Energy And Nutrient Intake Among University Students Enrolled In An Introductory Nutrition Course

by

Hibah Khawar

A Thesis submitted to
The Faculty of Graduate Studies of
The University of Manitoba
in partial fulfillment of the requirements
of the degree of

MASTER OF SCIENCE

Department of Food and Human Nutritional Sciences
The University of Manitoba
Winnipeg, Manitoba, Canada
December, 2018

Abstract

Introduction: Several Canadian studies have reported that Canadian children and adolescents do not consume the recommended amount of nutrients. Studies have also shown that dietary habits developed during adolescence are likely to persist during adulthood. The transition from late adolescence to early adulthood accompanies a shift in eating pattern especially among young adults entering university. Health-related behaviors acquired by students while in the university have a strong impact on their future health. Thus, this study investigates the dietary intakes of university students enrolled in an introductory nutrition course at the University of Manitoba.

Objectives: 1) To estimate the energy and nutrient intake and estimate the adequacy of nutrient intake according to the recommendations by applying the Cut-point method. 2) To estimate the number of servings of four food groups and the adequacy according to Canada′s Food Guide (CFG) recommendations. 3) To investigate whether the reported energy intake was corresponding to the energy required depending upon physical activity level, sex group, age, height, and weight.

Methodology: This cross-sectional study obtained data from the 3-day food log (n=68; 44 females and 24 males) from Summer 2015 and Summer 2016. For food analysis, Food Focus software version 4.1 was used. Students younger than 19 years of age, with the incomplete food log and pregnant women were excluded. Intake of energy, 32 nutrients and the number of servings from four food groups were estimated. Compliance with the dietary recommendations was assessed by applying the Cut-point method. This study was performed in an anonymized manner.

Results: On average, 19% of students were below the lower end of AMDR (Accept-

able Macronutrient Distribution Range) for carbohydrate and 16% were above the upper end of AMDR for total fat. The prevalence of inadequacy for micronutrient intake was higher among males than females. Average intake of sodium was excessive for 79% males and 36% females. For food groups, overall the prevalence of inadequacy was 65% for fruits and vegetables, 66% for grain products, 46% for milk and alternatives.

Conclusion: Findings from this self-reported 3-day food log study suggest that the university students may be at high risk for inadequate energy and nutrient intakes. Additional large-scaled studies are required to verify our findings.

Acknowledgments

First, I would like to thank my supervisor, *Dr. Mohammed Moghadasian* for his insightful criticism, and guidance that has proven highly beneficial throughout my program.

I owe immense debt of gratitude to my research committee *Dr. Natalie Riediger*, *Dr. Usha Thiyam-Hollander* and *Dr. Luc Clair* for their consideration to be the members of my thesis committee. I am thankful for their timely comments, guidance and support, making this a worthwhile undertaking. I am also grateful to all the staffs of the CCARM and St Boniface Hospital.

My deepest gratitude is for my mother, for her unwavering support over the years and allowing me to move far away from home for my graduate degree. Finally, I would like to thank my whole family and God, without whom my work would never have seen the light of the day.

In the end, to each of the above, I extend my deepest acknowledgement.

Contents

Acknowledgments iv
Table of Contents vi
List of Figures vii
List of Tables viii

1 Introduction **2**
1.1 Objectives 4
1.2 Research Questions 4
1.3 Significance 4
1.4 Thesis Organization 5

2 Literature Review **6**
2.1 Dietary Assessment Methods 7
2.2 Young Adults and Nutrition Transitions 8
2.3 Nutritional Status of University Students 10
2.4 Food Groups Intake 14

3 Methodology **17**
3.1 Study Population and Data Collection 17
3.1.1 Inclusion and exclusion criteria 19
3.2 Data Mining: Normality test and Missing values 20
3.3 Study Variables 25
3.3.1 Dependent variables for objective 1 25
3.3.2 Dependent variables for objective 2 25
3.3.3 Dependent variables for objective 3 25
3.4 Outliers Labeling Method: Boxplot Method 25
3.5 Data Analysis 26
3.6 Dietary Reference Intake (DRI) and the Cut-point Method 26
3.6.1 Applying the Estimated Average Requirement (EAR) for the Cut-point method 27

3.6.2 Applying the Adequate Intake (AI) value for the Cut-point method . . . 28
3.6.3 Applying the Tolerable Upper Intake Level (UL) for the Cut-point method . . . 28
3.6.4 Acceptable Macronutrient Distribution Range . . . 29
3.7 Evaluating the Intake from Food Groups in accordance with the CFG 30
3.7.1 Estimation of numbers of servings for fruits and vegetables . . 30
3.7.2 Estimation of numbers of servings for grain products . . . 31
3.7.3 Estimation of numbers of servings for milk and alternatives . . 31
3.7.4 Mixed Dishes . . . 32
3.8 Estimating Energy Intake and calculating Estimated Energy Requirement . . . 32
3.9 Statistical analysis . . . 34
3.9.1 Dependent and Independent variables . . . 34
3.9.2 Descriptive statistics . . . 35
3.10 Ethics Considerations . . . 35

4 Results 36
4.1 Demographic Characteristics . . . 36
4.2 Estimated Intake of Energy and Nutrients . . . 38
4.3 Intake from Food Groups and Adequacy . . . 46
4.4 Energy Intake and Estimated Energy Requirements . . . 47

5 Discussion, Conclusion, and Limitations 55
5.1 Overview . . . 55
5.1.1 Adequacy of Macronutrients and Micronutrients . . . 56
5.1.2 Intake from Food Groups and Adequacy . . . 59
5.1.3 Energy Intake and Estimated Energy Requirement . . . 61
5.2 Conclusion . . . 61
5.3 Limitations . . . 62

6 Bibliography 64

A Physical Activity Coefficient used for Estimating Energy Requirement 88

B Questionnaire used by Food Focus Software 90

C A sample of 3-day food log assignment used 92

D Recommendation by Canada's Food Guide (CFG) 99

E Supplementary Material 109

List of Figures

3.1 Overview of Methodology Flowchart 20

4.1 Percentage of Individuals within, below and above the AMDR distribution for Carbohydrates, Protein and Fat 44
4.2 Percentage of individuals (%) below, at or above the recommended number of servings for food groups 49
4.3 The frequency of the estimated number of servings of fruit and vegetables (FV) by sex group 50
4.4 The frequency of the estimated number of servings of grain products by sex group 51
4.5 The frequency of the estimated number of servings of milk and alternatives by sex group 52
4.6 The frequency of the estimated number of servings of meat and alternatives by sex group 53

List of Tables

3.1 Kolmogorov-Smirnov and Shapiro-Wilk Test Results 23
3.2 Skewness & Kurtosis Test Results 24
3.3 Acceptable Macronutrients Distribution Range 29
3.4 Counting food group number of servings in a mixed dish 32

4.1 Demographic Characteristics 37
4.2 Estimated Intake of Energy, Macronutrients, Water, and Fiber 40
4.3 Estimated Intake of PUFA, Total Sugar, Added Sugar, and Cholesterol 41
4.4 Estimated Intake of Vitamins 42
4.5 Estimated Intake of Elements 43
4.6 Mean Percentage (%) of Energy Intake for Males and Female for each Macronutrient 44
4.7 Estimating the adequacy using the Cut-point method 45
4.8 Estimated number of servings for food groups and proportion (%) of individuals consuming the number of servings from four food group relative to the recommendations in Canadaś Food Guide (CFG), by sex group 48
4.9 Energy Intake compared to Estimated Energy Requirement 54

E.1 Estimated intake of Energy and Nutrients from 1-day food record . . 117
E.2 Percentage Energy from Protein, Fat and Carbohydrate by Meal type and Snack 118
E.3 Energy and Nutritive value by Meal type and Snack 118
E.4 Characteristics of meals and snacks 119

List of Abbreviations

AI	Adequate Intake
ALA	Alpha-linolenic acid
AMDR	Acceptable Macronutrient Distribution Range
BMI	Body mass index.
Ca	Calcium
CFG	Canada food guide
CHO	Carbohydrates
CI	Confidence Interval
DHA	Docosahexaenoic acid
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
EPA	Eicosapentaenoic acid
Fe	Iron
g	Gram
IOM	Institute of Medicine
kcal	Kilocalories
kg	Kilogram
LA	Linoleic acid
μg	Microgram
NE	Niacin equivalents
PA	Physical Activity Coefficient
PAL	Physical Activity Level
QQ plot	Quantile-Quantile plot
SD	Standard Deviation
UL	Tolerable Upper Limit.

Chapter 1

Introduction

A healthy diet is one of the vital components of leading a healthy or active lifestyle. It encompasses a balanced intake of nutrients, which comes from a variety of foods from each of the four food groups. Dietary intake consistent with guidelines provides an optimal distribution of caloric intake and of nutrients, reducing the risk of developing diet-related diseases and maintains the optimal physical performance (Tapsell et al., 2016). University students represent a significant segment of young adults, who are in transition from late adolescent to early adulthood. During this transition phase of living away from their homes while attending post-secondary education, students face numerous challenges related to healthy eating and majority of students have been reported to skip breakfast(Stevenson, Doherty, Barnett, Muldoon, & Trew, 2007), choose highly processed food items, sugar-sweetened beverages (Alam, 2012) and fast food items (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). Unhealthy dietary habits established during this stage often continue throughout life (Stevenson et al., 2007), and have been associated with risk of developing obesity,

high blood pressure and an elevated lipid profile (Deliens, Clarys, De Bourdeaudhuij, & Deforche, 2014).

Research in nutritional practices of university students has been limited and qualitative in nature. However, quantitative studies assessing nutrient and energy intake according to recommendations have been limited in literature up to date. Survey studies have consistently revealed several poor dietary practices (i.e., breakfast skipping, frequent snacking, daily intake of sugar-sweetened beverage and increased fast food consumption (Gresse, Steenkamp, & Pietersen, 2015). It was reported that about 26% of Canadians, aged 2 years or older meet their minimum number of daily servings of fruit and vegetables (Black & Billette, 2013). Despite the acquaintance of health benefit for following dietary guidelines, the majority of Canadians diet fall outside the Acceptable Macronutrient Distribution Range (AMDR) for macronutrients (Garriguet, 2007). Colley et al. (2011) claimed that a sizable portion of the Canadian population remains inactive with about 69% of Canadian adults (aged 20-79 year) have a sedentary lifestyle. It is unknown whether these trends may apply to university students, although the reported dietary practices in the literature would appear to put them at risk of dietary deficiencies (Strawson et al., 2013; Strawson et al., 2015). Therefore, we hypothesized that dietary intake of university students enrolled in an introductory nutrition course does not meet the recommendations for energy, macronutrients, micronutrients, and number of servings intake from four food groups.

1.1 Objectives

This research intends to address the following objectives:

I. To estimate the nutrient intake and evaluate if the intake is adequate according to dietary recommendations by applying the Cut-point method.

II. To estimate the number of servings of four food groups and the adequacy according to Canada′s Food Guide (CFG) recommendations.

III. To investigate whether the reported energy intake was corresponding the energy required depending upon physical activity level, sex, age, height, and weight.

1.2 Research Questions

This research intends to answer the following questions

1. What proportion of individuals has estimated nutrient intake below the recommendations as recommended by IOM (Institute of Medicine)?

2. What proportion of individuals is adequately consuming a number of servings from each of the four food groups?

1.3 Significance

The nutritional status of university students is of concern, these young adults are usually characterized for poor dietary habits and may mark the onset of diet-related diseases. One way of assessing the nutritional status is by evaluating the dietary intake. Research into nutritional practices of young adults enrolled in the university has been qualitative in nature and have consistently revealed poor dietary practices

among young adults. However, our study quantitatively estimates the dietary intake of university students. Previous studies have used either 24-hour recall, and food frequency questionnaire (Hanning et al., 2007; Minaker et al., 2006). The literature on dietary intake among young adults is scant and lacks the consensus if dietary intake is in accordance with the dietary guidelines. This study estimates the intake of energy, nutrient and food groups among young adults. The results of this study will provide a better understanding of what are students consuming in terms of dietary guidelines and may contribute to the implementation of effective nutrition interventions to improve their dietary intake.

1.4 Thesis Organization

This thesis is organized into chapters as Chapter two provides a comprehensive literature review unfolding dietary intake of young adults. Chapter three outlines the framework and the methodology used. Chapter four consist of results. Chapter five provides discussion, conclusion, and limitations.

Chapter 2

Literature Review

Adulthood spans the major segment of human life cycle. The Institute of Medicine (IOM) subdivides adulthood into four clusters; early/young adulthood (aged 19-30 years), middle age adulthood (aged 31-50 years), adulthood (aged 51-70 years) and older adulthood (aged>70 years)(Institute of Medicine, 2006, p.15). Young adulthood is a period of transition and often regarded as the most complex and challenging life stage (Arnett, 2007) . With rapid changes and educational engagements, young adults face numerous challenges. Some young adults are more susceptible and likely to develop unhealthy habits placing their health at risk (Gorski & Roberto, 2015). This requires an investigation of nutrition status for the healthy transition of all young men and women.

2.1 Dietary Assessment Methods

According to Gibson (2005), dietary assessment methods are classified as either qualitative or quantitative. Quantitative methods include food recall (typically 24-hour recall) or food record. Qualitative methods obtain information on the dietary pattern, it includes food frequency questionnaire. In the literature the tools used for assessing the university students dietary intake varied depending on the goals of the study. Each of the tool has its own limitation and strengths.

The food frequency questionnaire (FFQ) primarily consist of a finite list of food items and beverages, which aims to collects the information on consumption frequency of those specific food items (Carroll, Pee, Freedman, & Brown, 1997). The FFQ may ask the subject to recall the average amount of particular food item over a relatively long period of time (6 months or over a year)using a close-ended questionnaire, administered either by a trained interviewer or self-reported (Jain, Rohan, Soskolne, & Kreiger, 2003). Studies have reported no possibility of substantial errors (systematic and random) from FFQ (Liu et al., 2013), and the FFQ may require accurate evaluation of developed questionnaire (Shim, Oh, & Kim, 2014). The usual serving size can be asked separately for each of the food item on the FFQ list and nutrient intake information can be collected based on reported frequency and serving size (Bingham et al., 1994).

The 24-hr recall is a quantitative research method, which intends to acquire detailed information about all food items consumed by respondent in the past 24 hours with a structured interview, using open ended questionnaires administered by a trained interviewer (Dietary Assessment Primer, 2015b). For college students, the

24-hr recall has been used, to investigate the snacking or meal patterns and to evaluate the impact on nutrient intake (Dwyer, Evans, Stone, & Feldman, 2001; Soriano, Moltó, & Manes, 2000).

The dietary record is a meal-based method that aims to collect the information of respondent dietary intake over a period using open-ended questionnaires which can be self-administered. Studies report that dietary record or food logs provide an accurate quantitative information on dietary intake but can be time consuming as multiple number of days accurately assess the actual dietary intake (Ortega, Pérez-Rodrigo, & López-Sobaler, 2015; Thompson & Subar, 2013). With food record method, high motivation and enough knowledge of accurately logging food consumption information is laid on the respondent (Shim, Oh, & Kim, 2014). Dietary assessment is a challenging measure, and any single method cannot measure the dietary intake accurately, however, the tools help in assessing the dietary intake or estimating the prevalence of adequacy. Recently, it was suggested that combination of these dietary assessment methods, such as FFQ with 24-hr recall method or food record with 24-hr recall may obtain more accurate information on dietary intake than that of an individual dietary method (Shim, Oh, & Kim, 2014).

2.2 Young Adults and Nutrition Transitions

Young adulthood, which spans around age 18 to 26, is an intermediate period yet a critical period of development. It is a critical period of maturation biologically and psychologically as it concurs with the end of adolescence and marks the beginning of adulthood (Arnett, 2007). This transition has been reported in studies impacting eat-

ing disorders (Nelson et al., 2008; Pendergast, Livingstone, Worsley, & McNaughton, 2016) and poor health outcomes among young adults, especially among university students (Kwan, Faulkner, Arbour-Nicitopoulos, & Cairney, 2013). Studies have shown that diseases such as atherosclerosis, obesity, and diabetes related to dietary intake and physical activity are more recurrently evolving in a second or third span of life (Burke, Beilin, Dunbar, & Kevan, 2004; Leslie, Sparling, & Owen, 2001), therefore, economic burden due to diet-related non-communicable disease (NCDs) cannot be forsaken.

According to Health Canada (2012), the eating pattern of Canadians does not fully meet the Canada′s food guide. It was also reported that approximately 5 of 10 females (age $>$ 19) and 7 of 10 males (age $>$ 19) have energy intakes that exceed their needs, carbohydrate intake that is below the acceptable range and inadequate intake of magnesium, calcium, vitamin A, and vitamin D. According to a Health Survey report, conducted among Germany, Poland and Bulgaria concluded that female students have unhealthy eating habits as compared to adult males and unhealthy eating habits were constantly associated with increased stress and mood conditions among females (Mikolajczyk, El Ansari, & Maxwell, 2009). Improving the dietary habits of young adults is likely to be very important as it does not only influence their physical and mental capabilities but also lowers the health-care cost in long run (Stroud, Walker, Davis, & Irwin 2015).

Dietary choices influence body mass index; previous studies show that consumption of higher meat intake and low fruits and vegetables were associated with higher BMI (Brunt, Rhee, & Zhong, 2008; Togo, Osler, Sørensen, & Heitmann, 2001). Aza-

gba and Sharaf (2012) described intake of fruits and vegetables as an effective strategy to control body weight. With various studies in the literature reporting excess dietary intake among children, adolescent and among elderly, still, young adults remain neglected in area of dietary assessment and intervention studies (Howarth & Street, 2000).

2.3 Nutritional Status of University Students

Šatalić, Colić Barić, and Keser (2007) described that university life has unique characteristics and is reflected on students self-directed eating pattern. According to the study by Deliens et al. (2014), university students are more likely to engage in unhealthy dietary habits and make nutritional errors. The shift in dietary patterns are often an outcome of various challenges faced by university students such as moving away from their family, homesickness, stress factor and finances constraints (Leslie et al., 1999). Poor diet quality which encompasses inadequacy or unbalanced intake of nutrients and food intake is critical to health. According to Mozaffarian (2016), unhealthy dietary habits acquired by students are likely to pose long-term health and financial constraint in long run. Irazusta et al. (2007) concluded that first-year university students in the have poor nutritional habits.

Neslişah and Emine (2011) evaluated the dietary practices of the university students enrolled at five universities in Ankara. It was reported that the intake of fiber, total fat, saturated fatty acid, cholesterol, and sodium intake was very high and vitamin E, vitamin B_6, and folate were found below the recommended values. In study by Neslişah and Emine (2011), dietary inadequacy was evaluated on the basis of the rec-

ommended dietary allowance values (RDA). The usage of RDA is not recommended to assess the adequacy of nutrient intake and the results are prone to misclassification or may underestimate the result (IOM, 2006).

Šatalić et al. (2007) assessed the diet quality and nutrient intake of university students enrolled in Croatian university, using the Quantified Food Frequency Questionnaire (Q-FFQ) and a separate questionnaire provided the consumption frequency of meals. The obtained information on energy and nutrients intakes were compared with the DRIs by IOM. It was reported that the students had an adequate number of meals and snacks. Intakes lower than the recommended values were observed for iron intake and for folate among females, and for vitamin E for both males and females.

In a study by Hoffman (1989), calcium and iron were identified as at risk nutrient among young females. However, this study did not estimate the intake value for other nutrients which are reported in our study. Among Malaysian university students, a cross-sectional study was conducted to examine difference in dietary intake and eating behaviours by sex group. A total of 584 university students (males= 237 and females=347) provided the questionnaire evaluating their eating behaviors and a 24-hour dietary recall. The eating behavior questionnaire assessed the eating frequency of meals, snacks, the frequency of eating outside of the home and collected information on dietary supplements. The 24-hr recall collected information on food and beverages consumed, methods of cooking used and brand names for the processed food items consumed during one weekday and one weekend day. Male students showed a significantly higher energy intake and all nutrients (which included carbohydrates, protein, fat, vitamin A, vitamin C, vitamin B_1, vitamin B_2, vitamin B_3, vitamin C,

sodium, iron, and calcium). However, the percentage of total energy contributed by macronutrient was similar for males and females. Malaysian food composition used in this study, were having raw food items only and lacked the cooked food items, which may affect the accuracy of the estimation of nutrient intake among students (WY & AS, 2011).

Perez-Gallardo et al. (2015) compared the quality of diet of students from Health Sciences (HS, n=37) and students from other disciplines (not HS, n=40) and also estimated the adherence to the Mediterranean dietary pattern. About, in total seventy seven university students (80.3% females) completed a questionnaire for socio-demographic information, the test of Mediterranean Diet Quality Index (KIDMED) and provided the 7-day food record. It was reported that, overall, students followed the diet with high protein and fat and low carbohydrate and fiber intake. However, a high percentage of students from Health Science discipline (51.4%) showed a high adherence to the Mediterranean dietary pattern.

Recently, Frehlich and colleagues (2017) reported that the combination of food groups servings consisting of fruits and vegetables, grain products, milk and alternatives and meat and alternatives contributed toward meeting the DRIs for nutrients. In this study, participants (n=124) were required to provide the 3-day food log, which provided information on intake of saturated fatty acids, omega-6 fatty acid, omega-3 fatty acid, fiber, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_6, vitamin B_9, vitamin B_{12}, vitamin C, vitamin A , vitamin D, vitamin E, calcium, iron, magnesium, potassium, zinc, sodium, cholesterol and water intake. The participants were grouped having met or not meeting the DRIs. It was also reported in this study that, majority

of females did not meet the recommendations for nutrients.

The transition from adolescent to adulthood is challenging for developing dietary habits that may impact health and risk of chronic health problems later in life (Blondin et al., 2016). The sub-optimal diet is among the leading causes of risk factors such as obesity, diabetes, cardiovascular disease, and diet-related cancers (Danaei et al., 2009; Lock, Pomerleau, Causer, Altmann, & McKee, 2005; Mozaffarian, 2016). For example, inadequate intake of calcium along with low vitamin D status impacts the health of bones. Inadequate nutrient intake not only influences the physiological development but also has been studied to have a correlation with cognition abilities (Fu, Cheng, Tu, & Pan, 2007; Smith & Blumenthal, 2010). Fernandes, Arts, Dimond, Hirshberg, and Lofgren, (2013) hypothesized that dietary habits (such as lower diet quality) in college put students at risk on traditional coronary heart diseases risk factors. They found that 33% of the students were overweight, 18% had elevated triacylglycerol (TAG) and 20% had low high-density lipoprotein cholesterol (HDL-C). Irazusta et al. (2007) also emphasized that poor dietary intake was associated with increased risk factors for cardiovascular diseases.

With a review of the literature, we found that there are only a few studies which have quantitatively expressed the dietary intake of university students. Many survey-based studies suggest that there is a need to investigate university students eating habits and knowledge of nutritional requirements. Our study sought to fill the gap in the literature by estimating the intake of energy, nutrients, intake from four food groups and evaluate the adequacy according to recommendations. This will provide a better understanding of dietary intake and will be useful to plan population-based

strategies to university settings and to motivate students to eat healthily.

2.4 Food Groups Intake

According to Statistic Canada (2018), the average consumption of fruits and vegetables among young adults (aged 19-50 years) is 4.7 with 95% CI [4.6, 4.8]. Ekwaru et al. (2017) used Canadian Community Health Survey to assess the inadequacy for consumption of fruits and vegetables and reported the prevalence of inadequacy was among 84.2% of Canadians.

A study conducted by El Ansari et al., (2011) used self-administered food frequency questionnaire. The questionnaire was developed as a general student health survey, which collected general demographic information, food consumption pattern, level of physical activity, restful sleep, tobacco smoking and use of illicit drugs among the university students. To assess the dietary intake, participants recorded the number of servings of fruits and vegetables they consumed each day on a 5-point scale and the frequency of usual consumption of sweets. Results showed that about 17% female and 11% of males consumed fewer than 5 number of servings of fruit and vegetables per day and less proportion of males than females consumed sweets. Among the Chinese young adults (aged 21 years on average), about 36% of female and 34% of male university students consumed two to four servings and 55% female and 41% male ate three and five number of servings of fruit and vegetables per day (Lee & Loke, 2005). Nebeling, Yaroch, Seymour, and Kimmons, (2007) described the pattern of fruit and vegetable consumption among American adults using the data from National Health and Nutrition Examination Survey. Their findings recorded poor

adherence to dietary guidelines were prevalent among young adults.

Brown et al. (2011) demonstrated in their study a lack of adherence to dietary guidelines among the freshmen. About 515 students enrolled in first year of their study, participated in this study. The food frequency questionnaire collected information on usual dietary intake, the intake of food groups and nutrients were compared to the Dietary Guidelines for Americans. Findings showed that average intake (servings/day) of fruits (1.42 $\pm$ 1.00), vegetables (1.5$\pm$ 1.1) , whole grains (1.06 $\pm$ 0.9), and low-fat dairy products (1.86 $\pm$ 1.6) was low and only 38% students consume three or more servings of fruits and vegetables. Furthermore, college students relied heavily on pre-packaged and high caloric convenience-type foods and reported limited time and money as major barriers to eating and cooking healthy meals. About 1-3% of the U.S population (reported data included adult and youth) fulfilled the recommended number of servings from food groups (Dixon, Cronin, & Krebs-Smith, 2001).

A qualitative study by Strawson and associates (2013) was conducted among female Canadian university students (n=36) enrolled in a nutrition course, displayed that most of the students did not meet the recommendations of Canada$'s$ Food Guide (CFG). In the study, food frequency questionnaire was used, focusing on specific food items to determine whether the dietary pattern of university students was similar to that recommendations of CFG or to the Traditional Healthy Mediterranean Diet Pyramid (THMDP). Mediterranean diet quality index scoring was used to measure the adherence to Mediterranean dietary pattern, and no students reported consuming the minimum number of portions of legumes, olive oil and of whole grains. Limitations to this study were that it lacked the data for male students and no socio-demographic

and physiological information for female students was collected to evaluate the data.

Numerous studies have also estimated how the economic burden is impacted by an inadequate intake of fruits and vegetables. It was reported by Krueger et al. (2014) that the economic burden attributable to inadequate consumption of fruit and vegetables is total $ CAN 3.3 billion to annual health-care. Richards, Kattelmann, and Ren (2006) suggested that consumption of an adequate number of food groups servings is an inexpensive intervention minimizing the risk of developing chronic health risk factors. Adequate intake of fruits and vegetables have been reported in numerous studies to be associated with numerous health benefits including lower risk of chronic disease (Rolls, Ello-Martin, & Tohill, 2004).

Chapter 3

Methodology

3.1 Study Population and Data Collection

Subjects reported in this study were the students enrolled in an introductory nutrition course at the University of Manitoba. Data used in this study is derived from self-reported food record. The 3-day and 1-day food record were submitted by students in the Summer 2015 and Summer 2016 as a part of their assignment for the course Nutrition for Health and Changing lifestyles (HNSC 1210) at the University of Manitoba. This introductory nutrition course addresses the relationship between nutrition and health, focusing on healthy eating. The main objective of this assignment was to familiarize the students with the tools to evaluate their dietary intake. We received two data sets, named as dataset I and dataset II, using different food analysis software. Dataset I used 3-day food record and provided the information with student age, height, weight, and sex. Dataset II lacked such information but provided us with information students dietary intake from 1-day using eaTracker. Dataset II

has been covered in a separate section (Appendix E). Dataset I provided information from 3-day food record compatible with Food Focus version 4.1, a nutrition analysis software available at the University of Manitoba. Students were required to record for all food items consumed for three consecutive days (2 weekdays and 1 weekend day). Initially, students were required to complete a short questionnaire. The questionnaire (Appendix B) aimed to collect the age (years), sex, height (m) and weight (kg), smoking at the time of food logging and self-report their level of physical activity by choosing one of the given options (sedentary, low active, active and very active). The software provided the related explanation to each level of physical activity, which helped the students for an appropriate selection. Explanation were as following

Sedentary : Daily living activities such as household task, walking to the bus.

Low Active : Daily living activities with the addition to 30-60 minutes of daily moderate activities such as walking at a rate of one mile in 14 to 19 minutes.

Active : Daily living activities plus at least 60 minutes of moderate activity such as walking at a rate of one mile in 14 to 19 minutes.

Very Active : Daily living activities and 60 minutes of moderate activity plus an additional 60 minutes of vigorous activity or an additional 120 minutes of moderate activity.

Food focus has in total 7278 food items enlisted. Students were given instruction to adequately describe the type of food and beverages (including brand names), quantity of food, and major characteristics (e.g. color: green or yellow beans; white or whole wheat bread, freshness: fresh, frozen, canned or dried, fat content: % fat content

consumed such as 1%, 2% or homo milk or leanness of meat such as extra lean ground beef) consumed. The software helped the user with specific words to make their search results more precise. For home prepared or mixed dishes, food focus allowed the user to enter the amount of each raw ingredient individually (quantities were recorded either by weight, shape or density or by standard unit sizes) and method of cooking was also required such as barbecued, fried or boiled. Food items in a package were reported in package size, example: 15 ml of frozen yogurt. Details about restaurant food, fast food or packaged food items, required the name of the brand such as McDonalds Big Mac or KFC zinger.

Food Focus allows users to add multiple days. Once all food items were entered for the number of days, the software estimates the nutrient content of each food it, yielding information on calorie and core nutrient consumed. For food groups, students were required to desegregate the food items into food groups categories: fruits and vegetables, grain products, milk and alternative, and meat and alternatives. For mixed dishes such as salads, food items were disintegrated into their major ingredients to be classified into each food group.

3.1.1 Inclusion and exclusion criteria

For this study, we have used a convenient sample of 68 students (males=24, females=44) from dataset I. Data were excluded if it failed to provide a complete food record (n=6), were pregnant women (n=1) and aged <19 years (n=8).

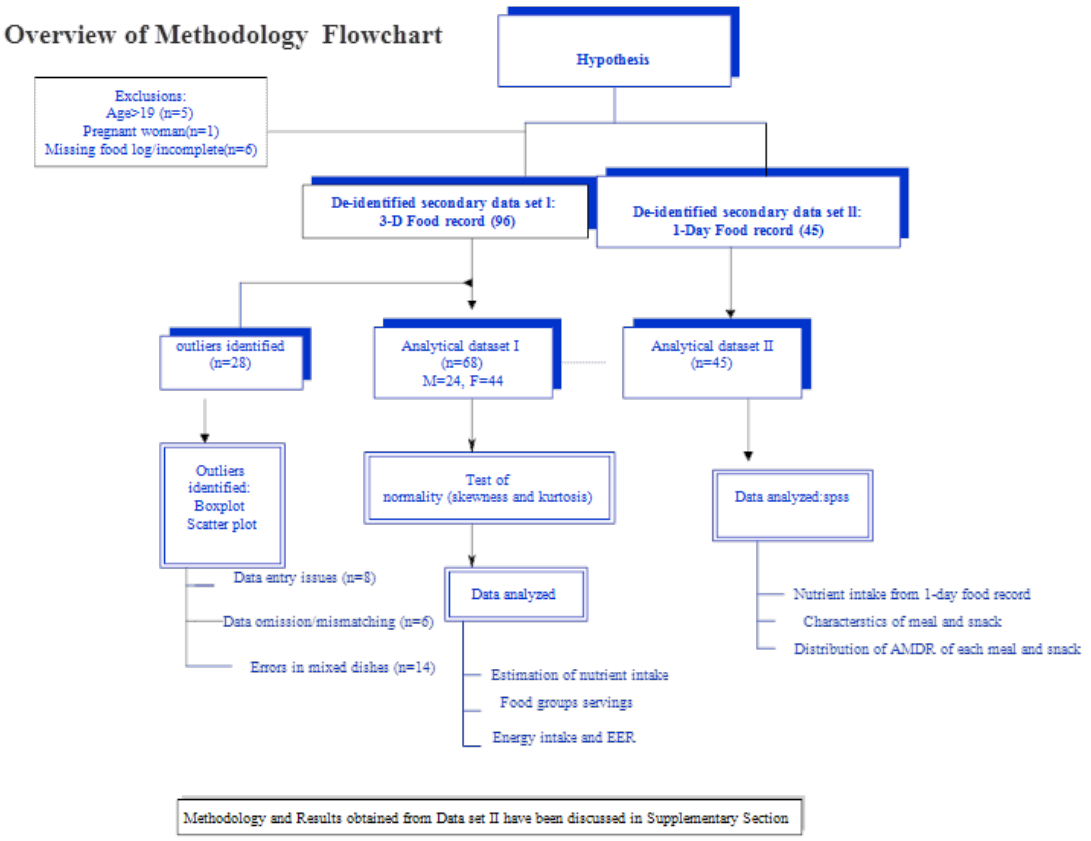


Figure 3.1: Overview of Methodology Flowchart

3.2 Data Mining: Normality test and Missing values

Before our data analysis, careful considerations were made for data quality. Missing data were excluded from data analysis for this study and analysis were done with listwise deletion (Graham, 2009). Listwise deletion excludes the response if data from one of the variables of interest is missing. A combination of tests were used to assess the normality of data sets which include visual inspection using Q-Q plot and boxplot, Kolmogorov-Smirnov normality test (abbreviated as K-S test) and z-test. For

a distribution that is symmetrical and bell-shaped (called as normal distribution), about 99.99% of data values lie within the three standard deviations on each side of the mean.

Kolmogorov-Smirnov normality test was used to test the normality of dataset (n=68). Significance value was denoted with an alpha value ($\propto$) 0.05 (Gissane, 2016; Kim, 2013). We used the assumptions as given below to determine the distribution of data.

Assumption **1**: if $p - value \leq 0.05$,values have a not normal distribution. Assumption 1 fits for variables: saturated fat, PUFA and $vitaminB_2$ (p=0.01); trans $-$fat, total *n-3* PUFA, ALA, EPA + DHA, added sugar, cholesterol, vitamin D, vitamin E, vitamin B_1, vitamin B_{12}, and vitamin C (p <0.001) Table 3.1.

Assumption **2**: if $p - value \geq 0.05$, values have a normal distribution. Assumption 2 fits for variables: carbohydrate, protein, fat, MUFA, total n-6 PUFA, LA and potassium (p=0.20); vitamin A, zinc and water (p=0.17); vitamin B_3 (p=0.05); vitamin B_6, potassium and calcium (p=0.18); vitamin B_9 (p=0.05); sodium (p=0.09) and iron (p=0.08) Table 3.1.

Numerically, the normality of distribution for variables was also tested using skewness and kurtosis values (Kim, 2013). Skewness quantifies the symmetry of the data set used and kurtosis measure the concentration of data around the mean (Shiffler, 1988). Use of these indexes determined how much each of the variable deviates from the normal distribution. We converted the values of skewness and kurtosis to the

absolute z-value using the following equation,

$$[z - value = Skewness/SE(skewness)]$$

$$[z - value = Kurtosis/SE(kurtosis)]$$

In the above equation, the values of skewness and kurtosis and their respective standard error (SE) for the continuous variables were produced by SPSS. Based on the previous studies (Kim, 2013; Shiffler, 1988), it was assumed that if the value for absolute z-value was over 3.29, it corresponded to a not normal distribution. Table 3.2 shows the computed z-values for the nutrients to determine their distribution, it is inferred that saturated fat, PUFA, trans fat, total *n-3* PUFA, ALA *n-3* PUFA, added sugar, and cholesterol exhibit non-normal distribution. Among the vitamins, vitamin D, Vitamin E, Vitamin B_1, Vitamin B_2, Vitamin B_{12} and vitamin C exhibit the non-normal distribution. Hence for the dietary variables with non-normal distribution, a non-parametric test was used for analysis. For datasets with a normal distribution, the parametric test (Independent t-test) was used and for not normal distribution, the non-parametric test (Mann-Whitney U test) was used.

Table 3.1: Kolmogorov-Smirnov and Shapiro-Wilk Test Results

	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistics	p-value	Statistics	p-value
Energy	0.10	0.07	0.96	0.05
Carbohydrate	0.09	0.20	0.95	0.01
Protein	0.09	0.20	0.974	0.161
Fat	0.08	0.20	0.96	0.03
Saturated Fat	0.12	0.01	0.89	0.00
Trans Fat	0.18	0.00	0.81	0.00
MUFA	0.14	0.20	0.94	0.30
PUFA	0.13	0.01	0.91	0.00
Total n-6 PUFA	0.11	0.20	0.98	0.74
LA (n-6 PUFA)	0.10	0.20	0.98	0.74
Total n-3 PUFA	0.28	0.00	0.57	0.00
ALA (n-3 PUFA)	0.29	0.00	0.50	0.00
EPA+DHA	0.37	0.00	0.61	0.00
Total Sugar	0.11	0.06	0.96	0.06
Added sugar	0.20	0.00	0.82	0.00
Cholesterol	0.15	0.00	0.90	0.00
Fiber	0.10	0.07	0.13	0.05
Water	0.10	0.17	0.96	0.04
Vitamin A	0.10	0.17	0.95	0.01
Vitamin D	0.18	0.00	0.84	0.00
Vitamin E	0.15	0.00	0.90	0.00
Vitamin B_1	0.15	0.00	0.84	0.00
Vitamin B_2	0.12	0.01	0.93	0.00
Vitamin B_3	0.11	0.05	0.97	0.13
Vitamin B_6	0.10	0.18	0.98	0.21
Vitamin B_9	0.11	0.05	0.83	0.00
Vitamin B_{12}	0.15	0.00	0.90	0.00
Vitamin C	0.16	0.00	0.92	0.00
Sodium	0.10	0.09	0.95	0.01
Potassium	0.07	0.20	0.96	0.03
Calcium	0.10	0.18	0.95	0.01
Iron	0.10	0.08	0.90	0.00
Zinc	0.10	0.17	0.96	0.04

Table 3.2: Skewness & Kurtosis Test Results

	Skewness	$SE_{skewness}$	z-value	Kurtosis	$SE_{kurtosis}$	z-value
Energy	0.7	0.3	2.36	0.14	0.574	0.24
Carbohydrate	0.94	0.29	3.18	1.81	0.98	1.84
Protein	0.42	0.29	1.44	-0.40	0.57	-0.70
Fat	0.75	0.29	2.57	0.40	0.57	0.69
Saturated Fat	1.67	0.29	5.73	5.39	0.57	9.40
Trans Fat	1.66	0.32	5.25	2.79	0.62	4.48
MUFA	0.83	0.29	2.85	0.49	0.58	0.84
PUFA	1.31	0.29	4.47	2.53	0.58	4.37
Total n-6 PUFA	0.02	0.44	0.04	-0.47	0.86	-0.54
LA (n-6 PUFA)	0.04	0.42	0.09	-0.57	0.82	-0.69
Total n-3 PUFA	3.85	0.44	8.72	17.37	0.86	20.24
ALA (n-3 PUFA)	4.43	0.42	10.53	22.18	0.82	27.01
EPA+DHA	2.15	0.43	4.96	4.39	0.85	5.19
Total Sugar	0.70	0.31	2.23	0.40	0.62	0.64
Added sugar	1.81	0.31	5.77	3.61	0.62	5.84
Cholesterol	1.47	0.29	5.06	3.13	0.57	5.45
Fiber	0.59	0.29	2.02	0.10	0.58	0.16
Water	0.75	0.295	2.54	0.849	0.582	1.46
Vitamin A	0.78	0.29	2.66	0.30	0.57	0.51
Vitamin D	1.45	0.29	4.97	1.50	0.58	2.58
Vitamin E	1.06	0.29	3.64	0.51	0.57	0.88
Vitamin B_1	1.76	0.29	6.03	3.83	0.57	6.66
Vitamin B_2	1.05	0.29	3.61	1.90	0.57	3.30
Vitamin B_3	0.60	0.29	2.06	0.43	0.57	0.75
Vitamin B_6	0.31	0.29	1.08	-0.32	0.57	-0.55
Vitamin B_9	0.80	0.29	2.72	1.09	0.58	1.88
Vitamin B_{12}	1.12	0.29	3.86	0.78	0.57	1.37
Vitamin C	1.06	0.29	3.64	1.06	0.57	1.85
Sodium	0.94	0.29	3.22	1.03	0.57	1.79
Potassium	0.66	0.29	2.23	0.32	0.58	0.54
Calcium	0.87	0.29	3.00	1.44	0.58	2.48
Iron	1.01	0.39	2.56	1.46	0.58	2.51
Zinc	0.67	0.30	2.28	0.41	0.58	0.71

SE: Standard error
p-value ≤ 0.05, test is significant
z-value (absolute) = Skew or kurtosis value / $SE_{skewness}$ or $SE_{kurtosis}$

3.3 Study Variables

For this study, dietary variables were an outcome of interest according to objectives

3.3.1 Dependent variables for objective 1

[Macronutrients]: Carbohydrate, protein, fat, fiber, and water.

[Micronutrients]: Vitamin A, D, E, B_1, B_2, B_3, B_6, B_9, B_{12}, and C.

[Elements]: Sodium, potassium, calcium, iron, and zinc.

3.3.2 Dependent variables for objective 2

[Four food groups]: fruits and vegetables, grain products, milk and alternatives, and meat and alternatives.

3.3.3 Dependent variables for objective 3

Estimated Energy Intake (EI) and Estimated Energy Requirement (EER)

3.4 Outliers Labeling Method: Boxplot Method

According to Hawkins (1980), outliers are defined as those data points that deviates so much from other observations as to arouse suspicions that it was generated by a different mechanism (Hawkins, 1980). Boxplot and scatter plot were also used to identify the outlying case number (Frank-Spohrer & Frank, 1996). We grouped the extreme cases into three categories based on the type of an error as data entry issues (i.e., the disparity in amounts recorded), data mismatching (i.e., mismatched

food items or food item missing), mixed dishes (i.e., salt was recorded as a major ingredient). Hence, if any value of the nutrient was truly indicative of erroneous data entry or potential outliers, they were removed from the further investigation (IOM, 2015a).

3.5 Data Analysis

Health Canada and the National Academy of Institute of Medicine (IOM) provide nutrient reference values called the Dietary Reference Intakes (DRIs). The DRIs are defined as a compilation of nutrient reference standards by sex and age. As suggested by other studies, estimated intake of the nutrients can be used to evaluate the adequacy relative to population-based recommendations (Trumbo, Barr, Murphy, & Yates 2013). Therefore, to assess the adequacy of nutrient intake, the reference intake values were used as cut-point to determine what proportion of individuals were meeting the recommendations.

3.6 Dietary Reference Intake (DRI) and the Cut-point Method

The dietary requirement of macronutrients, micronutrients or elements is defined as the intake level which meets a specified criteria for adequacy, thereby minimizing the risk of nutrient deficiency or excess. The DRIs are established standard values stratified by age and sex used to determine the adequacy of nutrients intake of a group or individuals in a group (IOM, 2006). Six reference values which are used in

dietary assessment, include the Estimated Average Requirement (EAR), Adequate Intake (AI) (which is used for nutrients without EAR), the Recommended Dietary Allowance (RDA), the Tolerable Upper Level Intake (UL), the Acceptable Macronutrients Distribution Range (AMDR), and the Estimated Energy Requirement (EER). We have used appropriate DRIs for each nutrient (stratified by sex) to evaluate nutrient adequacy by applying the Cut-point method (Health Canada, 2010). In this study we have used the EAR value for carbohydrates, protein, vitamin A, vitamin D, vitamin E, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_6 , vitamin B_9, vitamin B_{12}, vitamin C, calcium, iron, and zinc. The AI value was used for fiber, water, and potassium. The UL value was used for sodium (Health Canada, 2003). The AMDR values were used for carbohydrate, protein, total fat, saturated fat, LA and ALA (IOM, 2005a).

3.6.1 Applying the Estimated Average Requirement (EAR) for the Cut-point method

The EAR is average daily intake level that is estimated to meet the nutrient requirements of 50% of healthy individuals in a specific age and sex group (IOM, 2006, p.102). In this study, once the average value of a nutrient was obtained from 3-day food log, the EAR value was used as a cut off value. The proportion of individuals (stratified by sex) having intake above and below the EAR cut off value were estimated to assess the prevalence of adequacy. The proportion of individuals below the EAR reflect that the number of individuals with an inadequate intake of the specific nutrient. The proportion of individuals consuming nutrient at or higher than the

EAR value, reflect adequate intake (Barr, Murphy,&Poss, 2002).

3.6.2 Applying the Adequate Intake (AI) value for the Cut-point method

The IOM sets the AI values when the evidence is insufficient to determine the EAR for a nutrient(IOM, 2005b). The AI is defined as a recommended average daily nutrient intake level based on observed or experimentally determined approximation or estimates of nutrient intake by a group of apparently healthy people that are assumed to be adequate (IOM, 2005a; IOM, 2005b). Adequate intake was used to compare with an estimated intake of fiber, water, and potassium.

3.6.3 Applying the Tolerable Upper Intake Level (UL) for the Cut-point method

The Tolerable Upper Intake (UL) is the highest daily intake level, with a daily intake of nutrient above the UL may cause a potential risk of developing adverse health effects (IOM, 1998a). If the intake is estimated to be above the UL, the possible risk of adverse effects rises (Trumbo et al., 2013). According to Barr (2010), a large majority of the Canadian population in all age and sex group exceed the UL for sodium in their diet and processed foods have been estimated to contribute about 75% of sodium intake. Other research findings have also reported a high prevalence of excess intake of sodium among adults, aged 18-69 years (Alkerwi, Crichton, & Hébert, 2015). Therefore, we aimed to estimate the intake of sodium intake among university by using UL as a cut off value.

3.6.4 Acceptable Macronutrient Distribution Range

The Acceptable macronutrient distribution range (AMDR) value endorse specific range of intake for macronutrients. The recommended range minimizes the risk of a chronic disease while providing the adequate intake of nutrients (Institute of Medicine, 2005a). Table 3.3 shows the established recommended distribution range for macronutrients. The percentage intake of calories from carbohydrate, protein, and lipid were calculated using the *Atwater coefficients*, which are 4, 4, and 9 respectively (1gram of carbohydrate = 4 kcal; 1gram of protein= 4kcal; 1 gram of lipid= 9kcal). Intake of energy above the upper end of recommendation range may increase the incidence of chronic diseases while consuming below the lower end of range increases the risk of inadequate macronutrients intake (Thompson & Subar, 2013). According to the literature, AMDRs for fiber and MUFA have not been set due to a limited set of evidence on adverse effects of over-consumption of these nutrients (Strik et al., 2010).

Table 3.3: Acceptable Macronutrients Distribution Range

Macronutrients	AMDR range distribution[1]
Carbohydrate	45-65%
Protein	10-35%
Fat	30-40%
n-6 PUFA (linoleic acid)	5-10%
n-3 PUFA (-linolenic acid)	0.6-1.21%
Added Sugar	<25% of total calories

[1]Source for AMDR values: Summary Tables, Dietary Reference Intakes. Institute of Medicine. 2006, p. 537

3.7 Evaluating the Intake from Food Groups in accordance with the CFG

The 3-day food log elicits the desired amount of details on food description and quantities. For this study, students were encouraged to use common household utensils to quantify the serving sizes when comparing the intake with Canadas Food Guide (CFG). Amounts of each food item were reported in commonly used domestic measurements such as in cups and in a tablespoon, dimensional units, or weight, as appropriate to the food item consumed. During this all process, students were guided and assisted with the estimation of number of servings from each of the four food groups using CFG. Therefore, it was assumed that students reporting the quantity of food consumed over three days was recorded truthfully and represent their daily diet. Estimated number of servings for each food groups were recorded as a number or a fraction, such as 0.5, 1, or 1.5. To evaluate the adequacy of intake, the estimated number of servings of each of the four food groups were compared with age and sex-specific recommended by CFG. The prevalence of adequate intake was identified by determining the proportion of individuals with an average number of servings intake that falls at or above the recommended number of servings.

3.7.1 Estimation of numbers of servings for fruits and vegetables

Fruits and vegetables number of servings were estimated based on guidelines by CFG (Health Canada, 2011,Appendix D). One food guide serving for fruits and veg-

etables shall be equivalent to 125ml (1/2 cup) for fresh, frozen, or canned vegetables, 250 ml (1 cup) for leafy vegetables and 125ml (1/2 cup) for juices (Health Canada, 2011). The CFG recommends that an adult male shall consume 8-10 amount of servings per day and an adult female 7-8 serving per day.

3.7.2 Estimation of numbers of servings for grain products

According to CFG, grain products are classified into subgroups of whole grain, non-whole grain enriched and non-whole grain not enriched products. One food guide serving for grain products is equal to one slice of whole wheat bread (35g), half a slice of pita flat bread (35 grams), half a bagel (45gram) or half a cup cooked rice or pasta (125 ml)(Appendix D, p. 102-103). For an adult males and females, the recommendations for grain products are 7 and 6 servings per day respectively (Health Canada, 2011).

3.7.3 Estimation of numbers of servings for milk and alternatives

According to CFG, meat and alternatives include subcategories of organ meat, poultry, processed meat, fish, shellfish, legumes, nuts, and seeds. For meat, a serving size is estimated s 75g intake of meat, fish, shellfish. For alternatives, two eggs, 60 ml (1/4 cup) of nuts or seeds, 30ml (2 tbsp.) of peanut butter or nut butter are equivalent to one serving of food guide for meat and alternatives (Health Canada, 2011).

3.7.4 Mixed Dishes

Mixed dishes contain foods from more than one food group such as snacks, restaurant meals, and on-the-go meals may contain food items from fruits and vegetables or food group milk and alternatives. To estimate the number of servings of four food group, students were required to enlist the main ingredients (Table 3.4). The ingredients for the mixed dish were labeled into four of the food groups and quantified to estimate the number of servings from each of the food group according to the Canada′s Food Guidelines (Health Canada, 2011) by the student as a part of the assignment.

Table 3.4: Counting food group number of servings in a mixed dish

(Mix vegetables with boiled rice, stir-fried shrimps and tomato paste)	
Ingredients	Number of servings from food groups
1 cup of mix leafy vegetables	1 - vegetables and fruit food group
$\frac{1}{2}$ cup rice, boiled	1 - grain products
150 g (1 cup) of shrimp	2 - meat and alternatives
2 tablespoon (30ml) tomato paste	$\sim$ 1/4 - vegetable and fruit food group

3.8 Estimating Energy Intake and calculating Estimated Energy Requirement

Energy Intake (EI) estimated in this study, was calculated by taking average of three days energy intake. To calculate the EER, we used the equation 3.1 and equation 3.2 as mentioned below, considering age, sex, height, weight and physical activity coefficient (IOM, 2005a). Average EI was compared to EER, to evaluate the energy balance. It is stated that if energy intake is equivalent to the EER, energy

balance is established. Individuals with energy intake higher than their corresponding EER are assumed to be at risk of energy imbalance (IOM, 2006, p. 83).

Estimated Energy Requirement for Men

Equation A

$$EER = 662 - (9.53 * age\,[y]) + PA\,(*)\,(15.91 * weight\,[kg]) + (539.6 * height\,[m])) \tag{3.1}$$

Where PA= Physical activity coefficient, values are shown below :

PA = 1.0 if PAL is estimated to be: $\geq 1.0 < 1.4$ (sedentary)

PA = 1.11 if PAL is estimated to be: $\geq 1.4 < 1.6$ (low active)

PA = 1.25 if PAL is estimated to be: $\geq 1.6 < 1.9$ (active)

PA = 1.48 if PAL is estimated to be: $> 1.9 < 2.5$ (very active)

Estimated Energy Requirement for Women

Equation B

$$EER = 354 - (6.91 * age\,[y]) + PA * ()\,(9.36 * weight\,[kg]) + (726 * height\,[m])) \tag{3.2}$$

Where PA= Physical activity coefficient, values are shown below :

PA = 1.0 if PAL is estimated to be: $\geq 1.0 < 1.4$ (sedentary)

PA = 1.12 if PAL is estimated to be: $\geq 1.4 < 1.6$ (low active)

PA = 1.27 if PAL is estimated to be: $\geq 1.6 < 1.9$ (active)

PA = 1.45 if PAL is estimated to be: $> 1.9 < 2.5$ (very active)

It is assumed that if energy intake is equivalent to the EER, energy balance is established. Individuals with energy intake higher than their corresponding EER are assumed to be at risk of energy imbalance.

3.9 Statistical analysis

3.9.1 Dependent and Independent variables

The independent variables in this study were categorical: sex group (males and females). Dependent variables for this study were continuous variables, which included energy, nutrients, and four food groups. The nutrients are carbohydrate, protein, total fat, saturated fat, trans fat, Polyunsaturated fatty acid (PUFA), Monounsaturated fatty acid (MUFA), Linoleic acid (LA) , Alpha-linolenic acid (ALA) , Eicosapentaenoic acid (EPA)+ Docosahexaenoic acid (DHA), cholesterol, fiber, water, vitamin A, vitamin D, vitamin E, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_6, vitamin B_9, vitamin B_{12}, vitamin C, sodium, potassium, calcium, iron, zinc. For this study, we have compared mean by sex group for total sugar and added sugar as well. Food groups include fruits and vegetables, grain products, milk and alternatives, and meat and alternatives.

3.9.2 Descriptive statistics

Nutrient and food groups intake, were descriptively analyzed. Continuous variables were presented as mean (and standard error), median with interquartile ranges (IQR) whereas, categorical variables were expressed as frequency (%). The independent t-test and Mann-Whitney test were used to compare the mean intake by sex group. For a dependent sample, paired t-test was used, to compare the energy intake (EI) with EER by sex group. The Chi-square test was used to examine the differences in categorical demographics between groups which included: age groups, BMI, and cigarette smoking status. All p-values were reported as two-tailed, with p <0.05 was considered as significant. Descriptive analysis was conducted using Statistical Package for the Social Sciences (SPSS) version 24.0 for Windows (IBM Corporation,2016).

3.10 Ethics Considerations

Ethics was taken into consideration. Hence, this study was conducted under the anonymized category. All identifying information was removed by the third party at St Boniface Research Center, Office of Clinical Research.

Chapter 4

Results

4.1 Demographic Characteristics

Table 4.1 shows the baseline characteristics. Values are given as mean with standard error for continuous variables and as a percentage for categorical variables. Overall, the total number of students was 68 (n= 24 males, n=44 females), with a mean age of 23.7 years (SE= 0.7) and BMI 23.1 kg/m^2 (SE=0.5) which fall in a normal healthy BMI range. About 15% of students were underweight; 57% normal weight; 21% overweight and 7% were obese. On average, males were more likely to cigarette smoke (p<0.01). Females were on average had a lower height (p<0.01) and lower body weight (p<0.01)than males.

Table 4.1: Demographic Characteristics

Participants	All (n=68)	Male (n=24)	Female (n=44)	p-value*
Age, (y)	23.7(0.7)	21.8(0.4)	24.8(1.1)	0.42
Age *range*[b]				**0.01**
19-30	59(87%)	24(35%)	35(52%)	
31-50	9(13%)	■	9(13%)	
Anthropometrics [a]				
Height, (m)	1.7(0.01)	1.7(0.01)	1.6(0.01)	**<0.01**
Weight, (kg)	65.1(1.6)	70.8(2.0)	62.0(2.0)	**<0.01**
BMI, (kg/m^2)	23.1(0.5)	23.3(0.7)	22.9(0.7)	0.39
Body Mass Index, (kg/m^2)[b]				0.39
Underweight (<18.5)	10(15%)	2(18%)	8(82%)	
Normal weight (18.5-24.9)	39(57%)	14(36%)	25(64%)	
Overweight (25-29.9)	14(21%)	7(50%)	7(50%)	
Obese ($\geq$ 30)	5(7%)	1(20%)	4(80%)	
Cigarette Smoking (yes) [b]	6(9%)	5(21%)	1(2%)	
Cost of meal per day, ($)[c]	7.9(0.4)	9.8(0.6)	6.9(0.5)	

[a,c] Values presented as Mean(SE)

[b] Values presented as n (percentage %)

* p-value <0.05 difference by sex group

4.2 Estimated Intake of Energy and Nutrients

The estimated intake of energy and macronutrients is shown in Table 4.2. On average students consumed 1763.0 kcal/day (SE=62.5) of energy, 233.8 g/d(SE=9.1) carbohydrate, 1.3g/kg/d (SE =0.1) protein and 57.5g/d(SE=2.9) fat. Higher intake of protein and fat was recorded for males when compared with females (p=0.036, 0.006 respectively). Average intake of Monounsaturated fatty acid (MUFA) was estimated as major source of dietary fat (M=22.5g, SE= 1.3), and when compared by sex groups, males were dominant consumer of MUFA in their daily diet than females (p=0.002). Overall, average Polyunsaturated fatty acid (PUFA) intake was 12.8 g/d (SE= 0.9), with considerably more (n-6) PUFA (M=8.3g/d, SE= 0.6) than (n-3) PUFA (M= 1.7g/d, SE= 0.3). Intake of fiber was significantly higher among females (p= 0.014). Total sugar contributed 16% of the total energy, and when compared by sex group females were high consumers of total sugar (p= 0.089, Table 4.3). Average cholesterol intake was significantly higher among males (p=0.036).

Average Intake of fat-soluble vitamins varied by sex group (Table 4.4). Among male students median intake of vitamin A, vitamin D, and vitamin E was 421.7 μg/day, 154.1 IU/day, 4.9 mg/day respectively. Median intake of vitamin A, vitamin D, and vitamin E was 648.7μg/day, 166.2 IU/day and 6.0 mg/day respectively. Mean intake of sodium was significantly higher among males than females, with a mean of 3314.2 g/d (p<0.001, Table 4.5. Macronutrients intakes, as a percentage of daily energy, for males was (21% protein, 47% carbohydrate, 31% fat) and females (18% protein, 7% carbohydrate and 27% fat) were within the recommended ranges Table 4.6. Of total energy from fat intake (29%), 8.7% energy was contributed by saturated and 0.15%

from EPA and DHA.

Figure 4.1 shows the overall distribution of energy intake from macronutrients. Majority of students were withing the acceptable range for protein and 71% for fat and carbohydrate. Overall, 19% of students had an intake of energy below the lower end of AMDR for carbohydrate and 16% had energy intake above the upper end of AMDR distribution for total fat.

Table 4.7 describes the prevalence of adequacy for nutrient intake. For carbohydrate, 5% of male students did not meet the EAR. About 7% of females did not meet the average requirement for protein intake. Inadequate intake among males and females were estimated for vitamin A as (67 and 25%), vitamin D (92 and 82%), vitamin E (96 and 84%), vitamin B_1 (29 and 7%), vitamin B_2 (21 and 10%), vitamin B_6 (21 and 12%), vitamin B_9 (54 and 41%), vitamin B_12 (8 and 16%), vitamin C (46 and 9%), calcium (54 and 45%) and zinc (55 and 25%). For nutrients without an EAR, mean intake was compared to the recommended Adequate Intake (AI). Mean intake for fiber, potassium, and water intake were below the AI for above 50% of males and females. Excessive intake of sodium was estimated, for about 79% males and 36% females exceeded the Tolerable Upper Intake Level (UL) of sodium.

Table 4.2: Estimated Intake of Energy, Macronutrients, Water, and Fiber

	Sex	Mean (S.E)	95%CI	Median(IQR)	p-value[a]
Energy Intake (kcal/day)	All	1789.0(62.5)	(1664.2, 1913.8)	1682.0(734.3)	0.012
	Male	1990.1(109.0)	(1764.5, 2215.9)	1982.0(770.0)	
	Female	1679.4(71.8)	(1534.6 , 1824.1)	1640.8(542.6)	
Carbohydrate (g/day)	All	233.8(9.1)	(215.7 , 252.0)	227.9(93.6)	0.998
	Male	233.8(16.6)	(199.4 , 268.3)	229.9(116.6)	
	Female	233.9(10.9)	(211.9 , 255.9)	227.9(87.8)	
Protein (g/kg/day)	All	1.3(0.1)	(1.2 , 1.4)	1.2(0.7)	0.036
	Male	1.5(0.1)	(1.3 , 1.6)	1.5(0.6)	
	Female	1.2(0.1)	(1.1 , 1.4)	1.2(0.7)	
Fat (g/day)	All	57.5(2.9)	(51.7, 63.2)	54.8(33.6)	0.006
	Male	68.0(5.1)	(57.5, 78.4)	64.2(30.5)	
	Female	51.7(3.2)	(45.3, 58.2)	48.3(28.1)	
Saturated Fat (g/day)	All	17.3(1.0)	(15.3, 19.4)	16.2(9.3)	0.001**
	Male	21.6(2.0)	(17.5 , 25.7)	18.6(6.9)	
	Female	15.0(1.0)	(12.9 , 17.1)	13.9(8.5)	
Trans fat (g/day)	All	0.5(0.1)	(0.4 , 0.7)	0.4(0.7)	0.195**
	Male	0.6(0.1)	(0.4 , 0.7)	0.6(0.7)	
	Female	0.5(0.1)	(0.3 , 0.8)	0.3(0.6)	
MUFA (g/day)	All	22.5(1.3)	(20.0 , 25.1)	20.1(11.0)	0.002
	Male	27.7(2.0)	(23.5 , 31.9)	24.7(15.8)	
	Female	19.7(1.5)	(16.6 , 22.7)	19.4(10.7)	
Total PUFA (g/day)	All	12.8(0.9)	(11.1 , 14.5)	11.1(8.6)	0.015**
	Male	16.0(1.7)	(12.5 , 19.5)	13.3(11.4)	
	Female	11.1(0.8)	(9.4 , 12.8)	10.5(7.5)	
Water (L/day)	All	1.9(0.1)	(1.6 , 2.1)	1.7(1.4)	0.332
	Male	1.7(0.2)	(1.3 , 2.1)	1.5(1.0)	
	Female	1.9(0.1)	(1.6 , 2.2)	2.1(1.3)	
Fiber (g/day)	All	18.8(0.9)	(16.8 , 20.8)	16.9(9.3)	0.014
	Male	15.6(1.4)	(12.7 , 18.5)	15.3(7.8)	
	Female	20.1(1.1)	(17.9 , 22.2)	19.4(11.1)	

Abbreviation: IQR: Interquartile range; MUFA: Mono Unsaturated Fatty acid; PUFA : Polyunsaturated Fatty acid, CI: Confidence Interval

a. p-value <0.05 , males vs females

** Mann-Whitney U test

Table 4.3: Estimated Intake of PUFA, Total Sugar, Added Sugar, and Cholesterol

	Sex	Mean (S.E)	95%CI	Median(IQR)	p-value[a]
Total n-6 PUFA (g/day)	All	8.3(0.6)	(7.1,9.6)	8.7(5.6)	0.464
	Male	9.1(1.0)	(6.7,11.6)	8.9(2.6)	
	Female	8.1(0.8)	(6.5,9.7)	8.6(6.0)	
LA (n-6 PUFA) (g/day)	All	8.1(0.6)	(6.8,9.4)	8.3(5.5)	0.249
	Male	9.3(1.0)	(7.0,11.6)	9.0(5.0)	
	Female	7.7(0.8)	(6.0,9.3)	8.3(5.5)	
Total n-3 PUFA (g/day)	All	1.7(0.3)	(1.0,2.5)	1.2(1.4)	0.823**
	Male	1.5(0.3)	(0.9,2.1)	1.4(1.2)	
	Female	1.8(0.5)	(0.8,2.8)	1.1(1.4)	
ALA (n-3 PUFA) (g/day)	All	1.4(0.3)	(0.8,2.1)	0.9(0.8)	0.983**
	Male	1.2(0.2)	(0.6,1.7)	0.9(0.7)	
	Female	1.5(0.4)	(0.6,2.4)	1.0(0.9)	
EPA+DHA (g/day)	All	0.3(0.1)	(0.1,0.5)	0.1(0.2)	0.549**
	Male	0.2(0.1)	(0,0.6)	0.0(0.6)	
	Female	0.3(0.1)	(0.1,0.5)	0.1(0.2)	
Total sugar (g/day)	All	72.6(4.3)	(64.0,81.2)	66.5(41.8)	0.089
	Male	63.6(6.4)	(50.4,76.9)	58.3(35.7)	
	Female	78.5(5.5)	(67.2,89.8)	71.7(36.6)	
Added sugar (g/day)	All	30.8(3.4)	(24.0,37.5)	23.8(22.7)	0.773**
	Male	30.8(6.1)	(18.1,43.6)	24.1(25.4)	
	Female	30.7(4.0)	(22.7,38.7)	23.7(22.7)	
Cholesterol (mg/day)	All	303.3(20.1)	(263.1,343.5)	267.6(203.6)	0.036**
	Male	356.4(38.3)	(277.2,435.6)	283.2(176.1)	
	Female	274.3(22.2)	(229.5,319.1)	239.0(186.2)	

Abbreviation: IQR: Interquartile range; MUFA: Mono Unsaturated Fatty acid; PUFA : Polyunsaturated Fatty acid, CI: Confidence Interval

*. Independent t-test

a. p-value <0.05 , males vs females

** Mann-Whitney U test

Table 4.4: Estimated Intake of Vitamins

Vitamins	Sex	Mean (S.E)	95%CI	Median(IQR)	p-value[a]
Vitamin A (μg/day)	All	676.6(45.4)	(585.8 , 767.4)	600.8(442.9)	0.004
	Male	494.9(68.1)	(354.0 , 635.8)	421.7(509.4)	
	Female	762.1(53.6)	(653.9 , 870.3)	648.7(474.8)	
Vitamin D (IU/day)	All	199.7(19.7)	(160.3 , 239.2)	154.1(168.7)	0.028 **
	Male	150.4(26.1)	(96.5 , 204.4)	104.2(125.9)	
	Female	238.0(28.1)	(181.4 , 294.6)	166.2(206.2)	
Vitamin E (mg/day)	All	7.0(0.5)	(6.1 , 8.0)	5.6(4.7)	0.290**
	Male	6.3(0.7)	(4.8 , 7.7)	4.9(5.0)	
	Female	7.5(0.7)	(6.1 , 8.8)	6.0(5.8)	
Vitamin B_1 (mg/day)	All	1.5(0.1)	(1.3 , 1.7)	1.3(0.8)	0.608**
	Male	1.6(0.2)	(1.3 , 2.0)	1.4(1.2)	
	Female	1.5(0.1)	(1.2 , 1.7)	1.3(0.7)	
Vitamin B_2 (mg/day)	All	1.8(0.1)	(1.6 , 2.0)	1.7(1.0)	0.646
	Male	1.8(0.2)	(1.5 , 2.2)	1.9(1.1)	
	Female	1.7(0.1)	(1.5 , 2.0)	1.6(0.8)	
Vitamin B_3 (mg/day)	All	34.5(1.8)	(30.8 , 38.2)	31.4(19.6)	<0.001**
	Male	42.4(2.5)	(37.2 , 47.6)	42.8(19.5)	
	Female	30.2(2.3)	(25.6 , 34.7)	27.8(17.4)	
Vitamin B_6 (mg/day)	All	1.6(0.1)	(1.5 , 1.8)	1.5(0.8)	0.092
	Male	1.8(0.2)	(1.5 , 2.1)	1.8(1.4)	
	Female	1.5(0.1)	(1.4 , 1.7)	1.4(0.5)	
Vitamin B_9 (μg/day)	All	367.2(20.3)	(326.7 , 407.7)	326.3(180.2)	0.082
	Male	318.5(28.4)	(259.6 , 377.3)	304.9(152.0)	
	Female	392.2(26.6)	(338.5 , 445.9)	361.1(194.5)	
Vitamin B_{12} (μg/day)	All	4.0(0.3)	(3.5 , 4.5)	3.3(2.8)	0.074**
	Male	4.6(0.5)	(3.6 , 5.6)	3.9(2.9)	
	Female	3.7(0.3)	(3.1 , 4.3)	3.0(2.4)	
Vitamin C (mg/day)	All	130.9(10.7)	(109.6 , 152.2)	111.7(121.2)	0.003**
	Male	89.1(15.1)	(57.9 , 120.4)	92.7(88.5)	
	Female	153.6(13.2)	(127.0 , 180.2)	126.5(132.1)	

Abbreviation: vitamin A: Rational, vitamin D :25-Hydroxy Vitamin D, vitamin B_1: Thiamin, vitamin B_2 : Riboflavin, vitamin B_3 : Niacin, vitamin B_6 : Pyridoxine, vitamin B_9 : Folic acid, vitamin B_{12} : Cyanocobalamin

a. p-value<0.05 , males vs females

** Mann-Whitney U test

Table 4.5: Estimated Intake of Elements

Elements	Sex	Mean (S.E)	95%CI	Median(IQR)	p-value[a]
Sodium (mg/day)	All	2514.5(148.1)	(2218.9,2810.1)	2266.6(1629.2)	<0.001
	Male	3314.2(282.0)	(2730.9,3897.5)	3190.1(1959.0)	
	Female	2101.0(130.7)	(1837.4,2364.6)	1957.0(1160.0)	
Potassium (mg/day)	All	2716.7(105.0)	(2507.1,2926.4)	2719.7(1167.0)	0.242
	Male	2549.3(181.3)	(2174.3,2924.3)	2517.8(1351.4)	
	Female	2808.1(128.2)	(2549.6,3066.6)	2739.1(945.9)	
Calcium (mg/day)	All	839.7(45.0)	(749.9,929.5)	805.2(427.9)	0.298
	Male	775.9(80.2)	(609.9,941.8)	738.6(652.1)	
	Female	881.3(54.7)	(770.9,991.6)	824.9(441.5)	
Iron (mg/day)	All	13.2(0.6)	(12.0,14.5)	12.2(6.2)	0.383**
	Male	13.8(1.0)	(11.7,16.0)	11.9(5.5)	
	Female	12.9(0.8)	(11.3,14.4)	12.6(6.6)	
Zinc (mg/day)	All	8.7(0.4)	(7.9,9.6)	8.3(4.5)	0.781
	Male	8.9(0.7)	(7.4,10.4)	8.9(4.7)	
	Female	8.6(0.5)	(7.6,9.7)	8.1(3.5)	

a. p-value <0.05 , males vs females
** Mann-Whitney U test

Table 4.6: Mean Percentage (%) of Energy Intake for Males and Female for each Macronutrient

Macronutrient	AMDR Recommendation	Male	Female
Fat	20-35%	31	27
n-6 Poly unsaturated acids (linoleic acid)	5-10%	4	4
n-3 Poly unsaturated acids (alpha-linolenic acid)	0.6-1.2%	1	1
Carbohydrate	45-65%	47	55
Protein	10-35%	21	18
Added Sugar	<25%	6	7

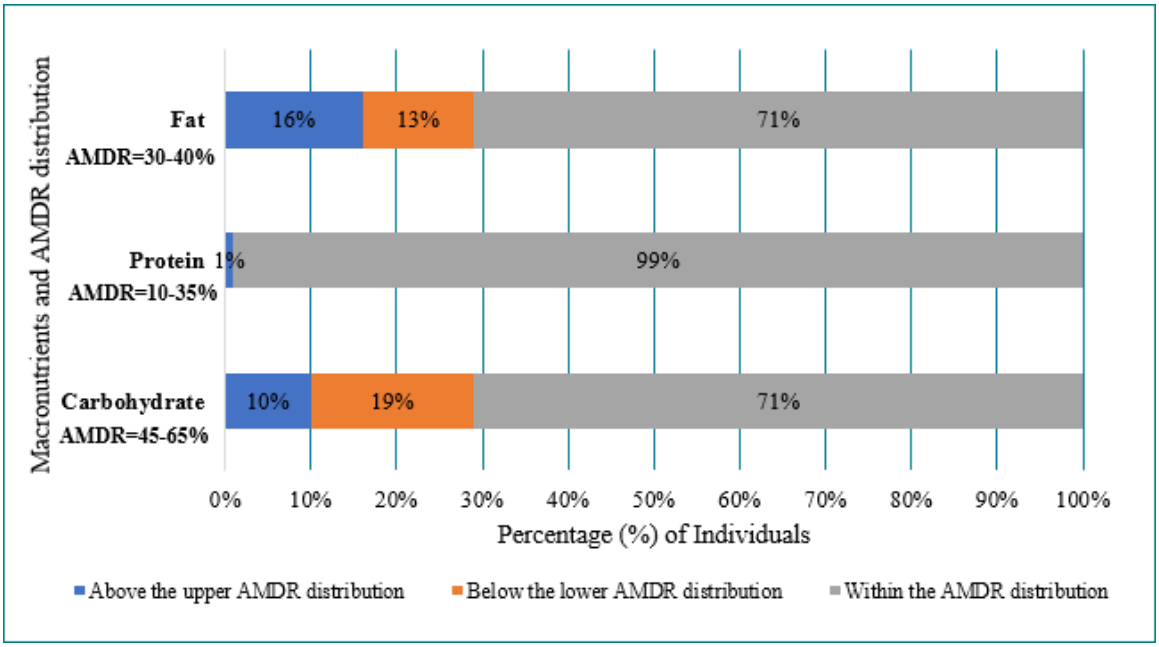


Figure 4.1: Percentage of Individuals within, below and above the AMDR distribution for Carbohydrates, Protein and Fat

Table 4.7: Estimating the adequacy using the Cut-point method

Macronutrients	Unit	Sex	DRI[a]	Cutoff-point	Prevalence (%) at/above
Carbohydrate	g/day	Male	EAR[b] = 100 g/d	0.95	95
		Female	EAR= 100 g/d	1.00	100
Protein	g/kg/d	Male	EAR= 0.66 g/kg/d	1.00	100
		Female	EAR= 0.66 g/kg/d	0.93	93
Fiber	g/day	Male	AI [c] = 38 g/d	0.04	4
		Female	AI= 25 g/d	0.27	27
Water	L/day	Male	AI= 3.7 L/d	0.04	4
		Female	AI= 2.7L/d	0.18	18
Vitamins	Unit	Gender	DRI	Cutoff-point	Prevalence (%) at/above
Vitamin A	μg/day	Male	EAR= 625μg/d	0.33	33
		Female	EAR= 500 μg/d	0.75	75
Vitamin D	IU/day	Male	EAR=400 IU/d	0.08	8
		Female	EAR=400 IU/d	0.18	18
Vitamin E	mg/day	Male	EAR= 12mg/d	0.04	4
		Female	EAR= 12mg/d	0.16	16
Vitamin B_1	mg/day	Male	EAR= 1.0 mg/d	0.71	71
		Female	EAR= 0.9 mg/d	0.93	93
Vitamin B_2	mg/day	Male	EAR= 1.1mg/d	0.79	79
		Female	EAR= 0.9 mg/d	0.90	90
Vitamin B_3	mg/day	Male	EAR= 12mg/d	1.00	100
		Female	EAR= 11mg/d	0.97	97
Vitamin B_6	mg/day	Male	EAR=1.1 mg/d	0.79	79
		Female	EAR=1.1mg/d	0.88	88
Vitamin B_9	μg/day	Male	EAR= 320μg/d	0.46	46
		Female	EAR= 320μg/d	0.59	59
Vitamin B_{12}	μg/day	Male	EAR=2.0μg/d	0.92	92
		Female	EAR= 2.0μg/d	0.84	84
Vitamin C	mg/day	Male	EAR= 75mg/d	0.54	54
		Female	EAR= 60 mg/d	0.91	91
Elements	Unit	Gender	DRI	Cutoff-point	Prevalence (%) at/above
Sodium	g/day	Male	UL^d =2.3g/d	0.79	79
		Female	UL=2.3g/d	0.36	36
Potassium	g/day	Male	AI=4.7 g/d	0.04	4
		Female	AI=4.7 g/d	0.05	5
Calcium	mg/day	Male	EAR= 800 mg/d	0.46	46
		Female	EAR= 800 mg/d	0.55	55
Iron	mg/day	Male	EAR=6.0 mg/d	1.00	100
		Female	EAR= 8.1 mg/d	0.91	91
Zinc	mg/day	Male	EAR=9.4 mg/d	0.45	45
		Female	EAR=6.8 mg/d	0.75	75

[a] DRI: Dietary Reference Intake, [b] EAR: Estimated Average Requirement, [c] AI: Adequate Intake, [d] UL: Tolerable Upper-Level Intake
Note The DRI values are taken from (Institute of Medicine,1998;2005a;2005b;2011)

4.3 Intake from Food Groups and Adequacy

Average number of servings intake for fruits and vegetables (FV) was 3.7 per day with 95% CI [2.8, 4.6] by males and 5.9 with 95%CI [5.3, 6.4] by females (Table 4.8). When compared by sex, females reported consuming a higher number of servings for FV than males ($p<0.001$). For grain products, estimated intake of the number of servings did not vary by sex group. Female students consumed a significantly more number of servings of milk and alternatives as compared to male students ($p= 0.043$, Table 4.8). The percentage of males adhering to recommendations for meat and alternatives was significantly higher than females ($p<0.001$). Figure 4.2 shows the prevalence of adequacy and inadequacy for each of the four food groups. About, 72% of young adults did not meet the minimum guidelines for fruits and vegetables, 74% for grain products and about 54% for milk and alternatives. For meat and alternatives, the prevalence of inadequacy was lower than the prevalence of adequacy. Difference by sex for intake is evident. Figure 4.3 to Figure4.6 describe the frequency of the number of servings intake by sex group. It was estimated that 27% of females reported intake of 4.5 number of servings for FV and 21% males reported consuming 3.0 number of servings per day for FV. For grain products, minimum number of serving estimated was 1.0 per day for both males and females and overall, three by four did not meet the guidelines for grain products (Figure 4.4). For milk and alternatives, 54% did not meet the recommendation of 2.0 number of servings (Figure 4.5).

4.4 Energy Intake and Estimated Energy Requirements

Energy requirement can vary widely by sex groups, age, body size, and physical activity. Males have a higher body weight and a greater proportion of lean body mass than females. They require more energy to main their body mass and to meet their activity level. Therefore, energy intake, on average, was comparatively higher among males than females. Table 4.9 presents energy intake (EI) by sex group and comparison between estimated energy intake and estimated energy requirement (EER). We used paired t-test to compare energy intake with their requirement for males and females. It was found that despite sex-group and level of physical activity reported, mean energy intake was significantly below the energy required.

Table 4.8: Estimated number of servings for food groups and proportion (%) of individuals consuming the number of servings from four food group relative to the recommendations in Canadaś Food Guide (CFG), by sex group

Food groups number of servings/day		Mean (S.E)	95%CI	Median(IQR)	Recommended number of food group servings/day	Percentage of Individuals at/above the recommended number of servings/day (%)	*p*-value *
Fruit and Vegetables	All	5.1(0.3)	(4.6, 5.6)	5.0(3.0)			
	Male	3.7(0.4)	(2.8, 4.6)	3.0(2.0)	8.0	13	
	Female	5.9(0.3)	(5.3, 6.4)	4.5(3.0)	7.0	36	<0.001
Grain products	All	4.7(0.2)	(4.3, 5.1)	4.5(2.8)			
	Male	4.7(0.4)	(3.8, 5.6)	4.0(3.8)	8.0	13	
	Female	4.8(0.2)	(4.3, 5.2)	4.5(2.0)	6.0	34	0.696
Milk and alternatives	All	1.6(0.1)	(1.4, 1.7)	1.0(1.0)			
	Male	1.3(0.1)	(1.1, 1.6)	1.0(1.0)	2.0	29	
	Female	1.7(0.1)	(1.5, 1.9)	1.5(1.0)	2.0	55	0.043
Meat and alternatives	All	2.6(0.2)	(2.3, 3.0)	3.0(1.0)			
	Male	3.4(0.3)	(2.8, 4.0)	3.0(1.0)	3.0	79	
	Female	2.3(0.2)	(1.9, 2.6)	2.0(1.8)	2.0	75	<0.001

* *p*-value significant <0.05, used MannWhitney U test
Abbrevitions SE: Standard Error, IQR:Interquartile range

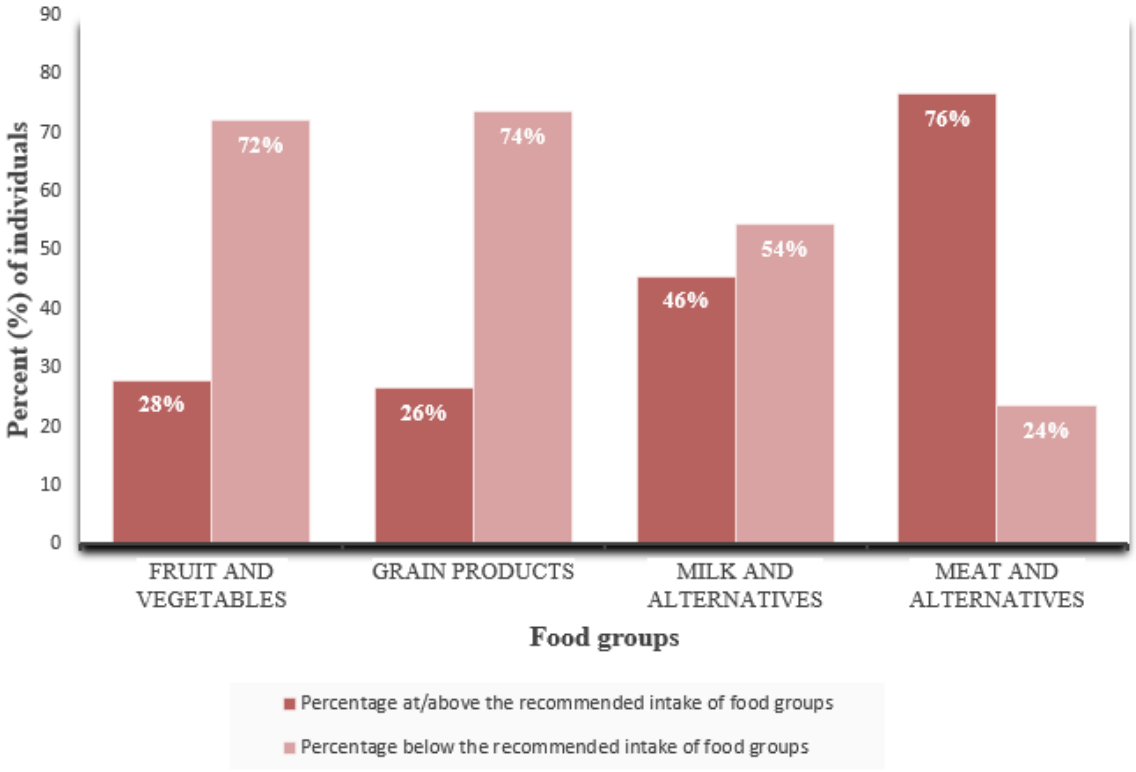


Figure 4.2: Percentage of individuals (%) below, at or above the recommended number of servings for food groups

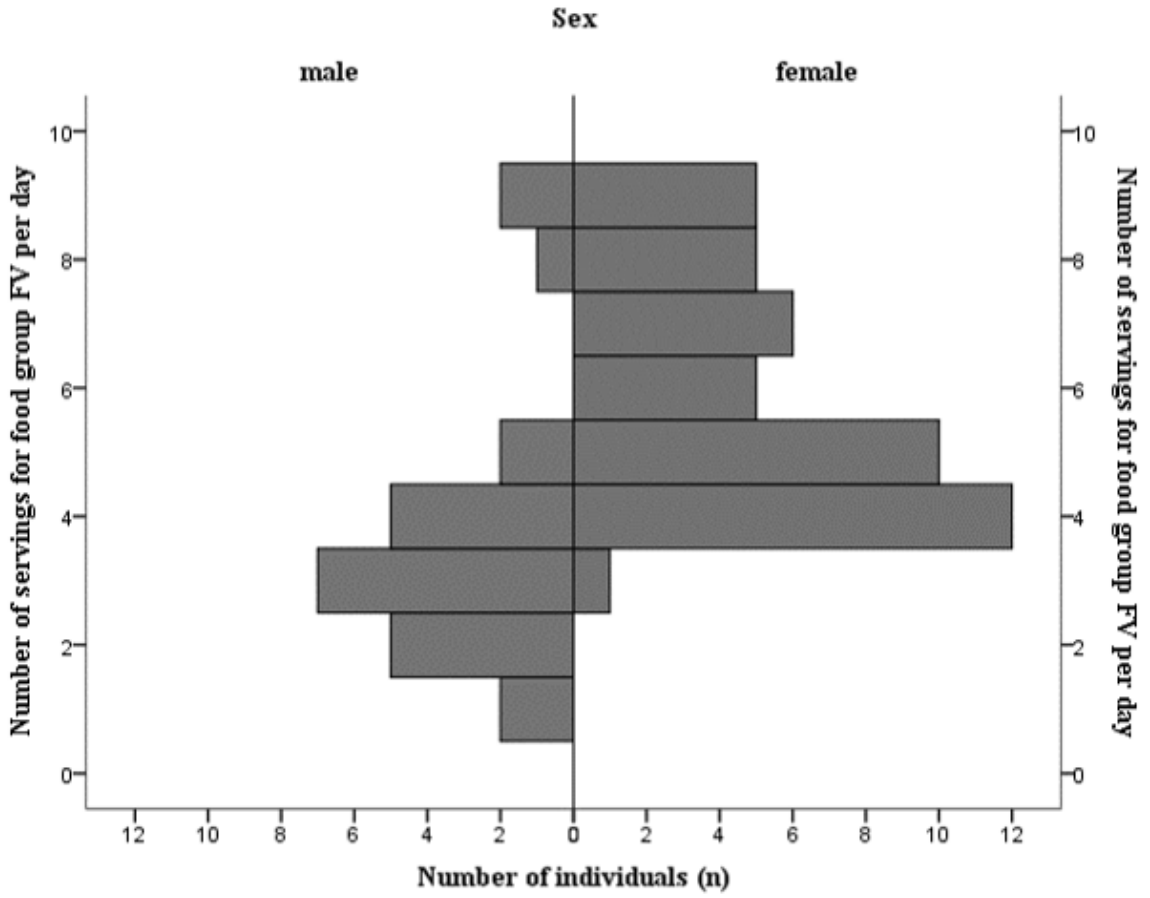


Figure 4.3: The frequency of the estimated number of servings of fruit and vegetables (FV) by sex group

Each histobar in the pyramid refers to the number of individuals (M=24, F=44) consuming the number of servings of food group

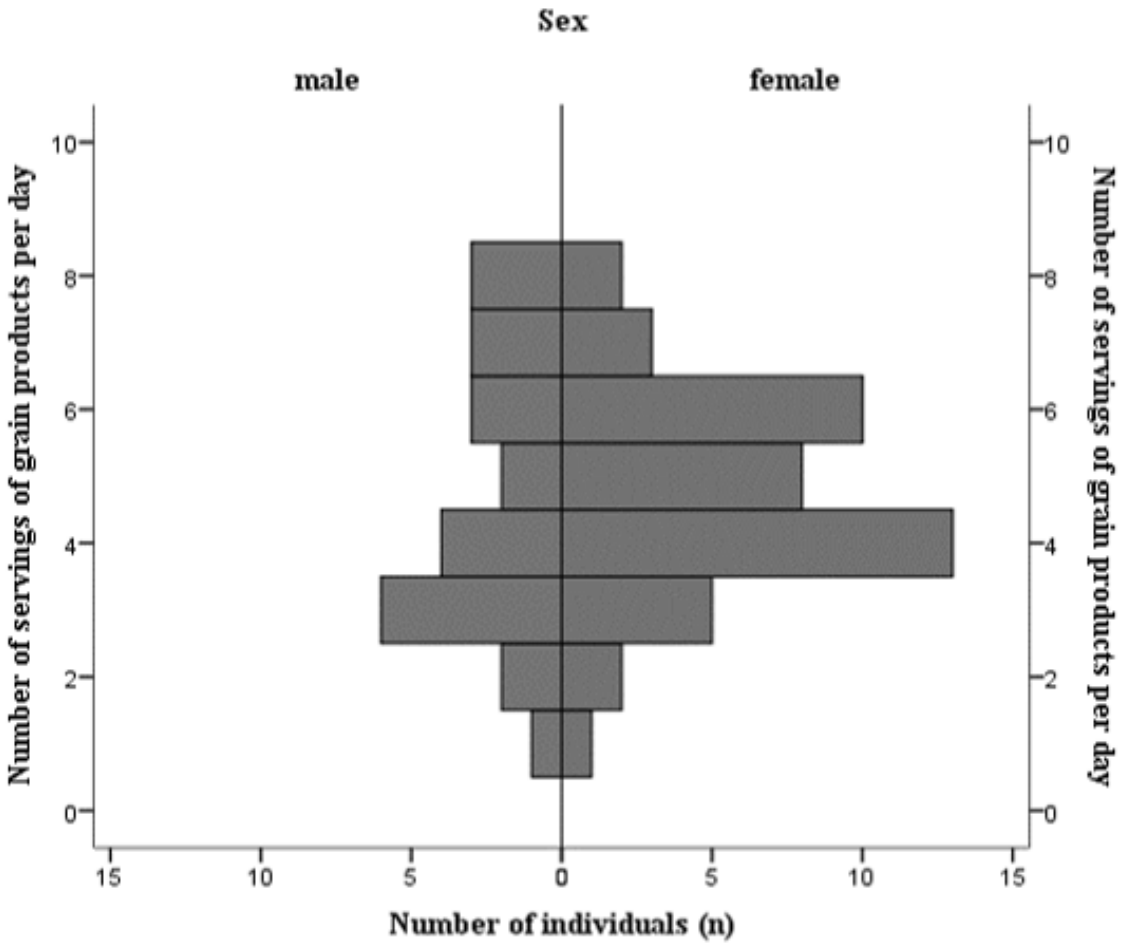


Figure 4.4: The frequency of the estimated number of servings of grain products by sex group

Each histobar in pyramid refers to the number of individuals (M=24, F=44) consuming the number of servings of food group

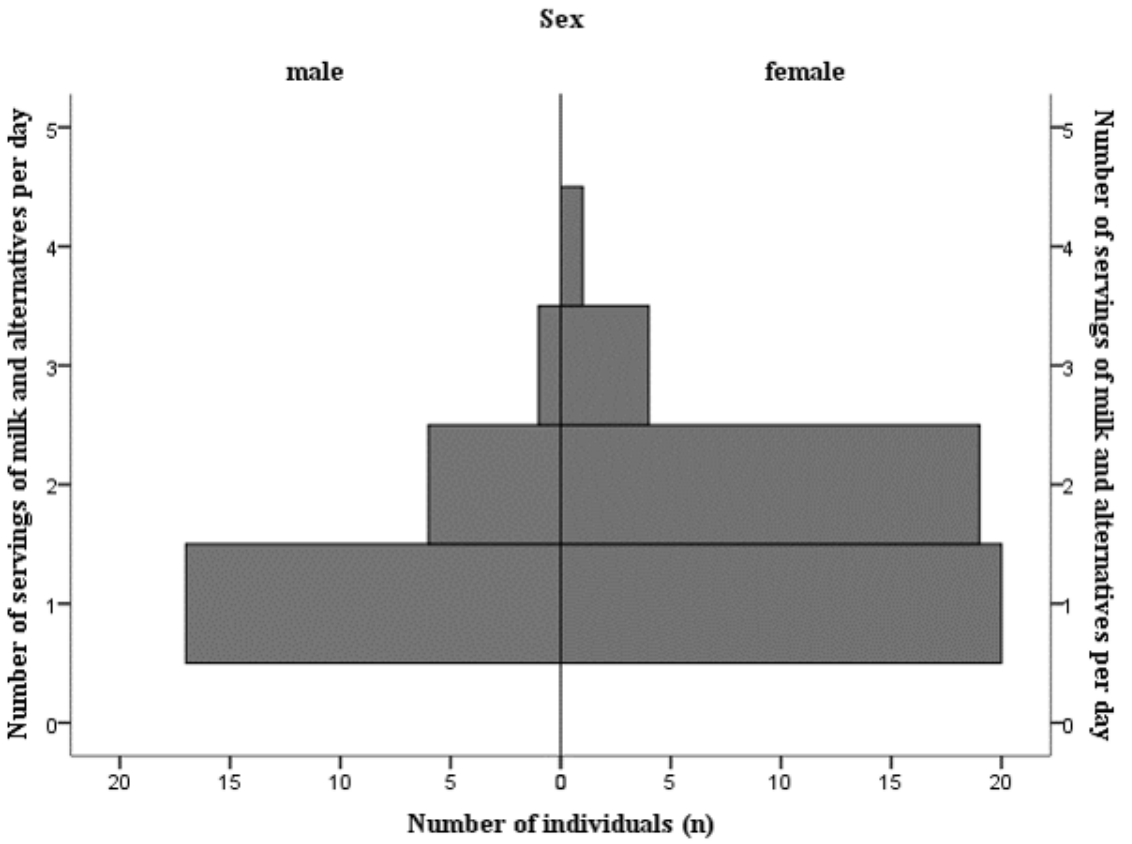


Figure 4.5: The frequency of the estimated number of servings of milk and alternatives by sex group

Each histobar in the pyramid refers to number of individuals (M=24, F=44) consuming the number of servings of food group

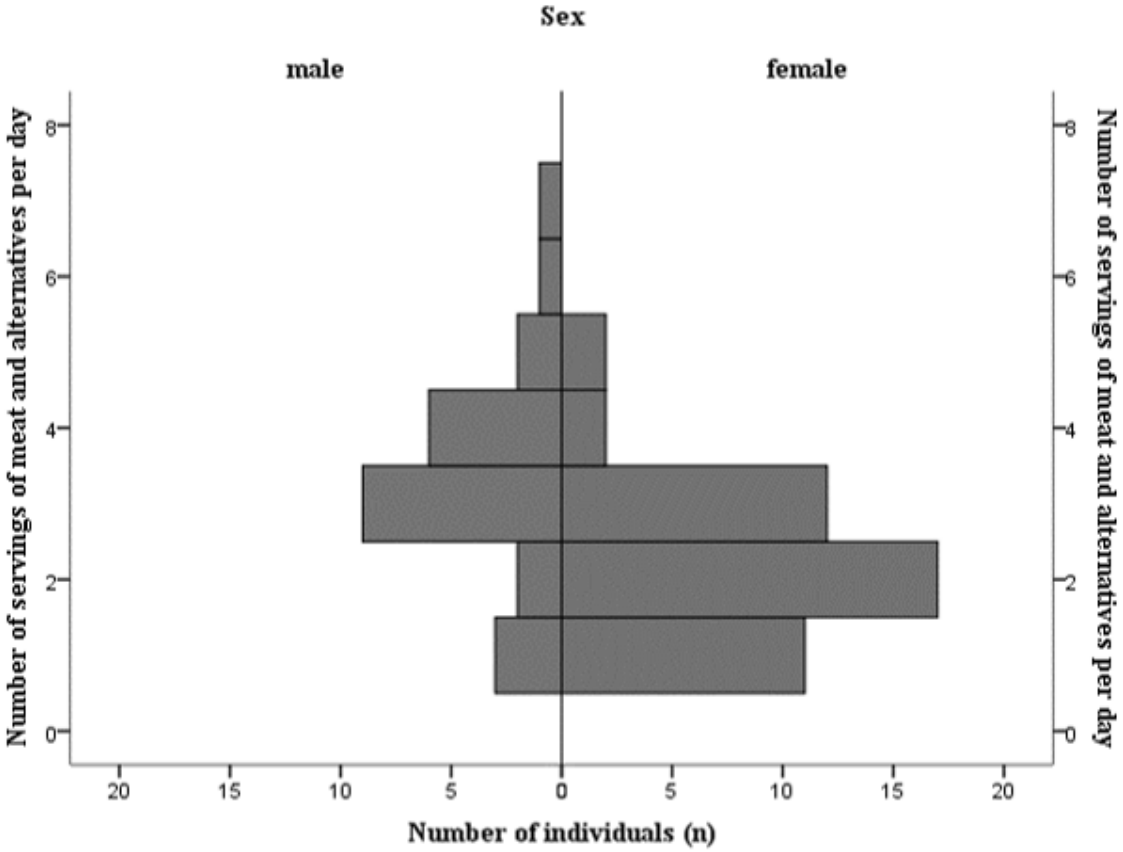


Figure 4.6: The frequency of the estimated number of servings of meat and alternatives by sex group

Each histobar in the pyramid refers to number of individuals (M=24, F=44) consuming the number of servings of food group

Table 4.9: Energy Intake compared to Estimated Energy Requirement

	Male						Female					
Average Energy Intake	N	Mean(SE) [a]	95%CI[b]	Median(IQR)[c]	EER [d]	*p*-value*	N	Mean(SE)	95%CI	Median(IQR)	EER [d]	*p*-value*
Sedentary [1]	8	2106.2 (153.9)	(1742.2, 2470.3)	2091.5(637.0)	2607.6	0.020	9	1439.6 (142.6)	(1111.1, 1768.1)	1333.0 (577.5)	1878.3	0.011
Low Active [2]	8	1785.8 (136.7)	(1462.6, 2109.1)	1774.0(582.7)	2617.0	0.001	19	1791.7 (117.3)	(1545.3, 2038.2)	1678.3 (464.3)	2034.4	0.066
Active [3]	7	2146.8 (285.1)	(1449.1, 2844.6)	2275.0(1433.0)	2863.3	0.034	15	1638.6 (106.7)	(1409.6, 1867.6)	1500.0 (518.0)	2135.6	0.001
Very Active [4]	1	na	na†	2312.0	3139.5	na	1	na	na	1595.0	3018.7	na

[a] SE: standard error
[b] CI: Confidence Interval [c] IQR: Interquartile range
[d] Equation to estimate the energy required was used
[1] Sedentary: Include daily routine (e.g., sitting for extended periods, using a computer, using daily transport services) and less physical activity in leisure time.
[2] Include daily routine of some physical activity (e.g., walking for bus, mowing the lawn) and additional physical activity in leisure time.
[3] Typical daily living activities plus at least 60 minutes of moderate activity such as walking at a rate of one mile in 14 to 19 minutes. Beat faster) each week
[4] Typical daily living activities and 60 minutes of moderate activity plus an additional 60 minutes of vigorous activity or an additional 120 minutes of moderate activity.
* p-value comparing EI and EER using a paired *t*-test
†na: not available, for very active male and female, only median values is reported as n is one for male and female

Chapter 5

Discussion, Conclusion, and Limitations

5.1 Overview

Post-secondary students experience numerous challenges when it comes to balancing nutritious diet and fulfillment of dietary guidelines (Anding, Suminski, & Boss, 2001; Korinth, Schiess, & Westenhoefer, 2010; Ouellette et al., 2012). At the university level, focused nutrition science studies are provided to address this shortfall. It is evident from previous studies that improved nutrition education is essential at all level of training and play a significant role in creating awareness on healthy eating (Corrina, 2013; Dhandevi & Jeewon, 2015; Wardle, Parmenter, & Waller, 2000). This study provided an ample opportunity to estimate energy and nutrient intake and identify the prevalence of adequacy among university students enrolled in an introductory nutrition course. Qualitative studies examining dietary patterns are very much evi-

dent from literature; however, the number of studies reporting the quantitative data on dietary intake of university students is limited.

5.1.1 Adequacy of Macronutrients and Micronutrients

In this study, we found, as hypothesized, university students enrolled in an introductory course exhibits dietary inadequacies in their daily diet. For macronutrients, 19% of students consumed carbohydrate less than the lower end of the AMDR and 16% had fat intake above the upper end of the AMDR. According to literature, diet below the AMDR for carbohydrate may adversely affect intake of vital nutrients such as folate, fiber and may increase the risk of chronic health diseases.

Sugar intake contributes significantly to total energy intake. In our study, when compared the total sugar by sex group, female students had a higher intake of total sugar as compared to male students. A likely explanation for this variance may be that females consume more fruits than males, as supported by other studies (Gibson, Francis, Newens, & Livingstone, 2016). Overall, consumption of total sugar averages 16% of total energy intake, and for added sugar accounted for 6.8% of total energy. Among females, 18.7% of total energy was contributed by total sugar which includes 7.3% from added sugar. For males, about 13% was from total sugar including 6.2% form added sugar. According to a health report, Canadians consumed an average of 110 grams of sugar a day, which is estimated to contribute 20-21% of their total energy intake (Langlois & Garriguet, 2011). Our study gives an estimate of total sugar and added sugars consumption, but limitation shall be taken into as data used was self-reported. Consequently, future research should examine differences by sex

for dietary sources of total and added sugar to identify key foods or food groups.

An additional area of concern is dietary fiber intake. Findings from our study show that about 96% males and 73% of females had fiber intake below the AI. This may relate to the food choices are either low in fiber or it may relate to the unavailability of food items with high fiber content. Epidemiological and clinical studies provide evidence that intake of dietary fiber reduces the risk of obesity, diabetes (type II), cancer and cardiovascular diseases (Brown, Rosner, Willett, & Sacks, 1999; König et al., 2003). Moreover, a longitudinal study by Ludwig et al. (1999) used data from CARDIA study, showed conflicting results that the weight gain in the span of 10-year was strongly associated with fiber intake than by fat consumption.

For fat-soluble vitamins, vitamin D recommendations were not met by most males and females (92 and 82% respectively). Adequate vitamin D intake is important throughout all stages of life to maintain health status. Studies have shown the inadequacy of vitamin D may be a risk factor for developing osteoporosis and non-skeletal chronic disease like diabetes (Grandi et al., 2010; Rhee et al., 2012). We found the prevalence of inadequacy was equal to or greater the 90% among male students. For vitamin E, the difference in intake for males and females did not reach the statistical significance ($p= 0.290$). Though, 96% males and 84% of females were consuming vitamin E less than an estimated average requirement. Comparable results were reported in other studies that adequacy of vitamin E decline among young adults (Maras et al., 2004). Studies suggest that, vitamins, particularly vitamin A, vitamin E and vitamin C play a vital role as an antioxidants. According to a study by Troisi et al (1995), daily consumption of vitamin E from the diet may have protective health benefits among

young adults. It is derived from literature that these nutrients are found in considerable amounts in nutrient-dense traditional foods such as fruits, vegetables, and fish (Deutch, Dyerberg, Pedersen, Aschlund, & Hansen, 2007). From the results, it can be inferred that these young adults were either consuming less traditional foods or were consuming more processed food in their diet.

Micronutrients (which include vitamin B_6, vitamin B_9, vitamin B_{12}, vitamin C, calcium, iron, and zinc) with potential public health concern due to reported inadequate intake in previous studies were also compared with recommended values in this study. Prevalence of inadequacies equal to or greater than 50% were estimated for vitamin B_9 and vitamin C among male students. For sodium, males consumed more than females (p <0.001). A prevalence rate lower than or equal to 5% was estimated for potassium for both males and females.

Limitations to our study were biomarkers were not collected to support the adequacy results. Vitamin D, also known as sunshine vitamin can be synthesized in-vivo with exogenous ultraviolet light exposure and can be also be consumed from our diet (fortified milk and soy beverages). The estimated average requirement (EAR) for vitamin D does not reflect the effect of ultraviolet light exposure (IOM, 2011). Therefore, the true nutritional status of vitamin D cannot be predicted from the estimated dietary intake. Future work is required which should address the prevalence of nutritional inadequacy by determining the 25-hydroxyvitamin D (25, (OH) D) using biomarkers status. When taking biomarker status into account, factors influencing the bioavailability of a nutrient must be taken into consideration which may be influenced by factors such as metabolic genotype (Zinjo et al., 2003) bioreactivity

with other metabolites (Crowe, Skeaff, McMahon, Williams, & Green, 2008), cooking method and physiological health status (König et al., 2003). The results in terms of nutrient intakes provide an important insight into nutrition surveillance of university students and can be used to target the population subgroups using interventions appropriately.

The research hypothesis stated that university students enrolled in an introductory nutrition course do not meet the recommendations for energy, nutrients and food groups. The findings in this study accepted the hypothesis as most young adults did not meet the dietary recommendations.

5.1.2 Intake from Food Groups and Adequacy

The aim of this study was also to estimate what proportion of young adults were consuming the number of servings from food groups according to CFG guidelines. In our study, about 72% of these young adults did not meet the minimum daily number of servings of fruits and vegetables for their respective age-sex group recommendations by Canadas Food Guide (Figure 4.2). The frequency of consumption of food groups showed variation by sex (Figure 4.3-Figure 4.6). The estimated mean intake for fruits and vegetables was significantly low for males when compared with females ($p<0.001$). Still, about 52% of females need to add two to three more servings in their daily diet to meet their minimum recommendations. These results are in line with other studies (Dehghan et al., 2011; Mikolajczyk et al., 2009) which reported that females had a usual intake of fruits and vegetables higher than their male counterpart. Our findings contradict with some of the previous studies, where high prevalence

of fruits and vegetables intake was reported among males (Black & Billette, 2013; Starkey et al., 2001).

Canadians on average consume less than one serving each day from grain products (Anderson, Randles, Kendall, & Jenkins, 2004). Findings from our study show that about 87% of males and 66% of females did not meet the recommendations for the minimum number of serving (Table 4.8). To meet the minimum number of recommended servings per day, about 13% males and 18% females would need to add up to one more serving per day, while the remaining individuals would need to have more than one serving of grain products per day. Higher prevalence of inadequacy among males may also reflect lower intake of fiber in their daily diet.

The estimated number of servings for meat and alternatives were above the recommendations for males and females. About 79% of males were consuming more than the 3 number of servings from meat and alternatives daily. Among male student, major source of food group meat and alternatives were beef, and egg. Some studies suggest that diets high in red meat have been a strong risk factor than total fat for colon cancer, whereas an increase in fiber intake may lessen its effect. Moreover, some studies have described, a shift in trend from a Traditional diet to Western diet widely prevalent among young adults, with an increase in red meat consumption (Takachi et al., 2011). The association of red meat with health outcomes have been reported in the literature but show a conflict in their results. A study by Giovannucci et al. (1994) reported that elevated colon cancer risk was associated with higher intake of red meat (relative risk, 1.71), among males consuming red meat 5 times or more per week and had relatively a higher risk of 3.57 as compared to men eating less than

that. However, a large cohort study conducted in North America has reported no association between increased consumption of red meat and developing diet-related chronic risk such as cardiovascular disease risk factors or cancer (Kappeler et al., 2013).

5.1.3 Energy Intake and Estimated Energy Requirement

The estimated energy requirement (EER), reflect the average energy required to uphold an energy balance of a healthy individual, it is defined by age, sex, weight, height, and level of physical activity. Unlike females, males were more likely to be less active and had higher energy intake (p=0.012, Table 4.2). The differences between mean EI and mean EER were large among females, this has been supported in other studies (Hernon, Skinner, Andrews, & Penfield, 1986). Studies propose that when EI equals to EER, it helps in maintaining a healthy weight; if it exceeds the EER sources a gain in weight and if it is smaller than EER, weight is likely to be reduced (Garriguet, 2007). It can be inferred from our results that respondents are likely to lose their weight. Studies report that females are more weight conscious than males and are observed to make extreme variations to regulate their weight (Davies& Furnham, 1986; French & Jeffery, 1994). Finding from our study may be related to the occurrence of dieting pattern among females.

5.2 Conclusion

Comparing dietary intake by sex group is an important source of information to better understand students$'$ dietary intake. Health professionals require dataset hav-

ing sufficient details on daily nutrient intakes from food and other dietary components, to compare and analyze the adequacy. The current study reported a considerable high prevalence of inadequate intake from fruits and vegetables, grain products and milk and alternatives. Furthermore, inadequate dietary intake of vitamin A, vitamin D, vitamin E, vitamin B_9, potassium, and calcium requires special attention by public health authorities. Concerted efforts are needed to help academics and policymakers keep abreast of the nutritional status of post-secondary students. Researchers and university administrations should provide information and advice to university students on how to improve healthy food choices and cooking skills (via social media).

5.3 Limitations

We acknowledge there are a few limitations to this study that are common in any study. We have included self-reported dietary data, which may have intended and unintended omissions. All factors (living conditions, educational level, ethnicity and factors such as stress) were not held constant at the time of the study. The participants may have experienced dietary challenges which may impact the energy or nutrient intake, yet such factors cannot be controlled in such observational studies. Therefore, results in this study are interpreted in the light of known evidence. We have included a convenient sample of university students. Students enrolled in an introductory nutrition course at the university were only included, these students have a satisfactory knowledge of nutritious food and nutrition education materials. Therefore, findings cannot be considered a reflection of intake from the entire student body from the campus. It is possible, that dietary adequacy was higher among the

group of nutritionally aware students. In this study, the estimated energy intake was low, which may suggests under-reporting as it was based on self-reported data. None of the findings were adjusted for energy intake. This may limit the accuracy of the energy estimation.

Chapter 6

Bibliography

Alam, P. (2012). Nutritional status and eating practices among university students in selected universities in Selangor, Malaysia. *Asian Journal of Clinical Nutrition, 4*(3), 77-87.

Alkerwi, A. A., Crichton, G. E., & Hébert, J. R. (2015). Consumption of ready-made meals and increased risk of obesity: Findings from the Observation of Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) study. *British Journal of Nutrition, 113*(2), 270-277. https://doi.org/10.1017/S0007114514003468

Anderson, J. W., Randles, K. M., Kendall, C. W., & Jenkins, D. J. (2004). Carbohydrate and fiber recommendations for individuals with diabetes: A quantitative assessment and meta-analysis of the evidence. Journal of the *American College of Nutrition, 23*(1), 5-17. https://doi.org/10.1080/07315724.2004.10719338

Anding, J. D., Suminski, R. R., & Boss, L. (2001). Dietary intake, body mass index, exercise, and alcohol: Are college women following the Dietary Guidelines for Americans?. *Journal of American College Health, 49*(4), 167-171.

Arnett, J. J. (2007). Emerging adulthood: The winding road from the late teens through the early twenties. *Child Development Perspectives, 1*(2), 68-73.

Azagba, S., & Sharaf, M. F. (2012). Fruit and vegetable consumption and body mass index: A quantile regression approach. *Journal of Primary Care & Community Health, 3*(3), 210-220.doi:10.1177/2150131911434206

Barr, S. I. (2010, January 20). Reducing dietary sodium intake: The Canadian context. *Applied Physiology, Nutrition, and Metabolism, 35*(1), 1-8. https://doi.org/10.1139/H09-126

Barr, S. I., Murphy, S. P., & Poos, M. I. (2002). Interpreting and using the Dietary References Intakes in dietary assessment of individuals and groups. *Journal of the American Dietetic Association, 102*(6), 780-788. doi:10.1016/s0002-8223(02)90177-x

Bingham, S. A., Gill, C., Welch, A., Day, K., Cassidy, A., Khaw, K. T., Sneyd,

M.J., Key, T.J.A., Roe, L. & Day, N. E. (1994). Comparison of dietary assessment methods in nutritional epidemiology: weighed records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. *British Journal of Nutrition, 72*(4), 619-643.

Black, J. L., & Billette, J. M. (2013). Do Canadians meet Canada's Food Guide's recommendations for fruits and vegetables?. *Applied Physiology, Nutrition, and Metabolism, 38*(3), 234-242. https://doi.org/10.1139/apnm-2012-0166

Blondin, S., Mueller, M., Bakun, P., Choumenkovitch, S., Tucker, K., & Economos, C. (2016). Cross-sectional associations between empirically-derived dietary patterns and indicators of disease risk among university students. *Nutrients, 8*(1), 3.

Brown, K., Wengreen, H., Dimmick, M., Eller, K., Frampton, A., Heaton, E., Staheli, T., & Christensen, N. (2011). Improving diets of college students: Survey of dietary habits and focus group perspectives on how to best teach students. *Journal of Health Behavior and Public Health, 1*(1), 23-29.

Brown, L., Rosner, B., Willett, W. W., & Sacks, F. M. (1999). Cholesterol-lowering effects of dietary fiber: A Meta-Analysis. *The American Journal of Clinical Nutrition, 69*(1), 30-42. https://doi.org/10.1093/ajcn/69.1.30

Brunt, A., Rhee, Y., & Zhong, L. (2008). Differences in dietary patterns among college students according to body mass index. *Journal of American College Health, 56*(6), 629-634. https://doi.org/10.3200/JACH.56.6.629-634

Burke, V., Beilin, L. J., Dunbar, D., & Kevan, M. (2004). Changes in health-related behaviours and cardiovascular risk factors in young adults: Associations with living with a partner. *Preventive Medicine, 39*(4), 722-730.

Carroll, R. J., Pee, D., Freedman, L. S., & Brown, C. C. (1997). Statistical design of calibration studies. *The American Journal of Clinical Nutrition, 65*(4), 1187S-1189S. https://doi.org/10.1093/ajcn/65.4.1187S

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011, March 01). Physical activity of Canadian adults accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health reports, 22(*1), 7.

Corrina H. (2013). *Promoting a healthy diet through nutrition education and changes in food environment: An international review of actions and interventions.* Retrieved from http://www.fao.org/docrep/017/i3235e/i3235e.pdf

Crowe, F. L., Skeaff, C. M., McMahon, J. A., Williams, S. M., & Green, T. J. (2008). Lowering plasma homocysteine concentrations of older men and women with

folate, vitamin B-12, and vitamin B-6 does not affect the proportion of (n-3) long-chain polyunsaturated fatty acids in plasma phosphatidylcholine. *The Journal of Nutrition, 138*(3), 551-555.

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J., & Ezzati, M. (2009, April 29). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Medicine, 6*(4), e1000058. https://doi.org/10.1371/journal.pmed.1000058

Davies, E., & Furnham, A. (1986). THE DIETING AND BODY SHAPE CONCERNS OE ADOLESCENT FEMALES. *Journal of Child Psychology and Psychiatry, 27*(3), 417-428. https://doi.org/10.1111/j.1469-7610.1986.tb01843.x

Dehghan, M., AkhtarDanesh, N., & Merchant, A. T. (2011). Factors associated with fruit and vegetable consumption among adults. *Journal of Human Nutrition and Dietetics, 24*(2), 128-134.

Deliens, T., Clarys, P., De Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behavior in university students: A qualitative study using focus group discussions. *BMC Public Health, 14*(1), 53. https://doi.org/10.1186/1471-2458-14-53

Deutch, B., Dyerberg, J., Pedersen, H. S., Aschlund, E., & Hansen, J. C. (2007).

Traditional and modern Greenlandic fooddietary composition, nutrients and contaminants. *Science of the Total Environment, 384*(1-3), 106-119.

Dhandevi, P. E. M., & Jeewon, R. (2015, October). Fruit and vegetable intake: Benefits and progress of nutrition education interventions-narrative review article. *Iranian Journal of Public Health, 44*(10), 1309-1321,

Dietary Assessment Primer. (2015a). *Learn More about Outliers.* National Institutes of Health, National Cancer Institute.

Dietary Assessment Primer. (2015b). *24-hour Dietary Recall (24HR) At a Glance.* National Institutes of Health, National Cancer Institute.

Dixon, L. B., Cronin, F. J., & Krebs-Smith, S. M. (2001). Let the pyramid guide your food choices: capturing the total diet concept. *The Journal of Nutrition, 13*1(2), 461S-472S. https://doi.org/10.1093/jn/131.2.461S

Dwyer, J. T., Evans, M., Stone, E. J., & Feldman, H. A. (2001). Adolescents' eating patterns influence their nutrient intakes. *Journal of the Academy of Nutrition and Dietetics, 10*1(7), 798-802.

Ekwaru, J. P., Ohinmaa, A., Loehr, S., Setayeshgar, S., Thanh, N. X.,& Veugelers, P. J. (2017). The economic burden of inadequate consumption of vegetables and fruit in Canada. *Public Health Nutrition, 20*(3), 515-523. doi:10.1017/S1368980016002846

El Ansari W, Stock C, John J, Deeny P, Phillips C, Snelgrove S, Adetunji H, Hu X, Parke S, State M, &Mabhala A. (2011). Health-promoting behaviors and lifestyle characteristics of students at seven universities in the UK. *Central European Journal of Public Health, 19(*4).197-204.

Ello-Martin JA, L. J. (2005). The influence of food portion size and energy density on energy intake: Implications for weight management. *The American Journal of Clinical Nutrition, 82*(1), 236S241S. https://doi.org/10.1093/ajcn/82.1.236S

Fernandes, J., Arts, J., Dimond, E., Hirshberg, S., & Lofgren, I. E. (2013). Dietary factors are associated with coronary heart disease risk factors in college students. *Nutrition Research, 33*(8), 647-652. doi: 10.1016/j.nutres.2013.05.013

Frank-Spohrer, G. C., & Frank, G. C. (1996). *Community Nutrition: Applying Epidemiology to Contemporary Practice.* California State University, Long Beach: Jones & Bartlett Learning.

Frehlich, L. C., Eller, L. K., Parnell, J. A., Fung, T. S., & Reimer, R. A. (2017).

Dietary Intake and Associated Body Weight in Canadian Undergraduate Students Enrolled in Nutrition Education. *Ecology of Food and Nutrition, 56* (3), 205-217.

French, S. A., & Jeffery, R. W. (1994). Consequences of dieting to lose weight: Effects on physical and mental health. *Health Psychology, 13*(3), 195.

Fu, M. L., Cheng, L., Tu, S. H., & Pan, W. H. (2007). Association between unhealthful eating patterns and unfavorable overall school performance in children. *Journal of the American Dietetic Association, 107*(11), 1935-1943.

Garriguet, D. (2007).*Overview of Canadians' Eating Habits.* Ottawa: Statistics Canada. https://www150.statcan.gc.ca/n1/en/pub/82-620-m/82-620-m2006002-eng.pdf?st=w4RnN48P

Gissane, C. (2016). Is the data normally distributed?. *Physiotherapy Practice and Research, 37*(1), 57-60. doi:10.3233/PPR-150069

Gibson Rosalind S. (2005). *Principles of Nutritional Assessment.* Oxford University Press. Retrieved from https://books.google.ca/books?id=lBlu7UKI3aQC

Gibson, S., Francis, L., Newens, K., & Livingstone, B. (2016). Associations between free sugars and nutrient intakes among children and adolescents in the UK.

British Journal of Nutrition, 116(7), 1265-1274. doi:10.1017/S0007114516003184

Giovannucci, E., Rimm, E. B., Stampfer, M. J., Colditz, G. A., Ascherio, A., & Willett, W. C. (1994, May 1). Intake of Fat, Meat, and Fiber in Relation to the Risk of Colon Cancer in Men. *Cancer Research, 54*(9), 2390-2397.

Gorski, M. T., & Roberto, C. A. (2015). Public health policies to encourage healthy eating habits: recent perspectives. *Journal of Health Care Leadership, 7,* 81-90.

Graham, J. W. (2009, January 10). Missing Data Analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576.

Grandi, N. C., Breitling, L. P., & Brenner, H. (2010). Vitamin D and Cardiovascular disease: Systematic review and Meta-analysis of Prospective studies. *Preventive Medicine, 51*(3-4), 228-233. https://doi.org/10.1016/j.ypmed.2010.06.013

Gresse, A., Steenkamp, L., & Pietersen, J. (2015). Eating, drinking and physical activity in the Faculty of Health Science students compared to other students at a South African university. *South African Journal of Clinical Nutrition, 28*(4), 154-159. https://doi.org/10.1080/16070658.2015.11734555

Hanning, R. M., Woodruff, S. J., Lambraki, I., Jessup, L., Driezen, P., & Murphy, C. C. (2007). Nutrient intakes and food consumption patterns among Ontario students in grades six, seven, and eight. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique, 98*(1), 12-16. https://www.jstor.org/stable/41994864

Hawkins, D. M. (1980). *Identification of Outliers (Vol. 11)*. London: Chapman and Hall. doi: 10.1007/978-94-015-3994-4

Health Canada. (2003, August 29). *Dietary Assessment Summary.* Retrieved from https://www.canada.ca/en/ health-canada/services/food-nutrition/ healthy-eating/ dietary-reference-intakes/assessment-summary.html

Health Canada. (2015). *Canadian guidelines for body weight classification.* Retrieved from https://www.canada.ca/en/ health-canada/services/food-nutrition/ healthy-eating/healthy-weights/canadian-guidelines-body-weight-classification-adults.html

Health Canada. (2010, November 29). *Using the Dietary Reference Intakes.* Retrieved from https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/dietary-reference-intakes/using-dietary-reference-intakes.html

Health Canada. (2011). *Eating Well with Canada's Food Guide: A Resource for Educators and Communicators.* Publications Health Canada. Retrieved from

http://www.hc-sc.gc.ca/fn-an/altformats/hpfb-dgpsa/pdf/pubs/res-educate-eng.pdf

Health Canada. (2012). *Do Canadian Adults Meet Their Nutrient Requirements Through Food Intake Alone?* - Canada. Retrieved from https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/canadian-adults-meet-their-nutrient-requirements-through-food-intake-alone-health-canada-2012.html

Hernon, J. F., Skinner, J. D., Andrews, F. E., & Penfield, M. P. (1986). Nutrient intakes and foods selected by college students: Comparisons among subgroups divided by energy intake. *Journal of the American Dietetic Association, 86*(2), 217-221.

Hoffman, C. J. (1989). Dietary intake of calcium, iron, folacin, alcohol, and fat for college students in central Michigan. *Journal of the American Dietetic Association,89*, 836-837.

Howarth, C., & Street, C. (2000). Sidelined: Young adult′*s* access to services. *NEW REVIEW-LONDON-LOW PAY UNIT*, 16-17.

Iglewicz, H. (1993). *How to Detect and Handle Outliers.* The University of California: ASQC Quality Press, 1993.

Institute of Medicine. (1998a). *Dietary Reference Intakes: A Risk Assessment Model for Establishing Upper Intake Levels for Nutrients.* Washington (DC): National Academies Press (US). Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK45182/

Institute of Medicine. (1998b). *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline.* Washington, DC: The National Academies Press. https://doi.org/10.17226/6015

Institute of Medicine. (2000). *Dietary Reference Intakes: Applications in Dietary Assessment.* National Academy Press. PMID:25077263

Institute of Medicine. (2005a). *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids.* Washington, DC: The National Academies Press. doi:10.17226/10490

Institute of Medicine. (2005b). *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate.* Washington, DC: The National Academies Press. doi:10.17226/10925

Institute of Medicine. (2006, August 03). *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements.* Washington, DC: The National Academies

Press. http://www.nap.edu/catalog/11537.html

Institute of Medicine. (2011). *Dietary Reference Intakes. Calcium and Vitamin D.* Washington, DC: The National Academies Press. PMID: 21796828.

Irazusta, A., Hoyos, I., Irazusta, J., Ruiz, F., Daz, E., & Gil, J. (2007) Increased cardiovascular risk associated with poor nutritional habits in first-year university students. *Nutrition Research, 27*(7), 387-394. doi:10.1016/j.nutres.2007.05.007

Jain, M. G., Rohan, T. E., Soskolne, C. L., & Kreiger, N. (2003). Calibration of the dietary questionnaire for the Canadian Study of Diet, Lifestyle and Health cohort. *Public Health Nutrition, 6*(1), 79-86. doi:10.1079/PHN2002362

Kappeler, R., Eichholzer, M., & Rohrmann, S. (2013). Meat consumption and diet quality and mortality in NHANES III. *European Journal of Clinical Nutrition, 67*(6), 598-608

Keogh, G. F., Cooper, G. J., Mulvey, T. B., McArdle, B. H., Coles, G. D., Monro, J. A., & Poppitt, S. D. (2003). Randomized controlled crossover study of the effect of a highly -glucanenriched barley on cardiovascular disease risk factors in mildly hypercholesterolemic men. *The American Journal of Clinical Nutrition, 78*(4), 711-

718. https://doi.org/10.1093/ajcn/78.4.711

Kim, H. Y. (2013, February 26). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics, 38*(1), 52-54. https://doi.org/10.5395/rde.2013.38.1.52

König, D., Bisse, E., Deibert, P., Müller, H. M., Wieland, H., & Berg, A. (2003). Influence of training volume and acute physical exercise on the homocysteine levels in endurance-trained men: Interactions with plasma folate and vitamin B12. *Annals of Nutrition and Metabolism, 47*(3-4), 114118. https://doi.org/10.1159/000070032

Korinth, A., Schiess, S., & Westenhoefer, J. (2010). Eating behavior and eating disorders in students of nutrition sciences. *Public Health Nutrition, 13*(1), 32-37. doi:10.1017/S1368980009005709

Krueger, H., Turner, D., Krueger, J., & Ready, A. E. (2014, January/February). The economic benefit of risk factors reduction in Canada: Tobacco smoking, excess weight, and physical inactivity. *Canadian Journal Public Health, 105*(1), e69-e78. Retrieved from https://www.jstor.org/stable/canajpublheal.105.1.0e69

Kwan, M. Y., Faulkner, G. E., Arbour-Nicitopoulos, K. P., & Cairney, J. (2013, June 6). Prevalence of health-risk behaviors among Canadian post-secondary stu-

dents: Descriptive results from the National College Health Assessment. *BMC Public Health, 13*(1), 548. doi:10.1186/1471-2458-13-548

Langlois, K., & Garriguet, D. (2011). *Sugar consumption among Canadians of all ages (Vol. 22).* Statistics Canada

Lawrence, G. D. (2013, May 03). Dietary fats and health: Dietary recommendations in the context of scientific evidence. *Advances in Nutrition,4*(3),294-302. https://doi.org/10.3945/an.113.003657

Lee, R. L., & Loke, A. J. Y. (2005). Healthpromoting behaviors and psychosocial wellbeing of university students in Hong Kong. *Public Health Nursing,22*(3), 209-220. https://doi.org/10.1111/j.0737-1209.2005.220304.x

Lennon-Edwards, S., Allman, B. R., Schellhardt, T. A., Ferreira, C. R., Farquhar, W. B., & Edwards, D. G. (2014). Lower potassium intake is associated with increased wave reflection in young healthy adults. *Nutrition Journal, 13*(1), 39. https://doi.org/10.1186/1475-2891-13-39

Leslie, E., Owen, N., Salmon, J., Bauman, A., Sallis, J. F., & Lo, S. K. (1999). Insufficiently active Australian college students: Perceived personal, social, and environ-

mental influences. *Preventive Medicine, 28*(1), 20-27. doi:10.1006/pmed.1998.0375

Leslie, E., Sparling, P. B., & Owen, N. (2001). University campus settings and the promotion of physical activity in young adults: Lessons from research in Australia and the USA. *Health Education, 101*(3), 116-125. doi:10.1108/09654280110387880

Liu L, Wang PP, Roebothan B, Ryan A, Tucker CS, Colbourne J, Baker N, Cotterchio M, Yi Y, &Sun G. (2013). Assessing the validity of a self-administered food-frequency questionnaire (FFQ) in the adult population of Newfoundland and Labrador, Canada. *Nutrition Journal, 12*(1), 49. doi:10.1186/1475-2891-12-49

Lock, K., Pomerleau, J., Causer, L., Altmann, D. R., & McKee, M. (2005, February). The global burden of disease attributable to low consumption of fruit and vegetables: Implications for the global strategy on diet. *Bulletin of the World Health Organization, 83*(2), 100-108.

Ludwig, D. S., Pereira, M. A., Kroenke, C. H., Hilner, J. E., Van Horn, L., Slattery, M. L., & Jacobs Jr, D. R. (1999). Dietary fiber, weight gain, and cardiovascular disease risk factors in young adults. *JAMA, 282*(16), 1539-1546. doi:10.1001/jama.282.16.1539

Mahfouz, M. S., Makeen, A. M., Akour, A. Y., Madkhly, T. M., Hakami, H. M., Shaabi, W. M., ...& Al-Ali, M. A. (2016). Nutritional habits and weight status among

Jazan university students: eating patterns and healthy lifestyle assessment. *Epidemiology, Biostatistics and Public Health, 13*(2). doi: https://doi.org/10.2427/11658

Maras, J. E., Bermudez, O. I., Qiao, N., Bakun, P. J., Boody-Alter, E. L., & Tucker, K. L. (2004). Intake of -tocopherol is limited among US adults. *Journal of the American Dietetic Association, 104*(4), 567-75. doi:10.1016/j.jada.2004.01.004

Mikolajczyk, R. T., El Ansari, W., & Maxwell, A. E. (2009). Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. *Nutrition Journal, 8*(1), 31. doi:10.1186/1475-2891-8-31

Minaker, L. M., McCargar, L., Lambraki, I., Jessup, L., Driezen, P., Calengor, K., & Hanning, R. M. (2006, September/October). School region socio-economic status and geographic locale is associated with food behaviour of Ontario and Alberta adolescents. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique, 97*(2), 357-361.

Mozaffarian, D. (2016). Dietary and policy priorities for cardiovascular disease, diabetes, and obesity: a comprehensive review. *Circulation*, *133*(2), 187225.

Nebeling, L., Yaroch, A. L., Seymour, J. D., & Kimmons, J. (2007). Still not enough: Can we achieve our goals for Americans to eat more fruits and vegetables in

the future? *American Journal of Preventive Medicine,32*(4),354-355.

Nelson, M. C., Story, M., Larson, N. I., NeumarkSztainer, D., & Lytle, L. A. (2008). Emerging adulthood and collegeaged youth: an overlooked age for weightrelated behavior change. *Obesity, 16*(10), 2205-2211

Neslişah , R., & Emine, A. Y. (2011). Energy and nutrient intake and food patterns among Turkish university students. *Nutrition Research and Practice, 5*(2), 117-123.

Ortega, R. M., Pérez-Rodrigo, C., & López-Sobaler, A. M. (2015, September 03). Dietary assessment methods: Dietary records. *Nutricion Hospitalaria, 31*(3),38-45.

Ouellette, C. D., Yang, M., Wang, Y., Yu, C., Fernandez, M. L., Rodriguez, N. R., & Chun, O. K. (2012). Assessment of nutrient adequacy with supplement use in a sample of healthy college students. *Journal of the American College of Nutrition, 31*(5), 301-310. doi: 10.1080/07315724.2012.10720424

Pendergast, F. J., Livingstone, K. M., Worsley, A., & McNaughton, S. A. (2016). Correlates of meal skipping in young adults: A Systematic Review. *International Journal of Behavioral Nutrition and Physical Activity,13*(1), 125. doi:10.1186/s12966-

016-0451-1

Perez-Gallardo, L., Mingo, T. G., Bayona, I. M., Ferrer, M. P., Marquez, E. C., Rámirez, R. D., Navas, C.F. & Navas, F. C. (2015). Diet quality in college students with different academic profile. *Nutricion Hospitalaria, 31*(5), 2230-2239. doi: 10.3305/nh.2015.31.5.8614

Raitakari, O. T., Porkka, K. V., Rsnen, L., & Viikari, J. S. (1994). Relations of life-style with lipids, blood pressure and insulin in adolescents and young adults. The Cardiovascular Risk in Young Finns Study. *Atherosclerosis*, *111*(2), 237-246.

Rhee, S. Y., Hwang, Y. C., Chung, H. Y., & Woo, J. T. (2012). Vitamin D and diabetes in Koreans: Analyses based on the Fourth Korea National Health and Nutrition Examination Survey (KNHANES), 20082009. *Diabetic Medicine, 29*(8), 1003-1010.

Richards, A., Kattelmann, K. K., & Ren, C. (2006). Motivating 18-to 24-year-olds to increase their fruit and vegetable consumption. *Journal of the American Dietetic Association*, *106*(9),1405-1411.

Rolls, B. J., Ello-Martin, J. A., & Tohill, B. C. (2004, January 01). What can intervention studies tell us about the relationship between fruit and vegetable consump-

tion and weight management. *Nutrition Reviews, 62*(1), 1-17. doi:10.1111/j.1753-4887.2004.tb00001.x

Šatalić, Z., Colić Barić, I., & Keser, I. (2007). Diet Quality in Croatian University Students: Energy, Macronutrient and Micronutrient intakes according to Gender. *International Journal of Food Sciences and Nutrition, 58(*5), 398-410.

Shiffler, R. E. (1988). Maximum Z scores and outliers. *The American Statistician,42*(1), 79-80. doi: 10.1080/00031305.1988.10475530

Shim, J. S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health, 36.* doi: 10.4178/epih/e2014009

Smith, P. J., & Blumenthal, J. A. (2010, February 01). Diet and neurocognition: Review of evidence and methodological considerations. Current aging science, 3(1), 57-66. (2010). Diet and neurocognition: Review of evidence and methodological considerations. *Current Aging Science, 3*(1), 57-66.

Song, H. J., Cho, Y. G., & Lee, H. J. (2013). Dietary sodium intake and prevalence of overweight in adults. *Metabolism*, *62*(5), 703-708.

Soriano, J. M., Moltó , J. C., & Manes, J. (2000). Dietary intake and food pattern among university students. *Nutrition Research, 20*(9), 1249-1258.

Starkey, L. J., Johnson-Down, L., & Gray-Donald, K. (2001). Food habits of Canadians. *Canadian Journal of Dietetic Practice and Research, 62*(2), 61-69.

Statistics Canada. (2018, January 17). *Surveys and statistical programs - Canadian Community Health SurveyAnnual Component, 2007 to 2014.* Retrieved from https://www150.statcan.gc.ca/n1/en/pub/82-003-x/2018001/article/54901-eng.pdf?st=smqZ6i6V

Stevenson, C., Doherty, G., Barnett, J., Muldoon, O. T., & Trew, K. (2007). Adolescents views of food and eating: Identifying barriers to healthy eating. *Journal of Adolescence, 30*(3),417-434. doi:10.1016/j.adolescence.2006.04.005

Strawson, C., Bell, R. C., Farmer, A., Downs, S. M., Olstad, D. L., & Willows, N. D. (2015). Changing dietary habits of Alberta nutrition students enrolled in a travel study program in Italy. *Canadian Journal of Dietetic Practice and Research, 76*(2), 93-96. https://doi.org/10.3148/cjdpr-2015-008

Strawson, C., Bell, R., Downs, S., Farmer, A., Olstad, D., & Willows, N. (2013). Dietary Patterns of Female University Students: With Nutrition Education. *Cana-*

dian Journal of Dietetic Practice and Research, 74(3), 138-142.

Strik, C. M., Lithander, F. E., McGill, A. T., MacGibbon, A. K., McArdle, B. H., & Poppitt, S. D. (2010). No evidence of differential effects of SFA, MUFA or PUFA on post-ingestive satiety and energy intake: A randomised trial of fatty acid saturation. *Nutrition Journal, 9*(1), 24. https://doi.org/10.1186/1475-2891-9-24

Stroud, C., Walker, L. R., Davis, M., & Irwin Jr, C. E. (2015). Investing in the Health and Well-Being of Young Adults. *Journal of Adolescent Health. 56*(2), 127-129. doi: 10.1016/j.jadohealth.2014.11.012

Takachi, R., Tsubono, Y., Baba, K., Inoue, M., Sasazuki, S., Iwasaki, M., & Tsugane, S. (2011). Red meat intake may increase the risk of colon cancer in Japanese, a population with relatively low red meat consumption. *Asia Pacific Journal of Clinical Nutrition, 20*(4), 603-612. doi:10.6133/apjcn.2011.20.4.14

Tanner, J., & Yabiku, S. (1999). Conclusion: The economics of young adulthoodOne future or two. *Transitions to adulthood in a changing economy: No work, no family, no future,* 254-268. Retrieved from https://books.google.ca/books?id =m5MujeuOIKIC

Tapsell, L. C., Neale, E. P., Satija, A., & Hu, F. B. (2016). Foods, nutrients, and

dietary patterns: interconnections and implications for dietary guidelines. *Advances in Nutrition, 7*(3), 445-454. doi: 10.3945/an.115.011718

Thompson, F. E., & Subar, A. F. (2013). *Dietary assessment methodology. In Nutrition in the Prevention and Treatment of Disease (Third Edition*) (pp. 5-46). Retrieved from https://doi.org/10.1016/B978-0-12-391884-0.00001-9

Thompson, J., Manore, M., &Sheeshka, J. (2007). *Nutrition-a Functional Approach,* Canadian Edition. Pearson: Benjamin Cummings. Toronto. Retrieved from https://books.google.ca/books?id=klcLlwEACAAJ

Togo, P., Osler, M., Sørensen, T. I., & Heitmann, B. L. (2001). Food intake patterns and body mass index in observational studies. *International Journal of Obesity, 25*(12), 1741-1751.

Troisi, R. J., Willett, W. C., Weiss, S. T., Trichopoulos, D., Rosner, B., & Speizer, F. E. (1995). A Prospective Study of Diet and Adult-Onset Asthma. *American Journal of Respiratory and Critical Care Medicine, 151*(5), 1401-1408.

Trumbo, P. R., Barr, S. I., Murphy, S. P., & Yates, A. A. (2013). Dietary reference intakes: Cases of appropriate and inappropriate uses. *Nutrition Reviews*, 657-664.

Wardle, J., Parmenter, K., & Waller, J. (2000). Nutrition knowledge and food intake. *Appetite*, 269-275. Retrieved from https://doi.org/10.1006/appe.1999.0311

WY, G., & AS, H. (2011). Differences in eating behaviours, dietary intake and body weight status between male and female Malaysian University students. *Malaysian Journal of Nutrition, 17*(2), 213-228.

Zijno, A., Andreoli, C., Leopardi, P., Marcon, F., Rossi, S., Caiola, S., Verdina A., Galati R., Cafolla A & Crebelli, R. (2003). Folate status, metabolic genotype, and biomarkers of genotoxicity in healthy subjects. *Carcinogenesis, 24*(6), 10971103. doi:10.1093/carcin/bgg064bgg064

Appendix A

Physical Activity Coefficient used for Estimating Energy Requirement

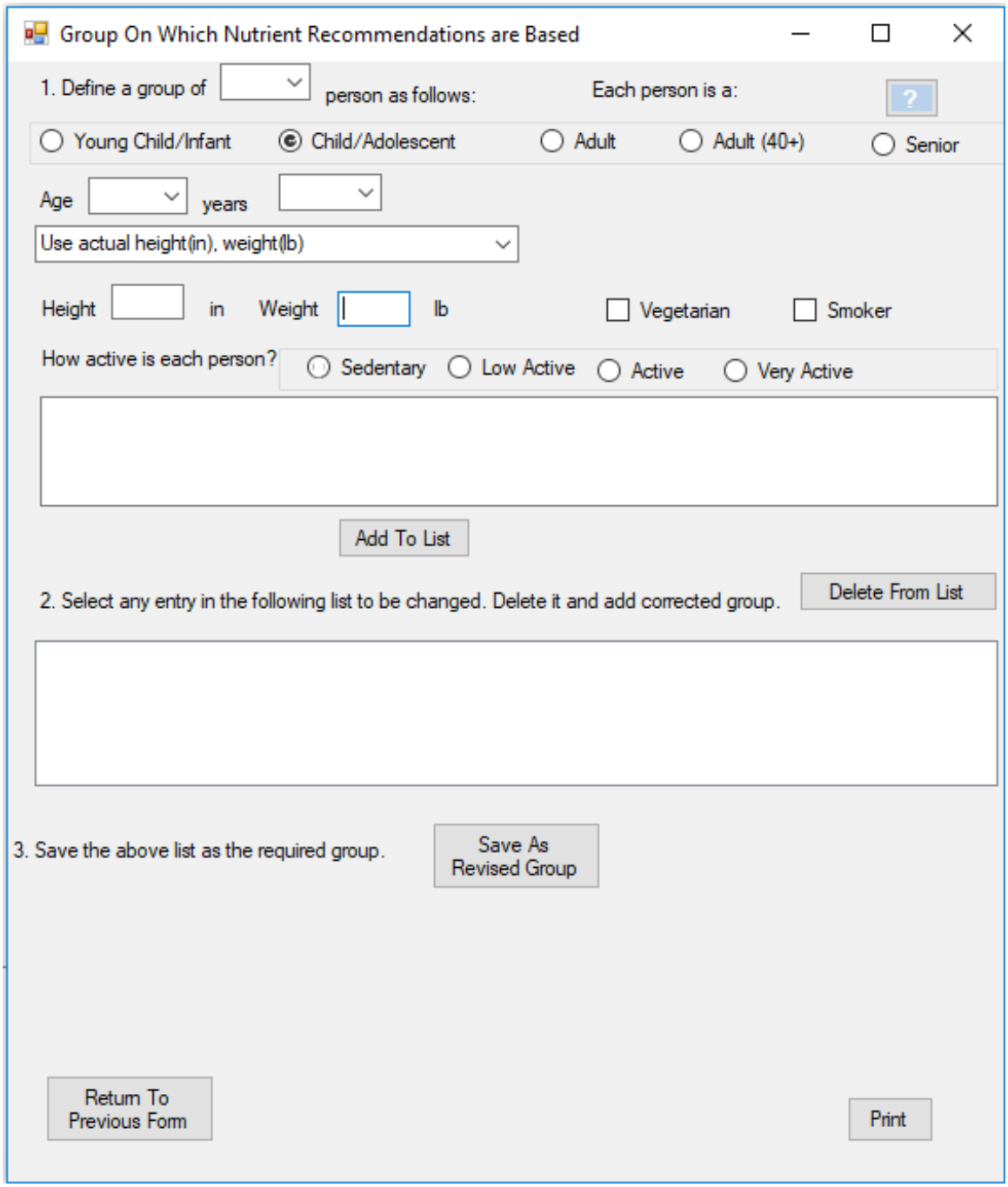
Physical Activity Coefficients (PA values) for use in EER equations

	Sedentary (PAL 1.0-1.39) Typical daily living activities (e.g., household tasks, walking to the bus)	Low Active (PAL 1.4-1.59) Typical daily living activities PLUS 30 - 60 minutes of daily moderate activity (ex. walking at 5-7 km/h)	Active (PAL 1.6-1.89) Typical daily living activities PLUS At least 60 minutes of daily moderate activity	Very Active (PAL 1.9-2.5) Typical daily living activities PLUS At least 60 minutes of daily moderate activity PLUS An additional 60 minutes of vigorous activity or 120 minutes of moderate activity
Boys 3 - 18 y	1.00	1.13	1.26	1.42
Girls 3 - 18 y	1.00	1.16	1.31	1.56
Men 19 y +	1.00	1.11	1.25	1.48
Women 19 y +	1.00	1.12	1.27	1.45

Source: Institute of Medicine. 2006. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Washington, DC: The National Academies Press.http://www.nap.edu/catalog/11537.html

Appendix B

Questionnaire used by Food Focus Software



* Source (Food Focus Nutrition Analysis Software, version 4.1), this questionnaire has been extracted from Food Focus version 4.1 software and was used to the collect the general demographics of students

Appendix C

A sample of 3-day food log assignment used

Date & Time	Location	Food/Beverage	Amount	Canada Food Guide Servings
Thursday, July 7, 12:30 pm	School	Toasted Everything bagel	1	2 Grain products
		Plain cream cheese	3 tablespoons	Other
		Tim Horton's regular coffee, brewed	1 cup	Other
		Cream (half & half)	2 tablespoons	Other
		Sugar	2 teaspoons	Other
Thursday, July 7, 5:00 pm	Restaurant	Curried Chicken breast (slices)	1 cup	2 meat and alternatives
		Curried carrots and squash	1 cup	2 vegetables and fruit
		Steamed white rice	1 cup	2 grain products
		Water	1 cup	Other
Friday, July 8, 8:00 am	Home	Toasted white bread	1 slice	1 grain products
		Planters Smooth Peanut butter	2 tablespoons	1 meat and alternatives
		Banana	1 fruit	1 vegetables and fruit
		2 % milk	1 cup	1 milk and alternatives
Friday, July 8, 1:30 pm	School	Tim Horton's potato wedges	½ cup	Other
		Tim Horton's Iced cappuccino	1 cup	Other
		Cream (half & half)	2 tablespoons	Other
Friday, July 8, 8:00 pm	Restaurant	Boiled Linguine Noodles	1 cup	1 grain products
		Pesto Sauce	½ cup	Other
		Sauteed Prawns	¼ cup	½ meat and alternatives
		Water	1 cup	Other
Saturday, July 9, 10:00 am	Home	Quaker Cinnamon Apple Oatmeal	1 cup	1 grain products
		2% Milk	1 ½ cup	1 ½ milk and alternatives
Saturday, Jul 1:30 pm	Home	Steamed white rice	½ cup	1 grain products
		Fried Filipino hot dogs (longanisa)	½ cup	1 meat and alternatives
		Canola oil	2 teaspoon	Other (daily fat + oil intake)
		Tropicana 100% Orange juice	1 cup	2 vegetables and fruit
Saturday, July 9, 7:00 pm	Restaurant	Fish tacos – soft corn taco shells	1 ½ taco shells	1 grain products
		Fried Haddock fish	½ cup	1 meat and alternatives
		Mixed veggies – lettuce, tomato	½ cup	1 Vegetables and Fruit
		Water	2 cups	Other

Food List
1 unit of 1 large bagel (11.4cm dia) BAGEL, PLAIN (WITH ONION, POPPY SEED AND/OR SESAME SEED), TOASTED
3 TBSP of CHEESE, CREAM
1 CUP of COFFEE, BREWED
2 TBSP of CREAM, CEREAL (HALF AND HALF), 10% M.F.
2 TSP of SWEETS, SUGARS, GRANULATED
1/2 CUP of (based on 100ml mashed) CARROT, BOILED, DRAINED, WITH SALT
1/2 CUP of (based on 100ml cubes) SQUASH, WINTER, BUTTERNUT, BAKED, WITH SALT
1 CUP of GRAINS, RICE, WHITE, STEAMED, CHINESE RESTAURANT
1 unit of 1 piece FAST FOODS, ENTREE, CHICKEN, BREADED AND FRIED, BREAST, MEAT AND SKIN WITH BREADING
2 CUP of WATER, MUNICIPAL
1 unit of 1 slice BREAD, WHITE, COMMERCIAL, TOASTED
2 TBSP of PEANUT BUTTER, SMOOTH TYPE, FAT, SUGAR AND SALT ADDED
1 unit of 1 fruit (22 cm x 3.6 cm dia) BANANA, RAW
1 CUP of MILK, FLUID, PARTLY SKIMMED, 2% M.F.
1 unit of 1 medium FAST FOODS, SIDE DISH, POTATO, FRENCH-FRIED IN VEGETABLE OIL
1 CUP of COFFEE, INSTANT, SWEETENED, CAPPUCINO FLAVOUR, POWDER, WATER ADDED
2 TBSP of CREAM, CEREAL (HALF AND HALF), 10% M.F.
1 CUP of PASTA, SPAGHETTI, ENRICHED, COOKED, SALTED
1/2 CUP of SAUCE, ALFREDO, DEHYDRATED
1/4 CUP of SHRIMP, MIXED SPECIES, BOILED OR STEAMED
2 CUP of WATER, MUNICIPAL
1 unit of 1 packet (individual) CEREALS, QUAKER, INSTANT OATMEAL, NUTRITION FOR WOMEN, APPLE SPICE, PREPARED WITH BOILING WATER REF#U23
1/2 CUP of MILK, FLUID, PARTLY SKIMMED, 2% M.F.
1/2 CUP of GRAINS, RICE, WHITE, STEAMED, CHINESE RESTAURANT
2 units of 1 link PORK SAUSAGE RICE LINKS, BROWN AND SERVE, COOKED
1 TBSP of VEGETABLE OIL, CANOLA
1 CUP of ORANGE JUICE, CHILLED, INCLUDES FROM CONCENTRATE, FORTIFIED WITH ADDED CALCIUM AND VITAMIN D
2 units of 1 tortilla (7.6cm dia) TORTILLA, READY-TO-BAKE / FRY, CORN
2 units of 100ml flaked HADDOCK, BAKED OR BROILED
1 unit of 100ml shredded or chopped LETTUCE, ICEBERG, RAW
1/4 unit of 250ml chopped or sliced (1 cup) TOMATO, RED, RIPE, RAW, YEAR ROUND AVERAGE
2 CUP of WATER, MUNICIPAL

Nutrient Detail

	Quantity	Food Name
#1	1unitof1largebagel(11.4cmd	BAGEL, PLAIN (WITH ONION, POPPY SEED AND/OR SESAME SEED), TOA
#2	3 TBSP of	CHEESE, CREAM
#3	1 CUP of	COFFEE, BREWED
#4	2 TBSP of	CREAM, CEREAL (HALF AND HALF), 10% M.F.
#5	2 TSP of	SWEETS, SUGARS, GRANULATED
#6	1/2CUPof(basedon100mlmashe	CARROT, BOILED, DRAINED, WITH SALT
#7	1/2CUPof(basedon100mlcubes	SQUASH, WINTER, BUTTERNUT, BAKED, WITH SALT
#8	1 CUP of	GRAINS, RICE, WHITE, STEAMED, CHINESE RESTAURANT
#9	1 unit of 1 piece	FAST FOODS, ENTREE, CHICKEN, BREADED AND FRIED, BREAST, MEAT
#10	2 CUP of	WATER, MUNICIPAL
#11	1 unit of 1 slice	BREAD, WHITE, COMMERCIAL, TOASTED
#12	2 TBSP of	PEANUT BUTTER, SMOOTH TYPE, FAT, SUGAR AND SALT ADDED
#13	1unitof1fruit(22cmx3.6cmdi	BANANA, RAW
#14	1 CUP of	MILK, FLUID, PARTLY SKIMMED, 2% M.F.
#15	1 unit of 1 medium	FAST FOODS, SIDE DISH, POTATO, FRENCH-FRIED IN VEGETABLE OIL
#16	1 CUP of	COFFEE, INSTANT, SWEETENED, CAPPUCINO FLAVOUR, POWDER, WATER
#17	2 TBSP of	CREAM, CEREAL (HALF AND HALF), 10% M.F.
#18	1 CUP of	PASTA, SPAGHETTI, ENRICHED, COOKED, SALTED
#19	1/2 CUP of	SAUCE, ALFREDO, DEHYDRATED
#20	1/4 CUP of	SHRIMP, MIXED SPECIES, BOILED OR STEAMED
#21	2 CUP of	WATER, MUNICIPAL
#22	1unitof1packet (individual	CEREALS, QUAKER, INSTANT OATMEAL, NUTRITION FOR WOMEN, APPLE
#23	1/2 CUP of	MILK, FLUID, PARTLY SKIMMED, 2% M.F.
#24	1/2 CUP of	GRAINS, RICE, WHITE, STEAMED, CHINESE RESTAURANT
#25	2 units of 1 link	PORK SAUSAGE RICE LINKS, BROWN AND SERVE, COOKED
#26	1 TBSP of	VEGETABLE OIL, CANOLA
#27	1 CUP of	ORANGE JUICE, CHILLED, INCLUDES FROM CONCENTRATE, FORTIFIED W
#28	2unitsof1tortilla(7.6cmdia	TORTILLA, READY-TO-BAKE / FRY, CORN
#29	2 units of 100ml flaked	HADDOCK, BAKED OR BROILED
#30	1unitof100mlshreddedorchop	LETTUCE, ICEBERG, RAW
#31	1/4unitof250mlchoppedorsli	TOMATO, RED, RIPE, RAW, YEAR ROUND AVERAGE
#32	2 CUP of	WATER, MUNICIPAL
SUM		

Nutrient Detail

	Mass	ENERGY	CARB	FIBRE	PROTEIN	FAT	SUGARS	AddSugars	SatFAT	TransFat
	grams	KCAL	G	G	G	G	G	G	G	G
#1	102.0	295	58.3	2.7	11.4	1.8	5.9	5.5	0.29	0.0
#2	44.0	150	1.8	0.0	2.6	15.1	1.4	0.0	8.49	0.0
#3	237.0	0	0.0	0.0	0.3	0.0	0.0	0.0	0.00	0.0
#4	30.0	35	1.3	0.0	0.9	3.0	0.0	0.0	1.87	0.0
#5	8.0	31	8.0	0.0	0.0	0.0	8.0	8.0	0.00	0.0
#6	114.0	40	9.4	3.4	0.9	0.2	3.9	0.0	0.03	0.0
#7	102.0	41	10.7	0.0	0.9	0.1	2.0	0.0	0.01	0.0
#8	132.0	199	44.7	1.2	4.2	0.4	0.0	0.0	0.00	0.0
#9	199.0	501	15.5	1.0	43.6	29.5	0.0	0.0	7.80	0.4
#10	474.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
#11	22.0	64	12.0	0.6	2.0	0.9	1.0	1.0	0.13	0.0
#12	32.0	188	6.3	1.8	8.0	16.1	3.0	1.0	3.36	0.0
#13	115.0	102	26.3	2.0	1.3	0.4	14.1	0.0	0.13	0.0
#14	244.0	122	11.7	0.0	8.1	4.8	12.3	0.0	1.70	0.1
#15	134.0	427	50.3	4.7	5.0	22.8	0.9	0.0	5.31	5.9
#16	256.0	82	14.3	0.0	0.5	2.8	9.5	7.7	2.44	0.0
#17	30.0	35	1.3	0.0	0.9	3.0	0.0	0.0	1.87	0.0
#18	140.0	220	42.8	2.5	8.1	1.3	0.8	0.0	0.25	0.0
#19	60.0	321	21.9	1.2	9.2	21.8	3.2	0.0	7.91	0.0
#20	36.0	36	0.0	0.0	7.5	0.4	0.0	0.0	0.10	0.0
#21	474.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
#22	166.0	178	34.9	3.2	5.0	2.0	0.0	0.0	0.33	0.0
#23	122.0	61	5.9	0.0	4.0	2.4	6.2	0.0	0.85	0.1
#24	66.0	100	22.4	0.6	2.1	0.2	0.0	0.0	0.00	0.0
#25	50.0	204	1.2	0.0	6.9	18.8	0.0	0.0	3.35	0.0

DRI Detail

Group #, Description

1 1 Female, 19 years, 61 in, 95 lb, sedentary

Nutrient (Units)	Group#	RDA_AI	UL	AMDR_Min	AMDR_Max
FOOD ENERGY (KCAL) DRI	1	1750.0			
Nutrients in 3 day Food List		3830.3 KCAL			
% of Dietary Reference Intake		73%			
CARBOHYDRATE (G) DRI	1			45.0%	65.0%
Nutrients in 3 day Food List		433.1 G		45.0%	45.0%
% of Dietary Reference Intake	Yellow			100%	69%
TOTAL DIETARY FIBRE (G) DRI	1	24.0*			
Nutrients in 3 day Food List		26.8 G			
% of DRI (energy adjusted AI)	Red	37%			
PROTEIN (G) DRI	1	34.5		10.0%	35.0%
Nutrients in 3 day Food List		164.5 G		17.0%	17.0%
% of Dietary Reference Intake	Green	159%		170%	49%
FAT (G) DRI	1			20.0%	35.0%
Nutrients in 3 day Food List		163.9 G		38.0%	38.0%
% of Dietary Reference Intake	Yellow			190%	109%
TOTAL SUGARS (G)	1				
Nutrients in 3 day Food List		74.3 G			
% of Dietary Reference Intake					
ADDED SUGARS (G)	1		19.1*		
Nutrients in 3 day Food List		23.2 G	23.2		
% of AHA/USDA recommendation	Green		40%		
TOTAL SATURATED FAT (G)	1		13.6*		
Nutrients in 3 day Food List		47.6 G	47.6		
% of AHA recommendation	Red		117%		
TOTAL TRANS FAT (G)	1				
Nutrients in 3 day Food List		6.8 G			
% of Dietary Reference Intake					
TOTAL MONOUNSATURATED FAT (G)	1				
Nutrients in 3 day Food List		62.3 G			
TOTAL PUFA (POLYUNSAT'D FAT) (G)	1				
Nutrients in 3 day Food List		31.4 G			
CHOLESTEROL (MG)	1		300.0*		
Nutrients in 3 day Food List		493.8 MG	493.8		
% of AHA recommendation	Yellow		55%		
VITAMIN A (RAE) (MCG) DRI	1	700.0	3000.0		
Nutrients in 3 day Food List		2477.4 MCG	2477.4		
% of Dietary Reference Intake	Green	118%	28%		
VITAMIN D (IU) DRI	1	600.0	4000.0		
Nutrients in 3 day Food List		458.0 IU	458.0		
% of Dietary Reference Intake	Red	25%	4%		

Group #, Description
1 1 Female, 19 years, 61 in, 95 lb, sedentary

Nutrient (Units)	Group#	RDA_AI	UL	AMDR_Min	AMDR_Max
VITAMIN E (MG) DRI	1	15.0	1000.0		
Nutrients in 3 day Food List		18.4 MG	18.4		
% of Dietary Reference Intake	Red	41%	1%		
THIAMIN (MG) DRI	1	1.1			
Nutrients in 3 day Food List		2.9 MG			
% of Dietary Reference Intake	Yellow	88%			
RIBOFLAVIN (MG) DRI	1	1.1			
Nutrients in 3 day Food List		2.6 MG			
% of Dietary Reference Intake	Red	79%			
NIACIN (NE) DRI	1	14.0			
Nutrients in 3 day Food List		83.5 NE			
% of Dietary Reference Intake	Green	199%			
VITAMIN B6 (MG) DRI	1	1.3	100.0		
Nutrients in 3 day Food List		4.1 MG	4.1		
% of Dietary Reference Intake	Green	105%	1%		
FOLATE (MCG) DRI	1	400.0	1000.0		
Nutrients in 3 day Food List		841.6 MCG	841.6		
% of Dietary Reference Intake	Red	70%	28%		
VITAMIN B12 (MCG) DRI	1	2.4			
Nutrients in 3 day Food List		7.3 MCG			
% of Dietary Reference Intake	Green	101%			
VITAMIN C (MG) DRI	1	75.0	2000.0		
Nutrients in 3 day Food List		124.4 MG	124.4		
% of Dietary Reference Intake	Red	55%	2%		
SODIUM (MG) DRI	1	1500.0*	2300.0		
Nutrients in 3 day Food List		5840.7 MG	5840.7		
% of Dietary Reference Intake	Yellow	130%	85%		
POTASSIUM (MG) DRI	1	4700.0*			
Nutrients in 3 day Food List		5183.5 MG			
% of Dietary Reference Intake	Red	37%			
CALCIUM (MG) DRI	1	1000.0	2500.0		
Nutrients in 3 day Food List		1981.1 MG	1981.1		
% of Dietary Reference Intake	Red	66%	26%		
IRON (MG) DRI	1	18.0	45.0		
Nutrients in 3 day Food List		25.1 MG	25.1		
% of Dietary Reference Intake	Yellow	46%	19%		

Note: * in the RDA_AI column indicates the value is an AI rather than an RDA
* in the 'UL' column value indicates the value represents 'above ideal' rather than being a DRI UL which represents 'above safe level'.
For infants, FoodFocus uses niacin guidelines which are approximations applied to niacin expressed as NE. The official DRI AI applies to preformed niacin.

Display Mode

○ Scientific Units ◉ % Daily DRI ○ Nutrient Balance

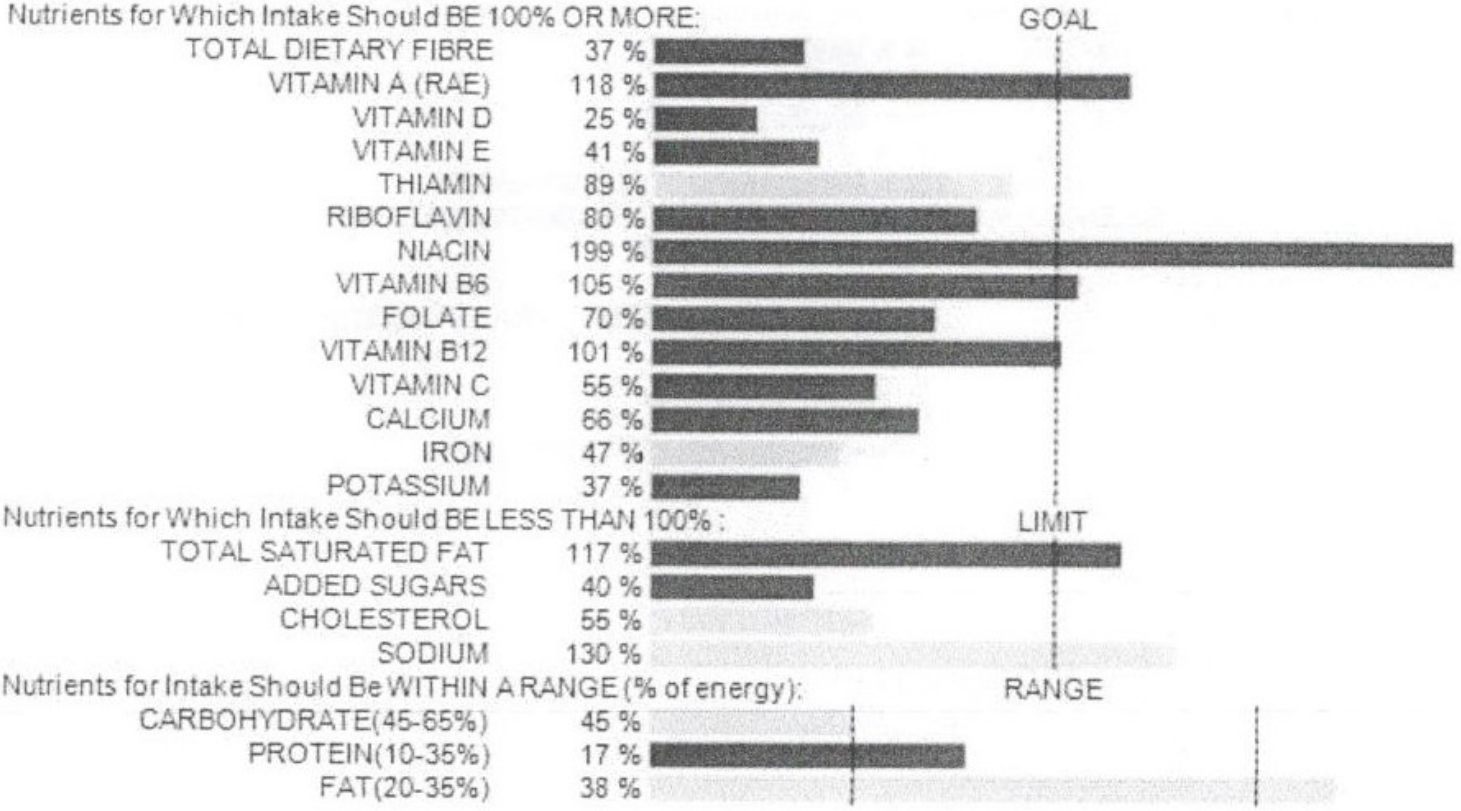
FIBRE(% of target) 50% Cost= $25.76

CALORIES FROM CARBOHYDRATES 45% (LOW) , FAT 38% (HIGH) , PROTEIN 17% (OK)

FROM SAT FAT 11 % (HIGH) ADDED SUGAR 2 % (OK)

% Dietary Reference Intake for 3 Days for 1 person

FOOD ENERGY	73 %



Show People Next Page Print

Appendix D

Recommendation by Canada's Food Guide (CFG)

Source: Health Canada. (2011). Eating Well with Canada's Food Guide: A Resource for Educators and Communicators.

Publications Health Canada. ISBN: 978-1-100-19678-7.

Retrieved from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/pubs/res-educate-eng.pdf

Recommended Number of Food Guide Servings per Day

	Children			Teens		Adults			
Age in Years	2-3	4-8	9-13	14-18		19-50		51+	
Sex	Girls and Boys			Females	Males	Females	Males	Females	Males
Vegetables and Fruit	4	5	6	7	8	7-8	8-10	7	7
Grain Products	3	4	6	6	7	6-7	8	6	7
Milk and Alternatives	2	2	3-4	3-4	3-4	2	2	3	3
Meat and Alternatives	1	1	1-2	2	3	2	3	2	3

The chart above shows how many Food Guide Servings you need from each of the four food groups every day.

Having the amount and type of food recommended and following the tips in *Canada's Food Guide* will help:

- Meet your needs for vitamins, minerals and other nutrients.
- Reduce your risk of obesity, type 2 diabetes, heart disease, certain types of cancer and osteoporosis.
- Contribute to your overall health and vitality.

What is One Food Guide Serving?
Look at the examples below.

Fresh, frozen or canned vegetables
125 mL (½ cup)

Leafy vegetables
Cooked: 125 mL (½ cup)
Raw: 250 mL (1 cup)

Fresh, frozen or canned fruits
1 fruit or 125 mL (½ cup)

100% Juice
125 mL (½ cup)

Bread
1 slice (35g)

Bagel
½ bagel (45 g)

Flat breads
½ pita or ½ tortilla (35 g)

Cooked rice, bulgur or quinoa
125 mL (½ cup)

Cereal
Cold: 30 g
Hot: 175 mL (¾ cup)

Cooked pasta or couscous
125 mL (½ cup)

Milk or powdered milk (reconstituted)
250 mL (1 cup)

Canned milk (evaporated)
125 mL (½ cup)

Fortified soy beverage
250 mL (1 cup)

Yogurt
175 g
(¾ cup)

Kefir
175 g
(¾ cup)

Cheese
50 g (1 ½ oz.)

Cooked fish, shellfish, poultry, lean meat
75 g (2 ½ oz.)/125 mL (½ cup)

Cooked legumes
175 mL (¾ cup)

Tofu
150 g or
175 mL (¾ cup)

Eggs
2 eggs

Peanut or nut butters
30 mL (2 Tbsp)

Shelled nuts and seeds
60 mL (¼ cup)

Oils and Fats

- Include a small amount – 30 to 45 mL (2 to 3 Tbsp) – of unsaturated fat each day. This includes oil used for cooking, salad dressings, margarine and mayonnaise.
- Use vegetable oils such as canola, olive and soybean.
- Choose soft margarines that are low in saturated and trans fats.
- Limit butter, hard margarine, lard and shortening.

Eating Well with Canada's Food Guide

What is a Food Guide Serving of…

Vegetables and Fruit

Dark Green and Orange Vegetables


Asparagus
125 mL, ½ cup, 6 spears

Beans, green
125 mL, ½ cup


Bok choy/Chinese cabbage (Choi sum)
125 mL, ½ cup – cooked


Broccoli
125 mL, ½ cup


Brussels sprouts
125 mL, ½ cup, 4 sprouts


Carrots
125 mL, ½ cup, 1 large


Chard
125 mL, ½ cup


Dandelion greens
250 mL, 1 cup – raw


Edamame (soy beans)
125 mL, ½ cup


Endive
250 mL, 1 cup


Fiddleheads
125 mL, ½ cup


Kale/collards
250 mL, 1 cup – raw


Leeks
125 mL, ½ cup, ½ leek


Lettuce, romaine
250 mL, 1 cup – raw


Mesclun mix
250 mL, 1 cup – raw


Mustard greens
250 mL, 1 cup – raw


Okra
125 mL, ½ cup


Peas
125 mL, ½ cup


Pepper, sweet, green
125 mL, ½ cup, ½ medium


Pumpkin
125 mL, ½ cup


Seaweed
125 mL, ½ cup


Snow peas
125 mL, ½ cup


Spinach
250 mL, 1 cup – raw


Squash
125 mL,½ cup


Sweet potato
125 mL, ½ cup


Yam
125 mL, ½ cup


Zucchini
125 mL, ½ cup

Canada

More Vegetables and Fruits

Some orange coloured fruit can be substituted for an orange vegetable. See the fruit marked with an asterisks (*)


Apple
1 medium


Apricot, fresh *
3 fruits


Avocado
½ fruit


Bamboo shoots
125 mL, ½ cup


Banana
1 medium


Beans, yellow
125 mL, ½ cup


Beets
125 mL, ½ cup


Berries
125 mL, ½ cup


Bitter melon
125 mL, ½ cup, ½ pod


Cabbage
125 mL, ½ cup


Cantaloupe *
125 mL, ½ cup


Cauliflower
125 mL, ½ cup, 4 flowerets


Celery
1 medium stalk


Chayote
125 mL, ½ cup


Cherries
20


Corn
1 ear, 125 mL, ½ cup


Cucumber
125 mL, ½ cup


Dried fruit
60 mL, 1/4 cup


Eggplant
125 mL, ½ cup


Fig, fresh
2 medium


Fruit juice
125 mL, ½ cup


Grapefruit
½ fruit


Grapes
20 fruits


Guava
125 mL, ½ cup, 1 fruit


Honeydew
125 mL, ½ cup


Kiwi
1 large fruit


Kohlrabi
125 mL, ½ cup


Lettuce (example: iceberg or butterhead)
250 mL, 1 cup – raw


Lychee
10 fruits


Mango *
125 mL, ½ cup, ½ fruit


Mixed vegetables
125 mL, ½ cup


Mushrooms
125 mL, ½ cup


Nectarine *
1 fruit


Orange
1 medium


Papaya *
½ fruit


Peach *
1 medium


Pear
1 medium


Peppers, bell
125 mL, ½ cup, ½ medium


Pineapple
125 mL, ½ cup, 1 slice


Plantain
125 mL, ½ cup

Plum
1 fruit

Potato
125 mL, ½ cup, ½ medium

Radishes
125 mL, ½ cup

Rhubarb
125 mL, ½ cup

Tomato
125 mL, ½ cup

Tomato sauce
125 mL, ½ cup

Turnip
125 mL, ½ cup

Vegetable juice
125 mL, ½ cup

Watermelon
125 mL, ½ cup

Eating Well with Canada's Food Guide

What is a Food Guide Serving of…

Grain Products

Whole Grain

Bagel, whole grain
½ bagel, 45 g

Barley
125 mL, ½ cup – cooked

Bread, pumpernickel or rye
1 slice, 35 g

Bread, whole grain
1 slice, 35 g

Bulgur
125 mL, ½ cup – cooked

Cereal, cold, whole grain
30 g

Cereal, hot, whole grain (example: oatmeal)
150 g, 175 mL, ¾ cup – cooked

Couscous, whole wheat
125 mL, ½ cup – cooked

Crackers, rye
30 g

Crackers, whole grain
30 g

English muffin, whole grain
½ muffin, 35 g

Muffin, whole grain
½ muffin, 35 g

Pasta/noodles, whole grain
125 mL, ½ cup – cooked

Pita, whole grain
35 g, ½ pita

Popcorn, plain
500 mL, 2 cups

Quinoa
125 mL, ½ cup – cooked

Rice, brown
125 mL, ½ cup – cooked

Rice, wild
125 mL, ½ cup – cooked

Roll, whole wheat
1 roll, 35 g

Tortilla, whole wheat
½ piece, 35 g

Waffle, whole wheat
1 small, 35 g

Canada

Non Whole Grain


Baguette, French
1 slice, 35 g


Bannock
1 medium, 35 g


Bread, white
1 slice, 35 g


Cereal, cold
30 g


Cereal, hot (example: cream of wheat)
150 g, 175 mL, ¾ cup – cooked


Congee
125 mL, ½ cup – cooked


Cornbread
1 slice, 35 g


Couscous
125 mL, ½ cup – cooked


Cracker, saltines
10 crackers, 30 g


English muffin, white
½ muffin, 35 g


Naan
¼ naan, 35 g


Pancake
1 small, 35 g


Pasta/noodles, white
125 mL, ½ cup – cooked


Pita, white
½ pita, 35 g


Polenta
125 mL, ½ cup – cooked


Rice cake
2 medium


Rice, white
125 mL, ½ cup – cooked


Roll, white
1 roll, 35 g


Tortilla, corn
½ piece, 35 g


Waffle
1 small, 35 g

Eating Well with Canada's Food Guide

What is a Food Guide Serving of…

Milk and Alternatives

Milk


Milk, skim, 1%, 2%
250 mL, 1 cup


Milk, chocolate
250 mL, 1 cup


Milk, evaporated, canned
125 mL, ½ cup – undiluted


Milk, goat, enriched
250 mL, 1 cup


Milk, lactose reduced
250 mL, 1 cup


Milk, powdered
25 g, 75 mL, ⅓ cup


Milk, powdered
250 mL, 1 cup – reconstituted


Milk, whole
250 mL, 1 cup

Alternatives

*** Fortified soy beverages are an option for people who do not drink milk.**


Buttermilk
250 mL, 1 cup


Cheese, block (example: cheddar, Mozzarella, Swiss, feta) 50 g, 1 ½ oz


Cheese, cottage or quark
250 mL, 1 cup


Cheese, goat
50 g, 1 ½ oz


Fortified soy beverage
250 mL, 1 cup

Kefir
175 g, 175 mL, ¾ cup

Paneer
50 g, 1 ½ oz


Pudding/custard (made with milk)
125 mL, ½ cup


Yogurt (plain and flavoured)
175 g, 175 mL, ¾ cup


Yogurt drinks
200 mL

Canada

Eating Well with Canada's Food Guide

What is a Food Guide Serving of…

Meat and Alternatives

Meat, fish, poultry and shellfish

All Food Guide Servings of meat, fish, poultry and shellfish are represented as cooked.

Beef
75 g (2 ½ oz) / 125 mL (½ cup)

Bison/Buffalo
75 g (2 ½ oz) / 125 mL (½ cup)

Chicken
75 g (2 ½ oz) / 125 mL (½ cup)

Deli meat, low-fat, low-salt
75 g (2 ½ oz) / 125 mL (½ cup)

Duck
75 g (2 ½ oz) / 125 mL (½ cup)

Fish and shellfish, canned (example: crab, salmon, tuna)
75 g (2 ½ oz) / 125 mL (½ cup)

Fish, fresh or frozen (example: herring, mackerel, trout, salmon, sardines, squid, tuna)
75 g (2 ½ oz) / 125 mL (½ cup)

Game birds (example: ptarmigan, partridge, grouse, goose)
75 g (2 ½ oz) / 125 mL (½ cup)

Game meats (example: deer, moose, caribou, elk)
75 g (2 ½ oz) / 125 mL (½ cup)

Goat
75 g (2 ½ oz) / 125 mL (½ cup)

Ham
75 g (2 ½ oz) / 125 mL (½ cup)

Lamb
75 g (2 ½ oz) / 125 mL (½ cup)

Organ meat (example: liver, kidney)
75 g (2 ½ oz) / 125 mL (½ cup)

Pork
75 g (2 ½ oz) / 125 mL (½ cup)

Rabbit /Hare
75 g (2 ½ oz) / 125 mL (½ cup)

Shellfish, fresh or frozen (example: clams, crab, lobster, mussels, scallops, shrimp, prawns)
75 g (2 ½ oz) / 125 mL (½ cup)

Turkey
75 g (2 ½ oz) / 125 mL (½ cup)

Veal
75 g (2 ½ oz) / 125 mL (½ cup)

Canada

Meat alternatives

Beans, cooked and canned
175 mL, ¾ cup

Egg
2

Hummus
175 mL, ¾ cup

Lentils
175 mL, ¾ cup

Nuts, shelled
60 mL, ¼ cup

Peanut butter or nut butters
30 mL, 2 Tbsp

Seeds, shelled
60 mL, ¼ cup

Tofu
150 g, 175 mL, ¾ cup

Appendix E

Supplementary Material

Abstract

The aim of this study was to estimate the nutritive value of each meal and report the dietary intake of the university students. A convenient sample of 45 was used. Subjects were university students enrolled in an introductory nutrition course, who were required to submit a 1-day food log and used the eatracker software to analyze the nutrient intake. The nutritive value of main meals (which included breakfast, lunch, and dinner) and snack was estimated. Dinner was the most energy dense meal of the day contributing about 35% of total caloric intake, with an average intake of 35.9 g of protein, 15.1 g fat, 72.7 g of carbohydrate, 5.9 g of fiber and 686.6 g of sodium. About 17% of total energy was consumed from snacks, with 9.3 g of protein, 9.9 g fat, 40.3 g carbohydrate, 3.9 g fiber and 262.9 g sodium intake as major constituents. Fruits were a prominent snacking item among the university students.

Introduction

Dietary patterns have a significant impact on an array of health outcomes (Franz et al., 2002). The dietary habits, which are largely evolved during childhood and adolescence, are likely to be altered with changing lifestyle factors (Dietz, 1998; Frech, 2012). Consequently, young adults when in transition to university, gain personal freedom and have more social activities which are likely to alter their eating behavior (El Ansari, Stock, & Mikolajczyk, 2012). Research has shown that unhealthy dietary habits such as skipping meals, increased convenience, and fast food consumption and snacking are more prevalent among university students. It is also reported that the dietary habits developed during this stage of life often persist into later life (Parcel, Muraskin, & Endert, 1998). However, a limited number of studies have estimated the nutritive value of meal consumed by young adults entering into university. This study is aimed to describe the nutritive value of meals and snacks consumed by university students enrolled in an introductory nutrition course. Results from this study provide valuable information regarding the contribution of meals and snacks to energy and nutrient intakes. The information could be used to improve the nutrition interventions for young adults.

Objectives of the study

1. To estimate the energy and nutrient intake from 1-day food log.

2. To estimate the nutritious value of meals (breakfast, lunch, and dinner) and snacks.

Literature Review

Meal pattern and Nutritive value of the meal

According to previous studies, university students dietary intake did not meet the recommended intakes for most of the macronutrients and micronutrients. Limited access to healthy foods, changing lifestyles and monetary issues are referred to as a constraint to the students' dietary pattern (Melo, de Moura, Aires, & Cunha, 2013). Howarth et al. (2007) evaluated differences in meal composition by age groups, young adults (aged 20-59 year, n=1792) and older adults (aged 60-90 year, n=893). Young adults tend to skip meal(breakfast most skipped meal) and consume more snacks as compared to older adults. Both young and older adults consumed a substantial portion of total energy at dinner and snacking was the least source of fiber intake for both the age groups. According to Berner, Becker, Wise, and Doi, (2013), among older males ($aged \geq 51 years$), about 44-48% of the protein was consumed for dinner and about 10-12% from a snack. Winkler, Dring, & Keil, (1999) used 7-day food records to study the meal pattern of men (n=899) aged 45-64 years. It was reported that breakfast and dinner were most regular meals of all eating occasions during the day, while dinner provided most energy (33.1% energy in kcal), 29.2 % at lunch and 17.2% at breakfast.Studies have claimed that environmental changes influence the quality of students diet . At Glasgow university, a research led by Papadaki et al. (2007) reported that, students living away from homes have developed unhealthy eating behavior which included a decrease in consumption of fresh fruits, cooked or raw vegetables, fish and legumes and an increased consumption of fast foods and sugar

intake. Yeh et al. (2010) claimed that students with fast food consumption had a lower intake of fruits and vegetables. Nesliah and Emine (2011) evaluated the eating habit and nutritional status of university students using the 24-hr recall method. It was reported that, among Turkish university students dinner was a major contributor to energy intake and snacks were a major source of total sugar. Meal skipping is a common dietary practice reported among university students (Alam, 2012). Young adults skip breakfast mostly, which coincides with the increase in obesity (Leech, Timperio, Livingstone, Worsley, & McNaughton, 2017; Martin & Benton, 1999). Benton, Slater, and Donohoe, (2001) reported conflicting results, stating that young females (n=150) who had their breakfast before the word recall memory test took longer to recall the words during the test than those who skipped their breakfast. In majority of the previous studies, researcher have assessed the nutritive quality of one meal or of snacks. However, in our study, we have quantitatively described the nutritive quality of three main meals and snacks.

Snacking

Merriam-Webster Dictionary, 11^{th} edition defines a snack as a light meal: eaten between regular meals (p. 1179). Marrale, Shipman, and Rhodes (1986) stated that college students consume about average 25-35% of their total calories from a snack. In another study, between-meal eating (or snacking) was a source of 15-25% of total energy intake among American adults (Drummond, Crombie, & Kirk, 1996). In literature, the frequency of snacking shows a variation from one time per day to eight times per day. According to a report on snacking pattern of U.S. adults,

snacking more times in a day is associated with consuming higher total calorie intake (Sebastian, Wilkinson Enns, & Goldman, 2011). The highest prevalence of 99 % was reported amongst female students at Cornell University, with lunch as a most skipped meal during the day (Jakobovits, Halstead, Kelley, Roe, & Young, 1977). Driskell, Keith, and Tangney (1979) used the 24-hour recall method followed by 2-day food record to evaluate the nutritional status of 150 college students at Virginia Polytechnic Institution. Prevalence of regular snacking was reported among 66%. Studies have shown that higher snacking contribute to higher energy intake and add more empty calories than meals (Hampl, Heaton, & Taylor, 2003; Whybrow & Kirk, 1997). Two studies reported that snacks provided a greater percentage of total sugar and least percentage of carbohydrate than main meals during the day (Summerbell, Moody, Shanks, Stock, & Geissler, 1995; Winkler et al., 1999).

Method

Dataset II comprised of a convenient sample of 45 university student. Students recorded food and beverages intake for one weekday and used eatracker as a nutrient analysis software. It is an online tool, used to track the dietary intake. The outcome variables used in this study are, average energy, nutrients and nutritive value by meal type (breakfast, lunch, and dinner) and snack. For eating occasion (which include breakfast, lunch, dinner and snacking) frequency, if the respondent recorded no food item for the meal, it was counted as a skipped meal. All the information was extracted from the 1-day food log. Information about dietary intake was collected for energy, carbohydrate, protein, fat, fiber, saturated fat, trans-fat, cholesterol, vitamin A, vitamin D, vitamin E, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_6, vitamin B_9, vitamin B_{12}, vitamin C, sodium, potassium, calcium, iron, and water. Nutrient intake by meal type and snack were also estimated from data available. Obtained dietary intake values are reported as mean (standard error), 95% CI, median (interquartile range) using Statistical Package for the Social Sciences (SPSS) version 24.0 for Windows (IBM Corporation,2016). The p-values for differences between meal and snack was based on the paired t-test and p-value <0.05 was considered as statistically significant.

Results

Table E.1 shows the total energy and nutrients intakes from 1-day (include three meals and snacks) food record of university students. Average energy intake (from meals and snacks) was 1673.0 kcal (SE= 84.4), with 95% CI [1499.1, 1839.5 kcal]. Carbohydrate intake was recorded was 214.4 g (SE= 1.8), contributing about 51% of total energy. Protein intake (M= 85.2g, SE=5.4) was estimated to contribute 20% of energy intake. Dietary fat intake (M=52.7, SE= 4.6) contributed 28% of the total energy. Saturated fat accounted for 8.5% of total calorie intake. Table E.2 shows the percentage of energy from macronutrients according to meal type and snack. For breakfast, percent of energy from carbohydrate intake was the highest among all meals of the day and dinner provided a large source of energy derived from protein intake. The nutritive value by meal type and snack was estimated (Table E.3 , Table E.4). Energy intake from meals was larger than that from snacks, contributing to, on average, 82% of total energy intake. In terms of dietary components, compared with snacks, meals were higher in protein (g), fat (g), carbohydrate (g), fiber (g) and sodium (mg). Dinner was the largest contributor to energy (kcal), carbohydrate (g), protein (g) and fiber (g). Snacking was prevalent among 69% of students, moreover, snacks tend to contribute fewer nutrients than meals.

Table E.1: Estimated intake of Energy and Nutrients from 1-day food record

Macronutrients	Unit	Mean(SE)	95%CI	Median(IQR)
Energy Intake	kcal/day	1673.0(84.4)	(1499.1 ,1839.5)	1617.0(756.0)
Carbohydrate	g/day	214.4(11.8)	(189.7 ,237.4)	205.0(106.0)
Protein	g/day	85.2(5.4)	(74.2 ,96.2)	82.4(52.8)
Fat	g/day	52.7(4.6)	(43.8 ,62.3)	46.1(45.0)
Saturated fat	g/day	15.8(1.8)	(12.1 ,19.5)	12.3(11.0)
Trans fat	g/day	0.5(0.1)	(0.3 ,0.7)	0.1(0.6)
Cholesterol	mg/day	239.8(26.6)	(186.1 ,293.5)	203.0(244.3)
Fiber	g/day	18.6(1.4)	(15.7 ,21.5)	16.7(14.7)
Water	L/day	1.2(0.1)	(1.0 ,1.5)	0.9(1.1)
Vitamins	Unit	Mean(SE)	95%CI	Median(IQR)
Vitamin A	g/day	769.9(94.0)	(580.4 ,959.3)	634.2(602.2)
Vitamin D	IU/day	184.8(18.6)	(147.4 ,222.2)	172.0(134.0)
Vitamin E	mg/day	6.2(0.7)	(4.7 ,7.6)	4.6(5.0)
Vitamin B_1	mg/day	1.4(0.1)	(1.2 ,1.7)	1.3(1.0)
Vitamin B_2	mg/day	1.7(0.1)	(1.5 ,1.9)	1.7(0.9)
Vitamin B_3	mg/day	41.7(3.2)	(35.2 ,48.2)	40.0(28.6)
Vitamin B_6	mg/day	2.0(0.1)	(1.7 ,2.2)	1.9(1.1)
Vitamin B_9	g/day	354.4(24.3)	(305.4 ,403.4)	320.8(193.8)
Vitamin B_{12}	g/day	3.7(0.3)	(3.0 ,4.4)	3.5(2.3)
Vitamin C	mg/day	105.8(12.4)	(80.8 ,130.7)	68.4(123.7)
Elements	Unit	Mean(SE)	95%CI	Median(IQR)
Sodium	mg/day	2089.5(180.5)	(1725.6 ,2453.3)	1798.0(1597.7)
Potassium	mg/day	2793.8(164.8)	(2461.7 ,3125.9)	2738.4(1630.6)
Calcium	mg/day	789.4(56.8)	(675.0 ,903.9)	773.7(444.5)
Iron	mg/day	11.0(0.7)	(9.6 ,12.5)	10.2(6.1)

Abbreviation: SE (standard error); CI (Confidence Interval); IQR (Inter Quartile Range); Vitamin B_1: Thiamine; Vitamin B_2: Riboflavin; Vitamin B_3: Niacin; Vitamin B_6: Pyridoxine; Vitamin B_9: Folate; Vitamin B_12: Cobalamin.

Table E.2: Percentage Energy from Protein, Fat and Carbohydrate by Meal type and Snack

	Breakfast	Lunch	Dinner	Snack
AMDR	(%)	(%)	(%)	(%)
Protein (10-35%)	16.5	22.2	25.2	13.0
Fat (20-35%)	30.1	30.9	23.7	31.0
Carbohydrate (45-65%)	53.3	46.9	50.0	56.1

Abbreviation: AMDR (Acceptable Macronutrient Distribution Range), refers to percentage of energy intake from macronutrients.

Table E.3: Energy and Nutritive value by Meal type and Snack

	Energy (kcal/day) Mean(SE)	Protein (g/day) Mean(SE)	Fat (g/day) Mean(SE)	Carbohydrate (g/day) Mean(SE)	Fiber (g/day) Mean(SE)	Sodium (mg/day) Mean(SE)
Breakfast	358.4(39.6)	14.8(2.0)	12.0(2.3)	47.8(4.8)	4.1(0.6)	430.1(72.8)
Lunch	457.4(43.2)	25.4(3.2)	15.7(2.1)	53.6(5.1)	4.8(0.5)	733.6(116.4)
Dinner	585.8(47.6)	35.9(3.7)	15.1(2.4)	72.7(7.1)	5.9(0.7)	686.6(98.4)
	Energy (kcal/day) Mean(SE)	Protein (g/day) Mean(SE)	Fat (g/day) Mean(SE)	Carbohydrate (g/day) Mean(SE)	Fiber (g/day) Mean(SE)	Sodium (mg/day) Mean(SE)
Snack	287.2(45.7)	9.3(1.7)	9.9(2.4)	40.3(6.2)	3.9(0.6)	262.9(63.2)

* p-value for differences between meals and snack was based on paired t-test. The significance threshold was set at 0.05.

Table E.4: Characteristics of meals and snacks

	Intake from meals Mean (SE)	Intake from snacks Mean (SE)	p-value*
Energy (kcal)	1385.6(78.0)	287.2(45.7)	<0.001
Protein (g)	76.1(5.3)	9.3(1.7)	<0.001
Fat (g)	42.8(3.9)	9.9(2.4)	<0.001
Carbohydrate (g)	173.7(10.8)	40.3(6.2)	<0.001
Fiber (g)	14.9(1.3)	3.9(0.5)	<0.001
Sodium (mg)	1850.3(166.3)	262.9(63.1)	<0.001

* p-value for differences between meals and snack was based on paired t-test. The significance threshold was set at 0.05.

Discussion

When estimated the nutritive value of each meal, energy intake and nutrient composition varied between main meals. Breakfast contributed the smallest amount of energy(kcal), carbohydrate(g), protein(g), fat (g), fiber (g) and sodium (mg). Lunch was a major contributor to dietary fat (M=15.7g, SE= 2.1) and dinner for total energy (M= 585.8kcal, SE=47.6). These results raise possible apprehension since it is possible that consuming energy food items later in the day may affect the body weight. These results are consistent with other studies (Dwyer, Evans, Stone, & Feldman, 2001; Ziegler, Jonnalagadda, Nelson, Lawrence, & Baciak, 2002). Frequency and nutritive quality of meal or snack are vital. Our study showed that majority of the students ate the traditional three meals (breakfast, lunch, and dinner) on a weekday, while 11% reported skipping breakfast, 7% skipped lunch and 31% of the students reported no snack food consumed during the day. Jenkins et al. (1989) investigated the effect of increasing the frequency of meals on serum lipid concentration and carbohydrate tolerance among normal healthy men (n=7), with two diets. One regimen consisted of the nibbling diet (17 snacks per day) and the other of three meals per day (traditional three-meal diet, gorging). As compared to the three meals diet, nibbling (snacking) diet reduced the fasting serum concentration of cholesterol by 9% and average insulin level decreased by 28%, suggesting that the nutritive value of meal and frequency a key factor of fasting serum lipids levels. Jenkins et al. (1992) have reported differences in mean blood glucose level and serum insulin with altered meal frequency, suggesting that frequent small meals during the day may improve fasting glucose levels. Snacks are often attributed to unhealthy foods, as a source of empty

calories. Findings from our study concluded that about 17% of the total energy was contributed by snacking. The fruit was consumed as a snack by 22%, sugar-sweetened beverages or desserts, salted snack bars, and nuts or almonds followed in popularity, consumed by 20%, 18%, and 9% respectively. Comparable results were reported in a previous study, where the common choice for snacks was reported as fruit among Croatian university students (Colić , Šatalić, & Lukešić, 2003). Our study also reports on the nutrient composition of snacks, where snacks provided average 3.9g fiber, 40.3g carbohydrate, 9.3g protein, 9.9g fat, and 262.9g sodium. This finding settles with other studies in literature (Bellisle, 2003; Summerbell et al.,1995). In previous studies, energy-dense foods and beverages have been found to be the major element of energy intake and food composition among different age groups (Piernas, 2010; Summerbell et al., 1995). Since studies report how snacking could help to improve satiety, therefore, promoting healthy snacks (food items rich in fiber and unsweetened) could potentially help to avoid over consumption during the subsequent meal and may lead to positive energy balance (Allirot et al., 2013; Miller, Benelam, Stanner, & Buttriss, 2013).

Limitations

There are limitations associated with this study. Eating pattern differs by sex. This study did not explore how dietary intake differed by sex group. Self-reported data were used in this study, which has the possibility of reporting or recall bias, therefore, precaution must be taken when generalizing the results.

Conclusion

The results presented in our study show that nutrient intake varies between meals and snacks. The meal-based and nutrient intake information provides a more detailed understanding of the dietary habit of young adults enrolled in the university. The findings shall help to better understand what meals and snacks are composed of and may help to target the meal-based nutritional guidelines for young adults. Further research, is needed to study the effect of consumption of a different combination of food in meals and snacks on improving the diet quality.

References

Alam, P. (2012). Nutritional status and eating practices among university students in selected universities in Selangor, Malaysia. *Asian Journal of Clinical Nutrition, 4*(3), 77-87.

Allirot, X., Saulais, L., Seyssel, K., Graeppi-Dulac, J., Roth, H., Charri, A., Drai, J., Goudable, J., Blond, E., Disse, E. & Laville, M. (2013). An isocaloric increase of eating episodes in the morning contributes to decrease energy intake at lunch in lean men. *Physiology & Behavior, 110*, 169-178.

Bellisle, F., Dalix, A. M., Mennen, L., Galan, P., Hercberg, S., De Castro, J. M., & Gausseres, N. (2003). Contribution of snacks and meals in the diet of French adults: a diet-diary study. *Physiology & Behavior, 79*(2), 183-189.

Benton, D., Slater, O., & Donohoe, R. T. (2001). The influence of breakfast and a snack on psychological functioning. *Physiology & Behavior, 74*(4-5), 559-571.

Berner, L. A., Becker, G., Wise, M., & Doi, J. (2013). Characterization of Dietary Protein Among Older Adults in the United States: Amount, Animal Sources, and Meal Patterns. *Journal of the Academy of Nutrition and Dietetics, 113*(6), 809-815.

Colić Barić, I., Šatalić, Z., & Lukešić Ž. (2003). Nutritive value of meals, dietary habits and nutritive status in Croatian university students according to gender. *International Journal of Food Sciences and Nutrition, 54*(6), 473-484.

Dietz, W. H. (1998). Childhood weight affects adult morbidity and mortality. *The Journal of Nutrition, 128*(2), 411S-414S. https://doi.org/10.1093/jn/128.2.411S

Driskell, J. A., Keith, R. E., & Tangney, C. C. (1979, January 01). Nutritional Status of White College Students in Virginia. *Journal of the American Dietetic Association, 74*(1), 32-35.

Drummond, S., Crombie, N., & Kirk, T. (1996). A critique of the effects of snacking on body weight status. *European Journal of Clinical Nutrition, 50*(12), 779-783.

Dwyer, J. T., Evans, M., Stone, E. J., & Feldman, H. A. (2001). Adolescents' eating patterns influence their nutrient intakes. *Journal of the Academy of Nutrition and Dietetics, 101*(7), 798-802.

El Ansari, W., Stock, C., & Mikolajczyk, R. T. (2012). Relationships between food consumption and living arrangements among university students in four European

countries-a cross-sectional study. *Nutrition Journal,11*(1),28.

Franz, M. J., Bantle, J. P., Beebe, C. A., Brunzell, J. D., Chiasson, J. L., Garg, A., Holzmeister, L. A., Hoogwerf, B., Mayer-Davis, E., Mooradian, A.D., & Purnell, J. Q. (2002). Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care, 12*(1), 148-198.

Frech, A. (2012). Healthy behavior trajectories between adolescence and young adulthood. *Advances in life Course Research, 17*(2), 59-68.

Hampl, J. S., Heaton, C. L. B., & Taylor, C. A. (2003). Snacking patterns influence energy and nutrient intakes but not body mass index. *Journal of Human Nutrition and Dietetics, 16*(1), 3-11.

Howarth, N. C., Huang, T. T., Roberts, S. B., Lin, B. H., & McCrory, M. A. (2007). Eating patterns and dietary composition in relation to BMI in younger and older adults. *International Journal of Obesity, 31*(4), 675684.

Jakobovits, C., Halstead, P., Kelley, L., Roe, D. A., & Young, C. M. (1977). Eating habits and nutrient intakes of college women over a thirty-year period. *Journal of the American Dietetic Association (USA),71*: 405411.

Jenkins, D. J., Wolever, T. M., Vuksan, V., Brighenti, F., Cunnane, S. C., Rao, A. V., ... & Corey, P. (1989). Nibbling versus gorging: metabolic advantages of increased meal frequency. *New England Journal of Medicine, 321*(14), 929-934.

Jenkins, D. J., Ocana, A., Jenkins, A. L., Wolever, T. M., Vuksan, V., Katzman, L., Hollands, M., Greenberg, G., Corey, P. & Patten, R. (1992). Metabolic advantages of spreading the nutrient load: effects of increased meal frequency in non-insulin-dependent diabetes. *The American Journal of Clinical Nutrition, 55*(2), 461-467.

Kant, A. K. (2018). Eating patterns of US adults: Meals, snacks, and time of eating. *Physiology & Behavior.193*. 270-278.

Leech, R. M., Timperio, A., Livingstone, K. M., Worsley, A., & McNaughton, S. A. (2017). Temporal eating patterns: associations with nutrient intakes, diet quality, and measures of adiposity. *The American Journal of Clinical Nutrition, 106*(4), 1121-1130.

Marrale, J. C., Shipman, J. H., & Rhodes, M. L. (1986). What Some College Students Eat. *Nutrition Today, 21*(1), 16-22.

Martin, P. Y., & Benton, D. (1999). The Influence of a Glucose Drink on a

Demanding Working Memory Task. *Physiology & Behavior, 67*(1), 69-74.

Melo, H., de Moura, A. P., Aires, L. L., & Cunha, L. M. (2013). Barriers and facilitators to the promotion of healthy eating lifestyles among adolescents at school: the views of school health coordinators. *Health Education Research, 28*(6), 979-992.

Merriam-Webster Dictionary.(2016). *The Merriam-Webster Dictionary.* Merriam-Webster, Incorporated. Retrieved from https://books.google.ca/books?id =tr0kswEACAAJ

Mesas, A. E., Muñoz-Pareja, M., López-García, E., & Rodríguez-Artalejo, F. (2012). Selected eating behaviours and excess body weight: A systematic review. *Obesity Reviews, 13*(2), 106-135.

McCrory, M. A.,& Campbell, W. W. (2010). Effects of Eating Frequency, Snacking, and Breakfast Skipping on Energy Regulation: Symposium Overview. *The Journal of Nutrition, 141*(1), 144-147.

Miller, R., Benelam, B., Stanner, S. A., & Buttriss, J. L. (2013). Is snacking good or bad for health: An overview. *Nutrition Bulletin, 38*(3), 302-322.

Nesliah, R., & Emine, A. Y. (2011). Energy and Nutrient Intake and Food Patterns among Turkish University students. *Nutrition Research and Practice, 5*(2),

117-123.

Papadaki, A., Hondros, G., Scott, J. A., & Kapsokefalou, M. (2007). Eating Habits of University Students living at, or away from home in Greece. *Appetite, 49*(1), 169-176. doi:10.1016/j.appet.2007.01.008

Piernas, C., & Popkin, B. M. (2009). Snacking Increased among US Adults between 1977 and 20063. *The Journal of Nutrition, 140*(2), 325-332.

Sebastian, R. S., Cleveland, L. E., & Goldman, J. D. (2008). Effect of snacking frequency on adolescents' dietary intakes and meeting national recommendations. *Journal of Adolescent Health, 42*(5), 503-511.

Sebastian, R. S., Wilkinson Enns, C., & Goldman, J. D. (2011). Snacking patterns of US Adults: What we eat in America, NHANES 20072008. *Food Surveys Research Group Dietary Data Brief, 4*, 1-8.

Speechly, D. P., & Buffenstein, R. (1999). Greater Appetite Control Associated With an Increased Frequency of Eating in Lean Males. *Appetite, 33*(3), 285-297.

Summerbell, C. D., Moody, R. C., Shanks, J., Stock, M. J., & Geissler, C. (1995).

Sources of energy from meals versus snacks in 220 people in four age groups. *European Journal of Clinical Nutrition, 49*(1), 33-41.

Whybrow, S., & Kirk, T. R. (1997). Nutrient intakes and snacking frequency in female students. *Journal of Human Nutrition and Dietetics, 10*(4), 237-244.

Winkler, G., Dring, A., & Keil, U. (1999). Meal patterns in middle-aged men in Southern Germany: Results from the MONICA Augsburg dietary survey 1984/85. *Appetite, 32*(1), 33-37.

Yeh, M. C., Matsumori, B., Obenchain, J., Viladrich, A., Das, D., & Navder, K. (2010). Validity of a competing food choice construct regarding fruit and vegetable consumption among urban college freshmen. *Journal of Nutrition Education and Behavior, 42*(5), 321-327.

Ziegler, P. J., Jonnalagadda, S. S., Nelson, J. A., Lawrence, C., & Baciak, B. (2002). Contribution of meals and snacks to nutrient Intake of male and female elite figure skaters during peak competitive season. *Journal of the American College of Nutrition, 21*(2), 114-119.