

**An examination of the association between self-reported Canada's Food Guide servings consumed and food safety knowledge, attitudes, and practices in Ontario high school students**

by

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## **Author's Declaration**

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis.

I understand that my thesis may be made electronically available to the public.

## **Statement of Contributions**

With the exception of the content noted below, the work of this thesis consists of content that I authored. In this thesis, I used existing data from two surveys used in previously conducted studies.

I conducted the data analysis for this thesis, with statistical guidance, including consultations regarding the coding of data, from Dr. Ashok Chaurasia (Assistant Professor, University of Waterloo). I also wrote this thesis with input from Dr. Shannon Majowicz (Associate Professor, University of Waterloo).

## **Abstract**

*Introduction:* Two food-related issues that are of concern in Canada are healthy eating and foodborne illness. A majority of students do not eat according to the recommendations outlined in Canada's Food Guide and foodborne illness is a costly, frequent, and preventable public health issue, often associated with poor food safety practices. The aim of this thesis was to investigate the potential association between self-reported Canada's Food Guide servings consumed and food safety knowledge, attitudes, and practices in Ontario high school students.

*Methods:* This secondary data analysis involved healthy eating and food safety data linked at the individual level by the COMPASS team, which included survey responses from 2860 high school students, aged thirteen to eighteen years, from four participating COMPASS schools during the 2014-2015 school year. Food safety knowledge dependent variables (4) were analyzed using logistic regression. Food attitude (6), food safety practice (3), and Canada's Food Guide use (1) dependent variables were analyzed using ordinal regression. Results were used to determine if there were any significant associations between the dependent variables and the number of Canada's Food Guide servings consumed by food group and when summed for a composite score, while adjusting for age, sex, food insecurity, school, currently working or volunteering at a restaurant, deli, other food service location, currently working or volunteering in a hospital, and having taken a course where they were taught how to prepare food or meals.

*Results:* There were no statistically significant associations between students' consumption of any food group and their knowledge of proper hand washing ( $p > 0.05$ ). Students who had a higher composite food group serving total ( $p = 0.01$ ) had significantly greater odds of knowing the proper way to prevent food poisoning than those who had a lower composite food group serving total. Students who consumed more fruits and vegetables ( $p = 0.01$ ) had significantly greater odds

of knowing the proper way to check if a hamburger was cooked enough, and students' who ate more servings of milk and alternatives ( $p=0.04$ ), had lower odds of knowing what a microorganism was, than those who ate less servings. Students who ate more fruit and vegetables ( $p<0.0001-0.001$ ) and had a greater composite food group serving total ( $p<0.0001-0.01$ ) had greater odds of positive food safety attitudes for all dependent variables, excluding students' reported concerns about food allergies and food poisoning. Students who ate more fruit and vegetables ( $p<0.0001-0.002$ ) and had a greater composite food group serving total ( $p=0.001-0.02$ ) reported proper food safety practices more frequently for all dependent variables, while students who ate more grains ( $p=0.002$ ) and milk and alternatives ( $p=0.02-0.04$ ) reported proper food safety practices less often. Students who ate more fruits and vegetables ( $p<0.0001$ ), milk and alternatives ( $p=0.009$ ), and had a greater composite food group serving total ( $p<0.0001$ ) had greater odds of frequently using Canada's Food Guide.

*Conclusion:* Overall, food safety knowledge and attitudes were not associated with healthy eating, with three exceptions each. Additionally, there were some sporadic associations between the frequency of proper food safety practices and the frequency of Canada's Food Guide use and healthy eating, respectively.

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## **List of Acronyms**

AIFS: Australian Institute of Food Safety

CCHS: Canadian Community Health Survey

CDC: Center for Disease Control and Prevention

FAO: Food and Agricultural Organization of the United Nations

iPHIS: Integrated Public Health Information System

OMHLTC: Ontario Ministry of Health and Long-Term Care

PHO: Public Health Ontario

WHO: World Health Organization

## **1. Background**

Food is an integral part of life and source of essential nutrients. However, if food becomes contaminated with chemicals or microorganisms, or a healthy or an adequate amount of food is not consumed, it can increase morbidity and mortality. Therefore, food issues are important public health concerns that need to be addressed to improve the quality of life of all consumers. Two food-related issues that are of concern in Canada are healthy eating and foodborne illness.

Adolescents are at risk for poor food intake and eating behaviours due to lifestyle changes and increased independence (Bauer et al. 2004, Cunningham et al. 2017, Das et al. 2017, Neumark-Sztainer et al. 2005). Canadian adolescents are at risk of obesity and yet under consume the recommended five servings of fruits and vegetables daily (Deka et al. 2015, Durksen et al. 2015, Leatherdale and Cole 2015, Riediger et al. 2007, Statistics Canada 2011, St. John et al. 2008, Wadsworth et al. 2012). Likewise, 40-80% of Canadian adolescents do not meet their three recommended daily servings of milk and alternatives (Canadian Community Health Survey [CCHS] 2006, St. John et al. 2008). Thus, adolescents may be moving to calorie rich, but less nutrient dense diets, with high intakes of sugar-sweetened beverages and unhealthy snack foods (Bauer et al. 2004, Durksen et al. 2015, Gilbert et al. 2012, Nelson et al. 2008, Raine 2014, Velazquez et al. 2015). Problematic teenage eating patterns are concerning, as adolescence is a critical growth period which requires ample nutrients for proper development (Salam et al. 2016).

Foodborne illness is a costly, frequent, and preventable public health issue (Hoffman et al. 2012, Newell et al. 2010, Wu et al. 2017). One in eight Canadians acquire foodborne illness, domestically, for a total of four million cases per year in Canada (Thomas et al. 2013, Thomas et

al. 2015). Within Ontario, there are approximately 100,000 cases of foodborne illness annually, caused by the top five enteric pathogens alone: *Campylobacter* spp., *Listeria monocytogenes*, non-typhoidal *Salmonella* spp., verotoxin-producing *E.coli*, and *Yersinia enterocolitica* (Public Health Ontario [PHO] 2017). Symptoms of infection can range from mild gastrointestinal discomfort, vomiting, and diarrhea, to deadly neurological conditions (Carabin et al. 2011, Kirk et al. 2015).

Foodborne illness is often associated with poor food skills and food safety practices, and most of the reported cases are linked to exposures in private homes (Byrd-Bredbenner 2010). Therefore, adolescents may increase their exposure to foodborne pathogens as they become more independent in choosing foods for consumption and as they prepare food in the home, especially if they are unaware of proper food safety techniques (Byrd-Bredbenner et al. 2010, Slater 2013, Watts et al. 2017). Increased food independence in conjunction with a decreased number of students participating in food-related high school courses could lead to food safety errors and illness in this demographic (Byrd-Bredbenner et al. 2010, Slater 2013).

To date, the possible link between food safety and healthy eating in Canadian adolescents has not been examined. Therefore, the aim of this thesis is to investigate the potential association between self-reported Canada's Food Guide servings consumed and food safety knowledge, attitudes, and practices in Ontario high school students.

## **2. Literature Review**

This literature review broadly discusses healthy eating with a focus on Canada's Food Guide recommendations, foodborne illness, and food safety knowledge, attitudes, and practices. The potential link between healthy eating and food safety is explored in detail, however, there is little

scientific evidence of this association explicitly. This literature review focuses on the Canadian population with an emphasis on Ontario adolescents, where possible.

## **2.1 Healthy Eating Concerns in North America**

A wholesome diet can reduce the severity and duration of acute illnesses and prevent a wide variety of chronic medical conditions. For example, a diet rich in fresh food has been noted to be a protective factor against atherosclerosis, cancer, and diabetes (Dagfinn et al. 2017, Liu 2005, Mursu et al. 2013, Senior 1997, Wang, X et al. 2014). Proper eating not only maintains physical health but also improves mental and social well-being by fostering positive body image (Cook-Cottone 2015, World Health Organization [WHO] 1998).

However, over the past several decades, there has been a transition in cooking from using raw ingredients to using prepackaged and processed food stuffs. In wealthier countries, like those in North America, processed and convenience foods are typically available, which are often high in sugar, fat, and salt (Moubarac et al. 2017, Neil et al. 2012). This transition, combined with the increased cost associated with purchasing fresh produce, heightens the problem, especially for those who are in financial need (Cassady et al. 2007, Darmon and Drewnowski 2015, Miller et al. 2016, Senior 1997).

### **2.1.1 Healthy Eating Concerns in High School Students**

It is essential that young adults eat healthily in order for complete development. Canada's Food Guide recommends that adolescents aged fourteen to eighteen years eat 7-8 servings of fruits and vegetables, 6-7 servings of grain products, 3-4 servings milk and alternatives, and 2-3 servings of meat and alternatives daily (Health Canada 2011). However, students and adults do not often follow or use Canada's Food Guide (Mathe et al. 2016, Rossiter et al. 2012, Vanderlee

et al. 2015). The 2010 CCHS noted that only 48% of males and 50% of females aged twelve to nineteen years ate the recommended servings of fruits and vegetables, with the majority of adolescents eating below the recommended levels in every food group (CCHS 2010, Deka et al. 2015, Rossiter et al. 2012, Statistics Canada 2011, Videon and Manning 2003).

Moreover, consumption patterns often begin to change during adolescence because of increased time with friends, less time spent at home, greater accesses to money, and more dietary independence (Cunningham et al. 2017, Das et al. 2017). Dietary patterns of adolescents involve more snacking and less regular eating intervals (Gilbert et al. 2012, Truswell and Darnton-Hill 1981, Velazquez et al. 2015). In addition, industry pressure, specifically fast-food advertisements and diet campaigns, aggressively target youth audiences and reinforce suboptimal eating behaviours and unsafe practices (Cunningham et al. 2017, Buote et al. 2011, Mask and Blanchard 2011, Perry et al. 1987). High school students consume more “convenience foods” which put them at risk for illness now and in the future, as these foods do not foster the development of cooking skills, nor provide adequate nutritional content (Caraher et al. 1999, Moubarac et al. 2017, Neil et al. 2012, Nelson et al. 2008). Therefore, adolescents typically exceed their caloric needs, likely due to the increased consumption of high-fat and high-sugar products, and lack certain nutrients like magnesium, vitamin A, phosphorous, potassium, calcium, and fibre (CCHS 2004, Newens and Walton 2016, Velazquest et al. 2015).

One barrier to improving student healthy eating patterns is the lack of student participation in home economics, food, and nutrition classes. In Ontario, 45.1% of high school students had reported ever taking a course in which nutrition or food skills were the focus (Majowicz et al. 2015). In Manitoba, student enrollment in home economics, food, and nutrition



classes decreased by 38% from grades 7 to 12, potentially due to the perceived notion that math and science are more helpful than food courses (Slater 2013).

## **2.2 Foodborne Disease and Food Safety**

Foodborne disease affects over 100,000 Ontarians every year (Ontario Ministry of Health and Long-Term Care [OMHLTC] 2012). In 2009, Ontario had only 26.6 cases per 100,000 people while in 2007 there were 33.7 cases per 100,000 (OMHLTC 2012). However, the actual number of cases is likely much higher as it is estimated that only 4% of foodborne illnesses are reported (OMHLTC 2012). Young adults are less likely to report symptoms than the average adult, making them an important food safety target (Byrd-Bredbenner et al. 2008, Vogt 2001, Yarrow et al. 2006). Moreover, the rates of foodborne illness vary depending on the season and from year to year. Foodborne illness rates usually increase during the summer months, as increasing temperatures promote pathogen development and different consumption behaviours occur, like barbecuing (Lal et al. 2012, Ravel et al. 2010).

Foodborne disease is caused by biological, chemical, and physical hazards. Biological hazards include zoonotic agents or foodborne pathogens such as *Salmonella* or *Escherichia coli* (*E. coli*) O157. Chemical agents include toxicants like mycotoxins, contaminants such as mercury or lead, and toxic substance residues, often attributed to pesticides. Physical hazards are foreign objects that appear in food, like barbecue bristles, that can cause physical harm (Food and Agricultural Organization of the United Nations [FAO] 2002). Symptoms of foodborne disease range from short-term gastrointestinal illness to kidney failure, and even death (Kirk et al. 2015). Infections can occur wherever food is consumed, prepared, handled or stored. In Ontario, the pathogens most commonly associated with disease are *Campylobacter* and *Salmonella* (OMHLTC 2012). Certain food groups are more likely to be associated with

particular foodborne illnesses. For example, *Salmonella* and *E. coli* O157:H7 have been associated with outbreaks in papayas and leafy greens, respectively (Center for Disease Control and Prevention [CDC] 2018). Grain products, like flour, have also been linked to outbreaks of *E. coli* O121 and O26 (CDC 2018, Neil et al. 2011). *Listeria monocytogenes* has been identified in ice cream (CDC 2018). Meat and alternatives are more commonly related to salmonellosis, *Campylobacter* enteritis, and yersinosis, as a result of improper cooking and handling of chicken and pork (OMHLTC 2012).

### **2.2.1. Food Safety in High School Students**

Studies investigating food safety often consider food safety knowledge, attitudes, and practices, reviewed individually below.

#### *Food Safety Knowledge*

Food safety knowledge is the awareness of proper food hygiene, handling, practice and other food related information (Australian Institute of Food Safety [AIFS] 1998). Food safety knowledge is the responsibility of all players of the food system, from the producer to the consumer. Increasing the food safety knowledge of consumers and the food industry increases the quality of the food sent to market for consumption and may reduce foodborne illness (Augustin et al. 2016, FAO 2002).

High school students typically have poor food safety knowledge overall (Abbott et al. 2009, Burke et al. 2016, Burke & Dworkin 2015, Lynch et al. 2008, Pedigo et al. 2009). For example, only 4.6% of Ontario high school students answered all food safety knowledge dependent variables correctly on a survey (Majowicz et al. 2017). Proper hand washing

procedures were known by less than half of Ontario students (45.5%, Majowicz et al. 2015). Just over half of Ontario students (50.3%) were aware that the best way to prevent food poisoning was to keep foods refrigerated until it is time to cook or serve them (Majowicz et al. 2017). When asked what the best method of determining whether hamburgers were cooked enough was, only 1 in 5 students (17.3%) were aware that they should use a meat thermometer (Majowicz et al. 2015). However, a majority of students did know what a microorganism was (72.8%, Majowicz et al. 2015).

Food related knowledge among adolescents fluctuates within groups, as well. Students of low socioeconomic status and who are male typically have less food safety knowledge than students of higher socioeconomic status and who are female (Hart et al. 2002, Lee et al. 2000, Majowicz et al. 2015).

### *Food Attitudes*

Overall, high school students do not perceive foodborne illness to be a direct, personal issue (Majowicz et al. 2017). Even though students acknowledge the severity of foodborne disease, they often report taking risks with food consumption and handling (Abbot et al. 2012). This risk-taking attitude may be due to the perception that they will not get foodborne illness (Haapala and Probart 2004). Despite the fact that less than 50% of students had proper food knowledge, 72.7% report that they have high confidence in cooking safe, healthy meals for themselves and their families (Majowicz et al. 2015).

Interestingly, a majority of Ontario high school students did enjoy learning how to keep foods safe to eat (57.4%) and showed concern regarding food poisoning (52.7%), yet were neutral in their concern about food allergies (Majowicz et al. 2015). Ontario students also

strongly believed that being able to cook safe, healthy meals was an important life skill (86.5%, Majowicz et al. 2015).

### *Food Safety Practices*

Food safety practices help combat biological, chemical, and physical foodborne hazards, as described above (FAO 2002). Typically, young adults comply with less than 50% of food safety recommendations (Feng 2015, Green and Knechtges 2015). A food handling skill observation of students found that only 16% of those that washed their hands washed them for the recommended 20 seconds (Byrd-Bredbenner et al. 2007). In addition, food thermometers were rarely used to ensure the proper internal temperature of meat and alternatives (Byrd-Bredbenner et al. 2007, Murray et al. 2017, Nesbit 2014, Pedigo et al. 2009).

A majority of Ontario students reported always (56.1%) or often (27.3%) washing their hands prior to food preparation (Majowicz et al. 2015). Although, only 45.3% knew the proper way to wash their hands (Majowicz et al. 2017). Most Ontario students reported always (76.7%) or often (14.4%) washing their hands after working with raw meat or chicken (Majowicz et al. 2015). Likewise, most Ontario students always (65.8%) or often (19.5%) kept raw meat or chicken away from ready to eat foods like raw vegetables (Majowicz et al. 2015). However, students often did not know that they should wash their hands after handling fruit (82.1%, Majowicz et al. 2017).

Food safety practices also include safe food consumption choices. Adolescents engage in eating behaviours that put them at a greater risk of foodborne illness. For example, of the 4343 students enrolled at 21 colleges and universities in the US, 53% consumed raw, homemade cookie dough, 33% consumed fried eggs with runny or soft yolks, 29% consumed sushi, 29%

raw sprouts, 11% raw oysters, clams, or mussels, and 7% consumed rare hamburger (Byrd-Bredbenner et al. 2008). Males in particular engage in riskier food practices which may increase the possibility of illness (Barclay et al. 2003, Byrd-Bredbenner et al. 2007, Byrd-Bredbenner et al. 2013, Majowicz et al. 2015, Murray et al. 2017, Nesbit et al. 2009). Males also typically lack experience with food safety practices and were generally less concerned with proper food safety (Barclay et al. 2003, Lazou et al. 2012, Sanlier and Konaklioglu 2012).

### **2.3 The Association between Healthy Eating and Food Safety**

Food safety is defined as “...handling, preparing, and storing food in a way to best reduce [the risk of] foodborne illnesses” (AIFS 1998), whereas, healthy eating is “...eating a variety of foods from the four food groups to feel good and maintain your health” (Health Canada 2015). People who are aware of healthy eating recommendations and report that they have a healthy diet are more likely to have good food safety behaviours (Taylor et al. 2012).

Foodborne gastrointestinal illness reduces the absorption of nutrients from the food that was consumed. Gastrointestinal illness can manifest in intermittent diarrhea causing impaired nutrient absorption leading to malnutrition (Dewey et al. 2011). Food contaminated with certain pathogens can result in illnesses that cause villi degeneration and intestinal hyper-permeability which ultimately reduces nutrient absorption (Anderson et al. 2007, Buret et al. 2002, Cotton et al. 2011).

Every food group is susceptible to foodborne pathogens causing illness. For example, an increasing amount of foodborne illness outbreaks are a result of fresh produce contamination (Callejon et al. 2015, Lynch et al. 2009, Yeni et al. 2016). Produce contamination can occur pre- or post-harvest, with certain fruits and vegetables being more susceptible to infection. Salad,

lettuce, juice, berries, melon, and sprouts are the most frequently contaminated (Callejon et al. 2015, CDC 2011, Ivey 2016, Sivapalasingam et al. 2004, Yeni et al. 2016). Moreover, flour can be contaminated with *E. coli* and other contaminants in its raw form and so should not be consumed without cooking (CDC 2018). Raw milk and alternatives can also be contaminated with *Staphylococcus aureus* and chicken with *Salmonella*, pathogens which can lead to disease (Fusco et al. 2011, Taha et al. 2010). Additionally, there are misconceptions that convenience foods, like chicken fingers, are partially or fully cooked when they are not, leading to a greater risk of illness (Currie et al. 2005, Murray et al. 2017).

### **2.3.1 The Association between Healthy Eating and Food Safety in High School Students**

Typically, evidence about healthy eating and evidence about food safety knowledge, attitudes, and practices exists in separate bodies of literature. Although, some studies have assessed healthy eating and food safety, independently, within the same study. No study has analyzed these issues together at an individual level.

Chinese youth reported that nutrition was very important or important to their health (95.2%) and establishing a healthy diet was very important or important (94.2%), while 62.2-96.4% were interested about the safety of the food they were consuming and 81.9% would throw away expired food items (Cheng et al. 2017, Wang, D et al. 2014). This level of concern is in line with the healthy eating and food safety interests in that of Chinese adults (Cheng et al. 2017, Zhigang et al. 2008). These findings might suggest that if the Canadian population is not as concerned with healthy eating or food safety then the attitudes of Canadian youth may follow suit, resulting in low fruit and vegetable intake and poor food attitudes. In addition, only 37% of Italian high school students had appropriate dietary patterns and 2.4% had satisfactory food

safety knowledge (Turconi et al. 2008). Similarly, Canadian students have also been shown to have poor dietary patterns (CCHS 2010, Deka et al. 2015, Rossiter et al. 2012, Statistics Canada 2010, Videon and Manning 2003) and have poor food safety knowledge (Majowicz et al. 2015, Majowicz et al. 2017).

Moreover, the literature suggests there is an association between better eating habits, safe cooking, and food knowledge (Brown 2005, Condrasky and Hegler 2010, Hartmann et al. 2013, Lavelle et al. 2016). A program instituted by the Oklahoma Cooperative Extension Service involving 229 youth participants showed that after eight cooking classes there were significant improvements in safe food handling and fresh produce consumption. For example, 69% of youth reported eating a new fruit or vegetable and 67% reported preparing fruits or vegetables in a new way. This program, along with other combined international programs, demonstrates that healthy eating and food safety increase when targeted together (Brown and Hermann 2005, Lee et al. 2016, Zhou et al. 2016). Since cooking skills and healthy eating both increased in this cohort, it is possible that students who have a higher fruit and vegetable intake might also have better food safety practices than students who do not.

As described above, there are studies that have looked at healthy eating and food safety among students (Abbot et al. 2012, Bredbenner et al. 2007, Byrd-Bredbenner et al. 2010, Deka et al. 2015, Durksen et al. 2015, Feng et al. 2015, Green and Knechtges 2015, Majowicz et al. 2015, Majowicz et al. 2017, Riediger et al. 2007, St. John et al. 2008, Wadsworth et al. 2012 Wang, D et al. 2014, Xiong et al. 2017) but none that have looked at how healthy eating and food safety are associated within individuals. Therefore, to begin to understand the association between healthy eating and food safety at the individual level, factors that affect both healthy

eating and food safety can guide hypotheses about possible associations by examining age, sex, income, school, and lifestyle choices.

### *Age*

The older the student, the less likely they are to consume the appropriate number of servings, especially of fruits and vegetables (CDC 2010, Jessri et al. 2016, Lien et al. 2001, Minaker and Hammond 2016, Riediger et al. 2007). For example, 5% of male and 7% of female students in grade 6 ate according to Canada's Food Guide, but, by the 9<sup>th</sup> grade, only 0.4% of male and 2% of female students met the recommendations (Rossiter et al. 2012). Conversely, Ontario students answered 1.06 times more food safety knowledge questions correctly for every year increase in age, while adjusting for age, sex, school and other food handling factors (Majowicz et al. 2015). Students' age was significantly associated with knowing the most hygienic way to wash their hands, the most important way to prevent food poisoning, the best way to determine whether hamburgers are cooked enough and the definition of microorganisms (Majowicz et al. 2015). Therefore, it is possible that there will be a negative correlation between healthy eating and food safety knowledge in Ontario high school students. Additionally, Ontario students' food attitudes, specifically their interest in learning about foodborne disease, decreased for every year increase in age (Diplock et al. 2017, Majowicz et al. 2017). Moreover, high school students reported safer food safety practices than children under the age of twelve (Nesbitt et al. 2009). Since students do acknowledge the severity of foodborne disease (Haapala and Probart 2004), they might be marginally more aware of proper precautions as they cook more independently but may also be choosing less nutritious foods, like fruits and vegetables, when doing so.



In summary, increasing age has been associated with better food safety knowledge and practice, and decreased fruit and vegetable consumption, food attitudes, and Canada's Food Guide adherence. Thus, it is reasonable to hypothesize that older Ontario high school students will have more food safety knowledge and better practices, and eat less fruit and vegetables, and have poorer food attitudes and Food Guide use than their younger counterparts.

### *Sex*

Male students typically consume more calories than female students, with a majority of their energy coming from protein, but most do not meet recommendations for fruits, vegetables, and milk and alternatives (Durksen et al. 2015, Jessri et al. 2016, Laxer et al. 2017, Minaker and Hammond 2016, Riediger et al. 2007, Storey et al. 2009, Velazquez et al. 2015, Wadsworth et al. 2012). The male diet has been reported to be poor or average quality, with greater intakes of sugar, fat and salt laden foods (Jessri et al. 2016, Storey et al. 2009, Vanderlee et al. 2014, Velazquez et al. 2015). Males also tend to consume riskier foods that are associated with foodborne illness, specifically, undercooked meat, bean sprouts and unpasteurized juice (Nesbitt et al. 2009, Storey et al. 2009). Similarly, male students typically have less healthy eating knowledge than their female counterparts (Lavelle et al. 2016, Lee et al. 2000). Male students also rated their food safety skills as fair to excellent, however, this was inaccurate 97% of the time (Byrd-Bredbenner et al. 2007). As a result, male students in Ontario might also have poor fruit, vegetable, and dairy intake, which may correlate with poor food safety knowledge and practices.

In contrast, females typically have better food safety knowledge and practices and are more concerned about healthy eating than males (Burke et al. 2016, Diplock et al. 2017, Haapala

and Probart 2004, Hassan et al. 2014). Female students in Ontario answered 1.08 times more food safety knowledge dependent variables correctly than males (Majowicz et al. 2015). Although young women do not often meet Canada's Food Guide recommendations, they typically consume more fruits and vegetables than males (Jessri et al. 2016, Rossiter et al. 2012, Vereecken et al. 2015). However, females who have poor dietary intake either have very low healthy eating knowledge or very high healthy eating knowledge (Hoogenboom et al. 2009, Lee et al. 2000, Nani 2016). Dietary advertising may be influencing the intake of female students who, although are very aware of what they should be eating, could be restricting their intake to conform to social standards and diet pressure (Buote et al. 2011, Mask and Blanchard 2011, Schneider 2000). Since low carbohydrate diets have been a fad for several years, female students may eat fewer servings of grains if they are engaging in diet culture, creating a discrepancy between consumption patterns and food related knowledge, as decreased grain consumption has already been shown in college students (Elmadfa et al. 2009, Hinton et al. 2004).

In summary, sex is a factor which affects healthy eating and food safety knowledge and practices. Females typically consume more fruits and vegetables and have greater food safety knowledge and practices, when compared to males. Thus, it is reasonable to hypothesize that female Ontario high school students will eat more fruit and vegetables and have better food safety knowledge, attitudes, and practices than male students.

### *Income*

Students from low income homes are more likely to have food security issues, eat less fruits, vegetables, and low fat milk and alternatives, yet consume more sugar sweetened beverages, fats, oils and meat and alternatives (Ball et al. 2015, Groth et al. 1999, Masse et al. 2014, Reidiger et al. 2007, Roos et al. 1998, St. John et al. 2008, Velazquez et al. 2015).

Conversely, students who attend schools in more affluent neighbourhoods typically recall more information about Canada's Food Guide itself, have greater overall food safety knowledge but have poorer food safety practices than students attending schools in lower socioeconomic areas (Hart et al. 2002, Nesbit et al. 2009, Vanderlee et al. 2015). Although, no studies have observed food attitudes in Ontario high school students across income levels, people from higher income homes are more likely to have positive food attitudes (Kennedy et al. 2008).

In summary, students from higher income homes are more likely to eat fruits and vegetables, have better food safety knowledge and attitudes, use Canada's Food Guide, but are less likely to practice proper food safety than students from lower income homes. Thus, it is reasonable to hypothesize that Ontario high school students from higher income neighbourhoods or food secure homes will eat more fruit and vegetables, have better food safety knowledge and attitudes and use the Food Guide more often, while having poorer food safety practices than students from less affluent neighbourhoods or food insecure homes.

### *School*

Schools play an important role in determining healthy eating patterns and food safety. Certain schools are more active in promoting healthy eating and participate in health interventions like the "farm to school" program which increases the availability of fresh, local foods to schools (Marshall 2006). There is a growing necessity for fresh, healthy foods in schools, as available and appealing healthy foods conveniently located in school cafeterias can improve the dietary consumption patterns of students, specifically fruit and vegetable intake (Au et al. 2017, Hakim et al. 2013, Jones, S. et al. 2015, Minaker et al. 2006, Taylor et al. 2017). In addition, if schools promote home economics, food, and nutrition classes, healthy eating patterns

and food safety knowledge in students can be improved by increasing cooking skills and confidence in preparing food (Sadegholvad et al. 2017). The school Ontario students attend has been shown to be significantly associated with their food safety knowledge and their interest in foodborne disease, suggesting some school environments may promote or impede food safety (Majowicz et al. 2015).

In summary, the school students attend has been associated with healthy eating and food safety knowledge, which may relate to food program and policy differences. Students who attend certain schools are more likely to have better fruit and vegetable intakes, food safety knowledge and attitudes. Thus, it is possible that Ontario high school students who attend certain schools will eat more fruit and vegetables, and have better food safety knowledge and attitudes than those who attend different schools.

### *Lifestyle Choices*

Vegetarians and people who consume higher amounts of fruits and vegetables are also more likely to have better attitudes and greater concern about general food safety and food bacteria (Booth et al. 2013, Harper et al. 2002). However, less than 50% of Ontario students consume five servings of fruits and vegetables (Statistics Canada 2011). Additionally, many Canadian high school students, showed little interest in food safety (Majowicz et al. 2015). Therefore, students who consume low amounts of fruits and vegetables might also be less likely to have positive food attitudes.

People also tend to be concerned about pesticide residues on fresh produce (Rimal et al. 2001). However, their concern is not backed by action, as only 34% of consumers took precautions against pesticide residues (Rimal et al. 2001). One way to reduce pesticide deposits

is to thoroughly wash vegetables before cooking with them and wash hands after touching the products (Chung et al. 2018, Krol et al. 2000, Lozowicka et al. 2016). Therefore, students who consume high amounts of fruits and vegetables may know that they should wash the food and their hands before cooking but may not actually practice it.

Food preferences of students may also impact their food safety knowledge, attitudes, and practices, for example, some consumers prefer to have their hamburgers cooked only to medium rare or rare. Interestingly, only 17% of Ontario students knew that using a meat thermometer was the best way to check if a hamburger was cooked enough (Majowicz et al. 2015). However, if students grow up around these kinds of preferences they may not be aware of proper food safety recommendations regarding meat temperatures. Another example of risky food preferences involves the consumption of eggs. Between 39-74% of consumers ingest raw or undercooked eggs (Byrd-Bredbenenr 2008, Kosa et al. 2015, Meer and Misener 2000, Nesbit et al. 2009, Roseman and Kurzynske 2006, Sharif and Al-Malki 2008). These preferences may be the reason why students still participate in some high-risk behaviours. Therefore, it is possible that students who consume more meat and alternatives, the foods that typically have these risky preference types, might have negative food attitudes, as food safety recommendations may affect the taste of the food they are consuming.

Furthermore, the consumption of convenience foods that are high in fat, sugar, and salt, is on the rise (Neil et al. 2012, Storey et al. 2009). These types of foods often fall under the “other category” of food groups due to their unhealthy content, yet they are frequently consumed by adolescents (Durksen et al. 2015, Starkey et al. 2001, St. John et al. 2008, Wadsworth et al. 2012). Additionally, these foods do not encourage the use of proper food safety practices. There are many misconceptions that convenience foods, like chicken fingers, are partially or fully

cooked when in reality they are not, leading to cross contamination issues (Currie et al. 2005, Murray et al. 2017). Due to these misconceptions, there is often a higher risk of illness (Currie et al. 2005, Murray et al. 2017). Since students are known to eat a high amount of convenience foods, it is likely that their poor intake, like low amounts of fruits and vegetables, may correlate with improper food practice leading to cross contamination.

Students that are immunocompromised and susceptible to foodborne illness and those that have previously acquired foodborne illness are more likely to be concerned about food poisoning (Chen et al. 2010, Fein et al. 1995). This heightened concern is intuitive as a negative experience or having a greater perceived susceptibility may make a consumer more concerned about risky foods and food safety to prevent future infection (Chen et al. 2010, Fein et al. 1995). Therefore, students who eat meat and alternatives and milk and alternatives, foods that are more likely to cause foodborne illness (Fein et al. 1995), may have had negative experiences resulting in greater concerns about food poisoning.

Where students choose to eat might also impact their consumption choices. Students who eat lunch at home and with family are more likely to consume a greater number of fruits and vegetables than students who eat at school (Jones, A. et al. 2015, Larson et al. 2013). Students who eat lunch at home or spend more time in the kitchen might have more opportunities to experience proper food practice and cooking skills (Jones, A. et al. 2015, Lavelle et al. 2016, Larson et al. 2013). Therefore, it is possible that students who eat more fruits and vegetables may also have better food safety practices.

In summary, people who consume higher amounts of fruits and vegetables are also more likely to have better attitudes about food safety but most high school students do not eat the recommended servings of fruits and vegetables and eat more convenience foods. However, high

school students frequently consume the recommended servings of meat and alternatives and often report washing their hands after exposure to meat and alternatives. Thus, it is reasonable to hypothesize that Ontario students who consume high amounts of fruits and vegetables may be more likely to have positive food attitudes compared to students who do not eat the recommended amount of fruits and vegetables, while those who consume the recommended servings of meat and alternatives may have better food safety practices than students who do not eat the recommended amount of meat and alternatives.

## **2.4 Conclusion**

Overall, healthy eating and food safety are two important issues in the adolescent population. These concerns have been investigated independently but no research has been done to analyze them in combination at the individual level. However, it is reasonable to hypothesize that there might be a relationship between these two food topics. Therefore, the aim of this thesis was to fill this research gap by determining whether healthy eating and food safety are interrelated.

## **3. Goals and Objectives**

The goal of this thesis was to investigate the association between self-reported food safety knowledge, attitudes, and practices, and healthy eating, as measured by the number of Canada's Food Guide servings consumed in high school students in Ontario. This thesis had fourteen research questions in four areas:

## **Food Safety Knowledge**

1. Is there an association between students knowing the most hygienic way to wash their hands, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for: age, sex, food insecurity, school, currently working or volunteering at a restaurant, deli, other food service location, currently working or volunteering in a hospital, and having taken a course where they were taught how to prepare food or meals?
2. Is there an association between students knowing the most important way to prevent food poisoning, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
3. Is there an association between students knowing the best method of determining whether hamburgers are cooked enough, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
4. Is there an association between students knowing what a microorganism is, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?



## Food Attitudes

1. Is there an association between students' interest in learning about how to keep foods safe to eat, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
2. Is there an association between students' interest in learning about how to choose nutritious foods to eat, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
3. Is there an association between students' concern about food poisoning, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
4. Is there an association between students' concern about food allergies, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
5. Is there an association between students' confidence in cooking safe, healthy meals for themselves and their families, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and

(v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?

6. Is there an association between students' belief that cooking safe, healthy meals is an important life skill, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?

### **Food Safety Practices**

1. Is there an association between how often students report washing their hands with soap and warm running water before preparing or handling food, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
2. Is there an association between how often students report washing their hands with soap and warm running water after working with raw meat or chicken, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?
3. Is there an association between how often students report keeping raw meat and chicken away from ready to eat foods like raw vegetables, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and

alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?

### **Canada's Food Guide Use**

1. Is there an association between how often students report using Canada's Food Guide to help them choose what to eat, and the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and (v) composite food group serving total, on the day prior to the survey, adjusting for the six covariates listed above?

## **4. Methods**

### **4.1 Existing Data**

This thesis was a secondary analysis of linked data from two studies. Ethics approval was granted by the University of Waterloo Research Ethics Board (Appendix A). This secondary data analysis involved data from both a COMPASS (Appendix B) and Food and Kitchen Skills survey (Appendix C).

The data provided were linked at the individual level by the COMPASS team (Table 1). The data set included survey responses from 2860 high school students, aged thirteen to eighteen years, from four participating COMPASS schools (each with circa 750 students) who completed both surveys (on the same date) during the 2014-2015 school year. The Food and Kitchen Skills Survey had a response rate of 79.1% (2860/3617, Majowicz et al. 2015), close to the predicted completion rate of 80% (Leatherdale and Cole 2015). Food insecurity was used as a proxy for income in this analysis. For this thesis missing data were omitted.

Table 1. Demographic, predictor, and dependent variables from the COMPASS Survey and Food Kitchen Skills Survey of Ontario high school students (2014-2015, n=2860)

Variable	Survey Question	Survey Answers (% of respondents per answer)
<b>Demographic Covariates</b> <sup>Reference of Source Data</sup>		
Age <sup>1</sup>	How old are you today?	13 years or younger (2.1) 14 years (22.8) 15 years (25.9) 16 years (24.1) 17 years (20.6) 18 years or older (4.4)
Sex <sup>1</sup>	Are you female or male?	Female (52.7) <sup>2</sup> Male (47.3) <sup>2</sup>
School ID <sup>1</sup>	N/A	School 1 (17.1) <sup>2</sup> School 2 (24.5) <sup>2</sup> School 3 (26.8) <sup>2</sup> School 4 (31.6) <sup>2</sup>
Food Insecurity <sup>1</sup>	If you do not eat breakfast every day, why do you skip breakfast? There is nothing to eat at home	Yes (10.0) No (90.0)
Work or volunteer experience <sup>2</sup>	Do you currently work or volunteer in any of the following? (Mark all that apply)	A restaurant, deli or other food service location (16.8) Hospital (2.6) Daycare (11.7) Retirement home, nursing home, or long term care facility (4.9) Not stated (NR)
Taken a food course <sup>2</sup>	Have you ever taken a course where you were taught how to prepare food or meals?	Yes (34.9) No (65.1)

<b>Healthy Eating (Predictor Variables)</b>		
Number of fruit and vegetable servings consumed <sup>1</sup>	Yesterday, from the time you woke up until the time you went to bed, how many servings of vegetables and fruits did you have? One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.	None (7.4) 1 serving (17.3) 2 servings (19.3) 3 servings (18.5) 4 servings (13.1) 5 servings (10.5) 6 servings (5.9) 7 servings (3.7) 8 servings (1.85) 9 or more servings (2.4) Not stated (NR)
Number of grain product servings consumed <sup>1</sup>	Yesterday, from the time you woke up until the time you went to bed, how many servings of grain products did you have? One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.	None (4.4) 1 serving (12.7) 2 servings (22.8) 3 servings (23.8) 4 servings (15.2) 5 servings (9.0) 6 servings (5.3) 7 servings (2.9) 8 servings (1.8) 9 or more servings (2.3) Not stated (NR)
Number of milk and alternative servings consumed <sup>1</sup>	Yesterday, from the time you woke up until the time you went to bed, how many servings of milk and alternatives did you have? One 'Food Guide' serving of milk and alternatives includes fortified soy beverage, reconstituted powdered milk and alternatives, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.	None (10.2) 1 serving (19.4) 2 servings (26.5) 3 servings (21.2) 4 servings (11.8) 5 servings (5.2) 6 servings (5.6) Not stated (NR)

<p>Number of meat and alternative servings consumed<sup>1</sup></p>	<p>Yesterday, from the time you woke up until the time you went to bed, how many servings of meat and alternatives did you have? One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.</p>	<p>None (5.8)  1 serving (22.5)  2 servings (34.1)  3 servings (24.2)  4 servings (7.4)  5 servings (6.2)  Not stated (NR)</p>
<p><b>Food Safety Knowledge (Dependent Variables)</b> (Correct answers are bolded)</p>		
<p>Knowing the most hygienic way to wash your hands<sup>2</sup></p>	<p>Which is the most hygienic way to wash your hands?</p>	<p>Apply sanitizer, run water, rub hands together for 20 seconds, rinse hands, dry hands, rub on an antiseptic hand lotion (10.7)  Apply soap, rub hands together for 20 seconds, rinse hands under water, dry hands, apply sanitizer (28.2)  <b>Run water, moisten hands, apply soap, rub hands together for 20 seconds, rinse hands, dry hands (45.5)</b>  Run water, moisten hands, apply sanitizer, rub hands together for 20 seconds, rinse hands, dry hands, rub on antiseptic hand lotion (14.3)  Not stated (NR)</p>
<p>Knowing the proper way to prevent food poisoning<sup>2</sup></p>	<p>Which of the following is considered the most important way to prevent food poisoning?</p>	<p>Spray for pests in the kitchen area at least every week (5.2)  Rarely or never serve leftovers (4.3)  <b>Keep foods refrigerated until it's time to cook or serve them (50.3)</b>  Clean kitchen counters with sanitizing solutions weekly (34.1)  Not stated (NR)</p>

<p>Knowing the best way to determine if hamburgers are cooked<sup>2</sup></p>	<p>Which method is the best way of determining whether hamburgers are cooked enough?</p>	<p>Cut one to check the colour of the meat inside (56.7)  Check the colour of the juice to be sure it is not pink (10.8)  <b>Measure the temperature with a food thermometer (17.3)</b>  Check the texture or firmness of the meat and alternatives (7.1)  Measure the length of time the hamburgers cook (3.4)  Not stated (NR)</p>
<p>Knowing what a microorganism is<sup>2</sup></p>	<p>What are microorganisms?</p>	<p>Poisons that can contaminate our food and water (10.9)  <b>Small living things that are too small to be seen with our eyes (72.8)</b>  Small insects that we can see (2.4)  Large bugs that can land on our food and surfaces (1.7)  Not stated (NR)</p>
<p><b>Food Attitudes (Dependent Variables)</b></p>		
<p>Interest in keeping foods safe to eat<sup>2</sup></p>	<p>I like learning about how to keep my foods safe to eat.</p>	<p>Strongly agree or agree (57.4)  Neither agree or disagree (33.5)  Disagree (5.7)  Strongly disagree (3.4)  Not stated (NR)</p>
<p>Interest in choosing nutritious foods<sup>2</sup></p>	<p>I like learning about how to choose nutritious foods to eat.</p>	<p>Strongly agree or agree (64.1)  Neither agree or disagree (27.7)  Disagree (5.5)  Strongly disagree (2.7)  Not stated (NR)</p>
<p>Concerns about food poisoning<sup>2</sup></p>	<p>I am concerned about getting food poisoning.</p>	<p>Strongly agree or agree (52.7)  Neither agree or disagree (28.1)  Disagree (13.5)  Strongly disagree (5.8)  Not stated (NR)</p>

Concerns about food allergies <sup>2</sup>	I am concerned about food allergies.	Strongly agree or agree (36.1) Neither agree or disagree (35.1) Disagree (17.0) Strongly disagree (11.8) Not stated (NR)
Confidence in cooking <sup>2</sup>	I am confident that I can cook safe, healthy meals for myself and my family.	Strongly agree or agree (72.7) Neither agree or disagree (16.9) Disagree (10.4) Strongly disagree (4.2) Not stated (NR)
Thinks cooking is an important life skill <sup>2</sup>	Being able to cook safe, healthy meals is an important life skill.	Strongly agree or agree (86.5) Neither agree or disagree (10.3) Disagree (1.6) Strongly disagree (1.7) Not stated (NR)
<b>Food Safety Practices (Dependent Variables)</b>		
Washes hands before handling food <sup>2</sup>	Before preparing or handling food, I wash my hands with soap and warm running water.	Always (56.1) Often (27.3) Sometimes (11.0) Rarely or never (5.3) Not applicable (2.3) Not stated (NR)
Washes hands after working with raw meat or chicken <sup>2</sup>	I wash my hands with soap and warm running water after working with raw meat and alternatives or chicken.	Always or often (76.7) Often (14.4) Sometimes (4.9) Rarely or never (3.6) Not applicable (8.0) Not stated (NR)
Separates foods <sup>2</sup>	I keep raw meat and alternatives and chicken away from ready-to-eat foods like raw vegetables.	Always (65.8) Often (19.5) Sometimes (7.9) Rarely or never (5.7) Not applicable (12.0) Not stated (NR)
<b>Canada's Food Guide Use (Dependent Variables)</b>		
Uses Canada's Food Guide <sup>2</sup>	I use the Canada's Food Guide to help me choose what to eat.	Always (5.1) Often (4.5) Sometimes (11.9) Rarely (20.1) Never (51.7)



		Not applicable (6.7) Not stated (NR)
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<sup>1</sup> Bredin and Leatherdale 2014

<sup>2</sup> Majowicz et al. 2015

NR: Not reported

## 4.2 Creation of New Variables

A composite food group serving total variable was created (Table 2).

Table 2. New variable created for healthy eating and food safety knowledge from the Food and Kitchen Skills Survey answers of Ontario high school students (2014-2015)

Variable	Description	Range value
<b>Healthy Eating</b>		
Composite food group serving total	Total number of servings eaten in each food group summed to a maximum of the recommended servings listed in each food group in Canada's Food Guide.	0-22 servings

For the composite food group serving total variable, individuals were given a total based on a continuous serving scale ranging from 0-22. For example, if a student ate 3 servings of fruits and vegetables (3 servings consumed / 8 servings recommended), 6 servings of grain products (6 servings consumed / 7 servings recommended), 1 serving of milk and alternatives (1 serving consumed / 4 servings recommended) and 4 servings of meat and alternatives (only 3 servings consumed / 3 servings recommended) their composite food group serving total would be 13 (13 servings consumed / 22 servings recommended). Only 3 of the 4 servings of meat and alternatives consumed were counted as the proportion will not exceed 100% of the recommendations for any one food group. The composite food group serving total was used to provide an overview of students' dietary quality as opposed to individual food groups consumed or meeting a minimum target of servings. Additionally, for the four food safety knowledge

dependent variables, new binary variables were created (correct versus incorrect food safety knowledge).

## **4.3 Analysis**

### **4.3.1 Descriptive analysis**

Descriptive analysis was conducted for all fourteen dependent variables. For the four food safety knowledge questions, the proportions of students who knew the correct answers were calculated. For the six food attitude, three food safety practice and the Canada's Food Guide use questions, the mean answer and standard deviation were calculated.

For all fourteen dependent variables, the mean (and standard deviation) number of servings consumed for each food group (fruit and vegetable, grain products, milk products, meat and alternatives), and composite food group serving totals were calculated for every level of the outcome (i.e., for each answer to a knowledge question). The mean number of servings consumed for each food group and composite food group serving total were compared across the food safety knowledge dependent variables using paired t-tests and means were compared across food attitude, food safety practice and Canada's Food Guide use dependent variables using ANOVA with Dunnett's post hoc test.

### **4.3.2 Univariable analysis**

Univariable analysis was conducted to determine the association of the five hypothesized predictor variables (e.g., food group intake) while adjusting for six covariates (e.g., age) with fourteen dependent variables (Appendix D). Logistic regression was used for the food safety knowledge dependent variables and ordinal regression was used for the food attitudes, food

safety practices, and Canada's Food Guide use dependent variables. Adjusted for school effects using a CLASS (variable classification) statement when modelling.

### **4.3.3 Multivariable analysis**

Multivariable logistic and ordinal regression were used to evaluate the association between the number of servings consumed of (i) fruit and vegetables, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives, and the composite food group serving total, on the day prior to the survey, and all food safety knowledge, attitude, practice, and Canada's Food Guide use dependent variables, respectively. For each of the fourteen dependent variables, three models were run. First, a model was run with only the six covariates (i.e., age, sex, food insecurity, school (adjusted for school effects using a CLASS statement when modelling), currently working or volunteering at a restaurant, deli, other food service location, currently working or volunteering in a hospital, and having taken a course where they were taught how to prepare food or meals) and the outcome. Second, a model was run with the six covariates and the four predictors together (i.e., number of servings of fruit and vegetables, grain products, milk and alternatives, and meat and alternatives) and the outcome. Third, a model was run with only the four predictors and the outcome, for comparison purposes only, to aid in identifying confounding.

For each of the fourteen dependent variables, another two models were run using the composite food group serving total in place of the four food groups. First, a model was run with the six covariates and the composite food group serving total predictor variable and the outcome. Second, a model was run with the composite food group serving total predictor variable and the outcome, for comparison purposes only, to aid in identifying confounding variables.

Each predictor estimate was evaluated based on the change in the size of the beta value (all changes were less than 25%), significance of the beta value, and sign of the beta value in the model. The results of the covariate only and covariate and predictor models were compared using effect size of the predictors as well as overall model fit.

Boxplots were used to compare the mean number of Food Guide servings and composite food group serving totals across all food safety knowledge, food attitude, food safety practice and Food Guide use dependent variables (data not shown).

## **5. Results**

Overall, students consumed an average (mean) of 3.15 (standard deviation [SD]:2.13, min:0, max:9) servings of fruit and vegetables, 3.22 servings of grain products (SD:1.94, min:0, max:9), 2.43 servings of milk and alternatives (SD:1.57, min:0, max:6), 2.23 servings of meat and alternatives (SD:1.22, min:0, max:5) and had a composite food group serving total of 10.37 (SD:4.67, min:0, max:22).

### **5.1 The association between students knowing the most hygienic way to wash their hands and the number of servings consumed**

With respect to food safety knowledge, students' consumption of fruits and vegetables (mean:3.11, SD:2.05, p=0.90), grain products (mean:3.14, SD:1.94, p=0.19), milk and alternatives (mean:2.37, SD:1.49, p=0.21) and meat and alternatives (mean:2.21, SD:1.18, p=0.72), as well as their composite food group serving total (mean:10.29, SD:4.48, p=0.32), on average, did not differ significantly whether they knew the most hygienic way to wash their hands or not (mean fruit and vegetables:3.14, SD:2.17, mean grain products:3.27, SD:1.98, mean

milk and alternatives:2.47, SD:1.64, mean meat and alternatives:2.23, SD:1.24, mean composite food group serving total:10.45, SD:4.76).

After adjusting for: age, sex, food insecurity, school (adjusted for school effects using a CLASS statement when modelling), currently working or volunteering at a restaurant, deli, other food service location, currently working or volunteering in a hospital, and having taken a course on how to prepare food or meals, there was no association between students knowing the most hygienic way to wash their hands, and the number of servings consumed of fruit and vegetables ( $p=0.84$ ), grain products ( $p=0.09$ ), milk and alternatives ( $p=0.80$ ), or meat and alternatives ( $p=0.19$ , Table 3), on the day prior to the survey and there was no association between students knowing the most hygienic way to wash their hands and their composite food group serving total ( $p=0.88$ , Table 4), on the day prior to the survey. The odds of students knowing the correct way to wash their hands were 1.07 times greater for every year increase in age and 1.40 times greater if the student was female versus male (Table 3).

Table 3. Association between Ontario high school students' (n=2860) food safety knowledge and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students' Food Safety Knowledge OR (95% CI)			
	Knowing the most hygienic way to your hands*	Knowing the best way to prevent food poisoning*	Knowing the best way to determine if hamburgers are cooked enough*	Knowing what a microorganism is*
Intercept	<b>0.23 (0.08, 0.67)</b>	<b>0.23 (0.08, 0.69)</b>	<b>0.01 (0.00, 0.03)</b>	<b>0.22 (0.04, 1.10)</b>
Number of fruit and vegetable servings consumed	1.00 (0.96, 1.05)	1.01 (0.97, 1.06)	<b>1.08 (1.01, 1.14)</b>	1.06 (0.99, 1.13)
Number of grain product servings consumed	0.96 (0.91, 1.01)	1.01 (0.96, 1.06)	1.01 (0.95, 1.08)	1.04 (0.96, 1.11)
Number of milk and alternative servings consumed	1.01 (0.95, 1.07)	0.97 (0.92, 1.03)	0.95 (0.87, 1.02)	<b>0.91 (0.83, 0.99)</b>
Number of meat and alternative servings consumed	1.05 (0.97, 1.14)	1.07 (0.99, 1.16)	0.99 (0.89, 1.10)	1.00 (0.89, 1.12)
Age in years	<b>1.07 (1.00, 1.15)</b>	<b>1.09 (1.01, 1.16)</b>	<b>1.22 (1.12, 1.34)</b>	<b>1.24 (1.12, 1.37)</b>
Female sex	<b>1.40 (1.18, 1.66)</b>	1.05 (0.89, 1.25)	1.24 (0.99, 1.56)	0.85 (0.66, 1.09)
Food insecurity at home	1.19 (0.76, 1.87)	0.97 (0.61, 1.54)	0.97 (0.53, 1.77)	1.07 (0.54, 2.13)
Worked at a deli, restaurant, or other food service location	1.14 (0.92, 1.41)	1.22 (0.98, 1.52)	<b>1.83 (1.43, 2.34)</b>	0.78 (0.57, 1.05)
Worked or volunteered at a hospital	0.78 (0.46, 1.32)	<b>0.59 (0.34, 1.00)</b>	1.39 (0.73, 2.65)	<b>0.39 (0.20, 0.74)</b>
Took a course on how to prepare food	0.94 (0.79, 1.12)	0.92 (0.77, 1.10)	<b>1.90 (1.52, 2.36)</b>	<b>0.70 (0.55, 0.90)</b>

\*Reference is the incorrect answer and adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 4. Association between Ontario high school students' (n=2860) food safety knowledge and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students' Food Safety Knowledge OR (95% CI)			
	Knowing the most hygienic way to your hands*	Knowing the best way to prevent food poisoning*	Knowing the best way to determine if hamburgers are cooked enough*	Knowing what a microorganism is*
Intercept	<b>0.22 (0.07, 0.64)</b>	<b>0.22 (0.08, 0.67)</b>	<b>0.01 (0.00, 0.02)</b>	<b>0.19 (0.04, 0.93)</b>
Composite food group serving total	1.00 (0.98, 1.02)	<b>1.02 (1.01, 1.04)</b>	1.02 (1.00, 1.05)	1.02 (1.00, 1.05)
Age in years	<b>1.07 (1.01, 1.15)</b>	<b>1.08 (1.01, 1.16)</b>	<b>1.22 (1.12, 1.34)</b>	<b>1.23 (1.11, 1.36)</b>
Female sex	<b>1.42 (1.21, 1.67)</b>	1.08 (0.92, 1.27)	<b>1.33 (1.07, 1.66)</b>	0.91 (0.71, 1.16)
Food insecurity at home	1.08 (0.69, 1.68)	0.96 (0.61, 1.51)	0.98 (0.54, 1.78)	1.19 (0.60, 2.36)
Worked at a deli, restaurant, or other food service location	1.10 (0.89, 1.36)	1.22 (0.98, 1.51)	<b>1.87 (1.46, 2.40)</b>	0.75 (0.55, 1.02)
Worked or volunteered at a hospital	0.77 (0.47, 1.28)	<b>0.58 (0.35, 0.97)</b>	1.26 (0.67, 2.37)	<b>0.42 (0.22, 0.79)</b>
Took a course on how to prepare food	0.94 (0.79, 1.12)	0.90 (0.76, 1.08)	<b>1.87 (1.50, 2.32)</b>	<b>0.71 (0.55, 0.91)</b>

\*Reference is the incorrect answer and adjusted for school effects using a CLASS (variable classification) statement when modelling

## 5.2 The association between students knowing the most important way to prevent food poisoning and the number of servings consumed

On average, students who knew the most important way to prevent food poisoning ate significantly more servings of meat and alternatives (mean:2.26, SD:1.19, p=0.002) and had a significantly greater composite food group serving total (mean:10.63, SD:4.51, p=0.01) than students who did not know the most important way to prevent food poisoning (mean meat and alternatives:2.16, SD:1.23, mean composite food group serving total:10.11, SD:4.69). Students'

consumption of fruit and vegetable (mean:3.07, SD:2.08,  $p=0.09$ ), grain product (mean:3.26, SD:1.89,  $p=0.16$ ), and milk and alternative (mean:2.41, SD:1.56,  $p=0.60$ ) servings did not differ significantly regardless of whether students knew the most important way to prevent food poisoning or not (mean fruit and vegetables:3.04, SD:2.11, mean grain products:3.17, SD:1.99, mean milk and alternatives:2.44, SD:1.57).

When age, sex, and the other covariates were adjusted for, there was no significant association between students knowing the most important way to prevent food poisoning and the number of servings consumed of any of the food groups (Table 3), however, there was significant association between students knowing the most important way to prevent food poisoning with the composite food group serving total consumed ( $p=0.01$ , Table 4). Specifically, the odds of students knowing the most important way to prevent food poisoning were 1.02 times greater for every serving increase in composite serving total, 1.09 times greater for every year increase in age, and 1.69 times lower for students who worked or volunteered at a hospital (Table 4).

### **5.3 The association between students knowing the best method of determining whether hamburgers are cooked enough and the number of servings consumed**

Students' consumption of each food group and the composite food group serving total was not significantly different (mean fruit and vegetables:3.16, SD:2.07,  $p=0.48$ , mean grain products:3.19, SD:1.88,  $p=0.16$ , mean milk and alternatives: 2.34, SD:1.56,  $p=0.31$ , mean meat and alternatives: 2.20, SD:1.19,  $p=0.16$ , mean composite food group serving total:10.56, SD: 4.46,  $p=0.50$ ), regardless of whether they knew the best way to determine if hamburgers were cooked enough or not (mean fruit and vegetables:2.96, SD:2.22, mean grain products:3.19,



SD:1.90, mean milk and alternatives:2.43, SD:1.55, mean meat and alternatives:2.21, SD:1.20, mean composite food group serving total:10.32, SD: 4.57).

When age, sex, and the other covariates were adjusted for, there was no significant association between students knowing the best method of determining whether hamburgers were cooked enough and the number of servings consumed of grain products, milk and alternatives, meat and alternatives, or composite food group serving total (Table 3), however, there was a significant association between students knowing the best method of determining whether hamburgers were cooked enough and the number of fruit and vegetables consumed ( $p=0.01$ , Table 4). Specifically, the odds of students knowing the best method of determining whether hamburgers were cooked enough were 1.08 times greater for every serving increase in fruit and vegetable consumption, 1.22 times greater for every year increase in age, and was 1.90 times greater for students who took a course on how to prepare food (Table 3).

#### **5.4 The association between students knowing what a microorganism is, and the number of servings consumed**

Students who knew what a microorganism was ate significantly more servings of fruits and vegetables (mean:3.96, SD:2.22,  $p=0.02$ ), grain products (mean:3.25, SD:1.84,  $p=0.02$ ), meat and alternatives (2.23, SD:1.18,  $p=0.04$ ) and had a greater composite food group serving total (mean:10.58, SD:4.41,  $p=0.003$ ) than students who did not know what a microorganism was (mean fruit and vegetables:3.16, SD:2.07, mean grain products:3.13, SD:2.20, mean meat and alternatives:2.15, SD:1.26, mean composite food group serving total:9.91, SD:4.98), on average. Students' consumption of milk and alternative (mean: 2.40, SD:1.51,  $p=0.97$ ) servings did not differ significantly whether students knew what a microorganism was or not (mean milk and alternatives:2.49, SD:1.71).

When age, sex, and the other covariates were adjusted for, there was no statistically significant association between students knowing what a microorganism was and the number of servings consumed of fruit and vegetables ( $p=0.09$ ), grain products ( $p=0.44$ ), meat and alternatives ( $p=0.99$ , Table 3) and composite food group serving total ( $p=0.09$ , Table 4), however, there was an association between students knowing what a microorganism was and the number of servings consumed of milk and alternatives ( $p=0.04$ , Table 3). Specifically, the odds of students knowing what a microorganism was were 1.10 times lower for every serving increase in milk and alternative consumption, 1.24 times greater for every year increase in age, 2.56 times lower if a student had worked or volunteered at a hospital and 1.43 times lower in students who had taken a course on how to prepare food (Table 3).

### **5.5 The association between students' interest in learning about how to keep foods safe to eat, and the number of servings consumed**

With respect to food safety attitudes, students who strongly agreed that they liked learning about how to keep foods safe to eat ate significantly more servings of fruits and vegetables (mean:3.49, SD:2.25) than students who neither agreed or disagreed (mean:2.92, SD:1.99,  $p=0.04$ ) and disagreed (mean: 3.00, SD:2.07,  $p=0.01$ ) but not significantly more than those who agreed (mean:3.15, SD:2.05,  $p=0.19$ ) or strongly disagreed (mean: 3.22, SD: 2.92,  $p=0.54$ ), on average (Table 5). Students' consumption of grain products (mean:3.31, SD:2.15, mean agree:3.18, SD:1.77,  $p=0.99$ , mean neither agree or disagree: 3.17, SD: 1.86,  $p=0.99$ , mean disagree: 3.36, SD: 3.35,  $p=0.40$ , mean strongly disagree: 3.35, SD:2.89,  $p=0.87$ ), milk and alternatives (mean:2.54, SD:1.64, mean agree:2.37, SD:1.47,  $p=1.00$ , mean neither agree or disagree: 2.41, SD: 1.51,  $p=0.97$ , mean disagree: 2.38, SD: 1.51,  $p=0.32$ , mean strongly disagree: 2.60, SD:1.99,  $p=0.50$ ), and meat and alternatives (mean:2.40, SD:1.24, mean agree:2.17,

SD:1.14,  $p=0.97$ , mean neither agree or disagree:2.15, SD: 1.19,  $p=0.93$ , mean disagree:2.21, SD: 1.22,  $p=0.17$ , mean strongly disagree:2.47, SD:1.75,  $p=0.06$ ), as well as the composite food group serving total (mean:11.01, SD:4.90, mean agree:10.42, SD:4.37,  $p=0.59$ , mean neither agree or disagree: 10.13, SD:4.43,  $p=0.28$ , mean disagree:10.57, SD:4.44,  $p=0.06$ , mean strongly disagree:9.62, SD:6.76,  $p=0.14$ ) did not differ significantly by level of interest in learning about how to keep foods safe to eat.

When age, sex, and the other covariates were adjusted for there was no statistically significant association between students' interest in learning about how to keep foods safe to eat and the number of servings consumed of milk and alternatives ( $p=0.96$ ) or meat and alternatives ( $p=0.30$ ), however, there was a statistically significant association between students' interest in learning about how to keep foods safe to eat and the number of servings consumed of fruit and vegetables ( $p<0.001$ ), grain products ( $p=0.05$ , Table 3) and composite food group serving total ( $p=0.01$ , Table 7). Specifically, the odds of students having interest in learning how to keep foods safe to eat were 1.08 times greater for every serving increase in fruit and vegetable consumption, 1.05 times lower for every serving increase in grains, 1.02 times greater for every serving increase in composite food group serving total, 1.12 times lower for every year increase in age, and 1.95 times greater if the student had taken a course on how to prepare food (Table 6 and Table 7).

Table 5. Mean number of servings consumed on the day prior to the survey and composite food group serving total by Ontario high school students (n=2860) food attitudes (2014-2015); statistically significant differences are bolded (p<0.05)

	Mean number of servings consumed (Standard deviation)				
	Fruits and Vegetables	Grain Products	Milk and Alternatives	Meat and Alternatives	Composite food group serving total
<b>I like learning about how to keep my foods safe to eat.</b>					
Strongly agree (n= 499)*	3.49 (2.25)	3.31 (2.15)	2.54 (1.65)	2.40 (1.24)	11.01 (4.90)
Agree (n= 1063)	<b>3.15</b> <b>(2.05)</b>	3.18 (1.77)	2.37 (1.47)	2.17 (1.14)	10.42 (4.37)
Neither agree or disagree (n= 911)	<b>2.92</b> <b>(1.99)</b>	3.17 (1.86)	2.41 (1.51)	2.15 (1.19)	10.13 (4.43)
Disagree (n= 155)	3.00 (2.07)	3.36 (1.83)	2.38 (1.51)	2.21 (1.22)	10.57 (4.44)
Strongly disagree (n= 93)	3.22 (2.92)	3.35 (2.89)	2.60 (1.99)	2.47 (1.75)	9.62 (6.76)
<b>I like learning about how to choose nutritious foods to eat.</b>					
Strongly agree (n= 619)*	3.79 (2.29)	3.38 (2.09)	2.54 (1.58)	2.40 (1.20)	11.45 (4.71)
Agree (n= 1119)	<b>3.12</b> <b>(1.94)</b>	3.16 (1.80)	2.36 (1.49)	<b>2.17</b> <b>(1.16)</b>	<b>10.36 (4.31)</b>
Neither agree or disagree (n= 752)	<b>2.75</b> <b>(2.02)</b>	3.21 (1.87)	2.46 (1.59)	<b>2.17</b> <b>(1.18)</b>	<b>10.05 (4.53)</b>
Disagree (n= 149)	<b>2.56</b> <b>(1.99)</b>	3.05 (1.90)	2.24 (1.53)	<b>2.13</b> <b>(1.24)</b>	<b>9.54 (4.52)</b>
Strongly disagree (n= 73)	<b>2.82</b> <b>(2.87)</b>	3.20 (2.80)	2.43 (1.95)	2.05 (1.76)	8.29 (6.75)
<b>I am concerned about getting food poisoning.</b>					
Strongly agree (n= 561)*	3.36 (2.19)	3.27 (2.03)	2.46 (1.59)	2.33 (1.16)	10.77 (4.71)
Agree (n= 864)	3.05 (1.96)	3.14 (1.77)	2.40 (1.52)	2.19 (1.18)	10.33 (4.28)
Neither agree or disagree (n= 759)	3.02 (2.13)	3.17 (1.87)	2.43 (1.54)	2.17 (1.19)	10.30 (4.53)

Disagree (n= 366)	3.16 (2.04)	3.39 (1.93)	2.38 (1.49)	2.17 (1.18)	10.52 (4.68)
Strongly disagree (n= 156)	3.19 (2.56)	3.30 (2.47)	2.46 (1.80)	2.32 (1.53)	9.95 (5.89)
<b>I am concerned about food allergies.</b>					
Strongly agree (n= 342)*	3.40 (2.29)	3.29 (2.14)	2.42 (1.66)	2.31 (1.22)	10.67 (4.98)
Agree (n= 634)	3.08 (1.98)	3.15 (1.85)	2.39 (1.47)	2.17 (1.17)	10.31 (4.31)
Neither agree or disagree (n= 950)	3.04 (2.11)	3.19 (1.81)	2.41 (1.55)	2.19 (1.16)	10.40 (4.49)
Disagree (n= 458)	3.09 (1.95)	3.16 (1.85)	2.45 (1.49)	2.16 (1.22)	10.30 (4.38)
Strongly disagree (n= 318)	3.28 (2.35)	3.49 (2.25)	2.51 (1.72)	2.40 (1.34)	10.64 (5.36)
<b>I am confident that I can cook safe, healthy meals for myself and my family.</b>					
Strongly agree (n= 815)*	3.54 (2.25)	3.34 (2.08)	2.50 (1.62)	2.37 (1.26)	11.08 (4.81)
Agree (n= 1161)	<b>3.07</b> <b>(1.95)</b>	3.15 (1.79)	2.38 (1.49)	2.16 (1.13)	10.28 (4.35)
Neither agree or disagree (n= 458)	<b>2.81</b> <b>(2.05)</b>	3.22 (1.91)	2.47 (1.60)	2.14 (1.18)	<b>10.10 (4.53)</b>
Disagree (n= 170)	<b>2.64</b> <b>(1.85)</b>	3.07 (1.67)	2.32 (1.39)	2.12 (1.17)	<b>9.79</b> <b>(4.27)</b>
Strongly disagree (n= 113)	<b>2.87</b> <b>(2.71)</b>	3.20 (2.50)	2.29 (1.80)	2.14 (1.53)	<b>9.19 (5.76)</b>
<b>Being able to cook safe, healthy meals is an important life skill.</b>					
Strongly agree (n= 1277)*	3.37 (2.16)	3.26 (1.93)	2.44 (1.55)	2.28 (1.18)	10.77 (4.57)
Agree (n= 1068)	<b>2.97</b> <b>(1.96)</b>	3.21 (1.83)	2.40 (1.52)	2.18 (1.17)	10.34 (4.37)
Neither agree or disagree (n= 278)	<b>2.75</b> <b>(2.05)</b>	3.11 (1.96)	2.37 (1.66)	2.13 (1.22)	9.76 (4.73)
Disagree (n= 42)	<b>2.35</b> <b>(2.14)</b>	<b>2.75</b> <b>(2.12)</b>	<b>1.95</b> <b>(1.45)</b>	<b>1.80</b> <b>(1.42)</b>	<b>8.00 (4.74)</b>
Strongly disagree (n= 47)	3.41 (3.47)	3.63 (3.35)	2.53 (2.05)	2.23 (2.01)	8.91 ( 7.69)

\*Reference is Strongly Agree and adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 6. Association between Ontario high school students' (n=2860) interest in learning how to keep foods safe to eat and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.08 (1.04, 1.13)</b>
Number of grain product servings consumed	<b>0.95 (0.91, 1.00)</b>
Number of milk and alternative servings consumed	1.00 (0.95, 1.06)
Number of meat and alternative servings consumed	1.04 (0.97, 1.12)
Age in years	<b>0.89 (0.87, 0.91)</b>
Female sex	1.02 (0.87, 1.19)
Food insecurity at home	0.76 (0.50, 1.17)
Worked at a deli, restaurant, or other food service location	1.19 (0.98, 1.45)
Worked or volunteered at a hospital	1.08 (0.65, 1.79)
Took a course on how to prepare food	<b>1.95 (1.66, 2.29)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 7. Association between Ontario high school students' (n=2860) interest in learning how to keep foods safe to eat and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Composite food group serving total	<b>1.02 (1.01, 1.04)</b>
Age in years	<b>0.89 (0.87, 0.90)</b>
Female sex	1.03 (0.88, 1.19)
Food insecurity at home	0.71 (0.47, 1.07)
Worked at a deli, restaurant, or other food service location	<b>1.23 (1.01, 1.49)</b>
Worked or volunteered at a hospital	1.32 (0.81, 2.14)
Took a course on how to prepare food	<b>1.92 (1.64, 2.25)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

### 5.6 The association between students' interest in learning about how to choose nutritious foods to eat and the number of servings consumed

Students who strongly agreed that they liked learning about how to choose nutritious foods ate significantly more servings of fruits and vegetables (mean:3.79, SD:2.29) than those who only agreed (mean:3.12, SD:1.94,  $p < 0.0001$ ), neither agreed or disagreed (mean:2.75,

SD:2.02,  $p<0.0001$ ), disagreed (mean:2.56, SD:1.99,  $p<0.0001$ ) or strongly disagreed (mean:2.82, SD:2.87,  $p=0.04$ ) and had a greater composite food group serving total (mean:11.45, SD:4.71) than students who agreed (mean:10.36, SD:4.31,  $p=0.02$ ), neither agreed nor disagreed (mean:10.05, SD:4.53,  $p=0.04$ ), and disagreed (mean:9.54, SD:4.52,  $p=0.01$ ), but not strongly disagreed (mean:8.29, SD:6.75,  $p=0.03$ ), on average (Table 5). Students' consumption of grain products (mean:3.38, SD:2.09, mean agree:3.16, SD:1.80,  $p=0.99$ , mean neither agree or disagree: 3.21, SD: 1.87,  $p=0.90$ , mean disagree: 3.05, SD: 1.90,  $p=0.99$ , mean strongly disagree: 3.20, SD:2.80,  $p=0.87$ ), milk and alternatives (mean:2.54, SD:1.58, mean agree:2.36, SD:1.49,  $p=0.99$ , mean neither agree or disagree: 2.46, SD: 1.59,  $p=0.59$ , mean disagree: 2.24, SD: 1.53,  $p=0.70$ , mean strongly disagree: 2.43, SD:1.95,  $p=0.99$ ), and meat and alternatives (mean:2.40, SD:1.20, mean agree:2.17, SD:1.16,  $p=0.47$ , mean neither agree or disagree:2.17, SD:1.18,  $p=0.58$ , mean disagree:2.13, SD:1.24,  $p=0.21$ , mean strongly disagree:2.05, SD:1.76,  $p=0.49$ ) did not differ significantly by level of interest in learning about how to choose nutritious foods to eat.

When age, sex, and the other covariates were adjusted for there was no statistically significant association between students' interest in learning about how to choose nutritious foods to eat, and the number of servings consumed of grain products ( $p=0.06$ ), milk and alternatives ( $p=0.37$ ), or meat and alternatives ( $p=0.49$ ), however, there was a statistically significant association between students' interest in learning about how to choose nutritious foods to eat, and the number of servings consumed of fruit and vegetables ( $p<0.0001$ , Table 8) and composite food group serving total ( $p<0.001$ , Table 9). Specifically, the odds of students having interest in learning how to choose nutritious foods were 1.21 times greater with every serving increase in fruit and vegetable consumption and 1.06 times greater for every serving

increase in composite food group serving total, 1.14 times lower for every year increase in age, 1.30 times greater if the student was female versus male, 1.54 times greater in students who worked or volunteered at a deli, restaurant, or other food service location and 1.58 times greater in students who had taken a course on how to prepare food (Table 8 and 9).

Table 8. Association between Ontario high school students' (n=2860) interest in learning how to choose nutritious foods and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.21 (1.16, 1.26)</b>
Number of grain product servings consumed	0.96 (0.91, 1.00)
Number of milk and alternative servings consumed	0.98 (0.92, 1.03)
Number of meat and alternative servings consumed	1.03 (0.95, 1.11)
Age in years	<b>0.88 (0.87, 0.90)</b>
Female sex	<b>1.30 (1.11, 1.51)</b>
Food insecurity at home	0.76 (0.50, 1.17)
Worked at a deli, restaurant, or other food service location	<b>1.54 (1.27, 1.88)</b>
Worked or volunteered at a hospital	0.87 (0.52, 1.45)
Took a course on how to prepare food	<b>1.58 (1.34, 1.85)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 9. Association between Ontario high school students' (n=2860) interest in learning how to choose nutritious foods and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Composite food group serving total	<b>1.06 (1.04, 1.08)</b>
Age in years	<b>0.87 (0.86, 0.89)</b>
Female sex	1.37 (1.18, 1.59)
Food insecurity at home	0.72 (0.47, 1.08)
Worked at a deli, restaurant, or other food service location	<b>1.62 (1.33, 1.96)</b>
Worked or volunteered at a hospital	1.07 (0.66, 1.75)
Took a course on how to prepare food	<b>1.55 (1.33, 1.82)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling



## 5.7 The association between students' concern about food poisoning and the number of servings consumed

Students' consumption of fruits and vegetables (mean:3.36, SD:2.19, mean agree:3.05, SD:1.96, p=0.99, mean neither agree or disagree: 3.02, SD:2.13, p=0.99, mean disagree: 3.16, SD:2.04, p=0.95, mean strongly disagree:3.19, SD:2.56, p=0.68), grain products (mean:3.27, SD:2.03, mean agree:3.14, SD:1.77, p=0.99, mean neither agree or disagree: 3.17, SD: 1.87, p=0.95, mean disagree: 3.39, SD:1.93, p=0.35, mean strongly disagree: 3.30, SD:2.47, p=1.00), milk and alternatives (mean:2.46, SD:1.59, mean agree:2.40, SD:1.52, p=0.98, mean neither agree or disagree:2.43, SD:1.54, p=0.93, mean disagree:2.38, SD:1.49, p=0.98, mean strongly disagree:2.46, SD:1.80, p=0.99) and meat and alternatives (mean:2.33, SD:1.16, mean agree:2.33, SD:1.16, p=0.71, mean neither agree or disagree:2.17, SD: 1.19, p=0.33 mean disagree:2.17, SD, p=0.71, mean strongly disagree:2.32, SD:1.53, p=0.99) and their composite food group serving total (mean:10.77, SD:4.71, mean agree:10.33, SD:4.28, p=0.99, mean neither agree or disagree:10.30, SD:4.53, p=0.59, mean disagree:10.52, SD:4.68, p=0.99, mean strongly disagree:9.95, SD:5.89, p=0.96) was not significantly different regardless of their reported concerns about food poisoning (Table 5).

When age, sex, and the other covariates were adjusted for there was no statistically significant association between students' concern about food poisoning, and the number of servings consumed of fruit and vegetables (p=0.37), grain products (p=0.12), milk and alternatives (p=0.83), or meat and alternatives (p=0.09, Table 10) and their composite food group serving total (p=0.24, Table 11). Specifically, the odds of students having concerns about food poisoning were 1.10 times lower for every year increase in age and 1.32 times greater in students who had taken a course on how to prepare food (Table 10).

Table 10. Association between Ontario high school students' (n=2860) concern about food poisoning and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	1.02 (0.98, 1.06)
Number of grain product servings consumed	0.96 (0.92, 1.01)
Number of milk and alternative servings consumed	1.01 (0.95, 1.06)
Number of meat and alternative servings consumed	1.07 (0.99, 1.14)
Age in years	<b>0.91 (0.89, 0.92)</b>
Female sex	1.00 (0.86, 1.17)
Food insecurity at home	0.78 (0.52, 1.18)
Worked at a deli, restaurant, or other food service location	1.03 (0.85, 1.24)
Worked or volunteered at a hospital	0.93 (0.56, 1.55)
Took a course on how to prepare food	<b>1.32 (1.13, 1.54)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 11. Association between Ontario high school students' (n=2860) concern about food poisoning and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Composite food group serving total	1.01 (0.99, 1.03)
Age in years	<b>0.91 (0.89, 0.92)</b>
Female sex	0.99 (0.86, 1.15)
Food insecurity at home	0.72 (0.48, 1.08)
Worked at a deli, restaurant, or other food service location	1.04 (0.86, 1.26)
Worked or volunteered at a hospital	1.02 (0.63, 1.66)
Took a course on how to prepare food	<b>1.31 (1.12, 1.52)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

### 5.8 The association between students' concern about food allergies and the number of servings consumed

Students' consumption of fruits and vegetables (mean: 3.40, SD:2.29, mean agree:3.08, SD:1.98, p=0.88, mean neither agree or disagree:3.04, SD:2.11, p=0.19, mean disagree:3.09, SD:1.95, p=0.17, mean strongly disagree:3.28, SD:2.35, p=0.26), grain products (mean:3.29, SD:2.14, mean agree:3.15, SD:1.85, p=0.98, mean neither agree or disagree:3.19, SD:1.81,

p=1.00, mean disagree:3.16, SD:1.85, p=0.92, mean strongly disagree:3.49, SD:2.25, p=0.71), milk and alternatives (mean:2.42, SD:1.66, mean agree:2.42, SD:1.66, p=1.00, mean neither agree or disagree:2.41, SD:1.55, p=0.97, mean disagree:2.45, SD:1.49, p=0.73, mean strongly disagree:2.51, SD:1.72, p=0.94), and meat and alternatives (mean2.31, SD:1.22, mean agree:2.17, SD:1.17, p=1.00, mean neither agree or disagree:2.19, SD:1.16, p=0.56, mean disagree:2.16, SD:1.22, p=0.95, mean strongly disagree:2.40, SD:1.34, p=0.19) and their composite food group serving total (mean:10.67, SD:4.98, mean agree: 10.31, SD:4.31, p=0.99, mean neither agree or disagree:10.40, SD:4.49, p=0.34, mean disagree:10.30, SD:4.38, p=0.72, mean strongly disagree:10.64, SD:5.36, p=0.20), was not significantly different regardless of their concerns about food allergies (Table 5).

When age, sex, and the other covariates were adjusted for there was no association between students' concern about food allergies, and the number of servings consumed of fruit and vegetables (p=0.23), grain products (p=0.40), milk and alternatives (p=0.40), or meat and alternatives (p=0.80, Table 12) and the composite food group serving total (p=0.67, Table 13). Specifically, the odds of students having concerns about food allergies were 1.14 times lower for every year increase in age, and 1.44 times greater for those who took a course on how to prepare food (Table 12).

Table 12. Association between Ontario high school students' (n=2860) concern about food allergies and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	1.02 (0.98, 1.07)
Number of grain product servings consumed	0.98 (0.94, 1.03)
Number of milk and alternative servings consumed	0.98 (0.93, 1.03)
Number of meat and alternative servings consumed	0.99 (0.92, 1.06)
Age in years	<b>0.88 (0.86, 0.89)</b>
Female sex	1.04 (0.90, 1.21)

Food insecurity at home	0.85 (0.57, 1.28)
Worked at a deli, restaurant, or other food service location	1.14 (0.95, 1.38)
Worked or volunteered at a hospital	1.23 (0.75, 2.00)
Took a course on how to prepare food	<b>1.44 (1.23, 1.68)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 13. Association between Ontario high school students' (n=2860) concern about food allergies and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Composite food group serving total	1.00 (0.98, 1.01)
Age in years	<b>0.88 (0.86, 0.89)</b>
Female sex	1.06 (0.92, 1.23)
Food insecurity at home	0.79 (0.53, 1.17)
Worked at a deli, restaurant, or other food service location	1.17 (0.96, 1.41)
Worked or volunteered at a hospital	1.46 (0.91, 2.34)
Took a course on how to prepare food	<b>1.44 (1.23, 1.68)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

### 5.9 The association between students' confidence in cooking safe, healthy meals for themselves and their families and the number of servings consumed

Students' consumption of grain products (mean:3.34, SD:2.08, mean agree:3.15, SD:1.79, p=0.98, mean neither agree or disagree:3.22, SD:1.91, p=1.00 mean disagree:3.07, SD:1.67, p=0.99, mean strongly disagree:3.20, SD:2.50, p=0.66), milk and alternatives (mean:2.50, SD:1.62, mean agree:2.38, SD:1.49, p=0.99, mean neither agree or disagree:2.47, SD:1.60, p=0.99, mean disagree:2.32, SD:1.39, p=0.88, mean strongly disagree:2.29, SD:1.80, p=0.62) and meat and alternatives (mean:2.37, SD:1.26, mean agree:2.16, SD:1.13, p=1.00, mean neither agree or disagree:2.14, SD:1.18, p=0.56, mean disagree:2.12, SD:1.17, p=0.95,

mean strongly disagree:2.14, SD:1.53,  $p=0.19$ ), was not significantly different for students regardless of their confidence in cooking safe, healthy meals for themselves and their families (Table 5). Moreover, students' consumption of fruits and vegetables (mean:3.54, SD: 2.25, mean agree:3.07, SD:1.95,  $p=0.81$ , mean neither agree or disagree:2.81, SD:2.05,  $p=0.13$ , mean disagree:2.64, SD:1.85,  $p=0.17$ , mean strongly disagree:2.87, SD:2.71,  $p=0.20$ ) and composite food group serving total (mean:11.08, SD:4.81, mean agree:10.28, SD:4.35,  $p=0.71$ , mean neither agree or disagree:10.10, SD:4.53,  $p=0.83$ , mean disagree:9.79, SD:4.27,  $p=0.77$ , mean strongly disagree:9.19, SD:5.76,  $p=0.42$ ), was significantly different for students regardless of their confidence in cooking safe, healthy meals for themselves and their families (Table 5).

When age, sex, and the other covariates were adjusted for there was no statistically significant association between students' confidence in cooking safe, healthy meals for themselves and their families and the number of servings consumed of grain products ( $p=0.32$ ), milk and alternatives ( $p=0.36$ ), or meat and alternatives ( $p=0.14$ ), however, there was a statistically significant association between students' confidence in cooking safe, healthy meals for themselves and their families, and the number of servings consumed of fruit and vegetables ( $p<0.0001$ , Table 14) and composite food group serving total ( $p<0.0001$ , Table 15). Specifically, the odds of students having confidence in cooking safe, healthy meals for themselves and their families were 1.13 times greater for every serving increase in fruit and vegetable consumption, 1.04 times greater for every serving increase in composite food group serving total, 1.11 times lower for every year increase in age, 1.20 times greater if the student was female versus male, 1.53 times greater if the student had worked at a deli, restaurant, or other food service location and 1.88 times greater if the student took a course on how to prepare food (Table 14 and Table 15).

Table 14. Association between Ontario high school students' (n=2860) confidence in cooking safe, healthy meals for themselves and their families and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.13 (1.09, 1.18)</b>
Number of grain product servings consumed	0.98 (0.93, 1.02)
Number of milk and alternative servings consumed	0.97 (0.92, 1.03)
Number of meat and alternative servings consumed	1.05 (0.99, 1.14)
Age in years	<b>0.90 (0.89, 0.92)</b>
Female sex	<b>1.20 (1.03, 1.41)</b>
Food insecurity at home	0.75 (0.49, 1.14)
Worked at a deli, restaurant, or other food service location	<b>1.52 (1.25, 1.84)</b>
Worked or volunteered at a hospital	0.88 (0.54, 1.44)
Took a course on how to prepare food	<b>1.88 (1.60, 2.20)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 15. Association between Ontario high school students' (n=2860) confidence in cooking safe, healthy meals for themselves and their families and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Composite food group serving total	<b>1.04 (1.03, 1.06)</b>
Age in years	<b>0.90 (0.88, 0.91)</b>
Female sex	<b>1.24 (1.07, 1.44)</b>
Food insecurity at home	0.74 (0.49, 1.11)
Worked at a deli, restaurant, or other food service location	<b>1.56 (1.28, 1.89)</b>
Worked or volunteered at a hospital	1.02 (0.64, 1.64)
Took a course on how to prepare food	<b>1.88 (1.60, 2.20)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

## **5.10 The association between students' belief that cooking safe, healthy meals is an important life skill, and the number of servings consumed**

Students' consumption of grain products (mean:3.26, SD:1.93), milk and alternatives (mean:2.44, SD:1.55), and their composite food group serving total (mean:10.77, SD:4.57) was significantly different for students who strongly agreed compared to students who disagreed (mean grain products:2.75, SD:2.12,  $p=0.008$ , mean milk and alternatives: 1.95, SD:1.45,  $p=0.02$ , mean composite food group serving total:8.00, SD:4.74,  $p=0.004$ ) but was not significantly different among those who strongly agreed and not those who agreed (mean grain products:3.21, SD:1.83,  $p=1.00$ , mean milk and alternatives: 2.40, SD:1.52,  $p=0.99$ , mean composite food group serving total:10.34, SD:4.37,  $p=0.99$ ), neither agreed or disagreed (mean grain products:3.11, SD:1.96,  $p=0.96$ , mean milk and alternatives:2.37, SD:1.66,  $p=0.97$ , mean composite food group serving total:9.76, SD:4.73,  $p=0.88$ ), or those who strongly disagreed (mean grain products:3.63, SD:3.35,  $p=0.73$ , mean milk and alternatives:2.53, SD:2.05,  $p=0.96$ , mean composite food group serving total:8.91, SD:7.69,  $p=0.95$ ), on average (Table 5). However, students who strongly agreed that being able to cook safe, healthy meals is an important life skill did not eat significantly more servings fruits and vegetables (mean:3.37, SD:2.16) or meat and alternatives (mean:2.28, SD:1.18) than students who agreed (mean fruit and vegetables:2.97, SD:1.96,  $p=0.96$ , mean meat and alternatives:2.18, SD:1.17,  $p=1.00$ ), neither agreed or disagreed (mean fruit and vegetables:2.75, SD:2.05,  $p=0.99$ , mean meat and alternatives:2.13, SD:1.22,  $p=0.99$ ), disagreed (mean fruit and vegetables:2.35, SD:2.14,  $p=0.33$ , mean meat and alternatives: 2.23, SD:2.01,  $p=0.06$ ), or strongly disagreed (mean fruit and vegetables: 3.41, SD:3.47,  $p=0.69$ , mean meat and alternatives:2.23, SD:2.01,  $p=0.48$ ).

When age, sex, and the other covariates were adjusted for there was no statistically significant association between students' belief that cooking safe, healthy meals is an important

life skill, and the number of servings consumed of grain products ( $p=0.52$ ), milk and alternatives ( $p=0.41$ ), or meat and alternatives ( $p=0.09$ ), however, there was a statistically significant association between students' belief that cooking safe, healthy meals is an important life skill, and the number of servings consumed of fruit and vegetables ( $p<0.0001$ , Table 16) and the composite food group serving total ( $p<0.0001$ , Table 17). Specifically, the odds of students perceiving that cooking safe, healthy meals in an important life skill were 1.12 times greater with every serving increase in fruit and vegetable consumption, 1.05 times greater for every serving increase in composite food group serving total, 1.04 times lower for every year increase in age, 1.35 times greater for females versus males, 1.79 times lower for students who worked or volunteered at a hospital and 1.19 times greater for students who had taken a course on how to prepare food (Table 16 and Table 17).

Table 16. Association between Ontario high school students' ( $n=2860$ ) perception that cooking safe, healthy meals is an important life skill and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Attitudes OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.12 (1.07, 1.17)</b>
Number of grain product servings consumed	0.98 (0.94, 1.03)
Number of milk and alternative servings consumed	0.98 (0.92, 1.03)
Number of meat and alternative servings consumed	1.07 (0.99, 1.15)
Age in years	<b>0.96 (0.94, 0.97)</b>
Female sex	<b>1.35 (1.15, 1.59)</b>
Food insecurity at home	0.73 (0.47, 1.12)
Worked at a deli, restaurant, or other food service location	1.13 (0.93, 1.38)
Worked or volunteered at a hospital	<b>0.56 (0.34, 0.93)</b>
Took a course on how to prepare food	<b>1.19 (1.01, 1.40)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling



Table 17. Association between Ontario high school students' (n=2860) perception that cooking safe, healthy meals is an important life skill and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

<b>Predictor Variables and Covariates</b>	<b>Students' Food Attitudes OR (95% CI)</b>
Composite food group serving total	<b>1.05 (1.03, 1.07)</b>
Age in years	<b>0.95 (0.93, 0.97)</b>
Female sex	<b>1.39 (1.19, 1.63)</b>
Food insecurity at home	0.71 (0.47, 1.09)
Worked at a deli, restaurant, or other food service location	1.17 (0.96, 1.43)
Worked or volunteered at a hospital	0.63 (0.39, 1.02)
Took a course on how to prepare food	1.17 (1.00, 1.38)

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

### **5.11 The association between how often students report washing their hands with soap and warm running water before preparing or handling food and the number of servings consumed**

With respect to food safety practices, students who always washed their hands with soap and warm running water before preparing or handling food ate significantly more servings of fruits and vegetables (mean:3.28, SD:2.12) than students who often (mean:2.99, SD:1.91, p=0.02) or rarely (mean:2.40, SD:1.98, p=0.07) washed their hands but not more than those who answered sometimes (mean:2.95, SD:1.91, p=0.74), or never (mean:3.27, SD:3.09, p=0.99), on average (Table 18). The mean number of servings of grain products (mean:3.15, SD:1.90, mean often:3.29, SD:1.82, p=0.99 mean sometimes:3.36, SD:1.98, p=0.24, mean rarely:2.88, SD:1.87, p=0.70, mean never:4.00, SD:3.07, p=0.83), milk and alternatives (mean:2.39, SD:1.54, mean often: 2.44, SD:1.52, p=0.52, mean sometimes:2.51, SD:1.54, p=0.99, mean rarely:2.48, SD:1.71, p=0.99, mean never:3.00, SD:1.96, p=0.99), and meat and alternatives (mean:2.23, SD: 1.17, mean often:2.21, SD:1.18, p=0.90, mean sometimes:2.17, SD:1.20, p=0.95, mean rarely:2.00, SD:0.10, p=0.31, mean never: 2.64, SD:1.99, p=0.99) consumed and students' mean

composite food group serving total (mean:10.56, SD:4.55, mean often:10.43, SD:4.36,  $p=0.41$ , mean sometimes: 10.45, SD:4.58,  $p=0.99$ , mean rarely:9.10, SD:4.57,  $p=0.13$ , mean never:10.22, SD:6.87,  $p=0.99$ ) did not differ significantly by frequency of hand washing before preparing or handling food.

When age, sex, and the other covariates were adjusted for there was no statistically significant association between how often students reported washing their hands with soap and warm running water before preparing or handling food, and the number of servings consumed of milk and alternatives ( $p=0.06$ ) or meat and alternative ( $p=0.44$ ), however, there was a statistically significant association between how often students reported washing their hands with soap and warm running water before preparing or handling food, and the number of servings consumed of fruit and vegetables ( $p<0.0001$ ), grain products ( $p=0.002$ , Table 19), and the composite food group serving total ( $p=0.001$ , Table 20). Specifically, the odds of students washing their hands with soap and warm running water before preparing or handling food were 1.14 times greater for every serving increase in fruit and vegetable consumption, 1.09 times lower for every serving increase in grain consumption, 1.03 times greater for every serving increase in composite food group serving total, 1.23 times greater for females versus males, 2.33 times lower for students living in food insecure homes, 2.63 times lower for student who worked or volunteered at a hospital, and 1.21 times greater for students who had taken a course on how to prepare food (Table 19 and Table 20).

Table 18. Mean number of servings consumed on the day prior to the survey and composite food group serving total by Ontario high school students (n=2860) food safety practices (2014-2015); statistically significant differences are bolded (p<0.05)

	Mean number of servings consumed (Standard deviation)				
	Fruits and Vegetables	Grain Products	Milk and Alternatives	Meat and Alternatives	Composite food group serving total
<b>Before preparing or handling food, I wash my hands with soap and warm running water.</b>					
Always* (n= 1480)	3.28 (2.12)	3.15 (1.90)	2.39 (1.54)	2.23 (1.17)	10.56 (4.55)
Often (n= 719)	<b>2.99</b> <b>(1.91)</b>	3.29 (1.82)	2.44 (1.52)	2.21 (1.18)	10.43 (4.36)
Sometimes (n= 298)	2.95 (2.21)	3.36 (1.98)	2.51 (1.54)	2.17 (1.20)	10.45 (4.58)
Rarely (n= 92)	<b>2.40</b> <b>(1.98)</b>	2.88 (1.87)	2.48 (1.71)	2.00 (1.10)	<b>9.10 (4.57)</b>
Never (n= 49)	3.27 (3.09)	4.00 (3.07)	3.00 (1.96)	2.64 (1.99)	10.22 (6.87)
<b>I wash my hands with soap and warm running water after working with raw meat or chicken.</b>					
Always* (n= 1898)	3.20 (2.09)	3.18 (1.86)	2.37 (1.52)	2.22 (1.15)	10.49 (4.47)
Often (n= 356)	3.06 (2.01)	<b>3.30</b> <b>(1.99)</b>	2.71 (1.55)	2.24 (1.23)	10.66 ( 4.62)
Sometimes (n= 133)	3.10 (2.21)	3.41 (2.02)	2.49 (1.57)	2.20 (1.24)	10.56 (4.77)
Rarely (n= 49)	3.11 (2.60)	3.36 (2.50)	2.51 (1.92)	2.47 (1.57)	10.04 (6.27)
Never (n= 40)	3.00 (2.85)	3.89 (3.16)	2.94 (2.08)	2.58 (1.87)	9.75 (6.83)
<b>I keep raw meat and chicken away from ready-to-eat foods like raw vegetables.</b>					
Always* (n= 1552)	3.25 (2.11)	3.19 (1.87)	2.38 (1.53)	2.22 (1.15)	10.57 (4.48)
Often (n= 460)	3.05 (2.03)	<b>3.33</b> <b>(1.95)</b>	2.60 (1.52)	2.31 (1.23)	10.69 (4.51)
Sometimes (n= 213)	2.91 (1.90)	3.04 (1.79)	2.30 (1.53)	2.11 (1.22)	9.78 (4.50)
Rarely (n= 68)	<b>2.92</b> <b>(2.09)</b>	3.5231 (2.14)	2.75 (1.69)	2.32 (1.25)	10.43 (5.10)
Never (n= 66)	3.06 (2.67)	3.33 (2.80)	2.97 (2.06)	2.54 (1.66)	10.08 (6.25)

\*Reference is Always and adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 19. Association between how often Ontario high school students (n=2860) washed their hands before preparing or handling food and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

<b>Predictor Variables and Covariates</b>	<b>Students' Food Safety Practices OR (95% CI)</b>
Number of fruit and vegetable servings consumed	<b>1.14 (1.09, 1.20)</b>
Number of grain product servings consumed	<b>0.92 (0.88, 0.97)</b>
Number of milk and alternative servings consumed	0.95 (0.89, 1.00)
Number of meat and alternative servings consumed	1.03 (0.95, 1.12)
Age in years	1.00 (0.98, 1.01)
Female sex	<b>1.23 (1.04, 1.46)</b>
Food insecurity at home	<b>0.43 (0.28, 0.65)</b>
Worked at a deli, restaurant, or other food service location	0.87 (0.71, 1.07)
Worked or volunteered at a hospital	<b>0.38 (0.22, 0.64)</b>
Took a course on how to prepare food	<b>1.21 (1.02, 1.44)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 20. Association between how often Ontario high school students (n=2860) washed their hands before preparing or handling food and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

<b>Predictor Variables and Covariates</b>	<b>Students' Food Safety Practices OR (95% CI)</b>
Composite food group serving total	<b>1.03 (1.01, 1.05)</b>
Age in years	<b>0.98 (0.96, 0.99)</b>
Female sex	<b>1.43 (1.22, 1.67)</b>
Food insecurity at home	<b>0.44 (0.30, 0.67)</b>
Worked at a deli, restaurant, or other food service location	0.92 (0.75, 1.12)
Worked or volunteered at a hospital	<b>0.43 (0.26, 0.69)</b>
Took a course on how to prepare food	<b>1.26 (1.07, 1.49)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

### **5.12 The association between how often students report washing their hands with soap and warm running water after working with raw meat or chicken and the number of servings consumed**

There was no significant difference between students who did or did not always wash their hands with soap and warm running water after working with raw meat or chicken and the mean servings consumed of fruit and vegetables (mean:3.20, SD:2.09, mean often:3.06, SD:2.01,  $p=0.18$ , mean sometimes:3.10, SD:2.21,  $p=0.57$ , mean rarely:3.11, SD:2.60,  $p=0.80$ , mean never:3.00, SD:2.85,  $p=0.90$ ), grain products (mean:3.18, SD:1.86, mean often:3.18, SD:1.86, mean often:3.30, SD:1.99,  $p=0.94$ , mean sometimes:3.41, SD:1.99,  $p=0.57$ , mean rarely:3.36, SD:2.50,  $p=0.93$ , mean never:3.89, SD:3.16,  $p=0.96$ ), milk and alternatives (mean:2.37, SD:1.52, mean often:2.71, SD:1.55,  $p=0.08$ , mean sometimes:2.49, SD:1.57,  $p=0.99$ , mean rarely:2.51, SD:1.92,  $p=1.00$ , mean never:2.94, SD:2.08,  $p=0.99$ ), meat and alternatives (mean:2.22, SD:1.15, mean often:2.24, SD:1.23,  $p=0.99$ , mean sometimes:2.20, SD:1.24,  $p=1.00$ , mean rarely:2.47, SD:1.57,  $p=0.25$ , mean never:2.58, SD:1.87,  $p=0.85$ ) and composite food group serving total (mean:10.49, SD:4.47, mean often:10.66, SD:4.62,  $p=0.35$ , mean sometimes: 10.56, SD:4.77,  $p=0.69$ , mean rarely:10.04, SD:6.27,  $p=0.86$ , mean never:9.75, SD:6.83,  $p=0.99$ ).

When age, sex, and the other covariates were adjusted for there was no statistically significant association between how often students report washing their hands with soap and warm running water after working with raw meat or chicken, and the number of servings consumed of grain products ( $p=0.48$ ) or meat and alternatives ( $p=0.73$ ), however, there was a statistically significant association between how often students report washing their hands with soap and warm running water after working with raw meat or chicken, and the number of servings consumed of fruit and vegetables ( $p=0.002$ ), milk and alternatives ( $p=0.02$ , Table 21) and the composite food group serving total ( $p=0.008$ , Table 22). Specifically, the odds of

students washing their hands with soap and warm running water after working with raw meat or chicken were 1.11 times greater for every serving increase in fruit and vegetable consumption, 1.09 times lower for every serving increase in milk and alternative consumption, 1.03 times greater for every serving increase in composite food group serving total, 1.04 times greater for every year increase in age, 1.85 times greater for females versus males, and 2.5 times lower for students who worked or volunteered at a hospital (Table 21 and Table 22).

Table 21. Association between how often Ontario high school students (n=2860) washed their hands after handling raw meat or chicken and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Safety Practices OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.11 (1.03, 1.15)</b>
Number of grain product servings consumed	0.98 (0.92, 1.04)
Number of milk and alternative servings consumed	<b>0.92 (0.85, 0.98)</b>
Number of meat and alternative servings consumed	1.02 (0.92, 1.13)
Age in years	<b>1.04 (1.02, 1.06)</b>
Female sex	<b>1.85 (1.50, 2.29)</b>
Food insecurity at home	<b>0.50 (0.30, 0.83)</b>
Worked at a deli, restaurant, or other food service location	0.98 (0.75, 1.26)
Worked or volunteered at a hospital	<b>0.40 (0.22, 0.73)</b>
Took a course on how to prepare food	1.02 (0.82, 1.26)

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 22. Association between how often Ontario high school students (n=2860) washed their hands after handling raw meat or chicken and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Safety Practices OR (95% CI)
Composite food group serving total	<b>1.03 (1.01, 1.05)</b>
Age in years	1.01 (0.99, 1.02)
Female sex	<b>1.70 (1.43, 2.03)</b>
Food insecurity at home	<b>0.62 (0.40, 0.95)</b>
Worked at a deli, restaurant, or other food service location	1.26 (0.99, 1.59)

Worked or volunteered at a hospital	0.61 (0.36, 1.01)
Took a course on how to prepare food	<b>1.27 (1.05, 1.54)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

**5.13 The association between how often students report keeping raw meat and chicken away from ready to eat foods like raw vegetables and the number of servings consumed**

There was no significant difference between students who did or did not always keep raw meat or chicken away from ready to eat foods like raw vegetables and the number of servings consumed of fruit and vegetables (mean:3.25, SD:2.11, mean often:3.05, SD:2.03, p=0.88, mean sometimes: 2.91, SD:1.90, p=0.95, mean rarely: 2.92, SD:2.09, p=0.75, mean never:3.06, SD:2.67, p=0.97), grain products (mean:3.19, SD:1.87, mean often:3.33, SD:1.95, p=0.37, mean sometimes:3.04, SD:1.79, p=0.34, mean rarely:2.75, SD:1.69, p=0.90, mean never:2.97, SD:2.06, p=0.95), milk and alternatives (mean:2.38, SD:1.53, mean often:2.60, SD:1.52, p=0.23, mean sometimes:2.30, SD:1.53, p=0.67, mean rarely:2.75, SD:1.69, p=0.44, mean never: 2.97, SD:2.06, p=0.17), meat and alternatives (mean:2.22, SD:1.15, mean often:2.31, SD:1.23, p=0.22, mean sometimes:2.11, SD:1.22, p=1.00, mean rarely: 2.32, SD:1.25, p=0.99, mean never:2.54, SD:1.66, p=0.43), and composite food group serving total (mean:10.57, SD:4.48, mean often:10.69, SD:4.51, p=0.98, mean sometimes:9.78, SD:4.50, p=0.27, mean rarely:10.43, SD:5.10, p=0.99, mean never:10.08, SD:6.25, p=0.99) (Table 18).

When age, sex, and the other covariates were adjusted for there was no association between how often students report keeping raw meat and chicken away from ready to eat foods like raw vegetables, and the number of servings consumed of grain products (p=0.95) or meat and alternatives (p=0.12), however, there was an association between how often students report keeping raw meat and chicken away from ready to eat foods like raw vegetables, and the number

of servings consumed of fruit and vegetables ( $p < 0.0001$ ), milk and alternatives ( $p = 0.004$ , Table 23) and composite food group serving total ( $p = 0.04$ , Table 24). Specifically, the odds of students keeping raw meat and chicken away from ready to eat foods like raw vegetables were 1.11 times greater for every serving increase in fruit and vegetable consumption, 1.10 times lower for every serving increase in milk and alternative consumption, 1.02 times greater for every serving increase in composite food group serving total, 1.02 times greater for every year increase in age, 1.85 times lower for students who lived in food insecure homes, and 1.60 times greater for students who took a course on how to prepare food (Table 23 and Table 24).

Table 23. Association between how often Ontario high school students ( $n = 2860$ ) kept raw meat and chicken away from ready to eat foods and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates		Students' Food Safety Practices OR (95% CI)
Number of fruit and vegetable servings consumed		<b>1.11 (1.06, 1.17)</b>
Number of grain product servings consumed		1.00 (0.94, 1.06)
Number of milk and alternative servings consumed		<b>0.91 (0.85, 0.97)</b>
Number of meat and alternative servings consumed		0.93 (0.85, 1.02)
Age		<b>1.02 (1.00, 1.04)</b>
Sex (Reference = Male)	Female	1.14 (0.94, 1.37)
Food insecurity at home		<b>0.54 (0.34, 0.85)</b>
Worked at a deli, restaurant, or other food service location		1.21 (0.95, 1.53)
Worked or volunteered at a hospital		0.67 (0.38, 1.18)
Took a course on how to prepare food (Ref= Taken a course on how to prepare food)		<b>1.60 (1.31, 1.95)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling



Table 24. Association between how often Ontario high school students (n=2860) kept raw meat and chicken away from ready to eat foods and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Food Safety Practices OR (95% CI)
Composite food group serving total	<b>1.02 (1.00, 1.04)</b>
Age in years	<b>0.98 (0.96, 1.00)</b>
Female sex	<b>1.27 (1.09, 1.49)</b>
Food insecurity at home	0.74 (0.50, 1.10)
Worked at a deli, restaurant, or other food service location	<b>1.46 (1.18, 1.81)</b>
Worked or volunteered at a hospital	0.93 (0.57, 1.52)
Took a course on how to prepare food (Ref= Taken a course on how to prepare food)	<b>1.93 (1.62, 2.30)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

#### 5.14 The association between how often students report using Canada's Food Guide to help them choose what to eat and the number of servings consumed

With respect to Canada's Food Guide use, students who always use Canada's Food Guide to help them choose what to eat consumed significantly more servings of fruits and vegetables (mean:4.36, SD:2.60), grain products (mean:4.00, SD:2.73), and composite food group serving total (mean:12.25, SD:5.92) than students who rarely (mean fruit and vegetables:3.22, SD:1.91, p=0.0005, mean grain products:3.25, SD:1.85, p=0.02, mean composite food group serving total:10.70, SD:4.32, p=0.004) or never (mean fruit and vegetables:2.79, SD:1.97, p<0.0001, mean grain products:3.06, SD:1.80, p=0.0009, mean composite food group serving total:9.81, SD:4.28, p<0.0001) used the Food Guide, but did not consume significantly more servings than those who answered often (mean fruit and vegetables:3.99, SD:2.37, p=0.85, mean grain products:3.58, SD:2.07, p=0.52, mean composite food group serving total:12.16, SD:4.85, p=0.97) or sometimes (mean fruit and vegetables:3.45, SD:1.88, p=0.17, mean grain

products:3.22, SD:1.91,  $p=0.23$ , mean composite food group serving total:11.70, SD:4.49,  $p=0.51$ ), on average. Furthermore, those who reported always using the Food Guide ate more servings of milk and alternatives (mean:2.99, SD:1.80) and meat and alternatives (mean:2.60, SD:1.45) than students who reported never using Canada's Food Guide (mean milk and alternatives:2.14, SD:1.96,  $p=0.009$ , meat and alternatives: 2.29, SD:1.52,  $p=0.02$ ), but did not consume significantly more servings than those who answered often (mean milk and alternatives:2.81, SD:1.60,  $p=0.98$ , mean meat and alternatives:2.50, SD:1.18,  $p=0.99$ ), sometimes (mean milk and alternatives:2.75, SD:1.46,  $p=1.00$ , mean meat and alternatives:2.27, SD:1.15,  $p=0.24$ ), or rarely (mean milk and alternatives:2.43, SD:1.48,  $p=0.09$ , mean meat and alternatives:2.23, SD:1.08,  $p=0.08$ ), on average (Table 25).

When age, sex, and the other covariates were adjusted for there was no statistically significant association between how often students reported using Canada's Food Guide to help them choose what to eat, and the number of servings consumed of grain products ( $p=0.60$ ) or meat and alternatives ( $p=0.47$ ), however, there was a statistically significant association between how often students reported using Canada's Food Guide to help them choose what to eat, and the number of servings consumed of fruit and vegetables ( $p<0.0001$ ) and milk and alternatives ( $p=0.009$ , Table 26), and the composite food group serving total ( $p<0.0001$ , Table 27). Specifically, the odds of students using Canada's Food Guide to help them choose what to eat were 1.21 times greater for every serving increase in fruit and vegetable consumption, 1.08 times greater for every serving increase in milk and alternative consumption, 1.08 times greater for every serving increase in composite food group serving total, 1.28 times lower for every year increase in age, 1.32 times greater for students who worked at a deli, restaurant, or other food service location, 1.87 times greater for students who worked or volunteered at a hospital, and

1.46 times greater for students who took a course on how to prepare food (Table 26 and Table 27).

Table 25. Mean number of servings consumed on the day prior to the survey and composite food group serving total by Ontario high school students (n=2860) responses to the frequency of Canada's Food Guide use (2014-2015); statistically significant differences are bolded (p<0.05)

	Mean number of servings consumed (Standard deviation)				
	Fruits and Vegetables	Grain Products	Milk and Alternatives	Meat and Alternatives	Composite food group serving total
<b>I use the Canada's Food Guide to help me choose what to eat.</b>					
Always* (n= 137)	4.36 (2.60)	4.00 (2.73)	2.99 (1.80)	2.60 (1.45)	12.25 (5.92)
Often (n= 122)	3.99 (2.37)	3.58 (2.07)	2.81 (1.60)	2.50 ( 1.18)	12.16 (4.85)
Sometimes (n= 320)	3.75 (2.06)	3.45 (1.88)	2.75 (1.46)	2.27 (1.15)	11.70 (4.49)
Rarely (n= 539)	<b>3.22</b> <b>(1.91)</b>	3.25 (1.85)	2.43 (1.48)	<b>2.23</b> <b>(1.08)</b>	<b>10.70 (4.32)</b>
Never (n=1388)	<b>2.79</b> <b>(1.97)</b>	<b>3.06</b> <b>(1.80)</b>	<b>2.14</b> <b>(1.96)</b>	<b>2.29</b> <b>(1.52)</b>	<b>9.81 (4.28)</b>

\*Reference is Always and adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 26. Association between how often Ontario high school students (n=2860) used Canada's Food Guide to help them choose what to eat and the number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

Predictor Variables and Covariates	Students' Canada's Food Guide Use OR (95% CI)
Number of fruit and vegetable servings consumed	<b>1.21 (1.15, 1.26)</b>
Number of grain product servings consumed	1.01 (0.96, 1.07)
Number of milk and alternative servings consumed	<b>1.08 (1.02, 1.15)</b>
Number of meat and alternative servings consumed	0.97 (0.89, 1.05)
Age in years	<b>0.78 (0.76, 0.80)</b>
Female sex	1.01 (0.85, 1.20)
Food insecurity at home	1.20 (0.76, 1.90)
Worked at a deli, restaurant, or other food service location	<b>1.32 (1.07, 1.63)</b>
Worked or volunteered at a hospital	<b>1.87 (1.09, 3.21)</b>
Took a course on how to prepare food	<b>1.46 (1.23, 1.73)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

Table 27. Association between how often Ontario high school students (n=2860) used Canada’s Food Guide to help them choose what to eat and the composite number of servings consumed on the day prior to the survey (2014-2015); statistically significant differences are bolded

<b>Predictor Variables and Covariates</b>	<b>Students’ Canada’s Food Guide Use OR (95% CI)</b>
Composite food group serving total	<b>1.08 (1.07, 1.10)</b>
Age in years	<b>0.77 (0.76, 0.79)</b>
Female sex	1.16 (1.00, 1.36)
Food insecurity at home	1.06 (0.69, 1.62)
Worked at a deli, restaurant, or other food service location	<b>1.32 (1.08, 1.61)</b>
Worked or volunteered at a hospital	<b>2.16 (1.30, 3.58)</b>
Took a course on how to prepare food	<b>1.35 (1.15, 1.59)</b>

\*Adjusted for school effects using a CLASS (variable classification) statement when modelling

For all dependent variables, the model which contained all the covariates and predictors had the lowest Akaike Information Criterion (AIC) scores (Appendix E) and was selected as the best fitting model. Additionally, for all dependent variables, no confounding was identified as the sign did not change, the size remained the same (within a 25% increase or decrease) and significance was stable for all variables regardless of what covariates or predictors were in the model.

## **6. Discussion**

The aim of this thesis was to investigate the association between self-reported food safety knowledge, attitudes, and practices, and healthy eating, as measured by the number of Canada’s Food Guide servings consumed in high school students in Ontario. Generally, there were no associations between students’ food safety knowledge and food safety attitudes and the number of servings consumed of fruit and vegetables, grain products, milk and alternatives, and meat and alternatives. However, there were associations between students’ food safety practices and

Canada's Food Guide use and the number of servings consumed of fruit and vegetables, grain products, and milk and alternatives.

Additionally, it is important to note that fruit and vegetable consumption among the Ontario high school students surveyed was low. Approximately, 92% of students ate below the recommended seven to eight servings of fruit and vegetables despite the fact that increased fruit and vegetable consumption was associated with some food safety knowledge, attitude, practices, and Food Guide use frequency questions (Table 1). This is of particular interest as Ontario is a vast producer of fresh fruit and vegetables yet consumption rates are low in Ontario students (Statistics Canada 2011).

## **6.1 Food Safety Knowledge**

Overall, food safety knowledge was not associated with healthy eating. This thesis juxtaposes other studies which claim that healthy eating and food safety knowledge are related (Booth et al. 2013, Harper et al. 2002, Tuconi et al. 2008). Food safety knowledge could be similar among students in this study as all attended schools in Ontario, meaning they followed the same curriculum, and had similar dietary patterns that are poor (Bauer et al. 2004, Cunningham et al. 2017, Das et al. 2017, Neumark-Sztainer et al. 2005), leading to a lack of an association. An effective way of improving food safety and healthy eating knowledge to a high school audience is through the integration of food principles in educational curriculum (Richards et al. 2008). By reinforcing food safety knowledge through language, math, and science material students could learn food safety techniques passively. In turn, teachers would not have to spend separate time teaching food safety and healthy eating, yet students will still learn proper food knowledge. A US study which integrated food safety knowledge into existing school curriculum noted a 21%

increase in food safety knowledge among participating students (Richards et al. 2008).

Furthermore, income may be affecting this association as students from low income homes could have similar educational exposures as other students but are more likely to have food security issues, meaning there could be low serving intakes across food groups, yet higher amounts of sugar, fat and salt-ridden foods, due to limited funds (Ball et al. 2015, Groth et al. 1999, Masse et al. 2014, Reidiger et al. 2007, Roos et al. 1998, St. John et al. 2008, Velazquez et al. 2015). Therefore, low income students might have the same knowledge as higher income students, but constantly eat less servings due to cost associated barriers, masking an association.

Although food safety knowledge is not often associated with healthy eating there were three exceptions. First, students who knew the most important way to prevent food poisoning had a greater composite food group serving total than students who did not know. This thesis supports the literature which also found that the better overall dietary pattern a student had the better their food safety knowledge (Turconi et al. 2008). This finding suggests that people who have diverse diets have increased food safety knowledge. Better dietary patterns are highly diverse and based on correct portions, leading to a higher composite food group serving total. In order to eat a variety of food, students must be comfortable in cooking and know about proper food safety techniques to keep themselves safe, although this has never been officially studied. Therefore, students who know how to prevent food poisoning may be more confident in eating a variety of foods since they would need to know how to avoid getting ill when preparing them.

Second, students who knew the best method of determining whether a hamburger was cooked enough ate more servings of fruits and vegetables than students who did not know. Those who ate more fruits and vegetables have better knowledge or awareness about general food safety and food bacteria related to proper meat temperatures, which might be the reason for this

association, as seen elsewhere (Booth et al. 2013, Harper et al. 2002). Therefore, those who ate more fruit and vegetable servings might be more aware of how to prevent food poisoning in order to avoid illness because of better general food safety.

Third, students who knew what a microorganism was ate less servings of milk and alternatives than students who did not know. Microorganism knowledge in milk and alternative consumers could cause food aversions since milk can become contaminated in an assortment of ways, as studies show that consumers will remove foods from their diet rather than learn proper practices, in some cases (Nago et al. 2017; Verbeke et al. 2006). Since microorganism knowledge was shown to be high in this study, similar to other literature (Majowicz et al. 2015), it may have influenced milk consumption. Some public health efforts have been introduced to help to appropriately inform consumers about foodborne illness and a majority of these programs could be applied to high school students. This may be an important approach to employ if students are avoiding milk products because of microbial contamination. Moreover, dietary preferences, allergies, or intolerances may be also a factor as few students consume the recommended servings of milk products (Deka et al. 2015, Rossiter et al. 2012, Statistics Canada 2011, Videon and Manning 2003) and so while knowledge may be high students might be showing a negative food preference creating this association, although this has not been investigated formally.

## **6.2 Food Attitudes**

Overall, food attitudes were not associated with healthy eating. The lack of interest in food safety and variability in students' consumption patterns may stem from public health initiatives that have a broad scope. The issue with this general approach is that programs that try to appeal

to everyone are less effective (Meideros et al. 2001). Thus, food safety and nutrition education initiatives need to be developed to target specific groups to effect behaviour change (Meideros et al. 2001, Kreuter et al. 2000). A novel technique in the US called “edu-tainment” employed strategies that may help to promote public health media through songs, plays, and computer games (Silk et al. 2008). Edu-tainment has been found to be attractive to youth audiences (i.e. Fantastic Food Challenge) and could be used to facilitate food knowledge (Silk et al. 2008). Additionally, two studies investigating hand washing attitudes reported better food safety attitudes in those who had taken a food course (McIntyre et al. 2013, Soon et al. 2012). Conversely, a Canadian study involving youth reported poorer food attitudes amongst adolescents who had participated in a food handling course (Majowicz et al. 2017). Therefore, there may be capricious attitude levels amongst students who have taken food related courses which may explain the lack of an association between food safety attitudes and the consumption patterns youth have. Furthermore, food attitudes in students may be affected by perceived levels of responsibility, as consumers often reported that they were not responsible for food safety, rather health departments, restaurants, and governments were responsible for food safety more than the individual (Janjic et al. 2017, Ovca et al. 2014, Unklesbay et al. 1998). Since students are often taking on a more independent role when choosing foods for consumption in adolescence (Cunningham et al. 2017, Das et al. 2017), these varying levels of responsibility and independence could be causing a lack of an association between food safety and consumption.

Although food attitudes were not often associated with healthy eating there were three exceptions. First, students who ate more fruits and vegetables had more positive food safety attitudes, in four of the dependent variables, than those who ate less servings. Similar to the findings in this thesis, other studies found that positive food safety attitudes and vegetable



consumption may mimic attitudes seen with vegetarians, as this lifestyle has been correlated with more healthy behaviours and food safety attitudes (Booth et al. 2013, Harper et al. 2002, Rimal et al. 2001). Students who eat a greater amount of fruit and vegetables might also be involved in more cooking at home. Eating home cooked meals is considered a more healthy behavior than eating at restaurants. Since this was not assessed it could be confounding the association as those who cook more, may eat better and have better attitudes. Additionally, healthy eating, or increased fruit and vegetable consumption, and food attitudes were shown to have an association in the Chinese population whose culture places great importance on healthy living (Cheng et al. 2017, Wang, D et al. 2014). Therefore, increased consumption of fruits and vegetables may be associated with better cultural food safety attitudes and vice versa.

Second, students with a higher composite food group serving total had more positive food safety attitudes in four of the dependent variables. Students' food attitudes can affect the types of foods they consume. Neophobic individuals, or "picky-eaters" may have less positive food attitudes and have a very restrictive diet, while vegetarians have been shown to have positive food attitudes and may have a varied diet including all food groups. Similarly, students who have more positive food attitudes have been shown to have healthier eating patterns, which includes a more varied diet (Axelson and Penfield 1983; Steptoe et al. 1995). Therefore, students who eat more aligned with Canada's Food Guide, a guide to health eating, may in turn have better food attitudes.

Third, students who ate less grain products had significantly greater odds of positive food attitudes with regards to students' interest in learning about how to keep foods safe to eat. Since fruits, vegetables, milk and alternatives and meat and alternatives can be contaminated through food preparation practice, unlike grains, there might be more negative experiences and greater

perceived susceptibility to foodborne illness. Should this be the case, consumers might be more concerned with future infection (Chen et al. 2010, Fein et al. 1995) culminating in greater food interest and better food attitudes. Therefore, students who consume less grain products may see the importance of learning how to keep foods safe, due to the increased likelihood of foodborne illness experiences from food contamination while preparing fruits, vegetables, milk and meat products.

### **6.3 Food Safety Practices**

Overall, there were some associations between the frequency of proper food safety practices and healthy eating. Students who ate more servings of fruits and vegetables or had a greater composite food group serving total reported the correct food safety practices more frequently, than those who ate less servings. The association between fruit and vegetable intake and proper food safety practice dependent variables are aligned with what researchers have found in combined healthy eating and food safety programs (Brown and Hermann 2005, Lee et al. 2016, Zhou et al. 2016). Students who eat more healthily are more likely to attend food safety programs which teach students the correct food practices by enhancing their knowledge about the topic (Brown and Hermann 2005, Lee et al. 2016, Zhou et al. 2016). Fruits and vegetables are often used as a proxy for healthily eating (CCHS 2010). Therefore, once students have the knowledge of food safety practices by attending said programs, which are more attended by those who eat healthily, they are then able to implement these learned behaviours to avoid sickness. Similarly, the literature suggests that people who are aware of healthy eating recommendations and report that they have a healthy diet are more likely to have good food safety practices (Taylor et al. 2012). A healthy diet would be one that is varied and plentiful

enough to reach the recommendations outlined in Canada's Food Guide. Therefore, a healthy diet may lead to greater food safety practices because the consumer must be able to prepare foods safely in order to avoid illness.

Students who ate less grain products or milk and alternatives products reported the correct food safety practices more frequently, than those who ate more servings. It is possible that even though students are consuming less grain products their food safety practices could be high because grain products do not require as much careful handling and are more shelf stable (ex. Granola bars, bagels, bread, crackers). If students are consuming less grain products, they would need to consume more of other food groups for sustenance and these foods might require more safe practices (e.g., Handwashing after working with raw meat or chicken to remove bacteria) so their practices could be better to avoid sickness, although not formally studied. Likewise, milk products can easily become contaminated with bacteria if they are left at unsafe temperature or are unpasteurized. In turn, people may avoid consuming these products due to the skills required to prevent bacterial growth (Nago et al. 2017; Verbeke et al. 2006). Additionally, those who are concerned about food bacteria, like those found in milk products, might be hyper-sensitive about hygiene, and thus are knowledgeable about the proper handwashing procedures after working with animal products. This has yet to be studied but is reasonable to hypothesize as Ontario students reported always (76.7%) or often (14.4%) washing their hands after working with raw meat and alternatives or chicken (Majowicz et al. 2015). This was similar to this thesis but may not relate to actual practice since students have been shown to over-report their skill level. A food practice skill observation of students found that only 16% of those that washed their hands washed them for the recommended 20 seconds (Byrd-Bredbenner et al. 2007) and only 45.3% knew the proper way to wash their hands (Majowicz et al. 2017). Therefore, students who eat

less grain products or milk and alternatives might claim to have better food safety practices but further investigation is required to see if students actually follow the proper practices while cooking.

#### **6.4 Food Guide Use**

Overall, there were some associations between the reported frequency of Food Guide use and healthy eating. Students who ate more servings of fruits and vegetables and milk and alternatives and had a greater composite food group serving total used Canada's Food Guide more often than students who ate less servings. These findings are comparable to those identified when surveying grocery shoppers. After shoppers were given tear-out copies of Canada's Food Guide they were found to buy more fruits and vegetables than those who did not use the Food Guide (Garcia et al. 2001). The students who use Canada's Food Guide are akin to the shoppers who used the tear-out sheets since they are informing themselves about how many fruits and vegetables they are supposed to have daily, thus they may be more aware of their intake and eat more of this food group. Moreover, our findings support the possibility that individuals are not accurately reporting the actual number of servings they consume. Other studies found that individuals usually underestimate the number of servings consumed of fruits and vegetables (Abramovich et al. 2012; Garriguet 2009). If individuals have varying knowledge of Canada's Food Guide and are not familiar with the recommended serving sizes they might not be able to depict the amount they consume accurately if a comprehensive example list is not represented in the survey. Therefore, students who use the Food Guide more often are more likely to not under-report showing higher levels of fruits and vegetables because of the use of Canada's Food Guide.

Moreover, our findings relate to other studies which found that the majority of people only use Canada's Food Guide as a reference (Garcia et al. 2001) and most people do not follow or meet Canada's Food Guide recommendations for milk products (Deka et al. 2015, Rossiter et al. 2012, Statistics Canada 2011, Videon and Manning 2003). Therefore, the people who use Canada's Food Guide more often may be meeting the recommendations as they are actively using it in menu planning.

Finally, students who have more family meals tend to consume a greater number of servings overall and have more balanced meals, than those who do not have family meals, as seen in other studies (Neumark-Sztainer 1999, Skinner et al. 1998, Tibbs et al. 2001). Therefore, students might have a higher composite food group serving total due to the amount and variety they are consuming, especially if they have meals at home that follow the balanced principles outlined in the Food Guide.

## **7. Conclusion**

Overall, Ontario high school students' self-reported food safety knowledge was low, as a majority of students answered only 50% of the dependent variables correctly (Majowicz et al. 2015). Conversely, Ontario high school students' self-reported food attitudes were optimistic, except that students were indifferent to food allergies (Majowicz et al. 2015). Additionally, Ontario high school students self-reported food safety practices were typically correct but students' self-reported use of Canada's Food Guide was poor (Majowicz et al. 2015).

Overall, food safety knowledge and attitudes were not associated with healthy eating, with three exceptions. Additionally, there were some associations between the frequency of proper food safety practices and the frequency of food guide use and healthy eating.

Students' fruit and vegetable consumption was significantly associated with greater odds of knowing the proper way to check if a hamburger was cooked enough, positive food attitudes, appropriate food safety practice, and use of Canada's Food Guide. Students' grain product consumption was significantly associated with lower odds of positive food attitudes and proper food safety practice among students. Students' milk and alternative consumption was significantly associated with greater odds of Canada's Food Guide use but lower odds of knowing what a microorganism was and proper food safety among students. Students' meat and alternative consumption was not significantly associated with any outcome. Students' composite food group serving total was significantly associated with greater odds of knowing the proper way to prevent food poisoning, positive food attitudes, and use of Canada's Food Guide. Although, all associations were minor as the odds ratios were very close to one.

Students' age was significantly associated with greater odds of appropriate food safety practices but lower odds of positive food attitudes and Canada's Food Guide use. Being female was significantly associated with greater odds of positive food attitudes. Students that had taken a course on how to prepare or handle food had significantly greater odds of positive food attitudes, appropriate food safety practices, and use of Canada's Food Guide. Students attending a certain school had greater odds of appropriate food safety practices but lower odds of Canada's Food Guide use. Students that had worked or volunteered at a hospital, deli, or restaurant had greater odds of appropriate food safety practice and used Canada's Food Guide more frequently. Students who were food secure had greater odds of appropriate food safety practice.

## **7.1 Contributions of this thesis**

This is the first study to examine the potential association between healthy eating and food safety knowledge, attitudes, and practices in high school students in Ontario and, more broadly, in Canada. Thus, this study has helped provide more information about the associations between healthy eating and food safety. Specifically, it identifies that there are only minor associations between increased serving consumption and students knowing the best method of determining whether hamburgers were cooked enough, microorganism knowledge, interest in learning how to keep foods safe to eat and choosing nutritious foods, confidence in cooking, belief that cooking safe, healthy meals is important, frequency of handwashing before handling food and after working with meat, keeping raw meat away from ready to eat foods and using Canada's Food Guide. It also identifies that there may not be an association between the servings consumed in any food group and knowing proper way to wash their hands, how to prevent food poisoning, and concerns about food poisoning or allergies, amongst high school students.

## **7.2 Limitations**

Since this study is cross sectional, no causal inferences can be made from the findings, rather only suggested associations from this data. Another potential problem is that it is difficult to compare specific results across studies due to varying study designs, target populations, survey dependent variables, and food safety behavior “correctness” (Nesbitt et al. 2014). Therefore, the results produced from this investigation may have limited generalizability to high school populations outside of Ontario, due to the lack of geographical representation.

Another limitation of this investigation includes the use of self-reported data both in the COMPASS and Food and Kitchen Skills survey. Students may indicate that they follow the

recommended practices outlined by public health officials, when in reality they do not. These inaccurate responses, even though it may not be intentional, may lead to recall, optimistic, or social desirability bias which may over or underestimate the true association between healthy eating and food safety. Bias is not an issue if all students inflate their serving consumption by the same amount but if only a few individuals report a very high consumption of a certain food group, or every student reported the highest consumption intake option, it could skew the results, again leading to an over or under estimation of the true association. For instance, if students reported consuming more servings, specifically fruits and vegetables, in order to meet the recommendation, and they reported using the Food Guide it could lead to a more positive association between fruit and vegetable consumption and Food Guide use than is true. Similarly, omitting missing data may result in non-response bias. Non-response bias may compromise the results if students who do not respond are different from those who do respond which could lead to an under or over estimation of the apparent association.

As this is a secondary data analysis, the dependent variables were pre-set so there may have been other dependent variables that could have provided more information about high school students' dietary patterns or food safety knowledge, attitudes or practices that were not included, as they were not asked in either survey. Since the food categories were broad it would have been ideal to ask more specific question like what kinds of grains (whole grain vs. highly processed) or meat and alternatives (unprocessed vs. processed) students consumed or how often convenience or "other" foods were consumed. This lack of specificity may lead to a false association and does not allow this thesis to comment on the types of healthy or unhealthy foods students consumed. It may also be bias as students who know Canada's Food Guide recommendation estimate their intake more accurately and the associations with



recommendations are inflated. Moreover, students' food safety knowledge, attitudes or practices may be inaccurately reported due to the interpretation or wording of the Food and Kitchen Skills survey which may over or under represent the associations presented.

In addition, the composite food group serving total, although a good attempt of making continuous servings consumed a collective score to investigate nominal variation, is not entirely accurate. The score simplifies the servings students consume and some information is lost when creating any groupings. For example, a student who eats no servings of fruits and vegetables and milk and alternatives but five servings of grains and three servings of meat and alternatives would have the same score as a student who eats five servings of fruits and vegetables, one serving of milk and alternatives, and two servings of meat and alternatives. This may lead to a false association between the outcome and servings consumed.

### **7.3 Future research and recommendations**

Future research should explore the association between healthy eating and food safety knowledge, attitudes, and practices in high school students across Canada to gain a more comprehensive understanding of these topics. Ideally, a more extensive survey would be required in the future to better evaluate the breadth of students' food safety knowledge, attitudes, and practices. In this more extensive survey, food attitudes could be examined at a qualitative level to more specifically identify priority areas for education programs. Additionally, a new survey will need to be developed in order to coordinate with the revised Canada's Food Guide. Furthermore, the COMPASS survey should include questions regarding convenience or "other" foods to better understand the quality of food adolescents are consuming, specifically evaluating how often students consume fat, sugar, and salt laden grain products. This would aid in identifying what

kinds of healthy or unhealthy grain products students are consuming. The COMPASS study should also consider adding some food safety questions to understand students' food safety knowledge, specifically regarding hand washing procedures and food thermometer use.

Moreover, there are limited studies which evaluate participants use of Canada's Food Guide, rather studies identified whether participants knew the specific recommendations. For example, in Alberta, 86.5% of people were aware of specific Canada's Food Guide recommendations, however, participants were not asked if they used the Food Guide in this study (Mathe et al. 2015). As such, researchers should compare knowledge of the Food Guide and adherence to the food serving recommendations in student populations to see if there is an association. This might also allow researchers to investigate the effectiveness of Food Guide use in improving eating choices and determine if there are better ways to engage high school students to improve the rates of Food Guide use, rather than just surveying knowledge of Food Guide recommendations.

Last, as of 2013, food safety has been a mandatory component of the Ontario Revised High School Curriculum, however, food courses are electives and so further research involving improving student enrollment is necessary (Government of Ontario 2013). By improving student enrollment, there may be an increase in food safety knowledge, attitudes, practices, and Canada's Food Guide use among student participants.

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## **Appendix A: Ethics Clearance**

Dear Researcher:

A University of Waterloo Research Ethics Committee is pleased to inform you the study named below has been reviewed and given ethics clearance.

Title: An analysis of the relationship between healthy eating, as measured by Canada's Food Guide servings, and self-reported food safety knowledge, practices, and attitudes in high school students in Ontario

ORE #: 22766

Faculty Supervisor: Dr. Shannon Majowicz ([smajowicz@uwaterloo.ca](mailto:smajowicz@uwaterloo.ca))

Faculty Supervisor: Dr. Scott Leatherdale ([sleatherdale@uwaterloo.ca](mailto:sleatherdale@uwaterloo.ca))

Student Investigator: Danielle Tuori ([dltuori@uwaterloo.ca](mailto:dltuori@uwaterloo.ca))

A signed copy of the notification of ethics clearance will be sent to the Principal Investigator (or Faculty Supervisor in the case of student research). Ethics approval to start this research is effective as of the date of this email. The above named study is to be conducted in accordance with the submitted application (Form 101/101A) and the most recent approved versions of all supporting materials.

University of Waterloo Research Ethics Committees operate in compliance with the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), Internalization Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), and the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (Human Research Ethics Committee) and IRB00007409 (Clinical Research Ethics Committee).

Renewal: Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified by the Research Ethics Committee on the signed notification of ethics clearance. Studies will only be renewed if the renewal report is received and approved before the expiry date (Form 105 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals>). Failure to submit renewal reports by the expiry date will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Modification: Amendments to this study are to be submitted through a modification request (Form 104 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/modifications>) and may only be implemented once the proposed changes have received ethics clearance.

Adverse event: Events that adversely affect a study participant must be reported as soon as possible, but no later than 24 hours following the event, by contacting the Chief Ethics Officer. Submission of an adverse event form (Form 106 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/adverse-event>)

ethics/research-human-participants/report-problems) is to follow the next business day.

Deviation: Unanticipated deviations from the approved study protocol or approved documentation or procedures are to be reported within 7 days of the occurrence using a protocol deviation form (Form 107 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems>).

Incidental finding: Anticipated or unanticipated incidental findings are to be reported as soon as possible by contacting the Chief Ethics Officer. Submission of the incidental findings form (Form 108 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems>) is to follow within 3 days of learning of the finding. Participants may not be contacted regarding incidental findings until after approval has been received from a Research Ethics Committee to contact participants to disclose these findings.

Study closure: Report the end of this study using a study closure report (Form 105 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals>).

You are responsible for obtaining any additional institutional approvals that might be required to complete this study.

## Appendix B: COMPASS Survey Questions



- This is **NOT** a test. All of your answers will be kept confidential. No one, not even your parents or teachers, will ever know what you answered. So, please be honest when you answer the questions.
- Mark only one option per question unless the instructions tell you to do something else.
- Choose the option that is the closest to what you think/feel is true for you.



Please, use a pencil to complete this questionnaire



Please mark all your answers with full, dark marks like this:



**START HERE**



Please read each sentence below carefully. **Write** the correct letter, number, or word on the line and then **fill** in the corresponding circle.

The first letter of your <b>middle</b> name (if you have more than one middle name use your first middle name; if you don't have a middle name use "Z" ): _____	The name of the month in which you were born: _____	The <b>last</b> letter of your full last name: _____	The <b>second</b> letter of your full first name: _____	The <b>first</b> initial of your <b>mother's</b> first name (think about the mother you see the most): _____																																																																																																								
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Figure 1. COMPASS Survey, Front Page. Source: (Bredin and Leatherdale 2014)

## About You

### 1. What grade are you in?

- Grade 9
- Grade 10
- Grade 11
- Grade 12

### 2. How old are you today?

- 13 years or younger
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

### 3. Are you female or male?

- Female
- Male

### 4. How would you describe yourself? (Mark all that apply)

- White
- Black
- Asian
- Aboriginal (First Nations, Métis, Inuit)
- Latin American/Hispanic
- Other

### 5. About how much money do you usually get each week to spend on yourself or to save? (Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)

- Zero
- \$1 to \$5
- \$6 to \$10
- \$11 to \$20
- \$21 to \$40
- \$41 to \$100
- More than \$100
- I do not know how much money I get each week

Figure 2. COMPASS Survey, Dependent variables 1-5. Source: (Bredin and Leatherdale 2014)

**27. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of meats and alternatives did you have? One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 or more servings

**Canada's Food Guide Serving Sizes of Meats and Alternatives**



**28. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of vegetables and fruits did you have? One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

**Canada's Food Guide Serving Sizes of Vegetables and Fruits**



**29. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of milk and alternatives did you have? One 'Food Guide' serving of milk or milk alternatives includes milk, fortified soy beverage, reconstituted powdered milk, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 or more servings

**Canada's Food Guide Serving Sizes of Milk and Alternatives**



**30. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of grain products did you have? One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

**Canada's Food Guide Serving Sizes of Grain Products**



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Figure 3. COMPASS Survey, Dependent variables 27-30. Source: (Bredin and Leatherdale 2014)

## Appendix C: Food and Kitchen Skills Survey Questions

### Food and Kitchen Skills

66. Do you currently work or volunteer in any of the following? (Mark all that apply)

- A restaurant, deli, or other food service location
- A hospital
- A daycare or other place where you interact with children (e.g., Big Brothers/Big Sisters)
- A retirement home, nursing home, or long-term care facility

67. If you checked any of the answers in #66, do you handle or prepare food in those places?

- Yes
- No
- I did not check any answers in question 66

68. Have you ever taken a course where you were taught how to prepare food or meals (e.g., high school classes, food handler certification)?

- Yes
- No

69. How would you describe your ability to cook from basic ingredients?

- I don't know how to cook
- I can only cook food when the instructions are on the box (like Kraft Dinner®)
- I can do the basics from scratch (like boil an egg or make a grilled cheese sandwich) but nothing more complicated
- I can prepare simple meals if I have a recipe to follow
- I can cook almost anything

For the following questions, please select what you think is the **BEST** answer:

70. Which is the **most** hygienic way to wash your hands?

- Apply sanitizer, run water, rub hands together for 20 seconds, rinse hands, dry hands, rub on an antiseptic hand lotion
- Apply soap, rub hands together for 20 seconds, rinse hands under water, dry hands, apply sanitizer
- Run water, moisten hands, apply soap, rub hands together for 20 seconds, rinse hands, dry hands
- Run water, moisten hands, apply sanitizer, rub hands together for 20 seconds, rinse hands, dry hands, rub on antiseptic hand lotion

71. Which of the following is considered the **most** important way to prevent food poisoning?

- Spray for pests in the kitchen area at least every week
- Rarely or never serve leftovers
- Keep foods refrigerated until it's time to cook or serve them
- Clean kitchen counters with sanitizing solutions weekly

72. Which method is the **best** way of determining whether hamburgers are cooked enough?

- Cut one to check the colour of the meat inside
- Check the colour of the juice to be sure it is not pink
- Measure the temperature with a food thermometer
- Check the texture or firmness of the meat
- Measure the length of time the hamburgers cook

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Continue 

Figure 4. Food and Kitchen Skill Survey, Dependent variables 66-72. Source: (Majowicz et al. 2015)



**73. What are microorganisms?**

- Poisons that can contaminate our food and water
- Small living things that are too small to be seen with our eyes
- Small insects that we can see
- Large bugs that can land on our food and surfaces

---

**74. Please read each statement and choose the answer that is the closest match to your own opinion.**

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I like learning about how to keep my foods safe to eat.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) I like learning about how to choose nutritious foods to eat.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I am concerned about getting food poisoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I am concerned about food allergies.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I am confident that I can cook safe, healthy meals for myself and my family.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Being able to cook safe, healthy meals is an important life skill.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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**75. These next statements are about food preferences and the ways you fix or prepare food. For each statement, choose the answer that describes how you usually do things.**

	Always	Often	Sometimes	Rarely	Never	Not applicable
a) I plan, or help plan, the meals in my household.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Before preparing or handling food, I wash my hands with soap and warm running water.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I wash my hands with soap and warm running water after working with raw meat or chicken.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I keep raw meat and chicken away from ready-to-eat foods like raw vegetables.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I use an ice pack when I take my lunch to school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) I use an ice pack when I take my lunch with me for day trips (like a track and field day).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) I use the Canada Food Guide to help me choose what to eat.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) When I cook or reheat meals, I use a microwave.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 5. Food and Kitchen Skill Survey, Dependent variables 73-75. Source: (Majowicz et al. 2015)

**Appendix D: Univariate Analysis Showing Number of Servings Consumed by Food Safety Knowledge, Attitude, Practice and Food Guide Use Dependent variables**

Univariable association between proper hand washing knowledge and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Knowledge OR (95% CI)	P-value
	Proper hand washing knowledge (Reference= Incorrect answer)	
Predictor Variables		
Number of fruit and vegetable servings consumed	0.99 (0.96,1.03)	0.72
Number of grain product servings consumed	0.96 (0.93,1.00)	0.07
Number of milk and alternative servings consumed	0.96 (0.92,1.01)	0.10
Number of meat and alternative servings consumed	0.99 (0.93,1.05)	0.66
Composite food group serving total	0.99 (0.98,1.01)	0.36
Covariates		
Age	<b>1.07 (1.01,1.14)</b>	<b>0.02</b>
Female sex	<b>0.72 (0.62,0.84)</b>	<b>&lt;0.0001</b>
Food insecurity at home	1.09 (0.71,1.66)	0.70
School 1	1.00 (0.79,1.27)	0.22
School 2	Reference	
School 3	1.11 (0.90,1.37)	
School 4	1.21 (0.99,1.48)	
Worked at a deli, restaurant, or other food service location	1.10 (0.90,1.34)	0.37
Worked or volunteered at a hospital	0.75 (0.46,1.22)	0.25
Took a course on how to prepare food	1.01 (0.86,1.19)	0.88



Univariable association between proper prevention of food poisoning knowledge and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Knowledge OR (95% CI)	P-value
	Proper prevention of food poisoning knowledge (Reference= Incorrect answer)	
Predictor Variables		
Number of fruit and vegetable servings consumed	1.03 (0.99,1.07)	0.14
Number of grain product servings consumed	1.02 (0.98,1.06)	0.28
Number of milk and alternative servings consumed	0.99 (0.94,1.04)	0.60
<b>Number of meat and alternative servings consumed</b>	<b>1.08 (1.01,1.15)</b>	<b>0.03</b>
<b>Composite food group serving total</b>	<b>1.03 (1.01,1.04)</b>	<b>0.004</b>
Covariates		
<b>Age</b>	<b>1.09 (1.02,1.16)</b>	<b>0.009</b>
Female sex	0.99 (0.85,1.16)	0.90
Food insecurity at home	0.94 (0.61,1.45)	0.78
School 1	1.22 (0.96,1.56)	0.17
School 2	Reference	
School 3	1.12 (0.90,1.38)	
School 4	1.25 (1.01,1.53)	
<b>Worked at a deli, restaurant, or other food service location</b>	<b>1.23 (1.01,1.51)</b>	<b>0.04</b>
<b>Worked or volunteered at a hospital</b>	<b>0.60 (0.37,0.97)</b>	<b>0.04</b>
Took a course on how to prepare food	0.93 (0.79,1.10)	0.41

Univariable association between the proper way to check if hamburgers are cooked enough and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Knowledge OR (95% CI)	P-value
	Proper way to check if a hamburger is cooked enough (Reference= Incorrect answer)	
Predictor Variables		
<b>Number of fruit and vegetable servings consumed</b>	<b>1.06 (1.01,1.10)</b>	<b>0.02</b>
Number of grain product servings consumed	1.00 (0.95,1.05)	0.99
Number of milk and alternative servings consumed	0.96 (0.90,1.03)	0.23
Number of meat and alternative servings consumed	0.99 (0.91,1.07)	0.79
Composite food group serving total	1.01 (0.99,1.03)	0.28
Covariates		
<b>Age</b>	<b>1.38 (1.27,1.50)</b>	<b>&lt;0.0001</b>
<b>Female sex</b>	<b>0.75 (0.61,0.91)</b>	<b>0.004</b>
Food insecurity at home	1.01 (0.58,1.77)	0.96
<b>School 1</b>	<b>0.95 (0.71,1.26)</b>	<b>&lt;0.0001</b>
School 2	Reference	
School 3	<b>0.53 (0.40,0.69)</b>	
School 4	<b>0.54 (0.42,0.71)</b>	
<b>Worked at a deli, restaurant, or other food service location</b>	<b>2.44 (1.94,3.07)</b>	<b>&lt;0.0001</b>
Worked or volunteered at a hospital	1.22 (0.67,2.23)	0.52
<b>Took a course on how to prepare food</b>	<b>2.32 (1.89,2.84)</b>	<b>&lt;0.0001</b>

Univariable association between proper microorganism knowledge and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Knowledge OR (95% CI)	P-value
	Proper microorganism knowledge (Reference= Incorrect answer)	
Predictor Variables		
Number of fruit and vegetable servings consumed	1.05 (0.99,1.11)	0.09
Number of grain product servings consumed	1.04 (0.98,1.10)	0.25
Number of milk and alternative servings consumed	0.96 (0.90,1.04)	0.30
Number of meat and alternative servings consumed	1.06 (0.96,1.16)	0.25
<b>Composite food group serving total</b>	<b>1.03 (1.01, 1.06)</b>	<b>0.009</b>
Covariates		
<b>Age</b>	<b>1.14 (1.04,1.25)</b>	<b>0.005</b>
Female sex	1.25 (1.00,1.57)	0.05
Food insecurity at home	1.20 (0.61,2.36)	0.59
<b>School 1</b>	<b>1.09 (0.78,1.52)</b>	<b>0.04</b>
School 2	Reference	
School 3	1.36 (1.00,1.85)	
School 4	<b>1.48 (1.10,1.99)</b>	
Worked at a deli, restaurant, or other food service location	0.79 (0.60,1.05)	0.10
<b>Worked or volunteered at a hospital</b>	<b>0.46 (0.25,0.84)</b>	<b>0.01</b>
<b>Took a course on how to prepare food</b>	<b>0.74 (0.59,0.93)</b>	<b>0.01</b>

Univariable association between interest in learning how to choose nutritious foods to eat and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
<b>Intercept</b>	<b>8.50</b> (6.65,10.80)	<b>15.32</b> (12.06,19.49)	<b>10.28</b> (8.08,13.1)	<b>2.03 (1.54,2.69)</b>	<b>&lt;0.0001</b>
Predictor Variables					
<b>Number of fruit and vegetable servings consumed</b>	<b>1.24</b> (1.09,1.41)	1.07 (0.94,1.22)	0.98 (0.86,1.12)	0.93 (0.80,1.08)	<b>&lt;0.0001</b>
Number of grain product servings consumed	1.05 (0.92,1.20)	0.99 (0.87,1.13)	1.00 (0.88,1.14)	0.96 (0.82,1.12)	0.19
Number of milk and alternative servings consumed	1.05 (0.89,1.24)	0.97 (0.83,1.15)	1.01 (0.86,1.19)	0.92 (0.76,1.12)	0.12
<b>Number of meat and alternative servings consumed</b>	<b>1.28</b> (1.03,1.60)	1.09 (0.88,1.36)	1.09 (0.88,1.36)	1.06 (0.83,1.37)	<b>0.0007</b>
<b>Composite food group serving total</b>	<b>1.17 (1.11, 1.24)</b>	<b>1.11</b> (1.05,1.18)	<b>1.10 (1.04, 1.16)</b>	<b>1.07 (1.00,1.14)</b>	<b>&lt;0.0001</b>
Covariates					
<b>Age in years</b>	1.01 (0.82,1.23)	0.94 (0.77,1.14)	0.86 (0.71,1.06)	0.88 (0.70,1.11)	<b>0.01</b>
<b>Female sex</b>	<b>0.51</b> (0.30,0.84)	<b>0.50</b> (0.30,0.82)	0.75 (0.45,1.24)	0.75 (0.42, 1.35)	<b>&lt;0.0001</b>
<b>Food insecurity at home</b>	<b>0.25</b> (0.10,0.63)	<b>0.27</b> (0.11,0.63)	<b>0.37</b> (0.15,0.87)	0.33 (0.10,1.07)	<b>0.03</b>
<b>School 1</b>	1.04 (0.53,2.04)	1.31 (0.68,2.54)	1.24 (0.63,2.43)	2.60 (1.17,5.78)	<b>0.001</b>
School 2	Reference	Reference	Reference	Reference	
School 3	2.11 (1.06,4.24)	2.49 (1.26,4.93)	2.45 (1.23,4.88)	2.54 (1.10,5.85)	

School 4	1.67 (0.89,3.14)	2.27 (1.22,4.20)	1.97 (1.05,3.68)	2.78 (1.30,5.93)	
<b>Worked at a deli, restaurant, or other food service location</b>	0.94 (0.53,1.64)	0.60 (0.34,1.04)	<b>0.49</b> <b>(0.28,0.87)</b>	<b>0.32 (0.15,0.68)</b>	<b>&lt;0.0001</b>
<b>Worked or volunteered at a hospital</b>	<b>0.21</b> <b>(0.09,0.47)</b>	<b>0.16</b> <b>(0.07,0.34)</b>	<b>0.10</b> <b>(0.04,0.25)</b>	<b>0.13 (0.03,0.49)</b>	<b>&lt;0.0001</b>
<b>Took a course on how to prepare food</b>	<b>2.25</b> <b>(1.28,3.95)</b>	1.42 (0.82,2.47)	1.09 (0.62,1.91)	1.18 (0.62,2.26)	<b>&lt;0.0001</b>

\*Reference is Strongly Disagree

Univariable association between the perception that cooking safe, healthy meals is an important life skill and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
Predictor Variables					
<b>Number of fruit and vegetable servings consumed</b>	0.99 (0.86,1.14)	0.91 (0.79,1.05)	<b>0.86</b> <b>(0.74,1.00)</b>	<b>0.76 (0.61,0.96)</b>	<b>&lt;0.0001</b>
Number of grain product servings consumed	0.91 (0.78,1.06)	0.90 (0.77,1.05)	0.87 (0.75,1.03)	<b>0.78 (0.62,0.99)</b>	0.23
Number of milk and alternative servings consumed	0.96 (0.79,1.18)	0.97 (0.79,1.18)	0.94 (0.76,1.16)	0.78 (0.58,1.04)	0.35
<b>Number of meat and alternative servings consumed</b>	1.04 (0.80,1.35)	0.97 (0.75,1.26)	0.93 (0.71,1.23)	0.73 (0.50,1.06)	<b>0.03</b>
<b>Composite food group serving total</b>	<b>1.10</b> <b>(1.03,1.17)</b>	<b>1.07</b> <b>(1.00,1.15)</b>	1.04 (0.97,1.12)	0.95 (0.86,1.05)	<b>&lt;0.0001</b>
Covariates					

Age in years	0.90 (0.70,1.16)	0.91 (0.71,1.17)	0.92 (0.71,1.20)	0.91 (0.64,1.30)	0.93
Female sex	<b>0.37</b> <b>(0.19,0.72)</b>	<b>0.41</b> <b>(0.21,0.81)</b>	0.54 (0.27,1.09)	0.70 (0.28,1.74)	<b>0.0009</b>
Food insecurity at home	<b>0.17</b> <b>(0.07,0.41)</b>	<b>0.18</b> <b>(0.07,0.42)</b>	<b>0.17</b> <b>(0.06,0.49)</b>	0.44 (0.11,1.82)	<b>0.0009</b>
School 1	1.04 (0.48,2.26)	1.20 (0.55,2.59)	1.70 (0.74,3.87)	0.66 (0.20,2.19)	<b>0.02</b>
School 2	Reference	Reference	Reference	Reference	
School 3	2.65 (1.14,6.19)	2.58 (1.10,6.04)	2.51 (1.02,6.18)	1.05 (0.31,3.57)	
School 4	2.30 (1.05,5.05)	2.67 (1.21,5.88)	2.54 (1.10,5.88)	1.68 (0.58,4.86)	
Worked at a deli, restaurant, or other food service location	<b>0.39</b> <b>(0.21,0.71)</b>	<b>0.37</b> <b>(0.20,0.68)</b>	<b>0.21</b> <b>(0.11,0.43)</b>	<b>0.24 (0.08,0.72)</b>	<b>0.0005</b>
Worked or volunteered at a hospital	<b>0.11</b> <b>(0.05,0.26)</b>	<b>0.14</b> <b>(0.06,0.32)</b>	<b>0.11</b> <b>(0.04,0.33)</b>	<b>0.12 (0.01,1.00)</b>	<b>&lt;0.0001</b>
Took a course on how to prepare food	1.36 (0.70,2.64)	1.02 (0.52,1.98)	1.08 (0.54,2.19)	1.83 (0.74,4.51)	<b>0.01</b>

\*Reference is Strongly Disagree

Univariable association between interest in learning how to keep foods safe to eat and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
Predictor Variables					
Number of fruit and vegetable servings consumed	1.06 (0.95,1.18)	0.98 (0.89,1.09)	0.93 (0.84,1.04)	0.95 (0.84,1.08)	<b>&lt;0.0001</b>
Number of grain product servings consumed	0.99 (0.88,1.11)	0.96 (0.85,1.07)	0.96 (0.85,1.07)	1.00 (0.88,1.15)	0.051
Number of milk and alternative	0.98 (0.85,1.13)	0.91 (0.79,1.05)	0.93 (0.81,1.07)	0.92 (0.77,1.08)	0.24

servings consumed					
<b>Number of meat and alternative servings consumed</b>	0.96 (0.80,1.15)	<b>0.82</b> <b>(0.69,0.98)</b>	<b>0.81</b> <b>(0.68,0.97)</b>	0.85 (0.68,1.05)	<b>0.0009</b>
<b>Composite food group serving total</b>	<b>1.07 (1.02, 1.12)</b>	1.04 (0.99,1.09)	1.03 (0.98,1.08)	1.05 (0.99,1.11)	<b>0.005</b>
Covariates					
Age in years	0.98 (0.81, 1.17)	0.96 (0.80,1.14)	0.96 (0.81,1.15)	1.02 (0.82,)	0.91
Female sex	0.58 (0.36,0.92)	0.54 (0.35,0.84)	0.61 (0.39,0.95)	0.63 (0.37,1.07)	0.09
Food insecurity at home	<b>0.38</b> <b>(0.15,0.96)</b>	<b>0.31</b> <b>(0.13,0.73)</b>	<b>0.46</b> <b>(0.20,1.08)</b>	0.50 (0.16,1.52)	0.10
<b>School 1</b>	0.69 (0.36,1.30)	0.91 (0.50,1.66)	1.10 (0.60,2.03)	2.80 (1.28,6.14)	<b>&lt;0.0001</b>
School 2	Reference	Reference	Reference	Reference	
School 3	<b>1.90</b> <b>(0.99,3.65)</b>	<b>1.87</b> <b>(0.99,3.54)</b>	<b>2.14</b> <b>(1.13,4.07)</b>	2.89 (1.26,6.61)	
School 4	0.88 (0.50,1.57)	1.34 (0.78,2.30)	1.36 (0.79,2.36)	2.99 (1.45,6.17)	
<b>Worked at a deli, restaurant, or other food service location</b>	1.00 (0.58,1.73)	0.82 (0.48,1.39)	0.64 (0.37,1.09)	1.01 (0.54,1.92)	<b>0.02</b>
<b>Worked or volunteered at a hospital</b>	<b>0.27</b> <b>(0.13,0.57)</b>	<b>0.18</b> <b>(0.09,0.37)</b>	<b>0.09</b> <b>(0.04,0.21)</b>	<b>0.04 (0.01,0.34)</b>	<b>&lt;0.0001</b>
<b>Took a course on how to prepare food</b>	<b>2.98</b> <b>(1.73,5.12)</b>	<b>2.03</b> <b>(1.20,3.44)</b>	1.19 (0.70,2.03)	1.25 (0.67,2.34)	<b>&lt;0.0001</b>

\*Reference is Strongly Disagree

Univariable association between concerns about food poisoning and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
Predictor Variables					

Number of fruit and vegetable servings consumed	1.04 (0.95,1.13)	0.97 (0.89,1.05)	0.96 (0.89,1.05)	0.99 (0.91,1.09)	0.05
Number of grain product servings consumed	0.99 (0.90,1.09)	0.96 (0.87,1.05)	0.97 (0.88,1.06)	1.02 (0.93,1.13)	0.24
Number of milk and alternative servings consumed	1.00 (0.89,1.13)	0.98 (0.87,0.99)	0.99 (0.88,1.11)	0.97 (0.86,1.10)	0.91
Number of meat and alternative servings consumed	1.01 (0.87,1.17)	0.92 (0.80,1.06)	0.90 (0.78,1.04)	0.91 (0.77,1.06)	0.09
Composite food group serving total	1.04 (1.00,1.08)	1.02 (0.98,1.06)	1.02 (0.98,1.06)	1.03 (0.99, 1.07)	0.20
Covariates					
<b>Age in years</b>	0.91 (0.79,1.06)	0.96 (0.83,1.11)	1.04 (0.90,1.20)	1.08 (0.92,1.26)	<b>0.01</b>
Female sex	<b>0.66</b> <b>(0.46,0.95)</b>	<b>0.62</b> <b>(0.44,0.88)</b>	<b>0.622</b> <b>(0.44,0.89)</b>	<b>0.59 (0.40,0.87)</b>	0.08
Food insecurity at home	0.40 (0.16,1.01)	0.62 (0.28,1.39)	0.53 (0.23,1.21)	0.96 (0.41,2.25)	0.11
<b>School 1</b>	0.92 (0.52,1.60)	1.22 (1.72,2.07)	1.24 (0.73, 2.12)	1.90 (1.07, 3.39)	<b>0.03</b>
School 2	Reference	Reference	Reference	Reference	
School 3	<b>1.71</b> <b>(1.04,2.83)</b>	1.51 (0.93,2.46)	1.51 (0.92, 2.47)	1.70 (0.99, 2.94)	
School 4	1.06 (0.67,1.67)	1.20 (0.77, 1.85)	1.10 (0.71,1.72)	1.50 (0.92, 2.46)	
Worked at a deli, restaurant, or other food service location	0.84 (0.54,1.30)	0.70 (0.46,1.08)	0.75 (0.49,1.15)	0.81 (0.50,1.29)	0.47
<b>Worked or volunteered at a hospital</b>	<b>0.47</b> <b>(0.22,0.97)</b>	<b>0.21</b> <b>(0.10,0.46)</b>	<b>0.28</b> <b>(0.13,0.59)</b>	<b>0.17 (0.06,0.48)</b>	<b>0.0003</b>
<b>Took a course on how to prepare food</b>	<b>1.75</b> <b>(1.16,2.64)</b>	1.36 (0.91,2.03)	1.36 (0.91,2.03)	1.32 (0.88,1.98)	<b>0.02</b>

\*Reference is Strongly Disagree



Univariable association between concerns about food allergies and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
Predictor Variables					
Number of fruit and vegetable servings consumed	1.03 (0.96,1.10)	0.96 (0.90,1.02)	0.95 (0.89,1.01)	0.96 (0.90,1.03)	0.06
Number of grain product servings consumed	0.95 (0.88,1.03)	<b>0.92 (0.86,0.98)</b>	<b>0.93 (0.87,0.99)</b>	<b>0.92 (0.85,0.99)</b>	0.10
Number of milk and alternative servings consumed	0.96 (0.87,1.06)	0.95 (0.87,1.04)	0.96 (0.89,1.04)	0.97 (0.89,1.07)	0.83
Number of meat and alternative servings consumed	0.94 (0.83,1.06)	<b>0.85 (0.76,0.95)</b>	<b>0.86 (0.78,0.96)</b>	<b>0.84 (0.75,0.95)</b>	0.101
Composite food group serving total	1.00 (0.97,1.04)	0.98 (0.96,1.01)	0.99 (0.96,1.02)	0.98 (0.95,1.02)	0.65
Covariates					
Age in years	0.92 (0.81,1.04)	0.91 (0.82,1.02)	0.94 (0.85,1.04)	1.02 (0.90,1.14)	0.16
Female sex	<b>0.65 (0.48,0.88)</b>	<b>0.52 (0.40,0.69)</b>	<b>0.62 (0.48,0.81)</b>	<b>0.53 (0.40,0.71)</b>	<b>&lt;0.0001</b>
Food insecurity at home	0.63 (0.27,1.50)	0.61 (0.29,1.28)	0.79 (0.41,1.53)	0.96 (0.46,1.99)	0.58
School 1	<b>0.68 (0.42,1.09)</b>	0.83 (0.55,1.25)	1.03 (0.70,1.51)	1.28 (0.84,1.96)	<b>0.002</b>
School 2	Reference	Reference	Reference	Reference	
School 3	<b>1.30 (0.86,1.99)</b>	<b>1.42 (0.97,2.07)</b>	<b>1.67 (1.16,2.40)</b>	1.17 (0.77,1.77)	
School 4	0.97 (0.65,1.46)	1.11 (0.77,1.58)	1.40 (0.99,1.96)	1.45 (0.99,2.12)	
Worked at a deli, restaurant, or other food service location	1.00 (0.69,1.45)	0.74 (0.53,1.05)	<b>0.71 (0.51,0.98)</b>	<b>0.64 (0.44,0.93)</b>	<b>0.04</b>

Worked or volunteered at a hospital	1.09 (0.50,2.40)	0.75 (0.36,1.57)	0.55 (0.27,1.14)	0.45 (0.18,1.12)	0.15
<b>Took a course on how to prepare food</b>	<b>1.87</b> <b>(1.34,2.61)</b>	<b>1.44</b> <b>(1.06,1.94)</b>	1.04 (0.78,1.39)	1.18 (0.86,1.63)	<b>&lt;0.0001</b>

\*Reference is Strongly Disagree

Univariable association between students' confidence in cooking safe healthy meals for themselves and their families and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Attitudes OR (95% CI)*				P-value
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	
Predictor Variables					
<b>Number of fruit and vegetable servings consumed</b>	<b>1.16</b> <b>(1.05,1.28)</b>	1.05 (0.95,1.16)	0.98 (0.89,1.09)	0.94 (0.83,1.07)	<b>&lt;0.0001</b>
Number of grain product servings consumed	1.04 (0.94,1.15)	0.99 (0.89,1.10)	1.01 (0.90,1.13)	0.96 (0.85,1.10)	0.22
Number of milk and alternative servings consumed	1.09 (0.95,1.24)	1.04 (0.91,1.18)	1.08 (0.94,1.24)	1.01 (0.86,1.19)	0.33
<b>Number of meat and alternative servings consumed</b>	1.17 (0.99,1.39)	1.01 (0.86,1.20)	1.00 (0.84,1.19)	0.99 (0.80,1.21)	<b>0.001</b>
<b>Composite food group serving total</b>	<b>1.10</b> <b>(1.05,1.15)</b>	<b>1.06 (1.01, 1.10)</b>	1.05 (1.00,1.10)	1.03 (0.98,1.09)	<b>&lt;0.0001</b>
Covariates					
<b>Age in years</b>	1.14 (0.96,1.34)	1.09 (0.93,1.28)	1.07 (0.90,1.27)	0.93 (0.76,1.31)	<b>0.04</b>
<b>Female sex</b>	0.64 (0.43,0.96)	0.61 (0.41,0.91)	0.77 (0.51,1.18)	1.11 (0.68,1.81)	<b>0.001</b>
<b>Food insecurity at home</b>	<b>0.25</b> <b>(0.11,0.54)</b>	<b>0.38</b> <b>(0.18,0.78)</b>	<b>0.18</b> <b>(0.07,0.48)</b>	0.58 (0.23,1.47)	<b>0.001</b>

School 1	1.07 (0.56,2.02)	1.32 (0.70,2.47)	0.91 (0.46,1.79)	1.28 (0.59,2.79)	0.13
School 2	Reference	Reference	Reference	Reference	
School 3	1.34 (0.75,2.39)	1.29 (0.73,2.28)	1.29 (0.71,2.36)	1.46 (0.72,2.93)	
School 4	<b>0.73</b> <b>(0.44,1.21)</b>	0.86 (0.52,1.41)	0.93 (0.55,1.59)	1.08 (0.58,2.02)	
<b>Worked at a deli, restaurant, or other food service location</b>	1.65 (0.95,2.87)	1.27 (0.73,2.20)	0.85 (0.46,1.54)	0.72 (0.35,1.48)	<b>&lt;0.0001</b>
<b>Worked or volunteered at a hospital</b>	<b>0.40</b> <b>(0.17,0.91)</b>	<b>0.35</b> <b>(0.16,0.78)</b>	<b>0.23</b> <b>(0.09,0.64)</b>	<b>0.16 (0.03,0.75)</b>	<b>0.03</b>
<b>Took a course on how to prepare food</b>	<b>4.10</b> <b>(2.39,7.03)</b>	<b>2.65 (1.55, 4.52)</b>	<b>1.93</b> <b>(1.102,3.38)</b>	1.29 (0.67,2.46)	<b>&lt;0.0001</b>

\*Reference is Strongly Disagree

Univariable association between hand washing before preparing or handling food and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Practices OR (95% CI)*				P-value
	Always	Often	Sometimes	Rarely	
Predictor Variables					
<b>Number of fruit and vegetable servings consumed</b>	1.00 (0.87,1.15)	0.94 (0.82,1.08)	0.93 (0.80,1.08)	<b>0.80 (0.67,0.96)</b>	<b>&lt;0.0001</b>
<b>Number of grain product servings consumed</b>	<b>0.82</b> <b>(0.71,0.93)</b>	<b>0.85</b> <b>(0.74,0.97)</b>	<b>0.86</b> <b>(0.75,1.00)</b>	<b>0.75 (0.63,0.90)</b>	<b>0.005</b>
Number of milk and alternative servings consumed	<b>0.79</b> <b>(0.66,0.95)</b>	<b>0.81</b> <b>(0.67,0.97)</b>	0.83 (0.68,1.00)	0.82 (0.66,1.02)	0.11
Number of meat and alternative servings consumed	<b>0.76</b> <b>(0.60,0.96)</b>	<b>0.75</b> <b>(0.59,0.95)</b>	<b>0.73</b> <b>(0.57,0.94)</b>	<b>0.64 (0.48,0.86)</b>	0.05

Composite food group serving total	1.02 (0.96,1.08)	1.01 (0.95,1.08)	1.01 (0.95,1.08)	0.94 (0.87,1.02)	0.06
Covariates					
<b>Age in years</b>	<b>0.82</b> <b>(0.65,1.05)</b>	0.92(0.72,1.17)	0.95(0.74,1.23)	0.84(0.63,1.12)	<b>0.005</b>
<b>Female sex</b>	0.64 (0.36,1.16)	0.83(0.46,1.51)	0.85(0.45,1.58)	0.90 (0.44,1.83)	<b>0.01</b>
<b>Food insecurity at home</b>	<b>0.15</b> <b>(0.06,0.38)</b>	<b>0.28</b> <b>(0.11,0.71)</b>	<b>0.35</b> <b>(0.13,0.97)</b>	0.50 (0.15,1.64)	<b>0.002</b>
<b>School 1</b>	1.07 (0.50,2.30)	1.23 (0.56,2.70)	1.22 (0.54,2.78)	2.22 (0.80,6.16)	<b>0.006</b>
School 2	Reference	Reference	Reference	Reference	
School 3	<b>3.77</b> <b>(1.48,9.59)</b>	<b>3.02</b> <b>(1.17,7.77)</b>	2.28 (0.85,6.09)	<b>5.36</b> <b>(1.73,16.61)</b>	
School 4	1.73 (0.85,3.52)	1.65 (0.80,3.40)	1.63 (0.76,3.47)	3.12 (1.23,7.96)	
Worked at a deli, restaurant, or other food service location	<b>0.49</b> <b>(0.26,0.92)</b>	0.59 (0.31,1.13)	<b>0.42</b> <b>(0.21,0.85)</b>	0.53 (0.23,1.20)	0.07
<b>Worked or volunteered at a hospital</b>	<b>0.08</b> <b>(0.04,0.17)</b>	<b>0.08</b> <b>(0.03,0.19)</b>	<b>0.16</b> <b>(0.07,0.40)</b>	<b>0.04 (0.01,0.35)</b>	<b>&lt;0.0001</b>
Took a course on how to prepare food	1.23 (0.66,2.30)	1.04(0.55,1.96)	0.99 (0.51,1.92)	0.88 (0.40,1.90)	0.21

\*Reference is Never

Univariable association between hand washing after cooking or handling raw meat or chicken and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Practices OR (95% CI)*				P-value
	Always	Often	Sometimes	Rarely	
Predictor Variables					
Number of fruit and vegetable servings consumed	1.05 (0.89,1.23)	1.01 (0.86,1.20)	1.02 (0.86,1.23)	1.03 (0.83,1.27)	0.079
Number of grain product servings consumed	<b>0.84</b> <b>(0.73,0.98)</b>	0.87 (0.74,1.02)	0.90 (0.76,1.07)	0.89 (0.72,1.09)	0.12

<b>Number of milk and alternative servings consumed</b>	<b>0.80</b> (0.65,0.98)	0.91 (0.74,1.13)	0.84 (0.67,1.05)	0.85 (0.64,1.11)	<b>0.001</b>
Number of meat and alternative servings consumed	0.79 (0.60,1.02)	0.80 (0.60,1.05)	0.77 (0.57,1.04)	0.93 (0.66,1.32)	0.27
Composite food group serving total	1.04 (0.97,1.11)	1.05 (0.97,1.12)	1.04 (0.96,1.12)	1.01 (0.93,1.11)	0.73
Covariates					
Age in years	0.99 (0.76,1.28)	1.05 (0.80,1.38)	1.09 (0.81,1.46)	1.13 (0.80,1.59)	0.43
<b>Female sex</b>	<b>0.44</b> (0.22,0.85)	0.80 (0.40,1.60)	1.13 (0.53,2.39)	0.54 (0.23,1.28)	<b>&lt;0.0001</b>
<b>Food insecurity at home</b>	<b>0.15</b> (0.06,0.38)	<b>0.23</b> (0.08,0.64)	<b>0.18</b> (0.05,0.66)	0.64 (0.18,2.29)	<b>&lt;0.0001</b>
<b>School 1</b>	1.46 (0.62,3.45)	1.53 (0.62,3.77)	1.30 (0.49,3.47)	1.07 (0.32,3.57)	<b>0.03</b>
School 2	Reference	Reference	Reference	Reference	
School 3	3.17 (1.23,8.18)	2.42 (0.91,6.46)	1.93 (0.68,5.54)	1.60 (0.46,5.59)	
School 4	2.29 (1.03,5.10)	1.54 (0.66,3.55)	1.52 (0.61,3.76)	1.81 (0.63,5.19)	
Worked at a deli, restaurant, or other food service location	0.88 (0.40,1.92)	0.94 (0.42,2.14)	0.59 (0.23,1.48)	1.03 (0.36,2.90)	0.56
<b>Worked or volunteered at a hospital</b>	<b>0.09</b> (0.04,0.21)	<b>0.09</b> (0.03,0.26)	<b>0.09</b> (0.02,0.37)	0.26 (0.06,1.06)	<b>&lt;0.0001</b>
Took a course on how to prepare food	0.95 (0.49,1.86)	0.78(0.39,1.58)	1.08 (0.51,2.30)	1.06 (0.43,2.57)	0.52

\*Reference is Never

Univariable association between keeping raw meat and chicken away from ready to eat foods and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Food Safety Practices				P-value
	OR (95% CI)*				
	Always	Often	Sometimes	Rarely	

Predictor Variables					
Number of fruit and vegetable servings consumed	1.04 (0.92,1.18)	1.00 (0.88,1.13)	0.96 (0.84,1.11)	0.97 (0.82,1.15)	0.09
Number of grain product servings consumed	0.96 (0.85,1.10)	1.00 (0.88,1.14)	0.92 (0.80,1.07)	1.05 (0.88,1.25)	0.24
<b>Number of milk and alternative servings consumed</b>	<b>0.79 (0.68,0.93)</b>	0.87 (0.74,1.02)	<b>0.77 (0.64,0.92)</b>	0.92 (0.75,1.14)	<b>0.001</b>
Number of meat and alternative servings consumed	<b>0.81 (0.66,0.99)</b>	0.86 (0.69,1.06)	<b>0.74 (0.59,0.93)</b>	0.87 (0.65,1.15)	0.07
Composite food group serving total	1.02 (0.97, 1.08)	1.03 (0.97,1.09)	0.99 (0.93,1.05)	1.02 (0.94,1.10)	0.13
Covariates					
<b>Age in years</b>	1.15 (0.93,1.41)	1.01(0.81,1.25)	1.03(0.82,1.30)	1.04(0.78,1.38)	<b>0.02</b>
<b>Female sex</b>	0.61 (0.37,1.02)	0.85 (0.50,1.44)	0.79 (0.45,1.40)	1.02 (0.51,2.05)	<b>0.002</b>
<b>Food insecurity at home</b>	<b>0.31 (0.12,0.83)</b>	0.53 (0.19,1.46)	0.42 (0.13,1.35)	1.40 (0.42,4.66)	<b>0.003</b>
School 1	1.09 (0.52,2.31)	1.13 (0.52,2.47)	0.75 (0.32,1.74)	1.80 (0.66,4.90)	0.17
School 2	Reference	Reference	Reference	Reference	
School 3	1.35 (0.68,2.69)	1.10 (0.53,2.26)	0.73 (0.34,1.58)	1.05 (0.39,2.83)	
School 4	1.19 (0.62,2.28)	1.21 (0.61,2.39)	0.89 (0.43,1.82)	1.26 (0.50,3.16)	
Worked at a deli, restaurant, or other food service location	0.99 (0.53,1.83)	0.78 (0.41,1.51)	0.72 (0.35,1.47)	0.47 (0.17,1.26)	0.12
<b>Worked or volunteered at a hospital</b>	<b>0.22 (0.09,0.51)</b>	<b>0.17 (0.06,0.47)</b>	<b>0.29 (0.10,0.85)</b>	0.26 (0.05,1.28)	<b>0.007</b>
<b>Took a course on how to prepare food</b>	<b>1.74 (1.00,3.04)</b>	1.12 (0.62,2.00)	0.96 (0.51,1.80)	1.19 (0.56,2.55)	<b>&lt;0.0001</b>

\*Reference is Never

Univariable association between Canada's Food Guide use and the number of servings consumed on the day prior to the survey (2014-2015); for Ontario high school students (n=2860), statistically significant differences are bolded (p<0.05)

Predictor Variables and Covariates	Students Canada's Food Guide Use OR (95% CI)*				P-value
	Always	Often	Sometimes	Rarely	
Predictor Variables					
Number of fruit and vegetable servings consumed	<b>1.41</b> (1.30,1.53)	<b>1.32</b> (1.21,1.43)	<b>1.25</b> (1.18,1.33)	<b>1.12 (1.06,1.18)</b>	<b>&lt;0.0001</b>
Number of grain product servings consumed	<b>1.26</b> (1.16,1.38)	<b>1.15</b> (1.05,1.26)	<b>1.11</b> (1.05,1.19)	<b>1.06 (1.00,1.12)</b>	<b>&lt;0.0001</b>
Number of milk and alternative servings consumed	<b>1.34</b> (1.19,1.50)	<b>1.24</b> (1.11,1.40)	<b>1.22</b> (1.12,1.32)	1.07 (1.00,1.14)	<b>&lt;0.0001</b>
Number of meat and alternative servings consumed	<b>1.37</b> (1.18,1.58)	<b>1.29</b> (1.11,1.50)	1.10 (0.99,1.22)	1.07 (0.98,1.16)	<b>&lt;0.0001</b>
Composite food group serving total	<b>1.13 (1.09, 1.17)</b>	<b>1.12 (1.08, 1.17)</b>	<b>1.10 (1.07, 1.13)</b>	<b>1.05 (1.02, 1.07)</b>	<b>&lt;0.0001</b>
Covariates					
Age in years	1.01 (0.87, 1.17)	0.95 (0.81, 1.10)	0.90 (0.82, 1.00)	0.90 (0.83, 0.97)	0.05
Female sex	1.50 (1.05, 2.14)	1.12 (0.77, 1.63)	0.95 (0.74, 1.21)	0.85 (0.70, 1.04)	0.05
Food insecurity at home	1.47 (0.61,3.52)	0.53 (0.13,2.23)	0.61 (0.26,1.45)	1.36 (0.81,2.31)	0.31
<b>School 1</b>	1.12 (0.68,1.85)	0.94 (0.54,1.66)	1.46 (1.00,2.13)	1.45 (1.05,2.01)	<b>0.02</b>
School 2	Reference	Reference	Reference	Reference	
School 3	0.86 (0.54,1.36)	0.77 (0.46,1.28)	1.17 (0.82,1.66)	1.29 (0.96,1.72)	
School 4	<b>0.46</b> <b>(0.28,0.76)</b>	0.78 (0.48,1.27)	1.07 (0.76,1.50)	1.34 (1.02,1.77)	
<b>Worked at a deli,</b>	<b>1.94</b> <b>(1.30,2.90)</b>	1.51 (0.97,2.35)	1.12 (0.82,1.54)	0.84 (0.64,1.12)	<b>0.002</b>

<b>restaurant, or other food service location</b>					
<b>Worked or volunteered at a hospital</b>	<b>4.75</b> (2.41,9.33)	<b>3.18</b> (1.42,7.09)	1.31 (0.62,2.79)	0.51 (0.21,1.23)	<b>&lt;0.0001</b>
<b>Took a course on how to prepare food</b>	<b>2.08</b> (1.46,2.98)	1.47 (1.00,2.17)	1.25 (0.96,1.61)	0.93 (0.75,1.16)	<b>&lt;0.0001</b>

\*Reference is Never



## **Appendix E: AIC Scores**

AIC scores for models using the four food groups in Canada's Food Guide

<b>Dependent Variable</b>	<b>AIC score for model with the six covariates and the outcome</b>	<b>AIC score for model with covariates, the four predictors and the outcome</b>
<b>Food Safety Knowledge</b>		
Knowing the most hygienic way to wash your hands	3601.36	3546.66
Knowing the proper way to prevent food poisoning	3472.98	3424.25
Knowing the best way to determine if hamburgers are cooked	2272.61	2251.78
Knowing what a microorganism is	1917.80	1894.37
<b>Food Attitudes</b>		
Interest in keeping foods safe to eat	6651.46	6539.19
Interest in choosing nutritious foods	6628.63	6424.76
Concerns about food poisoning	7481.85	7362.28
Concerns about food allergies	7686.73	7570.73
Confidence in cooking	6680.68	6538.59
Thinks cooking is an important life skill	5490.46	5359.32
<b>Food Safety Practices</b>		
Washes hands before handling food	5458.29	5335.54
Washes hands after working with raw meat or chicken	3513.00	3441.19
Separates foods	4408.36	4307.38
<b>Canada's Food Guide Use</b>		
Uses Canada's Food Guide	5794.73	5600.50