources that are closest to the university, as none of the sources within a 10-minute walking distance provide produce (Frech, Graham, & Hamel, 2016).

In comparison to the Canadian population, total fruit and vegetable consumption for the students was lower (Azagba & Sharaf, 2011). In a study that used similar methods to this study, it was found that fruit and vegetable consumption for the same age group of the Canadian population was similar to the value reported using the 24-hr. recall dietary assessment method (Wang, Dai, Wang, & Morrison, 2013). This indicates that the method for fruit and vegetable consumption is appropriate and low fruit and vegetable consumption could be due to other factors.

Younger Canadian females tend to report a consumption of fruit and vegetables more than five times a day, which is still below the 2007 CFG recommended daily intake (Colapinto, Graham, & St-Pierre, 2018). The results of this study are consistent with this, suggesting that intake for young female Canadians is similar to young females in the Canadian Population.

This study showed that students that visited retailers that provided more dietary options (low-sodium, gluten-free, vegetarian, and produce) were less likely to visit retailers that provide fewer options. Students who visited sit-down retailers, that provide more options, are less likely to visit takeaways. This shows that the students seem to be selecting food retailers that offer more options and indicates that the products they are seeking out may not be offered by retailers that offer fewer options. Due to the recent inclusion of nutritional information on Ontario menus at takeaway restaurants, individuals have reported an increased awareness of the nutrition content of foods being consumed (Goodman, Vanderlee, White, & Hammond, 2018). This could explain in part why takeaway restaurants are not being utilized to the same extent as retailer's sit-down retailer. One thing that is for certain is that students that are utilizing similar high option retailers are also denying

patronage to similar low option retailers. It could also be due to the distance to food retailer or due to some retailers not providing options that students wish to consume.

This study has shown that a higher proportion of students visit, than do not visit the following retailers: three-option sit-down retailer, zero and one option sit-down retailers, and four-option retailers. There was some use of two-option takeaways, two-option stores and three-option takeaway retailers. While students are consuming food items from fast-food restaurants according to Black and Billette (2015), their level of reported daily fruit and vegetable consumption indicates that they may be consuming menu options that offer fruits and vegetables. This is supported by the fact that three-option sit-down retailers and four-option retailers are used with a higher frequency than takeaway restaurants that offer fewer options and takeaway restaurants that offer more options. Additionally, sit-down retailers are associated with increased consumption of fruits and vegetables (Walton *et al.*, 2018). This does not necessarily support the notion that students' food choices are unhealthy but could provide a further avenue of study to determine what types of foods are being selected from each.

This study found that students that do not visit takeaway restaurants with one option or less have a higher fruit consumption than those that do visit. As these students are not visiting takeaways it is assumed that they have a lower consumption of fast food. Studies have shown that intake of at least five fruits and/or vegetables is also associated with lower fast food consumption (Black & Billette, 2015). This is similar to the results seen in this study. As the takeaway restaurants have limited options, students that are visiting these takeaway restaurants are reporting consumption of a lower number of fruits than those that don't visit, which in turn could mean they are consuming other foods that are less healthy.

Students that do not visit 0-1 option sit-down retailer and that visit 2 and 3 option stores have higher potato consumption than those that do visit. These are options that are associated with increased fruit and vegetable intake; furthermore, one conclusion that can be drawn is that the increased quantity does not guarantee an increased in quality of fruits and vegetables consumed. The 2019 version of Canada's Food Guide stresses which types of foods should be consumed and provides the emphasis on quality over quantity (Health Canada, 2019).

Non-white students were shown to be more likely to visit 2 option stores. Non-white individuals and visits to 2 option stores are both associated with increased potato consumption. This indicates that the link between ethnicity and visits of this type of source can impact potato consumption. Additionally, it aids in understanding the association between personal factors such as ethnicity and fruit and vegetable consumption in the context of the student population (Story *et al.,* 2008).

2 options stores were also associated with student car access. Those that have a car are less likely to visit 2 option stores. It is worth noting that one, of the two option sources, is in close proximity to the university and that could be why those with cars are not purchasing food from this type of source as they have the ability to travel to other food retailers. Access of this source by non-white students and potato consumption could be related to the specific options provided by this source and its proximity, but this is an area that would require further investigation in order to be able to state anything definitively.

While Canada's Food Guide no longer gives a specific number of recommended servings of fruits and vegetables that must be consumed, the Food Guide still emphasizes the importance of eating a variety of vegetables such as: leafy greens, broccoli, carrots, fruits, and cucumber. These vegetables fall into the categories set out in the CCHS (fruit juice, dark

green vegetables, fruit, and other vegetables). Understanding the quantities of fruits and vegetables that are being consumed is important in understanding possible health outcomes, as reduced consumption is still related to certain chronic illnesses. Access to food is a fundamental human right (OECD, 2017). Students of postsecondary educational institutions deserve to be able to obtain enough food to maintain a healthy lifestyle (OECD, 2017).

Students ability to obtain sufficient numbers of foods such as fruits and vegetables needs to be addressed to ensure students are not at risk of developing non-communicable diseases, such as cardiovascular disease and cancer. As some students have limited means they must rely on the food they bring with themselves or what is present in their food environment and the types of food they can obtain. If they are not bringing food from their homes, they are reliant on whether food retailers in their area provide affordable food that meets their dietary needs, and this can limit a student's ability to obtain adequate food quantity and/or quality. This study did not examine what percentage of students bring food from home, or purchase food from other sources. Further examination would be required to determine what other sources, such as food prepared at home and food from the university food services, play a critical role in fruit and vegetable intake.

As a large proportion of students are not meeting the recommended minimum daily intake of fruits and vegetables, examination of why the minimum is not being consumed should be conducted. The university could work in partnership with the municipality of Oshawa and the Region of Durham to ensure that the zoning surrounding the North campus of the university allows developers to provide students with future retailers that could provide students with access to an increased number of healthy foods. The university could also work on promoting increased consumption of fruits and vegetables and pointing out health complications of low consumption. Students represent the future of innovation,

economic growth, and the workforce and their wellbeing should be of concern (Silverthorn, 2016). Some Canadian universities have introduced food banks and food hamper programs to aid in insuring students have adequate food; however, some of these programs have been found to offer foods that are not nutritionally adequate (Silverthorn, 2016). Moving forward addressing fruit and vegetable intake could be a way to combat food access, by providing easy access to the foods that are needed to sustain life. Ensuring students have adequate fruit and vegetable consumption aids in assuring they have the nutrients they need to live healthy lives and to succeed academically (Silverthorn, 2016).

5.2 Contributions to the field of study

The students at Ontario Tech University have not been studied regarding fruit and vegetable consumption. This is the first study to look at the fruit and vegetable consumption of students at the university. While other university populations have been studied, the unique physical environment of the university; the growing sub-urban area, the distance students commute, and the distance to food retailers makes the research novel. This study has further provided insight into response rates for a study of this type which could be essential in completing future studies.

This study has established which takeaway restaurants students are using. This study has produced an extensive look at the frequency of visits of the types of food retailer visits surrounding the campus and provides insight into what types of retailers students are likely to patronize. This study also provides information on fruit and vegetable consumption, which can impact overall health. This study provides a baseline for future comparisons and aids in establishing the fruit and vegetable consumption of the FHS students in comparison to other Canadians. It also aids in understanding how FVC relates to the visits of the differing food retailers.

5.3 Limitations of the study

Limitations of the study design are that a cross-sectional survey does not allow for the establishment of causal relationships correlations between the factors of the sample population and fruit and vegetable consumption nor does it allow for the collection of temporal data; thus, trends cannot be observed. Another limitation of the study is the small sample size. While the sample characteristics were similar to the characteristics of the faculty the size was small enough to prevent full stratification of the data for the various responses available to students taking the survey but reduced the generalizability of the data. The response rate of surveys used in analysis was 12.6%. A recent study showed that outcomes for surveys administered to small post-secondary institutions, can be achieved based on a relatively low response rates (5 -10% or 50 – 75 participants) (Fosnacht, Sarraf, Howe, & Peck, 2017). Therefore, the low response rate may not directly impact the results of the study but is still an area that could be improved upon. Offering incentives for completion, reminding students, explaining the benefits of the survey, and sending personal emails can lead to an increased response rate (Goodman, Anson, & Belcheir, 2014).

Values for FVC were reported based on how many times *per* day these food types were consumed, not on serving size. It is possible that these reported values are based on the number of pieces consumed not an actual serving size. This is a limitation inherent to the survey design, but the approach has been previously used (Statistics Canada, 2018). For fruit and vegetable consumption, food frequency surveys and 24-hour recall are susceptible to social approval bias (Miller, Abdel-Maksoud, Crane, Marcus, & Byers, 2008). The possibility of recall bias also exists (Bowling, 2010); furthermore, the fruit and vegetable intake from the CCHS is an indirect measure of fruit and vegetable consumption (Health Canada, 2017).

Another limitation is that there is variation in the FVC data, which could be due to an attempt to conform to what is deemed desirable by society. For example, individuals know they should be consuming more fruits and vegetables so they overreport the number they are consuming (Bowling, 2010). Further limitations are that while specific retailers were identified, menu choices were not. The questionnaire also failed to capture how many meals were being prepared at home, which could account for overall lack of use of food retailers by the students that were surveyed. Not all fruit and vegetables meals served by food retailers if of equal nutritional value. Studying options associated with increased fruit and vegetable consumption does not necessarily indicate the number of menu items that contain fruits and/or vegetables. Additionally, since the study was conducted the menus and food retailers may have experienced change, which warrants an updated assessment of the food landscape.

Diet reporting is dependent on memory and may not be entirely accurate and can lead to both under and over reporting based on how desirable an individual deems an eating behaviour to be (Nishi, Jessri, & L'Abbe, 2018; Garriguet, 2008a; Garriguet, 2008b). Factors that could explain the variation in self report at various levels could be due to lack of recall, as to what has been eaten, or variations in day-to-day eating. Questions are also close-ended and do not take into account factors outside of the selected options that could potentially impact fruit and vegetable intake.

5.4 Future directions for research

Future directions that could be studied involve testing a larger sample from the faculty to determine if the results remain consistent. Other faculties could also be sampled to determine if the results differ, or if they are similar, as results from one faculty may not

transfer to other faculties. Sampling students from differing years could provide an insight into how habits change.

Modifications to the study could be made to determine what frequency of meals are prepared at home and what factors contribute to this, whether it is due to living arrangements, time availability, financial constraints, or any other factors. The study could also be modified to determine what number of meals students are purchasing on campus. Further in-depth consultations with the student population could further determine why students are selecting the retailers they are and why they are choosing to consume the fruits and vegetables that they are.

Overall, this study provides a starting point for understanding the dietary behaviours of health sciences students at Ontario Tech University, which could lead to future inquires to understand the population, which in turn could lead to proposed changes that would provide higher life quality for the students. Determining what specific factors lead to low fruit and vegetable consumption could lead to an understanding of what factors of access need to be addressed, whether it is due to acceptability, accessibility, accommodation, affordability, and availability.

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Appendix A

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Order Details

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1.1.1.1 Annual review of public health

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Portion	chart/graph/table/figure
Number of charts/graphs/tAbles/figures	1
The requesting Person/oranization	Abigail Graham
Title or numeric Reference of the Portions(s)	Figure 2.1. Ecological framework of the influences on what people eat.
Title of the article or chapter the portion is from	Chapter 2: Background, 2.3. 2.3 Factors impacting dietary intake: An overview
Editor of portion(s)	N/A
Author of portion(s)	N/A
Volume of serial or monograph	N/A
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In the following language(s)	Original language of publication
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Title	A Cross-Sectional Analysis of Student Fruit and Vegetable consumption at the University of Ontario Institute of Technology
Institution name	University of Ontario Institute of Technology

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v 1.1

Appendix B

REB Approval

Date:	*September 29, 2017*
To:	*Otto Sanchez*
From:	*Shirley Van Nuland, REB Chair*
File # & Title:	*14498 - Second Year Health Science Student Eating Patterns and Campus Food Finder Application Use*
Status:	***APPROVED***
Current Expiry:	***September 01, 2018***

Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario, Institute of Technology Research Ethics Board (REB) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 (2014)) and the UOIT Research Ethics Policy and Procedures. You are required to adhere to the protocol as last reviewed and approved by the REB.

Continuing Review Requirements (all forms are accessible from the IRIS research portal):

- **Renewal Request Form**: All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed 30 days post expiry date will be automatically suspended by the REB; projects not renewed 60 days post expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form**: Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form**: Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form**: This form must be completed when the research study is concluded.

Always quote your REB file number (**14498**) on future correspondence. We wish you success with your study.

Dr. Shirley Van Nuland	Janice Moseley
REB Chair	Research Ethics Coordinator
shirley.vannuland@uoit.ca	researchethics@uoit.ca

Appendix C

Invitation Email

UOITnet email template

For internal use only

Date to be sent:

Sender: Abigail Graham

Target audience: Second year students in the Faculty of Health Sciences

Subject line: Food retailer Questionnaire

This message is on behalf of Abigail Graham, Master of Health Science candidate. Please direct inquiries to abigail.graham@uoit.net, 905.721.8668 ext. 2994.

The questionnaire will take 5 to10 minutes and is informal. We are trying to capture information as to what food retailers you prefer. Your responses will be kept confidential.

This is a questionnaire being conducted as part of a research study to increase our understanding of student eating patterns. We aim to determine what types of food retailers you prefer—whether you are eating out or preparing food at home.

Your participation will be a valuable addition to our research, and findings could lead to greater understanding of eating patterns and food retailer preference.

To participate, please complete the food retailer questionnaire.

If you have any questions concerning the research study, or experience any discomfort related to the study, please contact the researcher Abigail Graham.

Any questions regarding your rights as a participant, complaints or adverse events, may be addressed to the Research Ethics Board through the Research Ethics Co-ordinator, researchethics@uoit.ca, 905.721.8668 ext. 3693.

This study has been approved by the university's Research Ethics Board REB 14498 on September 29, 2017.

Sincerely,

Abigail Graham

Master of Health Science Candidate

Appendix D

Consent Form

PURPOSE

You are invited to participate in a web-based online survey on Student Eating Patterns. This is a research project being conducted by Abigail Graham, a student at The University of Ontario Institute of Technology (UOIT). It should take approximately 10 – 15 minutes to complete. The purpose of this study is to increase the understanding of student eating patterns and how they change of the course of the year. Areas surrounding post-secondary institutions are often urban areas regarding access to food and can be considered food deserts (Cameron et al., 2015). For this study a food desert is defined as an area with fewer than ten suitable food retailers within ten minutes either by bus or by walking. This study seeks to understand the type of food retailers that students are accessing and the frequency that they access these sources. This project is the study of its kind to focus on the UOIT student population and will aid in increasing UOIT students' knowledge of the food environment surrounding their institution.

PARTICIPATION

Your participation in this questionnaire is voluntary. You may refuse to take part in the research or exit the questionnaire at any time without consequence. The data will not be saved. You are free to decline to answer any particular question you do not wish to answer for any reason.

BENEFITS AND RISKS

You will receive no direct benefits from participating in this research study. However, your responses may help us learn more about student eating patterns.

There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life.

CONFIDENTIALITY

Your survey answers will be sent to Qualtrics where data will be stored in a password protected electronic format. Qualtrics does not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study.

At the end of the questionnaire, you will be asked if you are interested in providing feedback. If you choose to provide feedback there will be a link that opens a separate form, ensuring that your responses remain anonymous to the researcher. No names or identifying information would be included in any publications or presentations based on these data, and your responses to this survey will remain confidential.

CONTACT

If you have questions at any time about the study or the procedures, you may contact Abigail Graham via email at abigail.graham@uoit.net

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older

☐ Agree (You will proceed to the rest of the questionnaire)

☐ Disagree (You will be exited from the questionnaire)

If you have any questions concerning the research study or experience any discomfort related to the study, please contact the researcher Abigail Graham at abigail.graham@uoit.net

Any questions regarding your rights as a participant, complaints, or adverse events may be addressed to Research Ethics Board through the Research Ethics Coordinator – researchethics@uoit.ca or 905.721.8668 x. 3693.

This study has been approved by the university's Research Ethics Board REB 14498 on September 29, 2017.

Appendix E

Food Questionnaire

Page 1:

Please enter the first two letters of your name, followed by the day of your birthday, followed by the last two letters of your first name (i.e. if your name is albert and your birthday is on the 3rd of September your code would be al03rt)

This code will be used to link data to a future questionnaire for statistical analysis. The code ensures that data remains confidential.

What is your age?

18 – 24

25 – 34

35 – 44

45 – 54

55 – 64

65 – 74

75 years or older

Ethnicity (or Race) please specify your ethnicity:

White

Hispanic or Latino

Black or African American

Indigenous People

Asian / Pacific Islander

Other

What is your gender?

Male

Female

Other

What is your program of study?

Bachelor of Health Science (Honours)

Kinesiology

Bachelor of Health Science (Honours) in Medical Laboratory Science

Bachelor of Science (Honours) in Nursing

Do you have a car?

Yes

No

Page 2:

In the last month, how many times per day, per week or per month did you drink 100% PURE fruit juices, such as pure orange juice, apple juice or pure juice blends? Do not include fruit-flavored drinks with added sugar or fruit punch. Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

In the last month, not counting juice, how many times did you eat fruit? Please remember to include frozen, dried or canned fruit. Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

In the last month, how many times did you eat dark green vegetables such as broccoli, green beans, peas and green peppers or dark leafy greens including romaine or spinach? Please remember to include (frozen or canned vegetables and) vegetables that were cooked in soups or mixed in salad. Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

In the last month, how many times did you eat orange-colored vegetables such as carrots, orange bell pepper, sweet potatoes, pumpkin or squash? (Please remember to include frozen or canned vegetables and vegetables that were cooked in soups or mixed in salad). Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

In the last month, how many times per day, per week or per month did you eat potatoes that are not deep fried? Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

Excluding the green and orange vegetables as well as the potatoes you have already reported, in the last month, how many times did you eat OTHER vegetables? Examples include cucumber, celery, corn, cabbage and vegetable juice. Min = 0; Max = 300

- 1: Per day
- 2: Per week
- 3: Per month

Page 3:

Please indicate how often you obtain food from the following sources:

Mary Browns Famous Fried Chicken, Kentucky Fried Chicken, Double Apple Café, Skywalk Café, Halibut House, British Style Fish and Chips, Churchill's Fish and Chips

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Crown Valley Bakery, Taunton Bakery

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

The Crooked Uncle, T. Williams Pub and Grill, The Players Bench

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

King Pita, Ming's Kitchen, Tybah's Kebab, Sinatra's Italian Sandwiches

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Shoppers Drug Mart, Glover's Milk, El-Madina Grocery Store

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Buster Rhino's, La Pizza & Pasta, Chef Tommy's Authentic Greek, Simcoe Blues & Jazz, Golden Gate Buffet, Momma's Family Restaurant, The Waltzing Weasel

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Kip's Flaming Burger's, Bang Bang Burrito, Double Double Pizza and Chicken, Taco Bell, Square Boy, Pizza Hut, Pizzaville, Dairy Queen, Harvey's, Arby's, Malinee's Thai House, Pizza Pizza

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Subway, McCoy Burger Company, Pizza Express, Coffee Culture, McDonalds, Mr. Sub, Tim Hortons, Pizza Nova, Quiznos Sub, Burger King

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Kotsy's, Tokushima Sushi, Mandarin Restaurant, Rainbow Sushi, Aunt Audry's Favorites, Whimpy's Diner, St. Louis Bar and Grill

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Giant Tiger

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Fresh Co., No Frills, Metro

Daily:	Weekly:	Monthly:
1	1-2	1 or less
1+	3-4	2-3
	5-6	Never

Page 4.

Thank you for participating in this study.

Results for this study will be published by September 2018.

If you have any questions, please feel free to contact Abigail Graham via email at abigail.graham@uoit.net

If you have any questions concerning the research study or experience any discomfort related to the study, please contact the researcher Abigail Graham at abigail.graham@uoit.net

Any questions regarding your rights as a participant, complaints, or adverse events may be addressed to Research Ethics Board through the Research Ethics Coordinator – researchethics@uoit.ca or 905.721.8668 x. 3693.

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