Changes in Body Mass, Body Composition, Physical Activity and Nutrition from the First to the Fourth Academic Year in University Students

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Submitted in partial fulfillment of the requirements for the degree of

Master of Science

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ABSTRACT

Background: The transition to university life is a critical time of change, often accompanied by the adoption of negative lifestyle habits, including an unhealthy diet and a decrease in physical activity. Lifestyle changes during university may result in a positive energy balance and a decrease in diet quality, which can lead to weight gain, a percent body fat in the overweight/obesity range, and increased cardiometabolic disease risk over time. The purpose of the current study was to investigate changes in body mass and composition from 1st to 4th year among university students, and to assess whether changes in physical activity and dietary intake were related to observed changes in body mass and composition.

Methods: Thirty-eight participants completed food frequency and activity questionnaires and had their body mass measured and body composition assessed using bioelectrical impedance analysis. These measurements were obtained at the beginning (fall) and end (spring) of 1st year and the end (spring) of 4th year. Results: During the 1st year, body mass and percent fat increased by 3.2 kg and 2.1%, respectively (P<0.01), while daily energy intake was maintained and daily energy expenditure decreased (-435.2 kcal/day, P<0.01). Between the end of the 1st year and the end of the 4th year, students continued to increase their body mass, but this increase was smaller (+2.2 kg, P=0.05) than the change occurring during the 1st year. Additionally, percent fat and energy intake did not change while energy expenditure increased from the end of 1st year to the end of 4th year (+208.6 kcal/day, P<0.01). Conclusions: Increases in percent body fat during university occurred only during the 1st year. However, students were not able to reverse these gains by the end of the 4th year.

Keywords: weight gain, percent body fat, physical activity, nutrition, University
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ABBREVIATIONS

%BF Percent body fat

ACSM American college of sports medicine

BIA Bioelectrical impedance analysis

BM Body mass

BMI Body mass index

BMR Basal metabolic rate

Bodpod Air displacement plethysmography

CSEP Canadian society for exercise physiology

DES dentistry students

DXA Dual energy x-ray absorptiometry

EAT Exercise activity thermogenesis

ECW Extra cellular water

EE Energy expenditure

EI Energy intake

FFAQ Food frequency and Activity Questionnaire

FFQ Food and Questionnaire

FM Fat mass

g Grams

g/d Grams per day

Kcal Kilocalories

kg Kilograms

LBM Lean body mass
**lbs** Pounds

**LPA** Light physical activity

**MET** Metabolic Equivalent

**MPA** Moderate physical activity

**MRI** Magnetic resonance imaging

**NEAT** Nonexercise activity thermogenesis

**PA** Physical activity

**REB** Research ethics board

**RDA** Recommended dietary allowance

**RM ANOVA** Repeated measure analysis of variance

**SPS** Sport science students

**TBW** Total body water

**TEF** Thermic effect of food

**VPA** Vigorous physical

**WHO** World health organization

**WHR** Waist to hip ratio
CHAPTER 1: INTRODUCTION

1.1 Rationale

Obesity is a global epidemic, with a worldwide prevalence that has almost tripled since 1975 (World Health Organization, 2018). In Canada, 34% of the adult population have overweight, and 27% have obesity (World Health Organization, 2018). Overweight and obesity are defined as excess fat mass which present a risk to health (World Health Organization, 2018). Obesity can lead to chronic diseases such as diabetes, insulin resistance, stroke, heart disease, musculoskeletal disorders, and cancer (World Health Organization, 2003). Furthermore, once acquired, an overweight or obese BMI tends to be chronic, as most attempts to lose excess BMI fail (Brownell, 1993; Kramer, Jeffery, Forster, & Snell, 1989).

When looking at critical periods for BMI gain, the transition from high school to university was found to be linked with a high risk for weight gain (Crombie, Ilich, Dutton, Panton, & Abood, 2009). In turn, BMI gained during this time can lead to the onset of obesity and increase the risk of chronic diseases and early mortality (Barbour-Tuck et al., 2018; Barbour-Tuck et al., 2019; Katzmarzyk, Craig, & Bouchard, 2001). BMI gain and changes in body composition during the freshman year of university have been well studied (Crombie et al., 2009); however, studies investigating changes in BMI and composition across all four years of university are limited and demonstrate inconsistent results. For example, Hovell et al. (1985) found a significant increase in BMI during the 1st year of university, followed by a decrease almost to baseline by the end of the third year. In contrast, Gropper et al. (2012) found an average gain of 5.3 kg during all 4 years of university. Moreover, there is a gap in the literature regarding the factors responsible for
BM gain during the 4 years of university, such as diet quality, and there is limited information about physical activity behaviors.

The present study investigated the changes that occur in BM and body composition during the 1st versus the 4th year of university. To our knowledge, this is the first study in a Canadian university sample that provides a better picture of the effects of lifestyle habits on BM and body composition changes during the 1st year compared to the other 3 years of university. The findings can help to inform the design of programs focused on healthy habits accessible to students throughout their university studies, to help combat the issues of poor general health and obesity on Canadian campuses.

1.2 Objectives

The current study investigated differences in BM and body composition between the beginning of 1st year, the end of 1st year, and the end of 4th year of university, and how these differences corresponded to changes in nutrition and physical activity (PA) amongst undergraduate students at Brock University. Specific objectives included:

1. Determine and compare differences in BM and body composition [percent body fat (%BF)] between the beginning and the end of 1st year and the end of 4th year.
2. Determine and compare differences in nutrition and PA between the beginning and the end of 1st year and the end of 4th year.

1.3 Hypotheses

We expected that students would continue to gain BM and %BF after the 1st year, and as such, would have higher BM at the end of the 4th year compared to both the beginning and end of the 1st year; however, we estimated that the amount of BM and %BF
gained would be higher during the 1\textsuperscript{st} year compared with from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year (objective 1). In addition, we hypothesized diet and physical activity, would improve slightly from the end of the 1\textsuperscript{st} year to the end of 4\textsuperscript{th} year (objective 2).
CHAPTER 2: REVIEW OF LITERATURE

2.1 Overweight and Obese Ranges

2.1.1 Prevalence of Overweight BM and Obesity

Obesity is a global epidemic, as worldwide obesity prevalence has nearly tripled from 1975 to 2016 (World Health Organization, 2018). In 2016, more than 1.9 billion adults 18 years and older were classified as overweight, with over 650 million having obesity (World Health Organization, 2018). Likewise, the prevalence of children and adolescents aged 5-19 years having overweight or obesity has also increased, starting at 4% in 1975 to just over 18% in 2016 (World Health Organization, 2018). In Canada, in 2018, 36.3% of the adult population in Canada had overweight, and another 26.8% had obesity. The national average was slightly higher than the obesity prevalence of 26.1% in Ontario (Statistics Canada, 2019). A similar pattern is observed when assessing the prevalence of overweight and obese children and adolescents in Canada, with the population rates having more than doubled during the past decade (Roberts, Shields, De Groh, Aziz, & Gilbert, 2012). The latest data from the Canadian Health Measures Survey estimates that 8.6% of children and adolescents up to age 18 years are obese (Statistics Canada, 2019).

2.1.2 Health Concerns Associated with Excess Body Mass

Obesity increases the risk of chronic diseases such as diabetes, insulin resistance, stroke, heart disease, musculoskeletal disorders, and cancer (Woodvine, 2006; World Health Organization, 2003). For example, a meta-analysis of 26 observational studies investigating middle-aged adults with normal weight (BMI 18.5-24.9) and obesity (BMI ≥ 30) found that the risk of mortality for those with obesity was 22% higher than for those
with normal weight (McGee, 2005). In addition, Abdullah et al. (2011) found a positive correlation between the number of years lived with obesity and the risk of mortality, suggesting that the longer time lived with obesity was associated with a higher risk of mortality. Furthermore, once obesity is acquired, it is difficult to lose the excess BM, as most attempts to lose the excess BM end with failure (Brownell, 1993; Kramer, Jeffery, Forster, & Snell, 1989).

The health risks associated with excess BM for adults are also a growing concern for children and adolescents. Compared with previous years, there are now more children and adolescents suffering from health conditions such as prediabetes, insulin resistance, sleep apnea, musculoskeletal disorders, and risk factors for cardiovascular disease related to excess BM (McCrindle, 2015; Centers for Disease Control and Prevention, 2015).

2.1.3 Assessment of Overweight and Obese Individuals

There are multiple metrics based on BM, height and the level of excess body fat used to identify overweight/obesity and its associated health risks (Kim, 2016). One of the most common metrics is the BM Index (BMI, kg/m²). The advantage of using BMI is that it is simple and inexpensive. The classification of overweight and obesity by BMI is detailed in Table 1 (Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults, 1998). However, BMI does not take into account body composition, as it cannot distinguish fat mass (FM) from lean body mass (LBM). Additionally, the use of BMI as a reflection of body fat percentage is problematic for individuals who are extremely tall, extremely short, extremely lean, or extremely muscular. For example, when assessing BMI, a very muscular athlete might display BMI similar to
an obese individual due to higher LBM and not because of excess body fat (Janssen, Katzmarzyk, & Ross, 2004).

Another way to screen for health risks that are related to excess fat is by measuring how body fat is deposited across the body. Research suggests that there is a higher rate of mortality and morbidity associated with higher abdominal fat. Metrics such as waist circumference and waist-to-hip ratio have been used to measure abdominal fat, and have been shown to be superior to BMI for indicating health status in young and middle-aged adult populations (Janssen et al., 2004; Smith et al., 2001). Classifications of overweight and obesity by BMI, waist circumference, and associated disease risk are detailed in Table 1 (American Society for Clinical Nutrition, 1998).

**Table 1**: Classification of overweight and obesity by BMI and waist circumference (Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults, 1998)

<table>
<thead>
<tr>
<th>Obesity Class</th>
<th>BMI (kg/m²)</th>
<th>Disease Risk Relative to Normal Weight and Waist Circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
<td>Men ≤ 102 cm (40 in) Women ≤ 88 cm (35 in)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 – 24.9</td>
<td>Men &gt; 102 cm (40 in) Women &gt; 88 cm (35 in)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0 – 29.9</td>
<td>Increased</td>
</tr>
<tr>
<td>Obesity</td>
<td>30.0 – 34.9</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>35.0 – 39.9</td>
<td>Very High</td>
</tr>
<tr>
<td>Extreme Obesity</td>
<td>≥ 40</td>
<td>Extremely High</td>
</tr>
</tbody>
</table>

A more accurate way to assess health risk is by measuring body fat (Kim, 2016). Percent body fat (%BF) can be measured using multiple technologies including skin folds, hydrostatic weighing, air displacement plethysmography (Bodpod), bioelectrical impedance analysis (BIA), ultrasound, magnetic resonance imaging (MRI) and dual-
energy X-ray absorptiometry (DXA). The latter two are considered gold standard technologies for this assessment (Z M Wang et al., 1996).

The ideal fat percentage for an individual varies depending on age and sex and is described in Table 2 below (Medicine, 2008). Sex-specific ideal body fat percentages by fitness category, are presented in Table 2 and are based on essential body fat, which is the amount of fat necessary for maintaining life and reproductive function. Furthermore, adult men tend to carry more fat around the abdomen compared to women, which is more detrimental to one’s health. As such, women can be healthy at higher levels of total body fat. The essential body fat for men is 2-5% of BM and 10-13% of BM for women (Lau, Cohen, Ward, & Ma, 2013; Health Canada, 2012).

**Table 2:** Ideal percent body fat (%BF) based on age and sex (ACSM, 2008)

<table>
<thead>
<tr>
<th>Male</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness category</td>
<td>20-29</td>
<td>30-39</td>
<td>40-49</td>
<td>50-59</td>
<td>60+</td>
</tr>
<tr>
<td>Essential fat</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
</tr>
<tr>
<td>Excellent</td>
<td>7.1-9.3</td>
<td>11.3-13.8</td>
<td>13.6-16.2</td>
<td>15.3-17.8</td>
<td>15.3-18.3</td>
</tr>
<tr>
<td>Good</td>
<td>9.4-14</td>
<td>13.9-17.4</td>
<td>16.3-19.5</td>
<td>17.9-21.2</td>
<td>18.4-21.9</td>
</tr>
<tr>
<td>Average</td>
<td>14.1-17.5</td>
<td>17.5-20.4</td>
<td>19.6-22.4</td>
<td>21.3-24</td>
<td>22-25</td>
</tr>
<tr>
<td>Below average</td>
<td>17.4-22.5</td>
<td>20.5-24.1</td>
<td>22.5-26</td>
<td>24.1-27.4</td>
<td>25-28.4</td>
</tr>
<tr>
<td>poor</td>
<td>&gt;22.4</td>
<td>&gt;24.2</td>
<td>&gt;26.1</td>
<td>&gt;27.5</td>
<td>&gt;28.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Female</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness category</td>
<td>20-29</td>
<td>30-39</td>
<td>40-49</td>
<td>50-59</td>
<td>60+</td>
</tr>
<tr>
<td>Essential fat</td>
<td>10-13</td>
<td>10-13</td>
<td>10-13</td>
<td>10-13</td>
<td>10-13</td>
</tr>
<tr>
<td>Excellent</td>
<td>14.5-17</td>
<td>15.5-17.9</td>
<td>18.5-21.2</td>
<td>21.6-24.9</td>
<td>21.1-25</td>
</tr>
<tr>
<td>Good</td>
<td>17.1-20.5</td>
<td>18-21.5</td>
<td>21.3-24.8</td>
<td>25-28.4</td>
<td>25.1-29.2</td>
</tr>
<tr>
<td>Average</td>
<td>20.6-23.6</td>
<td>21.6-24.8</td>
<td>24.9-28</td>
<td>28.5-31.5</td>
<td>29.3-32.4</td>
</tr>
<tr>
<td>Below average</td>
<td>23.7-27.6</td>
<td>24.9-29.2</td>
<td>28.1-32</td>
<td>31.6-35.5</td>
<td>32.5-36.5</td>
</tr>
<tr>
<td>poor</td>
<td>&gt;27.7</td>
<td>&gt;29.3</td>
<td>&gt;32.1</td>
<td>&gt;35.6</td>
<td>&gt;36.6</td>
</tr>
</tbody>
</table>
2.2 Factors affecting body mass changes

2.2.1 Energy balance

Energy balance is composed of two main components, energy intake (EI) and energy expenditure (EE). Energy intake is the total amount of energy an individual consumes during the day (Hill, Wyatt, & Peters, 2012). EE is the total amount of energy being used by the body each day, including basal metabolic rate, resting metabolic rate, thermal effect of food, and activity (exercise and non-exercise), related thermogenesis (Hill et al., 2012). When the daily EE is equal to the daily EI, the body maintains the energy balance. Energy balance describes a situation in which the same number of calories are consumed and expended during the day, which has a major role in maintaining one’s BM (Hill et al., 2012). If EI exceeds EE, positive energy balance will occur, which will cause weight gain. Preserving positive energy balance over the long run can lead to overweight BM and obesity (Hill et al., 2012). Conversely, when EE exceeds EI, negative energy balance will occur, which will cause weight loss (Hill et al., 2012).

2.3 Nutrition

2.3.1 Macronutrients

Macronutrients are nutrients consumed in relatively large quantities which provide the energy needed to keep the body functioning, as well as for all daily activities. There are three types of macronutrients: proteins, carbohydrates, and fats (Calabrese et al., 2018).

2.3.1.1 Carbohydrates

Carbohydrates are organic molecules that are made from carbon, hydrogen and oxygen to form sugars, starches and fibers, which are found in fruits, grains, vegetables,
milk, and alternative dairy products. Their primary role is to provide energy to cells in the body. Oxidation of one gram of carbohydrate yields approximately 4 kcal of energy (Pennington, 1992; Institute of Medicine, 2008). The correlation between carbohydrates and weight gain in the North American diet has been repeatedly demonstrated, suggesting that high consumption of carbohydrates with a high glycemic index is a key factor for weight gain and health complications, including type 2 diabetes (Bosy-Westphal & Müller, 2015; De Souza et al., 2015). However, carbohydrates with low glycemic index are more slowly digested and less readily absorbed. Therefore, low glycemic index carbohydrates may promote satiety and weight loss, which in turn can help prevent health complications associated with obesity (Bosy-Westphal & Müller, 2015).

2.3.1.2 Fat

Fats or lipids include oils, fats, and related compounds found in animal products (meat, eggs, and dairy products), and in plant base products (nuts and vegetables). Simple lipids consist primarily of triacylglycerols, which are stored in adipose tissue. Triacylglycerols are made from one alcohol molecule (glycerol) attached to three fatty acid molecules. The primary role of fatty acids is to serve as an energy source (oxidation of one gram of fatty acids yields approximately 9 kcal of energy), compose cell membranes, and act as precursors to signaling molecules (Calder, 2011; Pennington, 1992). Dietary guidelines from the World Health Organization and the Dietary Reference Intakes recommendations include limiting the intake of fats, in order to improve general health (Trumbo, Schlicker, Yates, & Poos, 2002; World Health Organization, 2003). However, even though the intake of fat has decreased over the past 40 years, obesity rates continue to rise, suggesting fat consumption is not necessarily responsible for this epidemic (Kratz,
Baars, & Guyenet, 2013). Likewise, no clear association between higher intake of saturated fats and all-cause mortality, ischemic stroke, and type 2 diabetes has been found within healthy adult populations (De Souza et al., 2015).

2.3.1.3 Protein

Proteins can be found in animal products, such as chicken, beef, eggs, and dairy products, and can also be found in plant products, such as soy, legumes, and beans. Like carbohydrates, oxidation of one gram of protein yields approximately 4 Kcal of energy. Yet, the main function of proteins is not to provide energy to the body (Pennington, 1992; Hammond, Whitney & Rolfes, 2013). Proteins play a role in nearly every biological process, including constructing structures, carrying substances in the blood, coordinating activities of different body systems, and acting as enzymes (Hammond, Whitney & Rolfes, 2013). Proteins are composed of amino acids. There are 20 different amino acids required by the body, some of which are essential and others non-essential. While the body is capable of synthesizing the non-essential amino acids, it is not capable of synthesizing the essential amino acids. Therefore, essential amino acids have to be consumed through diet. The essential amino acids include isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine (Hammond, Whitney & Rolfes, 2013).

A high protein diet has been linked with weight loss and prevention of weight gain due to satiety and enhanced energy expenditure, explained by increased diet-induced thermogenesis. (Brownell, 1993; Mikkelsen, Toubro, & Astrup, 2000; Weigle et al., 2005; Bendtsen, Lorenzen, Bendsen, Rasmussen, & Astrup, 2013). In addition, even with a restriction of diet and weight loss, high protein diet acts to preserve LBM when combined with exercise (Josse, Atkinson, Tarnopolsky, & Phillips, 2011). Skeletal muscle plays a
major role in the regulation of glycemia and lipidemia, which is one of the reasons why preserving LBM during weight loss diet is important (Samuel, Petersen, & Shulman, 2010).

2.3.1.4 Recommended Dietary Allowances (RDA)

The RDA for the macronutrients described in Table 3 vary based on age and sex (Health Canada, 2006).

Table 3: RDA (g/d) values per macronutrient per sex and age group

<table>
<thead>
<tr>
<th></th>
<th>Carbohydrate (g/d)</th>
<th>Protein (g/d)</th>
<th>Omega-6 (g/d)</th>
<th>Omega-3 (g/d)</th>
<th>Fiber (g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males 9-13 y</td>
<td>130</td>
<td>9-13 y - 34</td>
<td>9-13 y - 12</td>
<td>9-13 y - 1.2</td>
<td>9-13 y - 31</td>
</tr>
<tr>
<td>14-18 y</td>
<td></td>
<td>14-18 y - 52</td>
<td>14-18 y - 16</td>
<td>14-18 y - 1.6</td>
<td>14-18 y - 38</td>
</tr>
<tr>
<td>19-30 y</td>
<td></td>
<td>19-30 y - 56</td>
<td>19-30 y - 17</td>
<td>19-30 y - 1.6</td>
<td>19-30 y - 38</td>
</tr>
<tr>
<td>Females 9-13 y</td>
<td>130</td>
<td>9-13 y - 34</td>
<td>9-13 y - 10</td>
<td>9-13 y - 1.0</td>
<td>9-13 y - 26</td>
</tr>
<tr>
<td>14-18 y</td>
<td></td>
<td>14-18 y - 46</td>
<td>14-18 y - 11</td>
<td>14-18 y - 1.1</td>
<td>14-18 y - 26</td>
</tr>
<tr>
<td>19-30 y</td>
<td></td>
<td>19-30 y - 46</td>
<td>19-30 y - 12</td>
<td>19-30 y - 1.1</td>
<td>19-30 y - 25</td>
</tr>
</tbody>
</table>

Y = years of age.

2.3.2 Micronutrients

Micronutrients are composed of vitamins and minerals that must be consumed in our diet. They are called micronutrients because they are only needed in minuscule amounts. Nevertheless, they are essential for proper growth and development, and even a small deficiency might cause significant consequences. Refer to Appendix A and B for the description of vitamins and minerals (Hammond, Whitney & Rolfes, 2013; Smolin, 2014; Mckardle, 2013).

2.3.3 Assessing dietary intake

Methods to assess dietary intake include dietary history, 24-hour recall, food records, and food frequency questionnaires (FFQ) (Block, 1982; Brownell, 1993;
Schoeller, 1995; Sharma et al., 2010). The Block FFQ is a common approach for assessing dietary intake, in which all foods consumed on average during the past 6 months are written down based on estimated portion sizes. Using this method puts demand on the participants, and therefore this method is susceptible to inaccuracies such as underreporting and overreporting (Block, 1982). However, the strengths of the FFQ include the ability to measure long-term dietary intake using a relatively low-cost assessment, which can allow for the repeated measurement of large samples (Cade, Thompson, Burley, & Warm, 2002; Schatzkin et al., 2003). The FFQ includes questions used to quantify commonly eaten foods, as well as questions to adjust for fat, protein, carbohydrate, sugar, and whole-grain intake (Khani, Ye, Terry, & Wolk, 2004).

The Block FFQ is one type of FFQ. The reliability and validity of the Block FFQ was investigated in Canadian women, by comparing the Block FFQ to multiple 24-hour dietary recalls and a secondary FFQ (Boucher et al., 2006). This study showed a moderate to high validity between the FFQ and 24-hour dietary recalls ($r^2$ ranging from 0.11 to 0.73 for macronutrients, and from 0.50 to 0.76 for micronutrients). The reliability of the Block FFQ was also found to be high, with $r^2$ ranging from 0.57 to 0.90 for macronutrients, and from 0.65 to 0.88 for micronutrients. The reliability and validity of the Block FFQ has also been investigated in multiple populations, such as Western Japanese and Swedish populations and demonstrated a reasonable reproducibility and validity of the major dietary patterns (Hu et al., 1999; Khani et al., 2004; Nanri et al., 2012). Therefore, the Block FFQ has shown evidence of reliability and validity for assessment of dietary intake in a variety of populations, and is thus suitable for the purposes of this study.
2.4 Physical Activity

2.4.1 Physical activity and well being

The long-term contribution of physical activity to overall health has been well studied (Reiner, Niermann, Jekauc, & Woll, 2013; Warburton, Nicol, & Bredin, 2006). Long-term health benefits of physical activity include maintaining and improving BM and body composition, bone health, muscular strength, endurance, and mental health (Warburton et al., 2006; Reiner et al., 2013). Likewise, long-term physical activity has been shown to increase life expectancy and to decrease the prevalence of chronic diseases, including cardiovascular disease, type 2 diabetes, metabolic syndrome, and cancer (Reiner et al., 2013; Warburton et al., 2006). In fact, compared with inactive individuals, individuals who exercised 150 minutes (2.5 hours) per week meeting the Canadian Society for Exercise Physiology (CSEP) recommendations, reduced the risk for all-cause mortality by 19% (Public Health Agency of Canada, 2011).

2.4.2 Physical activity guidelines for adults

CSEP guidelines for physical activity for adults to achieve health benefits are as follows: adults aged 18-64 years should engage in at least 150 minutes of moderate to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more. Resistance training involving major muscle group is recommended twice per week to strengthen the muscles and the bones (Tremblay et al., 2011)

2.4.3 Assessment of physical activity

To investigate the interaction between daily physical activity and health, a valid and reliable method for the assessment of physical activity is required. Methods to assess
physical activity in free-living environments include behavioral observation, questionnaires in the form of diaries, recall questionnaires, and interviews, as well as physiological markers like heart rate, calorimetry, and motion sensors (Westerterp, 2009). Self-reporting activity questionnaires are the most common tools for the assessment of physical activity. It is the least expensive method, which allows for assessment of large samples; however, the reliability and validity of the measurement of habitual physical activity by questionnaires were found to be low (Westerterp, 2009; Shephard, 2003). The most accurate method to measure habitual physical activity was found to be motion sensors; however, this method (in comparison to questionnaires) is more expensive, making it difficult to use the investigation of large samples (Westerterp, 2009).

2.5 Body mass and body composition changes during university

Most of the research regarding weight gain has focused on the transition from high school to the 1st year of university. In contrast, studies that encompass the typical 4-year period spent as an undergraduate student in the university are less common. The phenomenon of weight gain during the 1st year of university is often called the “freshman 15” and refers to a weight gain of 15 pounds (~7 kg) during the 1st year of university. Studies investigating the “freshman 15” phenomenon confirm the occurrence of weight gain during this period; however, the amount of weight gain identified in previous studies is less than 15 pounds (~7 kg). An analysis conducted by Crombie et al. (2009) examined 17 longitudinal studies that followed students over their 1st year and revealed an average weight gain of 4.4 pounds (~2 kg). The reason for this weight gain is likely multifactorial but may include changes in dietary intake and physical activity habits (Beaudry et al., 2019; Crombie et al., 2009; Thomas et al., 2019). The study previously done at our institution,
which this thesis is extending, investigated factors related to changes in BM and body composition during the 1\textsuperscript{st} year in university. The main findings included weight gain, increased percent body fat, lower quality of the diet, and lower participation in physical activity (Thomas et al., 2019; Beaudry et al., 2019).

Our group found that dietary changes during the 1\textsuperscript{st} year of university include higher consumption of high sugar beverages, alcohol, and fried foods. Additionally, the consumption of healthy food such as fruits, vegetables and high-quality proteins during this time was shown to decrease (Beaudry et al., 2019). Furthermore, reductions in physical activity during the 1\textsuperscript{st} year of university included decreases in light, moderate, and vigorous activity minutes (Thomas et al., 2019). Taken together, these changes in both diet and physical activity may contribute to increased BM and %BF during the 1\textsuperscript{st} year of university (Beaudry et al., 2019; Thomas et al., 2019).

When investigating the same variables of dietary changes, physical activity, BM, and body composition over periods longer than one year, the amount of available information is limited, and the outcomes are inconsistent. For instance, one study by Hovell et al. (1985) monitored the changes in weight of women during three years of university. For the 43 women who came back for all the measures across the 3 years, a significant weight gain of approximately 5 pounds (~2 kg) was found during the 1\textsuperscript{st} year, followed by a decrease almost to baseline by the end of the 3\textsuperscript{rd} year (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985). This decrease in weight after freshman year is not consistent with the literature. One study by Gropper et al. (2012) found a significant weight gain for men and women during four years of university. Within this study, 70\% of the participants gained on average 5.3 kg, while men were found to gain more FM and LBM (and
consequently overall BM) than women. Likewise, by the end of the 4th year, the number of participants who were classified as overweight or obese increased by 13% (Gropper, Simmons, Connell, & Ulrich, 2012a). Another study that compared changes in physical activity and body composition between sport science students (SPS) and dentistry students (DES) during 4.5 years of school found no decrease in weight after their freshman year. No significant changes in diet and EI were found for either SPS or DES. While no change in body fat was found for the SPS group, the DES group gained on average 1.6 ± 3.8 kg of FM. These differences are likely explained by the higher level of physical activity in the SPS group. While the SPS group maintained their level of leisure time sports activity, resistance training, and aerobic training, the DES showed a significant decrease in leisure time sports activity, as well as a large decrease of 40% in resistance and aerobic training (Kemmler, Von Stengel, Kohl, & Bauer, 2016). Thus, due to inconsistent information and lack of detailed information regarding physical activity and diet during periods longer than the 1st year, it is meaningful to investigate changes in body weight and body composition, along with physical activity levels and nutrition habits, from the end of the 1st to the end of the 4th year of university.
CHAPTER 3: METHODS

3.1 Participants

This study and all related procedures received ethical clearance from the Brock University Research Ethics Board (REB# 13-297 and REB# 17-334). This thesis reports data from a follow-up study that added a third time point of data collection, at the end of the 4th year of university, to a study (called the “Transition Study”) that investigated the changes in nutrition and exercise during the 1st year of university. Participant recruitment for the initial study (Beaudry et al., 2019; Thomas et al., 2019) occurred during the summer/September of 2014 and 2015 at Brock University. Thus, participant recruitment took 2 years. Participants included both male and female students between the ages of 17-20 years, entering their 1st year of study at Brock University directly from high school, i.e., with no previous university or college experience. A total of 301 participants completed both the Fall and Spring study visits in their 1st year. Three years later, during the spring of 2018 and 2019 (February-May), participants who initially expressed that they would like to participate in future research studies were contacted through email and asked whether they would be interested in returning to the laboratory for follow-up measures. In an attempt to maximize participant retention, multiple emails were sent, and those who did respond were then contacted by phone. After the students expressed interest in the follow-up study, they were sent an individualized email containing further information about it (i.e., the invitation letter), and were provided with a new consent form specifically for the follow-up study (Appendix C). Informed consent for the follow-up was obtained before commencing data collection. All subjects were given a code name (the same one as before),
to ensure anonymity. Figure 1 displays the overall study design and data collection time points.

![Figure 1: Study design.](image)

### 3.2 Procedures

Details regarding the specific data collection procedures during the 1st year of university have been published elsewhere (Beaudry et al., 2019; Thomas et al., 2019). With respect to data collection for the follow-up study, upon providing consent to participate in the follow-up, participants were invited to the Nutrition, Exercise, and Lifestyle Improvement Laboratory to fill out questionnaires as well as to take the in-person measurements (detailed below). All visits were scheduled during the hours of 8:00 am - 11:30 am. Participants were instructed to arrive at the laboratory in a fasted state (no food or drink for 8 hours prior). They were also asked to refrain from alcohol consumption for a minimum of 24 hours prior and to refrain from exercise for a minimum of 12 hours before their lab visit. These guidelines were set to ensure that the participants’ body fluid levels were stable before body composition assessment with the bioelectric impedance (BIA) analysis device. Upon arrival at the laboratory, all participants verbally confirmed that all pretesting parameters (listed above) were followed. In the lab, the participants started by answering the questionnaires. The questionnaires included one about their general health and demographics (Appendix D) and a Food Frequency and Activity Questionnaire.
(FFAQ; NutritionQuest, 2014). These were the same ones that were used previously (Beaudry et al., 2019). After completing the questionnaires, the participants had anthropometric measurements taken including height and BM, and had their body composition measured.

3.3 Measurements

3.3.1 Anthropometric measurements and body composition

Height and BM were measured without shoes and in light clothing using a scale and stadiometer (Portable Fitness Scale 140-10-7N, Rice Lake Weighing Systems, Rice Lake, WI). Height was recorded to the nearest 0.1 centimeters (cm). BM was recorded to the nearest 0.1 kilograms (kg). Body composition was measured using Bioelectric Impedance Analysis (BIA) (Lunar In-Body 520, Biospace, GE Healthcare, Madison, WI). The BIA device has been reported to produce accurate and reliable measurements of %BF in subjects with healthy and overweight body weights when compared to the gold standard of dual-energy X-ray absorptiometry (DXA) and to other standard methods such as the air displacement plethysmography (Bodpod; Wang et al., 1996; Wagner, 2013; Pineau et al., 2007; Smith-Ryan, Fultz, Melvin, Wingfield, & Woessner, 2014; Jaffrin, 2009).

We used the Lunar In-Body 520 BIA device, which is a commonly used device for assessing body composition (National Institutes of Health Technology, 1994). The device measures the flow of electrical signals through an individual’s body. The electrical signals pass quicker through fat-free tissues, which are composed of a higher amount of water compared to fat tissue (70-75% and 10-20%, respectively). Briefly, the participants were asked to stand on the metal footplate with bare feet and age, height, and sex were manually
entered into the device. The participants were then asked to gently hold on to the handles with their arms relaxed by their side. A weak electrical current was generated at 3 frequencies (5, 50, 500kHz), and 15 impedance measurements at 5 segments (right arm, left arm, right leg, left leg, and truck) were calculated using a tetrapolar 8-point tactile electrode system. The procedure takes approximately 50 seconds to complete and provides additional measures of intracellular water (ICW), extracellular water (ECW), total body water (TBW), ECW/TBW, BMI, and BMR. During the assessment, if an individual is hyperhydrated and/or retaining water (from consuming fluids and high doses of salt, from engaging in exercise prior to the measurement, or from a menstrual cycle) the percentage of FM could be underestimated. If an individual is hypohydrated/dehydrated (not consuming a sufficient amount of water), the percentage of FM could be overestimated (National Institutes of Health Technology, 1994). Therefore, to ensure that all participants were well hydrated, immediately upon arrival to the lab, they were all given 500mL of water to consume. They then completed the questionnaires (FFAQ and health questionnaire; approximately 45 minutes) and were then asked to void their bladder immediately before stepping on the device. In doing this, we aimed to minimize the influences of hypo- and hyperhydration on our BIA measures. The same hydrating procedures were carried out at all three measurement occasions.

3.3.2 Assessment of Diet and Habitual Physical Activity

The 2014 Block FFAQ (Appendix E; NutritionQuest, 2014) included 127 different food and beverage items. The responses were used to calculate the longer-term amounts and frequency of consumption of all these foods over the past 6 months. Data on the intakes of specific nutrients (i.e., carbohydrates/day, fat/day, protein/day) as well as foods (i.e.,
milk, chicken, vegetables, etc.) can be extracted from this FFAQ. The participants were also given a standard portion size sheet to help them quantify the amounts of food that they were eating and to better aid them in answering the questions.

Additionally, the FFAQ was used to collect information on the frequency and duration of light, moderate, and vigorous physical activity the participants engaged in on a weekly basis, to measure total EI (kcal/day) as well as EE (kcal/day). The physical activity portion of the questionnaire calculated the average number of MET minutes (metabolic equivalents) of light, moderate, and vigorous physical activity minutes that the students engaged in per week, and the average weekly EE for the six months preceding the survey. From the answers provided, estimates of intensity of effort and total EE in kcal and kJ units were obtained. METs are physiological measurements that quantify the caloric expenditure of activities. One MET is equal to the amount of energy expended at rest (1 MET = 3.5 ml O2/kg/min for a 70kg person) (Godin & Shephard, 1997). The Block FFAQ used in the current study defines low physical activity (LPA, e.g., walking) as lower than 3 METs, moderate physical activity (MPA, ex: leisure biking) ranging from 3-6 METs, and vigorous physical activity (VPA, ex: running) as higher than 6 METs (Block et al., 2009).

3.4 Statistical Analysis

Statistical analyses were performed using SPSS version 21.0 for Windows (SPSS, Chicago, Illinois, USA). Descriptive statistics were used to provide information about the overall characteristics of the sample population. In cases where the data did not meet the assumptions of univariate normality, a Ln transformation or sqrt transformation was conducted. BM, FM, Proteins intake and MPA were Ln transformed. EE, LPA, VPA and
MET were sqrt transformed. Finally, LBM, EI and carbohydrates intake did not meet the assumptions for univariate normality, and so nonparametric analyses were conducted. For all data, outliers were not removed nor manipulated.

Differences in anthropometrics, body composition, physical activity and dietary intake from the beginning of 1st year university, end of 1st year university, and end of 4th year university were examined using a two-way repeated measure analysis of variance (RM ANOVA) with sex as the between-subject variable and time as the within-subject variable. In case of a significant main effect for time, post hoc pairwise analyses were conducted using a paired t-test. In case of a significant main effect for sex, post hoc pairwise analysis was conducted using an independent t-test. For variables showing a time by sex interaction, a follow-up analysis using a one-way repeated measure analysis of variance (RM ANOVA) with Bonferroni adjustment was conducted within each sex. Additionally, for variables that did not meet the assumption of normality, a nonparametric analysis using a repeated measures Friedman test, with post hoc analysis using the Wilcoxon and Mann-Whitney U tests. For all the analysis performed, $P \leq 0.05$ and $P \leq 0.016$ for the Bonferroni adjustment were considered statistically significant.
CHAPTER 4: RESULTS

4.1 Demographic characteristics

Out of 301 participants (n = 71 males, n = 230 females) who completed both the fall and spring study visits during their 1st year of university, a total of 38 participants returned for the third study visit during the spring of their 4th year. The reasons for attrition included dropping out of university, changing to a different university, changing contact information, and disinterest in the follow-up study after 3 years from their participation in the first transition study. Of these 38 participants who returned for the third visit (average age = 21 ± 1 years), 63% were female (n = 24) and 37% were male (n = 14). Seventy-four percent of the students lived in a student house off campus (n = 28), 21% of the students lived at home (n = 8), and 5% of the students lived in residence (n = 2). Seventy-nine percent of the sample were Caucasian (n = 30), 13% were African American (n = 5), 3% were Arab (n = 1), 3% were Spanish (n = 1) and 2% were Asian (n = 1).

4.2 Anthropometrics and body composition

Figure 2 displays BM and body composition results from the beginning of the 1st year, the end of the 1st year, and the end of the 4th year of university. For BM, %BF and FM, there were significant main effects for time and sex, with no significant sex-by-time interaction. Males had consistently higher BM and lower %BF and FM compared to females (sex effect). In both sexes (time effect), BM, %BF and FM significantly increased from the beginning to the end of the 1st year (+3.21±3.79 kg, +2.07±2.78%, +2.47±3.05 kg, respectively) and from the beginning of the 1st year to the end of the 4th year (+5.41±7.98 kg, +2.26±4.90%, +3.38±6.25 kg, respectively). In addition, there was a significant increase from the end of 1st year to the end of 4th year in BM (+2.21±7.81 kg),
with no significant change in %BF (+0.2±4.74) or FM (+0.91±6.09). LBM was analyzed using nonparametric analysis and showed a significant increase from the beginning to the end of 1\textsuperscript{st} year (+0.73±2.10 kg, p<0.05) and a further increase from the end of 1\textsuperscript{st} year to the end of 4\textsuperscript{th} year (+1.30±2.90 kg, p<0.01) in both sexes. LBM was higher in males across all time points. Finally, figures 3, 4, 5 and 6 display the spread of individual changes from the beginning of the 1\textsuperscript{st} year to the end of the 1\textsuperscript{st} year, as well as from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year for BM, %BF, FM and LBM respectively.

![Graph showing changes in body mass, lean body mass, fat mass, and percent body fat over time.](image)

**Figure 2**: Body mass (BM), lean body mass (LBM), fat mass (FM) and percent body fat (%BF) changes in University students during the first and the fourth academic year.
Figure 3: Body mass - individual absolute change (Δkg) from beginning to end of 1st year (T1-T2) and from end of 1st year to end of 4th year (T2-T3).

Figure 4: Percent body fat - individual absolute change (Δ%) from beginning to end of 1st year (T1-T2) and from end of 1st year to end of 4th year (T2-T3).
Figure 5: Fat mass - individual absolute change (Δkg) from beginning to end of 1st year (T1-T2) and from end of 1st year to end of 4th year (T2-T3).

Figure 6: Lean body mass - individual absolute change (Δkg) from beginning to end of 1st year (T1-T2) and from end of 1st year to end of 4th year (T2-T3).
4.3 Dietary Intake

Table 4 displays macronutrient intakes from the beginning of 1\textsuperscript{st} year, the end of 1\textsuperscript{st} year, and the end of 4\textsuperscript{th} year of university. EI (kcal/day) was not analyzed for sex-by-time interactions due to the use of a nonparametric analysis. However, there was a significant main effect for time, reflecting a drop (-359.34±1018.91, p<0.01) from the beginning to the end of the 1\textsuperscript{st} year, and a similar negative difference (-355.11±895.24, p<0.05) from the beginning of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year. However, no significant changes were observed in EI from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year (p>0.05). Sex differences indicate that EI for males was higher than for females at all time points (p<0.01).

For daily fat intake, there was no significant main effect for time, but there was a significant sex-by-time interaction (p=0.05), and main effect for sex. Sex differences indicate that fat consumption for males was higher than females at all time points (p<0.01). For protein intake, there was no significant sex-by-time interaction (p=0.10); however, a significant main effect for time was observed, which reflects a significant decrease in protein consumption from the beginning of the 1\textsuperscript{st} year to the end of the 1\textsuperscript{st} year, and from the beginning of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year (-19.93±48.81 gr/day, p<0.01; -21.23±46.30 gr/day, p<0.05, respectively) with no change from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year (p>0.05). Finally, a significant main effect for time was observed for carbohydrates intake, reflecting a decrease from the beginning of the 1\textsuperscript{st} year to the end of the 1\textsuperscript{st} year, and from the beginning of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year (-44.75±125.70 gr/day p<0.01, -46.46±105.53 gr/day p<0.05, respectively), with no change from the end of the 1\textsuperscript{st} year to the end of 4\textsuperscript{th} year (p>0.05). In addition, the carbohydrate consumption
was higher in males than in females at all time points (p<0.05), which is related to the higher overall intake of energy in males.

**Table 4:** Total energy, fat, protein and carbohydrate consumption in University students during the first year and fourth academic year.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy intake (kcal/day)</td>
<td>2255 ± 1108</td>
<td>1896 ± 1140.9(^a)</td>
<td>1900 ± 845(^a)</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>3200 ± 1077(^*)</td>
<td>2671 ± 1506(^*)</td>
<td>2439 ± 1062(^*)</td>
</tr>
<tr>
<td>Female (n =24)</td>
<td>1704 ± 678</td>
<td>1444 ± 482</td>
<td>1586 ± 480</td>
</tr>
<tr>
<td>Fat intake (g/day)</td>
<td>92.2 ± 47.4</td>
<td>78.8 ± 47.2</td>
<td>80.1 ± 37.0</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>139.2 ± 42.6(^*)</td>
<td>114.1 ± 59.5(^*)</td>
<td>100.7 ± 42.8(^*)</td>
</tr>
<tr>
<td>Female (n =24)</td>
<td>67.8 ± 27.3</td>
<td>60.4 ± 25.4</td>
<td>69.3 ± 29.0</td>
</tr>
<tr>
<td>Protein intake (g/day)</td>
<td>93.2 ± 58.2</td>
<td>73.2 ± 52.8(^a)</td>
<td>71.9 ± 35.1(^a)</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>151.0 ± 58.8(^*)</td>
<td>117.6 ± 69.4(^*)</td>
<td>91.2 ± 36.4(^*)</td>
</tr>
<tr>
<td>Female (n =24)</td>
<td>63.2 ± 27.2</td>
<td>50.2 ± 16.6</td>
<td>61.9 ± 30.6</td>
</tr>
<tr>
<td>Carbohydrate intake (g/day)</td>
<td>264.3 ± 117.1</td>
<td>219.5 ± 137.6(^a)</td>
<td>217.8 ± 101.5(^a)</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>347.5 ± 116.5(^*)</td>
<td>295.1 ± 194.0(^*)</td>
<td>272.2 ± 136.6(^*)</td>
</tr>
<tr>
<td>Females (n =24)</td>
<td>215.7 ± 87.9</td>
<td>175.4 ± 60.7</td>
<td>186.0 ± 56.2</td>
</tr>
</tbody>
</table>

\(^a\)significant difference from T1 (time effect); \(^*\)p<0.05 between males and females (sex effect); T1 = beginning of 1\(^{st}\) year; T2 = end of 1\(^{st}\) year; T3 = end of 4\(^{th}\) year.
4.4 Physical Activity

Table 5 displays total EE expenditure, MET minutes and time spent doing PA broken down into categories of intensity (light, moderate, and vigorous activity [in minutes per day]). The data is displayed for both males and females at the beginning of 1st year, the end of 1st year, and the end of 4th year of university. For all variables, including total EE, LPA, MPA, VPA and MET, there was no significant sex-by-time interaction. However, a significant main effect for time was observed for EE, LPA, MPA and MET. Specifically, EE decreased (-434.52±786.02 kcal/day, p<0.01) from the beginning of the 1st year to the end of the 1st year, followed by an increase (+208.6±703.11 kcal/day, p<0.01) from the end of the 1st year to the end of the 4th year in both sexes. LPA followed the same pattern of decreasing during the 1st year (-60.54±100.22 min/day, p<0.01) and increasing from the end of the 1st year to the end of the 4th year (+33.26±62.24 min/day, p<0.01). MPA decreased significantly during the 1st year and was significantly lower between the end of the 1st year and the end of the 4th year (-42.85±77.99 and -39.25±77.01 min/day, p<0.01, respectively). The MET minutes showed a decrease from the beginning of the 1st year to the end of the 1st year, as well as from the beginning of the 1st year to the end of the 4th year (-407.4 ± 599.2 min, p<0.01 and -243.1 ± 628.4 min/day, p<0.05, respectively). However, from the end of the 1st year to the end of the 4th year, MET minutes increased (164.2± 488.3 min/day, p<0.01) in both sexes. No significant main effect for time was observed for VPA. Additionally, EE and VPA showed a significant main effect for sex, reflecting that both were consistently higher in males compared to females across all time points.
**Table 5**: Total Energy Expenditure and Physical activity in University students in the first and fourth academic year.

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EE (kcal/day)</strong></td>
<td>1151.2 ± 690.6</td>
<td>716.7 ± 779.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>925.3 ± 625.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Male (n=14)</td>
<td>1519.1 ± 717.34&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1256.3 ± 1038.9&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1246.1 ± 581.6&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Female (n=24)</td>
<td>936.6 ± 588.1</td>
<td>401.9 ± 293.5</td>
<td>738.2 ± 582.8</td>
</tr>
<tr>
<td><strong>LPA (min/day)</strong></td>
<td>111.8 ± 86.2</td>
<td>51.2 ± 52.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>84.5 ± 54.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>84.1 ± 72.0</td>
<td>64.9 ± 77.1</td>
<td>80.8 ± 40.6</td>
</tr>
<tr>
<td>Female (n = 24)</td>
<td>127.9 ± 91.1</td>
<td>43.2 ± 31.0</td>
<td>86.6 ± 61.6</td>
</tr>
<tr>
<td><strong>MPA (min/day)</strong></td>
<td>75.2 ± 70.5</td>
<td>32.4 ± 48.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.0 ± 47.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>151.0 ± 58.8</td>
<td>117.6 ± 69.4</td>
<td>91.2 ± 36.4</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>VPA (min/day)</strong></td>
<td>55.4 ± 56.3</td>
<td>40.3 ± 43.7</td>
<td>49.6 ± 45.9</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>91.4 ± 65.2&lt;sup&gt;*&lt;/sup&gt;</td>
<td>66.2 ± 56.5&lt;sup&gt;*&lt;/sup&gt;</td>
<td>74.0 ± 41.4&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Female (n = 24)</td>
<td>34.3 ± 38.0</td>
<td>25.2 ± 24.8</td>
<td>35.3 ± 42.9</td>
</tr>
<tr>
<td><strong>MET minutes</strong></td>
<td>928.61 ± 502.75</td>
<td>521.21 ± 481.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>685.43 ± 409.10&lt;sup&gt;a, b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Male (n = 14)</td>
<td>1070.56 ± 529.45</td>
<td>805.02 ± 634.89&lt;sup&gt;*&lt;/sup&gt;</td>
<td>801.50 ± 323.06</td>
</tr>
<tr>
<td>Female (n = 24)</td>
<td>845.81 ± 478.28</td>
<td>355.66 ± 258.48</td>
<td>617.72 ± 444.15</td>
</tr>
</tbody>
</table>

<sup>a</sup>significant difference from T1 (time effect); <sup>b</sup>significant difference from T2 (time effect); <sup>*</sup>p<0.05 between males and females (sex effect); T1 = beginning of 1<sup>st</sup> year; T2 = end of 1<sup>st</sup> year; T3 = end of 4<sup>th</sup> year; EE = energy expenditure; LPA = light physical activity; MPA = moderate physical activity; VPA = vigorous physical activity.
CHAPTER 5: DISCUSSION

The present study aimed to investigate differences in BM and %BF from the beginning of the 1st year to the end of the 1st year, and then to the end of the 4th academic year in undergraduate University students, and whether these differences are accompanied by changes in measures of nutrition and physical activity. The main result is that BM continued to increase from the end of the 1st year to the end of the 4th year, but the amount of weight gained during this period was less than during the 1st year and consisted of higher LBM, while the %BF gained during the 1st year, although did not continue to increase, it was retained until the end of 4th year. Additionally, after a decrease in both total energy intake and energy expenditure during the 1st year, no change in total EI was observed from the end of 1st year to the end of 4th year, while EE increased during this period. These results highlight the impact of the initial weight and fat gain during the 1st year, suggesting that the lifestyle in university can increase the risk of students becoming overweight or obese. Indeed, by the end of the 4 years spent in university, the obesity rates in the current sample increased by 6%.

The time spent during university is a critical time for gains in BM (Crombie et al., 2009; Gropper et al., 2012b, Gropper et al., 2012c); however, research on the time course for gains in BM and %BF during these 4 years in university remained unclear. Studies exploring this field have focused mainly on the transition from high school to 1st year in university (Crombie et al., 2009). Furthermore, studies investigating the changes in BM and body composition during the 4 years spent in university have provided limited information in relation to changes in nutrition and physical activity (Racette et al., 2008; Gropper et al., 2012c). Longitudinal studies spanning all 4 years of university have
typically included two time points of data collection, at the beginning of the 1st year and the end of the 4th year (Racette et al., 2008; Gropper et al., 2012c). The current study focused specifically on potential changes in nutrition, physical activity, BM and body composition not only from the beginning of the 1st year to the end of the 1st year but also from the end of the 1st year to the end of the 4th year, and was able to capture the different trajectories of BM and %BF gains during these different time periods.

Our hypotheses were partially confirmed. First, as hypothesized, BM and %BF gains were higher from the beginning of the 1st year to the end of the 1st year than from the end of the 1st year to the end of the 4th year (objective 1). However, while we hypothesized that both BM and %BF would continue to increase after the 1st year, we only found an increase in BM and no change in %BF beyond the 1st year. Second, no changes were observed in daily EI, daily fat, protein and carbohydrate intake from the end of the 1st year to the end of the 4th year for either males or females, a result which also differed from our initial hypothesis (objective 2). Lastly, in accordance with our hypothesis, PA levels increased from the end of the 1st year to the end of the 4th year, marked by an increase in both total EE and MET minutes/day in both sexes (objective 2).

5.1 Participants characteristics

The current sample is a representative sample of the first transition study for several reasons. In both cases, most of the participants were females; 76% in the first transition study and 63% in the present sample. Likewise, the ethnicities were very similar, with most of the participants being Caucasians; 75% in the first transition study and 79% in the present sample. In addition, living arrangements at baseline (beginning of the 1st year) were very similar, with most of the participants living in residence; 71% in the first transition
study and 68% in the present sample. Furthermore, at baseline, there were no differences between the responders (the current sample, n=38) and the non-responders sample from the first transition study (n=263) for age, %BF, FM, LBM, EE, LPA, MPA, VPA, EI, and consumption of carbohydrates, proteins and fats (p>0.05). However, BM was higher in the sample of the first transition study (p<0.05). In addition, when comparing the responders with the non-responders in terms of observed changes from the beginning of the 1st year to the end of the 1st year, there were no differences for BM, %BF, FM, LBM, EE, LPA, MPA, VPA, EI and consumption of carbohydrates, proteins and fats (p>0.05).

5.2 Transition from high school to university

Young adulthood has been previously shown to be a critical period for weight gain (Barbour-Tuck, Erlandson, Muhajarine, Foulds, & Baxter-Jones, 2018b). This period includes the transition from high school to university, a time during which many people develop poor nutritional and PA habits (Beaudry et al., 2019; Thomas et al., 2019). One of the reasons for this concern is that PA and nutritional habits are evolving during this period, and these have high transferability to adulthood (Barbour-Tuck, Erlandson, Muhajarine, Foulds, & Baxter-Jones, 2018a). Therefore, poor lifestyle habits developed during early life can chronically impact BM and body composition during adulthood, increasing the risk of becoming overweight or obese (Gunes, Bekiroglu, Imeryuz, & Agirbasli, 2012; Serdula et al., 1993). Changes during the transition from high school to the 1st year of university included a decrease in daily EI. However, it also reflected a compromise in diet quality, as shown by a decrease in the consumption of healthy foods, such as fruits, vegetables and high quality proteins, and a shift towards unhealthy foods, such as French-fries, energy drinks and alcohol. In addition, the transition was marked by a decrease in daily EE. This
decrease in EE was found in all types of PA, i.e., light, moderate and vigorous PA. At the same time, when these changes in diet and PA are taking place, BM and %BF also increased. These changes were investigated in the first transition study and are reported elsewhere (Beaudry et al., 2019; Thomas et al., 2019).

Briefly, the first transition study found that on average males gained 3.7 kg while females gained 1.6 kg (Beaudry et al., 2019). These gains in weight during the 1st year in university were in line with the literature, suggesting weight gain during the 1st year in university ranges between 0.73 kg to 3.99 kg for both sexes (Crombie et al., 2009; Vella-Zarb & Elgar, 2009). Body composition changes in the first transition study showed that males gained 2.9 kg of LBM and 1.3 kg of FM, while females gained 1.4 kg of FM and only 1 kg of LBM (Beaudry et al., 2019). The increase in FM observed was consistent with previous literature (Butler, Black, Blue, & Gretebeck, 2004; Crombie et al., 2009). Likewise, the first transition study reported a reduction in EI, as well as EE, which was consistent with the literature (Butler et al., 2004; Pullman et al., 2009). In contrast, the higher increase in LBM compared to FM observed in the males, which was first seen in the first transition study, does not agree with a previous study, which has reported males having a higher increase in FM (Hoffman, Policastro, Quick, & Lee, 2006).

The current study, carried out in a subset of the same participants, followed the same patterns observed in our first transition study, showing a significant increase in BM and %BF during the 1st year in university (Beaudry et al., 2019; Thomas et al., 2019). Likewise, as previously shown, the increase in BM and %BF during the 1st year took place despite a significant decrease in EI, suggesting that the gains might be explained by the observed reduction in EE (Thomas et al., 2019). However, another potential explanation is
that along with the decreased EE and diet quality, by the second measurement (end of first-year) students were already in a positive energy balance. Despite the observed decrease in EI during the 1st year, this may not have been enough to create substantial changes in the energy balance.

5.3 Body mass and body composition changes from the 1st year to 4th university

The current study offers information about BM and %BF gains not only during the 1st year of university, but also whether such gains continue to occur until graduation. Interestingly, BM and body composition variables showed no sex by time interaction effects, and as such, males and females were combined into one group. However, in line with the literature (Nieves et al., 2005; ACSM, 2008), male students had higher BM and LBM, and lower FM and %BF, when compared with females at all times. Importantly, students gained less weight from the end of the 1st year to the end of the 4th year than during the 1st year of university (2.21 ± 7.81 kg, p=0.05, 3.21 ± 3.79 kg, p<0.01). Furthermore, during the same later period, no changes were observed in %BF. As previously stated, studies investigating changes in nutrition, PA BM and body composition after the 1st year in university are limited and inconsistent, and one cannot distinguish between gains observed during the 1st year with those found beyond the 1st year. For instance, Racette et al. (2008) found a significant gain in BM during the 4 years in university, such that females gained 1.7 ± 4.5 kg and males gained 4.2 ± 6.4 kg. However, body composition was not assessed, and one cannot decipher when, over the 4 years, the bulk of the weight was gained. Racette et al. (2008) also investigated whether the students met the guidelines established by the 5 Day campaign to eat at least 5 fruits and vegetables daily, while limiting intake of fried foods and high-fat fast foods to a maximum of 2 times per week.
(Havas et al., 1994). They found that during the 1st and 4th years, less than one-third of the participants consumed the recommended servings of fruits and vegetables. No further information was given for EI or macronutrients consumption. In the same study, PA was assessed by measuring whether the participants met the 1998 ACSM exercise recommendations. These ACSM recommendations included prescriptions for aerobic, strength and flexibility training, which included aerobic exercises 3 to 5 days per week, 20 to 60 minutes per day, strengthening exercises 2 or 3 days per week for the largest muscle groups, and stretching exercises 2 or 3 days/week (American College of Sports medicine Position Stand., 1998). However, these recommendations do not include LPA, so habitual PA was assessed in the Racette et al. (2008) study. Increasing these type of PA, as found in the present study, can highly contribute to increasing daily EE (Flint, Cummins, & Sacker, 2014; Gordon-Larsen et al., 2009; Pate, 1995). Another study by Gropper et al. (2012) showed that females increased their %BF by 2.9 ± 3.2 % and males by 5.2 ± 3.6 % from the beginning of the 1st year to the end of the 4th year in university, but again, it is unclear when this weight was gained. In Gropper et al.’s (2012) study, females gained 1.7 ± 4.4 kg of BM and males gained 5.9 ± 5.0 kg of BM, which is consistent with Racette et al. (2008). Unlike these two previous studies, our study had an additional measurement after 1st year of university allowing us to better understand when the weight was gained, yet even our study does not show the yearly weight gain trajectories. One study by Hovell et al. (1985), which monitored the weight changes in 43 women each year of 3 years in university, found that BM gained during the 1st year dropped almost to baseline by the end of the 3rd year. Our study and that of Hovell et al. (1985), clearly demonstrate that the 1st year of university is a unique time for weight gain.
Our study investigates changes in BM and body composition over all 4 years of university, with 3 time points of data collection. During the 4 years, the students gained 2.26 ± 4.90 %BF. However, we know that from the end of the 1st year to the end of the 4th year, no changes were observed. During this time, there was also a significant increase in LBM, which was larger than that found during the 1st year (1.30 ± 2.90, 0.73 ± 2.10, p<0.05, respectfully). Therefore, the composition of the weight that was gained in the 1st year was different than the composition of the weight gained after the 1st year. The former was characterized by greater fat mass and the latter by greater lean mass. Yet, given the young age of the participants, one may question whether these gains in LBM were due to improvements in lifestyle habits including PA and nutrition or simply due to normal growth. However, we found no significant changes in height during this period, for neither females nor males, which suggests minimal somatic growth occurring during these 4 years in University. Indeed, at the end of the 1st year the average age was 18.3±0.46 years, which is after most growth induced somatic changes take place, especially for the majority of our sample who were females (63%). Lean body mass differs between females and males during the period when there is rapid growth in height (peak height velocity). In females, peak height velocity occurs earlier, between 12-14 years of age and stabilize at approximately 15-16 years of age, while in males, it occurs between 14-16 years of age and stabilize 2-3 years later than females (Malina, Bouchard, & Bar-Or, 2004; Veldhuis et al., 2005). Therefore, it is not likely that growth contributed to the observed increase in LBM.

Our data demonstrate the importance of assessing body composition rather than just BM or BMI alone. This has further implications. Although frequently used, BMI is
unable to discriminate between body fat and lean mass, and it cannot accurately classify normal body weight individuals when their body fat is too high and their muscle mass is low, and those who have an excessive BM with little BF and high muscle mass (Jackson, Ellis, McFarlin, Sailors, & Bray, 2009; Romero-Corral et al., 2008). A meta-analysis of 32 different studies and a total of 31,968 patients showed that the use of BMI to classify obesity failed to find half of the cases of people who had excess %BF (Okorodudu et al., 2010). In addition, from a health standpoint, the use of %BF was shown to be a superior predictor of cardiovascular risk factors in 2173 males adults and 1686 females adults without a history of cardiovascular disease, when compared with BMI (Zeng, Dong, Sun, Xie, & Cui, 2012). Likewise, %BF was shown to better predict mortality and length of hospital stay in 1707 healthy adult males and females (Forbes, 1988; Kyle, Pirlich, Lochs, Schuetz, & Pichard, 2005). In addition, the larger increase in LBM during the later years is essential, as these gains are associated with improving one’s health. Health benefits associated with increasing LBM in adult populations include a decreased risk of mortality, increased bone density, and lower cardiovascular disease risk factors, including arterial stiffness and blood pressure (Filippin, Teixeira, da Silva, Miraglia, & da Silva, 2015; Wannamethee & Atkins, 2015; Ilesanmi-Oyelere, Coad, Roy, & Kruger, 2018). Thus, future studies that investigate health implications should invest in the assessment of body composition as the use of BM or BMI alone might be misleading.

It is important to note that even though students did not further increase their %BF from the end of the 1st year to the end of the 4th year in university, this does not mean that the students overcame the unhealthy behavior observed in the 1st year. The %BF gained during the 1st year was maintained from the end of the 1st to the end of the 4th year of
university, so they did not subsequently lose the body fat gained after the 1st year. Moreover, during 4 years of university, the number of participants who were classified as obese increased by 6%, using %BF cutoffs made by the World Health Organization (≥25 for men, ≥35 for female; World Health Organization, 1995). The increase in obesity rates highlights the importance of promoting health plans throughout university. Specifically, since most of the gains in BM and %BF took place during the 1st year, it is suggested that a better strategy will be to promote these plans during the 1st year rather than the later years. Investing more effort during the first year is preferred as it is harder to lose the excess weight than to prevent it to begin with (Brownell, 1993; Kramer et al., 1989).

5.4 Nutrition and physical activity changes from the 1st year to 4th university

This study explored university students who are in the period of emerging adulthood, which is generally from 18 to 25 years of age. This is a period during which individuals will develop their adult lifestyle habits, including those related to health behaviors such as dietary intake, alcohol consumption, and PA behaviors (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). During this final stage of development, coinciding with the time they enter university, individuals become more independent and continue to develop their self-identity, which includes health-related variables, such as “exerciser/non-exerciser” or “healthy eater/eat whatever I want” (Arnett, 2000; Strachan & Brawley, 2009; Strachan, Brawley, Spink, & Jung, 2009). This critical period in one’s life is associated with increased FM, which as mentioned before, is related to increased health risk (Barbour-Tuck, Erlandson, Muhajarine, Foulds, & Baxter-Jones, 2018). Therefore, it is very important to have a better understanding of the changes occurring to
health behaviors and body composition during this time to inform targeted health interventions for university students across their university career.

When investigating dietary habits during university, it is important to assess the overall daily energy intake as well as the daily macronutrient consumption. Our study demonstrated that changes during the 1st year included a decrease in daily EI, protein intake, carbohydrate intake, but no change in fat intake. These results are consistent with other studies that have used FFAGs to quantify daily EI and daily macronutrient consumption during the 1st year in university (Butler, Black, Blue, & Gretebeck, 2004; Pliner & Saunders, 2008). It is interesting that studies exploring the 1st year in university, including the current study, observed an increase in BM despite a decrease or maintenance of EI (Beaudry et al., 2019; Butler et al., 2004; Pliner & Saunders, 2008). The decrease or maintenance in EI suggests that gains in BM and %BF during the 1st year of university are more likely due to the decrease in EE. This is the other main factor that could affect one’s energy balance and contribute to weight and fat gain (Hill et al., 2012).

EE changes in the present study are mainly represented by changes in PA. During the investigated period, changes in one’s basal metabolic rate (BMR), which explains approximately 70% of the daily expenditure of calories, could not explain the changes in EE, as changes in BMR will only be minor. The main contributor for changes in BMR is LBM (Zi Mian Wang et al., 2007). Increased FM can also increase BMR. However, this was only found to be significant in obese individuals (Johnstone, Murison, Duncan, Rance, & Speakman, 2005). However, the overall observed changes of LBM during the 4 year study period were relatively low (+2.03±3.73). To give some perspective, 1 kg of muscle tissue will expend approximately 10 kcal per day (Elia, 1992). Therefore, on average the
contribution of the observed increased LBM to the daily BMR in our sample during the 4 years in university, would be as low as approximately +20±37 kcal. This value is even lower when looking into these changes during the 1st year and the latter years separately. Other contributors to daily EE include the thermic effect of food (TEF), which represents approximately 10% of the daily expenditure of calories, will only account for a very little amount of the expended calories per day. Exercise activity thermogenesis (EAT), and nonexercise activity thermogenesis (NEAT) together make up the rest of the approximate 20% of the daily expenditure (MacLean, Bergouignan, Cornier, & Jackman, 2011). Both EAT and NEAT are included under the different previously mentioned components of PA. It is well known that PA has a major impact on the regulation of BM and body composition. Therefore, it is expected that a decrease in PA during university will have a negative effect on BM and body composition (Chaput et al., 2011; Slentz et al., 2004). Changes in PA habits during the 1st year in our sample (Table 5) were reflected in the lower daily EE observed in both males and females. Specifically, PA-related changes in the current sample include a decrease in LPA and MPA, but no change in VPA for both sexes. These changes in PA during the 1st year are consistent with the changes observed in the first transition study and one other study, investigating 1st year university students (Jung, Bray, & Ginis, 2008; Thomas et al., 2019).

The present study also measured EI and macronutrient changes from the end of the 1st year to the end of the 4th year in university. During this period, no changes were observed in the consumption of any of the macronutrients or the daily EI (Table 4), but recall this was different from baseline (beginning of 1st year). Therefore, the changes in EI, macronutrient intake, and %BF from the end of the 1st year remained stable across the
remaining 3 years while BM continue to increase. Since EI and macronutrient consumption did not change for the remaining 3 years in university, if EE also remained the same (or decreased further), one would expect to see higher gains in BM and %BF. However, from the end of the 1st year to the end of the 4th year, EE increased, which may explain why students gained less BM with no change in %BF instead of what they would have been expected to gain without the observed increase in EE.

These changes in PA for both sexes, including an increase in EE and in LPA, with no change in MPA and VPA, reflect slight improvements in PA habits after 1st year of university. This observation strengthens the suggestion that EE plays a major role in body composition management during this period. In other words, it is possible that the increase in EE tilted the energy balance in a negative direction, likely explaining the plateau observed in %BF (Hill et al., 2012). This has a major impact on our understanding of how PA affects BM and body composition change during university. When looking only at EE changes during university, these changes correspond to the observed changes in %BF. That is, when EE decreases during the 1st year, %BF increases. However, from the end of the 1st year to the end of the 4th year, when EE increases, no changes are observed in %BF, and LBM increases. This strengthens the suggestion that changes in body composition during university are influenced by changes in PA and not necessarily due to nutritional changes.

The students in the current sample met the CSEP guidelines of 150 minutes of moderate to vigorous PA per week both during the 1st year and from the end of the 1st to the end of the 4th year. Importantly, from the end of the 1st year to the end of the 4th year, LPA increased significantly, suggesting that the change in body composition may not have been related to more structured/planned exercise expressed as moderate and vigorous PA,
but rather to the overall physical activity and mobilization of the students, expressed as LPA. Hence, it will likely be of great value to emphasize to students how important it is to increase the opportunities for habitual PA during the day to maintain a healthy body composition and BM. This was shown previously by Flint et al. (2014) and Gordon-Larson et al. (2009). They demonstrated that individuals who made more choices to increase habitual PA, such as walking or biking to work and using the stairs rather than the elevator, gained less weight over time than those who chose not to increase their PA in this way (Flint, Cummins, & Sacker, 2014; Gordon-Larsen et al., 2009; Pate, 1995). The increased PA from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th} year, which was mainly in light activities, was sufficient to stop further increases in %BF after the year 1, but not enough to reverse the gains in BM and %BF, which took place during the 1\textsuperscript{st} year. Consequently, during the 4 years in university, the number of students classified as obese increased (using %BF cutoffs). Therefore, there is still a need to improve PA habits beyond the 1\textsuperscript{st} year in university.

5.4 Strengths and Limitations

The present study had two main strengths. The most important is its longitudinal nature, including 3 time points of data collection, at the beginning of the 1\textsuperscript{st} year, the end of the 1\textsuperscript{st} year, and the end of the 4\textsuperscript{th} year. This allowed for a comparison of changes observed during the 1\textsuperscript{st} year with those observed from the end of the 1\textsuperscript{st} year to the end of the 4\textsuperscript{th}, leading to a better understanding of the trajectories for BM and %BF gains during university time. The ability to isolate the information found during the 1\textsuperscript{st} year is also important, because most of the gains in BM and %BF took place during the 1\textsuperscript{st} year, highlighting the importance of addressing these gains as early as possible, i.e., during their
habituation to university life in their 1st year. Another strength of the present study is the comprehensive assessment of nutrition and PA variables. The results suggest that changes in PA may help to explain further gains in BM (and LBM) and the plateau in %BF despite the lack of improvement in EI.

The present study had several limitations. The main limitation of the current study was the small sample size (n =38). Although, retention rates for longitudinal studies in university populations tend to be low, we acknowledge that the 10% retention rate of our study is low. A post-hoc power analysis using G*Power (version 3.1), with an effect size of 0.15 and a significance level set at 0.05, revealed a 50% power. An estimated 66 participants would be needed to obtain statistical power at the recommended 80% level at the same effect size and significance threshold. However, despite clear differences in the size of the samples, the same patterns were observed for the changes in BM and body composition during the 1st year in both the 1st transition study (n=301) and the current sample (n=38). In both cases, significant weight and %BF gain were observed during the 1st year (Beaudry et al., 2019). This suggests that the current sample is representative of the first transition study cohort. Selection bias is possible, as those who came back might have done so because they had lower BM at baseline, which could have affected their confidence, however, we found no other differences at baseline between responders and non-responders for %BF, EE, LPA, MPA, VPA, EI, and macronutrient consumption. In addition, no differences were found between responders and non-responders, for the changes occurring from the beginning of the 1st year to the end of the 1st year, in any of the investigated variables. Another limitation is the large variability in our sample as illustrated in the scatterplots (Figures 3-6) of the individual changes in BM, %BF, FM and LBM.
Additionally, other factors that could affect the results were not analyzed. Such factors include stress levels, programs of study, and any underlying health conditions or medications that can affect weight gain like oral contraceptives, which are common in this population. Living arrangements could also influence the results, but most of the students lived in a student house off campus (n = 28, 74%). Likewise, most of the students were Caucasian (n = 30, 79%), therefore, ethnicity was not used as a covariate. In addition, the FFAQ relied on participants' recall, which has been shown to produce over and underestimation (Paffenbarger, Blair, Lee, & Hyde, 1993). Yet, for the purpose of this study, we mainly focused on the changes between the 3 timepoints and assumed that any over or underestimation will be similar within a person at each timepoint. Finally, this study required students to have their BM and body composition measured only 3 times over the 4 years, and not every year. Thus, the potentially important information from the 2 years between the end of 1st to the end of 4th year is missing, so we cannot determine whether additional fluctuations in BM and body composition occur during this time.

5.5 Implications and future directions

This thesis has several practical implications, especially for students and universities. First, these findings highlighted the importance of assessing BM and body composition not only during the 1st year, but also throughout other years of university and comparing them, as the trajectories for BM and %BF may change during each year of university and might not be linear. Information from the present study suggests that the main issue with %BF gain takes place only during the 1st year since no additional fat was gained by the end of year 4. Further investigations with more time points will determine the trajectories of BM and %BF changes in more detail. This will allow for a better
understanding of when the most efficient time will be to invest in programs to improve health during university. According to our data, we should focus our efforts on addressing the contributors to body fat gain occurring in the initial year of university, as these may be the most important and may mitigate further gains seen in the latter 3 years. Likewise, the results support the importance for students to increase their habitual PA. Thus, we should systematically encourage students to make healthy choices to increase their daily habitual activity, such as walking to the university instead of using the bus, choosing the stairs over the elevator, and implementing short durations of walking breaks while studying. These choices can help to mitigate the increasing prevalence of overweight and obesity observed in university students, as reduction in PA was highlighted as one of the main reasons for weight gain (Flint et al., 2014; Gordon-Larsen et al., 2009; Pate, 1995; Pullman et al., 2009). Therefore, it is important to incorporate PA in the health program designed for the students. It may also be beneficial to incorporate PA within the student’s university schedule to make PA more accessible to the students.

BM gains were detected during all 4 years in the current sample, and even when EE increased, it was not sufficient to reverse the BM gains observed in the 1st year. Therefore, further education and changes in healthy behaviors, including dietary habits are needed to incorporate into the designed health programs for university students. This should include more knowledge about how to prepare healthy meals, as students might be lacking this information (Vella-Zarb & Elgar, 2009). In addition, changes in university diet should include offering smaller portions of food for students who have a meal plan, while avoiding all you can eat style buffets (Rolls, Morris, & Roe, 2002). Likewise, students should increase the amounts of fruits and vegetables in their diet (Beaudry et al., 2019).
There is still a lot to learn about the university environment and the reasons for BM and %BF gains during this period in life. Future studies should be encouraged to compare university programs to college programs and working environments and determine if other factors are at play. For instance, hours of study/work per week, planned and unplanned hours of PA per week, eating behaviors at these different environments, and level of stress.

5.6 Conclusions

The present study followed a sample of 38 students during their 1st year and 3 years after the end of their 4th year of study at Brock University. The most significant finding of the current study is that %BF gains occurred only during the 1st year, and these gains were maintained thereafter until the end of the 4th year. However, students were not able to reverse the gains obtained during the 1st year, which may have negative health implications. One of the main reasons this is a concern is weight gained early in life can follow into adulthood, and so there is an increased risk for overweight and obesity to continue throughout adulthood (Serdula et al., 1993). Therefore, even though the observed gains in %BF during university time are relatively low and most likely will not cause health implications in the short term, the increased %BF and the lifestyle habits developed during university can lead to increased obesity rates in the long run. The present study provided detailed information about nutrition and PA habits during university. No changes were observed in macronutrient consumption from the end of the 1st year to the end of the 4th year. However, it seems that the path for the changes in PA, which included an increase in LPA, was in line with the stabilization of %BF by the end of the 4th year. Specifically, while daily EE decreased during the 1st year, %BF increased. Additionally, when EE increased from the end of the 1st year to the end of the 4th, %BF plateaued. This highlights
the possible contribution of PA changes to body composition during university. Finally, the results of the present study suggest that university is associated with adverse changes in BM and %BF leading to an increased risk of overweight and obesity, so the promotion of health programs, particularly during the 1st year of university, where most of the gains occurred and lifestyle changes take place, should be of great importance.
REFERENCES


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### APPENDIX

Appendix A - Information on select vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Fat/Water Soluble</th>
<th>Food Sources</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitamin D</strong></td>
<td>Fat Soluble</td>
<td>Beef liver, egg yolk, dairy (fortified)</td>
<td>Maintains normal amounts of calcium and phosphorus. Helps the body absorb Calcium</td>
</tr>
<tr>
<td><strong>Vitamin A</strong> (beta-carotene)</td>
<td>Fat Soluble</td>
<td>Dark leafy green vegetables</td>
<td>Maintenance of epithelial tissues and constituent of visual pigment</td>
</tr>
<tr>
<td><strong>Vitamin C</strong></td>
<td>Water Soluble</td>
<td>Citrus fruits, tomatoes, green peppers, salad greens</td>
<td>Maintains intercellular matrix of cartilage, bone and dentine. Important in collagen synthesis</td>
</tr>
<tr>
<td><strong>Vitamin E</strong></td>
<td>Fat Soluble</td>
<td>Seeds, green leafy vegetables, margarines, shortenings</td>
<td>Functions as an antioxidant to prevent cell damage</td>
</tr>
<tr>
<td><strong>Vitamin B1</strong></td>
<td>Water Soluble</td>
<td>Pork, organ meats, whole grains, nuts, legumes, milk, fruits, vegetables</td>
<td>Coenzyme in reactions involving the removal of carbon dioxide</td>
</tr>
<tr>
<td><strong>Vitamin B2</strong></td>
<td>Water Soluble</td>
<td>Meats, eggs, milk products, whole-grains, wheat germ, green leafy vegetables</td>
<td>Constituent of two flavin nucleotide coenzymes involve in energy metabolism</td>
</tr>
<tr>
<td><strong>Niacin</strong></td>
<td>Water Soluble</td>
<td>Liver, lean meats, poultry, grains, legumes, peanuts</td>
<td>Constituent of two coenzymes in oxidation reduction reactions</td>
</tr>
<tr>
<td><strong>Folate</strong></td>
<td>Water Soluble</td>
<td>Legumes, green vegetables, whole wheat, meats, eggs, milk products, liver</td>
<td>Coenzyme involve in transfer of single-carbon units in nucleic acid and amino acid metabolism</td>
</tr>
<tr>
<td><strong>Vitamin B6</strong></td>
<td>Water Soluble</td>
<td>Meats, fish, poultry, vegetables, whole-grain, cereals, seeds</td>
<td>Coenzyme involved in amino acid and glycogen metabolism</td>
</tr>
</tbody>
</table>
Appendix B - Information on select minerals

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Major/Minor</th>
<th>Food Sources</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Major</td>
<td>Milk, cheese, dark green vegetables, dried legumes</td>
<td>Bone and tooth formation, blood, clotting, nerve transmission</td>
</tr>
<tr>
<td>Zinc</td>
<td>Minor</td>
<td>Widely distributed in Foods</td>
<td>Constituent of enzymes involved in digestion</td>
</tr>
<tr>
<td>Iron</td>
<td>Minor</td>
<td>Eggs, lean meats, legumes, whole grains, green leafy vegetables</td>
<td>Constituent of hemoglobin and enzymes involved in energy metabolism</td>
</tr>
<tr>
<td>Potassium</td>
<td>Major</td>
<td>Leafy vegetables, cantaloupe, lima beans, potatoes, bananas, milk, meats, coffee, tea</td>
<td>Fluid balance, nerve transmission, acid-base balance</td>
</tr>
<tr>
<td>Sodium</td>
<td>Major</td>
<td>Common salt</td>
<td>Acid-base balance, body water balance, nerve function</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Major</td>
<td>Whole grains, green leafy vegetables</td>
<td>Activates enzymes involved in protein synthesis.</td>
</tr>
</tbody>
</table>
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

STUDY TITLE: Identifying lifestyle changes that impact students’ physical and emotional wellbeing during university – A follow up study

You are being invited to participate in a research study conducted by the investigators listed below. Prior to participating in this study please read this form to find out about the purpose of our study and what is required of you should you choose to participate. All testing will be carried out in the Nutrition Laboratory (WH144, Brock University) or online.

INVESTIGATORS: DEPARTMENT: CONTACT:
Dr. Andrea Josse FAHS, Brock University (905) 688-5550 ex. 3502

PURPOSE: The purpose of our study is to identify the key health-related issues and lifestyle changes that may occur from the time students finish first year university until the end of their 4th year of university. Specifically, we are assessing the changes in nutrition, exercise and sleep habits, stress levels, body image, mental health and anthropometry (body weight and body composition) during this time.

INCLUSION CRITERIA: You may participate in this study ONLY if you already completed the initial TRANSITION study during your first year at Brock University.

STUDY TIMELINE: Should you consent to participate, you will be asked to fill out the same surveys that you did before. The surveys will be filled out in person in the laboratory, Welch Hall 144. This testing session will last approximately 2 hours in the laboratory. You will also have your height, weight, waist circumference, and body composition measured, and you will provide a saliva sample. Two or 3 participants will be scheduled to visit the lab simultaneously, however all measurements will be taken individually and privately, and if requested, by a same-sex investigator. All procedures are detailed below.

DESCRIPTION OF TESTING PROCEDURES: You will be asked to arrive at the Nutrition Laboratory for your scheduled testing session. Please refrain from eating or drinking anything for 4 hours prior to this testing session. Please refrain from exercise for 12 hours and from alcohol for 24 hours prior to this testing session. Students of the study investigators will be facilitating the testing and taking the measures. Specific testing procedures are outlined below.

1. Questionnaires: You will be asked to complete questionnaires in person, in the laboratory upon your arrival. These questionnaires will ask about your general health and demographics, medical history during university, exercise, nutrition, sleep habits,
stress levels, body image and mental health. Remember that your responses will be kept confidential and that you may choose not to answer any question without penalty. Only your subject ID will be used as an identifier, i.e. those analyzing the data will not know who filled out the survey, only their subject ID.

2. **Body composition:** We will measure your body composition (% body fat) in two ways, as we have previously done. The first is using BIA, which stands for “Bioelectric Impedance Analysis”. The BIA assessment requires you to stand on a weight scale and grasp two handles. A mild electrical current (50kHz, 800μA) will pass through your hands to your feet. This current cannot be felt and causes no harm. Valid measurements require abstinence from exercise, alcohol consumption, and eating/drinking for at least 12, 24 and 4 hours, respectively, prior to testing. You will be asked to consume 1 cup of water (500 mL) at the start of the visit and then void prior to BIA measures being taken. Body composition will also be assessed using the BodyMetrix system. The BodyMetrix system uses ultrasound to accurately measure fat thickness in your thigh and calculate % body fat. There is no discomfort associated with either measurement.

With BIA, body composition will be measured by having you stand on a weight scale putting your feet on electrode plates while holding electrode wands in your hands (as mentioned above). With the BodyMetrix ultrasound device, body composition will be measured on the top part of your thigh. Waist circumference will be measured using a standard, retractable, non-metallic tape measure placed at your waist at the level of your belly button. Hip circumference will be measured using the same tape measure across the largest part of your buttocks and below your ‘hip bones’.

3. **Saliva sample:** We will ask you to provide a saliva sample to determine your salivary cortisol (stress hormone) and testosterone levels. Saliva samples must be collected in the morning hours. The samples will be collected using specifically designed cotton ball/swabs which are to be placed between your cheek and teeth. You will hold the swab there for 1 minute and then place it into labeled tubes for storage. You will be asked to follow these additional procedures and answer additional related questions prior to collection:
   a. Avoid foods with high sugar or acidity, or high caffeine content. 4 hours before sample collection.
   b. Document consumption of alcohol, caffeine, nicotine, and prescription/over-the-counter medications as well as physical activity within the prior 12 hours.
   c. Document the presence of oral diseases or injury.
   d. Do not eat a major meal within 4 hours of sample collection.
   e. Rinse mouth with water to remove food residue and wait at least 10 minutes after rinsing to avoid sample dilution before collecting saliva.

**CONFIDENTIALITY:** All of your data collected during this study will remain confidential and will be stored in offices and on secured computers to which only the principal investigator and the research students she directly supervises will have access. You should be aware that the results of this study will be made available to scientists, through publication in a scientific journal.
but your name and any personal data will not appear in compiling or publishing these results. Electronic and paper data will be kept for 5 years after the date of publication, at which time all information will be destroyed. Additionally, you will have access to your own data, as well as group data when it becomes available and if you are interested.

**PARTICIPATION AND WITHDRAWAL:** You can choose whether to participate in this follow-up study or not. You may also refuse to answer any questions posed to you during the study and still remain a participant in the study. There will be no effect on your academic standing or standing within the university if you choose not to participate. Upon completion of this follow-up study, you will receive $5 for your time.

**RISKS AND BENEFITS:** There is little direct risk to you. Although you have experienced all these measures previously, you may experience some discomfort due to the personal nature of the questions asked. Contact information for Student Health Services will be readily available within your view (posted in our laboratory) if needed. You may also feel uncomfortable during the body composition test. This test will take place in a private room with the door propped open with a student investigator of the same sex. This study poses no physical risk. Participation will allow you to become exposed to a research protocol, contribute to the advancement of science and, gain general knowledge about lifestyle habits of students at Brock University.

**RIGHTS OF RESEARCH PARTICIPANTS:** You may request to receive a signed copy of this consent form. You may withdraw your consent to participate in this study at any time, and you may also discontinue participation at any time without penalty. This research has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (REB#17-334). If you have any questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 ext 3035, reb@brocku.ca).

**INFORMATION:** Our study office is located in Welch Hall 144. Please contact our study office at brocktransitionstudy@gmail.com or 905-688-5550 ext. 5826, or any of the above investigators at any time if you have any questions about the study.
CONSENT

I HAVE READ AND UNDERSTAND THE ABOVE EXPLANATION OF THE PURPOSE AND PROCEDURES OF THE PROJECT. I HAVE ALSO RECEIVED A SIGNED COPY OF THE INFORMATION AND CONSENT FORM. MY QUESTIONS HAVE BEEN ANSWERED TO MY SATISFACTION AND I AGREE TO PARTICIPATE IN THIS STUDY.

____________________________________  ______________________________
SIGNATURE OF PARTICIPANT              DATE

____________________________________
PRINTED NAME OF PARTICIPANT

INVESTIGATOR

In my judgment the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent and participate in this research study.

____________________________________  ______________________________
SIGNATURE OF INVESTIGATOR              DATE
Appendix D

ID # ______________________

Transition Study 2.0 – BREB#17-334

General Health and Demographics Questionnaire

Your responses to this questionnaire are confidential. You may refuse to answer any of the following questions.

Contact Information

Name: ____________________________________________

Phone number (___) ____________

E-mail address (please print clearly)

________________________________________________

General/Demographic Information

Today’s date: _________________________________

Age: ______

Living arrangements for 2nd, 3rd and 4th year (e.g. house with other students, residence, at home with family):

2nd: _______________________________________

3rd: _______________________________________

4th: _______________________________________

Describe your commute to Brock for 2nd, 3rd and 4th year:

2nd: _______________________________________

3rd: _______________________________________

4th: _______________________________________
Please indicate if you have been diagnosed with any of the following conditions in 2\textsuperscript{nd}, 3\textsuperscript{rd}, or 4\textsuperscript{th} year.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tick if YES</th>
<th>Age at Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>High cholesterol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High blood pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
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<tr>
<td>Anxiety disorder</td>
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<td></td>
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<tr>
<td>Bulimia</td>
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<tr>
<td>Anorexia</td>
<td></td>
<td></td>
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<tr>
<td>Chest pain or shortness of breath</td>
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<td></td>
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<tr>
<td>Kidney problems</td>
<td></td>
<td></td>
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<tr>
<td>Food allergies, specify</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other allergies, specify</td>
<td></td>
<td></td>
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<tr>
<td>Asthma</td>
<td></td>
<td></td>
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<tr>
<td>Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer, specify</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crohns/Ulcerative Colitis</td>
<td></td>
<td></td>
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<tr>
<td>Irritable Bowel Syndrome</td>
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<tr>
<td>Ulcer</td>
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<tr>
<td>Thyroid conditions</td>
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<tr>
<td>Celiac disease</td>
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<tr>
<td>Arthritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteoporosis/Osteopenia</td>
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<td></td>
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<tr>
<td>Broken bone (which bone(s)?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other condition, specify</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What medications/supplements have you taken within the \textbf{last few days}?

Indicate whether you habitually (over the last few months) take any of the mentioned medications or supplements.

<table>
<thead>
<tr>
<th>Medication name</th>
<th>Reason</th>
<th>Amount</th>
<th>Habitually?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
What vitamins, minerals, herbal supplements or other nutritional supplements have you taken within the last few days (i.e., multivitamin, protein powder, ginkgo)?

<table>
<thead>
<tr>
<th>Supplement Name</th>
<th>Reason</th>
<th>Amount</th>
<th>Habitually?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Do you currently smoke (at least 1 cigarette per day for 1 month or longer)?

- [ ] Yes  - [ ] No

If yes, how many years have you been smoking? ____________

If yes, how many cigarettes do you smoke per day? ____________

Are you a past smoker (have previously smoked at least 1 cigarette per day for 1 month or longer but have not smoked at least 1 cigarette per day in the last month)?

- [ ] Yes  - [ ] No

If yes, when did you quit (approximate date)? ____________

how many years did you smoke? ____________

how many cigarettes did you smoke per day? ____________

Please list any food restrictions (e.g., salt, fat, carbohydrate, etc.) or special diets you are have been on in the last few months (e.g., Atkins, South Beach, vegan) and the reason (e.g., health, religious or other reasons).

<table>
<thead>
<tr>
<th>Food Restrictions/ Special Diet</th>
<th>Reason</th>
<th>How long?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Please answer the next few questions about your sleep patterns over the last 4 weeks.

Generally, how many hours a night do you sleep?

Weekday: ______________________

Weekend: ______________________

Is this enough sleep for you? ______________________

Describe the quality* of your sleep (circle one):
*How often you get up, tossing and turning, restlessness, etc.

bad mediocre good very good excellent

Describe the time it takes you to currently fall asleep (circle one):

Takes a long time usual time takes little time

Describe the way you currently awaken from a night’s sleep (circle one):

Still very tired feeling somewhat rested feeling very well rested

Stay in bed a long time usual routine (maybe press snooze once) get right out of bed

Are you tired right now? ______________________

Thank You!
Appendix E

FOOD AND ACTIVITY QUESTIONNAIRE

ABOUT THIS SURVEY
Please answer each question as best you can. Estimate if you aren't sure.

- DETACH THE LAST PAGE OF THIS BOOKLET. These are your portion pictures.
- USE ONLY A NUMBER 2 PENCIL.
- FILL IN THE CIRCLES COMPLETELY and erase completely if you make any changes.

INSTRUCTIONS
This form is about the foods you usually eat. Think about your intake over the last 6 months. This includes all meals or snacks, at home, in a restaurant, or carry-out.

Please tell us...

1. HOW OFTEN, on average, did you eat the food? DO NOT SKIP any foods. Mark "Never" if you didn't eat any of the food.
2. HOW MUCH of the food did you usually eat on the days you ate it? Sometimes we ask "How much?" as A, B, C or D. LOOK AT THE PORTION PICTURES. Pick the picture that looks the most like the serving size you usually eat. (If you don't have pictures: A = 1/4 cup, B = 1/2 cup, C = 1 cup, D = 2 cups.)
3. WHAT TYPE? For some foods we ask the type (low-fat, low-sugar...) near the end of the survey.

EXAMPLE: This person drank orange juice twice a week, and had one glass each time. Once a week this person ate a "C"-sized serving of cold cereal (about 1 cup).

How often in the past 6 months?

<table>
<thead>
<tr>
<th>How often</th>
<th>0-2 times per month</th>
<th>3+ times per month</th>
<th>2-3 times per week</th>
<th>2-3 times per week</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange juice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold cereal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### EGGS and DAIRY FOODS

<table>
<thead>
<tr>
<th>Item</th>
<th>0-1 TIMES PER DAY</th>
<th>1-3 TIMES PER WEEK</th>
<th>2 TIMES PER WEEK</th>
<th>3-4 TIMES PER WEEK</th>
<th>5-6 TIMES PER WEEK</th>
<th>EVERY DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast sandwiches or breakfast burritos with eggs or meat</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Other eggs like scrambled or boiled, or quiche (no egg substitutes)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Yogurt (not frozen yogurt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottage cheese, ricotta cheese</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cream cheese, sour cream, dips</td>
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<tr>
<td>Cheese, sliced cheese, cheese spread, including in sandwiches and quesadillas</td>
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</tr>
</tbody>
</table>

### CEREALS, GRAINS, BREADS

<table>
<thead>
<tr>
<th>Item</th>
<th>0-1 TIMES PER DAY</th>
<th>1-3 TIMES PER WEEK</th>
<th>2 TIMES PER WEEK</th>
<th>3-4 TIMES PER WEEK</th>
<th>5-6 TIMES PER WEEK</th>
<th>EVERY DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold cereals, ANY KIND, like corn flakes, fiber cereals, sweetened cereals</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Oatmeal, or whole grain cereal like Wheatena or Plaiton</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Grits, cream of wheat, cornmeal mush</td>
<td></td>
<td></td>
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<tr>
<td>Milk or milk substitutes on cereal</td>
<td></td>
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<tr>
<td>Brown rice, or dishes made with brown rice</td>
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<tr>
<td>White rice, or dishes made with rice, like rice and beans</td>
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<tr>
<td>Pancakes, waffles, French toast, crepes</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Breakfast pastries, like muffins, scones, sweet rolls, Carish, Pop Tarts, pan dulce</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biscuits, not counting breakfast sandwiches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn bread, corn muffins, hush puppies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger buns, hotdog buns, submarine or hoagie buns</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Bagels or English muffins, dinner rolls, pita, naan</td>
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</tr>
<tr>
<td>Tortillas (not counting in tacos or burritos)</td>
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<tr>
<td>Any other bread or toast, including white, dark, whole wheat, and what you have in sandwiches</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### VEGETABLES

<table>
<thead>
<tr>
<th>Item</th>
<th>0-1 TIMES PER DAY</th>
<th>1-3 TIMES PER WEEK</th>
<th>2 TIMES PER WEEK</th>
<th>3-4 TIMES PER WEEK</th>
<th>5-6 TIMES PER WEEK</th>
<th>EVERY DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli, Chinese broccoli, or Brussels sprouts</td>
<td></td>
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<tr>
<td>Carrots and mixed vegetables containing carrots</td>
<td></td>
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<tr>
<td>Corn</td>
<td></td>
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<tr>
<td>Green beans, string beans, green peas</td>
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<tr>
<td>Cooked greens like spinach, collards, turnip greens, kale, mustard greens</td>
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</tr>
<tr>
<td>Food Item</td>
<td>A Few Times Per Month</td>
<td>Once Per Month</td>
<td>1-2 Times Per Week</td>
<td>3-5 Times Per Week</td>
<td>5-6 Times Per Week</td>
<td>Every Day</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Cabbage, cole slaw, Chinese cabbage</td>
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<tr>
<td>Green salad with lettuce or raw spinach</td>
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<tr>
<td>Raw tomatoes</td>
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<tr>
<td>Salad dressing</td>
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<tr>
<td>Avocado, guacamole</td>
<td></td>
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<tr>
<td>Sweet potatoes, yams</td>
<td></td>
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</tr>
<tr>
<td>French fries, home fries, hash browns, tater tots</td>
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<tr>
<td>Potatoes not fried, like baked, boiled, mashed, or in stew or potato salad</td>
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<tr>
<td>Any other vegetable, like squash, cauliflower, peppers, onion, peppers</td>
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</tbody>
</table>

**FRUITS**

How often do you eat the following fruits? Include fresh or frozen fruits. Only include canned or dried fruit when mentioned.

- Watermelon, cantaloupe, honeydew, other melons
- Strawberries or other berries
- Bananas
- Apples or pears
- Oranges, tangerines, grapefruit
- Peaches and nectarines
- Any other fresh fruit, like grapes, plums, mango, fruit salad
- Raisins, dates, other dried fruit
- Canned fruit, like apricots, fruit cocktail, canned peaches or pineapple

**BEANS, TOFU, AND MEAT SUBSTITUTES**

Include those eaten alone, or in mixed dishes like burritos, chili, stir-fry, salad

- Refried beans, bean burritos, or hummus
- Pinho beans, black beans, kidney beans, baked beans, lentils
- Tofu or tempeh
- Most substitutes, like veggie burgers, veggie chicken, vegetarian hot dogs or vegetarian lunch meats

---

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #
### SOUPS, MIXED DISHES, AND NOODLES

<table>
<thead>
<tr>
<th>Dish Description</th>
<th>0-3 times per month</th>
<th>1-2 times per month</th>
<th>3-4 times per month</th>
<th>5-6 times per month</th>
<th>Every week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split pea, bean, or lentil soup</td>
<td></td>
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<tr>
<td>Vegetable soup, vegetable beef soup, or tomato soup</td>
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<tr>
<td>Any other soup, including chicken noodle, cream soups, Cup-A-Soup, ramen</td>
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<tr>
<td>Pizza or pizza pockets</td>
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<tr>
<td>Macaroni and cheese</td>
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<tr>
<td>Spaghetti, lasagna, other pasta with tomato sauce</td>
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<tr>
<td>Other noodles like plain pasta, pasta salad, soba noodles</td>
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<tr>
<td>Egg rolls, won tons, samosas, empanadas</td>
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</tbody>
</table>

### MEAT AND CHICKEN

<table>
<thead>
<tr>
<th>Dish Description</th>
<th>0-3 times per month</th>
<th>1-2 times per month</th>
<th>3-4 times per month</th>
<th>5-6 times per month</th>
<th>Every week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamburgers, cheeseburgers, turkey burgers, at home or from a restaurant</td>
<td></td>
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<tr>
<td>Hot dogs or dinner sausage like Polish, Italian, chicken apple</td>
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<tr>
<td>Bacon or breakfast sausage</td>
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<tr>
<td>Lunch meats like bologna, sliced ham, sliced turkey, salami</td>
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<tr>
<td>Meat loaf, meat balls</td>
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<tr>
<td>Steak, roast beef, pot roast, including in frozen dinners or sandwiches</td>
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<tr>
<td>Tacos, burritos, enchiladas, tamale, tostadas, with meat or chicken</td>
<td></td>
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<tr>
<td>Ribs, spare ribs</td>
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<tr>
<td>Pork chops, pork roast, cooked ham (including for breakfast)</td>
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<tr>
<td>Any other meat or pork dish like stew, pot pie, corned beef hash, chili, Hamburger Helper, curry</td>
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<tr>
<td>Liver, including chicken liver or liverwalet</td>
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<tr>
<td>Pigs feet, neck bones, oxtails, tongue, chillings</td>
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<tr>
<td>Veal, lamb, goat, deer meat, other game</td>
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<tr>
<td>Fried chicken, including chicken fingers, chicken nuggets, wings, chicken patty</td>
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<tr>
<td>Roasted or broiled chicken or turkey</td>
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</tr>
<tr>
<td>Any other chicken or turkey dish, like chicken stew or curry, chicken saus, stir-fry, Chinese chicken dishes</td>
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<td></td>
</tr>
<tr>
<td>FISH, SEAFOOD</td>
<td>A FEW TIMES PER YEAR</td>
<td>3-6 TIMES PER MONTH</td>
<td>3-4 TIMES PER WEEK</td>
<td>2-3 TIMES PER WEEK</td>
<td>1-2 TIMES PER WEEK</td>
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<tr>
<td>Oysters</td>
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<tr>
<td>Shellfish like shrimp, scallops, crab</td>
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<tr>
<td>Tuna, tuna salad, tuna casserole</td>
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<tr>
<td>Salmon, mackerel, sea bass, trout, sardines, herring, without breading</td>
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<tr>
<td>Fried fish, fish sticks, fish sandwich, breaded fillets</td>
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<tr>
<td>Any other fish</td>
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<tr>
<td><strong>NUTS, SEEDS, SNACKS</strong></td>
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<tr>
<td>Peanut butter or other nut butters</td>
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<tr>
<td>Walnuts or flax seeds (don’t count flaxseed oil)</td>
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<tr>
<td>Peanuts, sunflower seeds, other nuts or seeds</td>
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<tr>
<td>Energy or protein bars, like Power Bar, Clif, EBOOST, Luna, South Beach, Atkins</td>
<td></td>
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<tr>
<td>Breakfast bars, cereal bars, granola bars (not energy or protein bars)</td>
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<tr>
<td>Popcorn</td>
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<tr>
<td>Whole grain crackers, like Wheat Thins, Ryegrain, Krysta, Wasa</td>
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<tr>
<td>Any other crackers, like saltines, Ritz, Chex-Lite, cheese-filled pretzels</td>
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<tr>
<td>Tortilla chips or corn chips, like Fritos, Doritos, corn nuts</td>
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<tr>
<td>Any other snack chips, like potato chips, Cheetos, Chex mix</td>
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</tr>
<tr>
<td><strong>SWEETS AND DESSERTS</strong></td>
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<tr>
<td>Donuts</td>
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<tr>
<td>Cake or snack cakes like cupcakes, Twinkies, pound cake, banana bread</td>
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<tr>
<td>Cookies, brownies</td>
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<tr>
<td>Pumpkin pie, sweet potato pie</td>
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<tr>
<td>Any other pie or cobbler, including fast food pies, snack pies</td>
<td></td>
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<tr>
<td>Ice cream, ice cream bars, frozen yogurt, fast food milkshakes</td>
<td></td>
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<tr>
<td>Pudding, custard, rice pudding, pie</td>
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<tr>
<td>Chocolate or other flavored sauces or syrup, on ice cream</td>
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</tr>
</tbody>
</table>

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #

PAGE 5

78
<table>
<thead>
<tr>
<th>Foods</th>
<th>A Few Times Per Week</th>
<th>Once per Month</th>
<th>Twice per Week</th>
<th>2-3 Times per Week</th>
<th>3-4 Times per Week</th>
<th>5-6 Times per Week</th>
<th>Every Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popsicles, gel, frozen fruit bars, slushies, sherbet (don’t count sugar-free)</td>
<td></td>
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<tr>
<td>Chocolate candy, candy bars like Snickers, Hershey’s, M&amp;Ms</td>
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</tr>
<tr>
<td>Any other candy, not chocolate, like hard candy, Lifesavers, Skittles, Starburst, breath mints, chewing gum (NOT sugar free)</td>
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<tr>
<td>Margarine (not butter) on bread, rice, vegetables, or other foods</td>
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<tr>
<td>Butter (not margarine) on bread, rice, vegetables, or other foods</td>
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<tr>
<td>Mayonnaise, sandwich spreads</td>
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<tr>
<td>Ketchup, salsa, chili sauce, chili peppers</td>
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<tr>
<td>Mustard, barbecue sauce, soy sauce</td>
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<tr>
<td>Gravy, or other rich sauces like Alfredo, white sauce, moé, peanut sauce</td>
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<tr>
<td>Jam, jelly, marmalade</td>
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<tr>
<td>Pickles, pickled vegetables, sauerkraut, kimchi</td>
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</tr>
<tr>
<td>Salt, added to your food at the table</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Beverages</th>
<th>A Few Times Per Week</th>
<th>Once per Month</th>
<th>Twice per Week</th>
<th>2-3 Times per Week</th>
<th>3-4 Times per Week</th>
<th>5-6 Times per Week</th>
<th>Every Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate milk, cocoa, hot chocolate</td>
<td></td>
<td></td>
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<tr>
<td>Glasses of milk or soy milk, not counting on cereal, in coffee, or chocolate milk</td>
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<tr>
<td>Meal replacement drinks like Slim Fast, Ensure, or high protein drinks or powders</td>
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<tr>
<td>Tomato juice, Y6, other vegetable juice</td>
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<tr>
<td>Real 100% orange juice or grapefruit juice. Don’t count: orange soda or Sunny Delight</td>
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<tr>
<td>Other 100% juices, like apple, grape, 100% fruit blends, or fruit smoothies</td>
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<tr>
<td>HP-C, cranberry juice cocktail, Hawaiian Punch, Tang</td>
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<tr>
<td>Drinks with some juice like Sunny Delight, Knudsen</td>
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<tr>
<td>Iced tea, homemade, instant or bottled, like Nestea, Lipton, Snapple, Tazo</td>
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<tr>
<td>Gatorade, Powerade, or other sports drinks</td>
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</tbody>
</table>

**How Much on those days?**

See portion size pictures for A-B-C-D.
<table>
<thead>
<tr>
<th>Beverage Type</th>
<th>A Few Times a Week</th>
<th>2 3 Times a Week</th>
<th>3 4 Times a Week</th>
<th>5 6 Times a Week</th>
<th>7 8 Times a Week</th>
<th>Every Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy drinks (like Red Bull, Rockstar, Monster)</td>
<td></td>
<td></td>
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<tr>
<td>Kool-Aid, lemonade, fruit flavored drinks, like Crystal Light, 7-Up,</td>
<td></td>
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<tr>
<td>Orange soda, regular or diet</td>
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<td></td>
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</tr>
<tr>
<td>Beer or non-alcoholic beer</td>
<td></td>
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<tr>
<td>Wine or wine coolers</td>
<td></td>
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<tr>
<td>Liquor or mixed drinks, cocktails</td>
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<tr>
<td>Water, bottled or tap</td>
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<tr>
<td>Milky coffee drinks like latte, mocha, cappuccino, Frappuccino</td>
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<tr>
<td>Coffee (brewed or instant), regular or decaf</td>
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<tr>
<td>Hot tea (not including herbal tea)</td>
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</tr>
</tbody>
</table>

**MILKY COFFEE DRINKS:** What kind do you usually drink? MARK ONLY ONE

- Frappuccino
- Mocha
- Latte or cappuccino
- Cafe con leche
- Some of each
- Don't drink them

What are your milky coffee drinks usually made with? MARK ONLY ONE

- Whole milk
- 1 or 2% milk (reduced fat)
- Skim milk or non-fat
- Soy milk
- Something else
- Don't drink

**COFFEE:** Is your coffee usually regular or decaf?  

- Regular
- Decaf
- Both kinds
- Don't drink coffee

What do you usually add to your regular or decaf coffee? MARK ONLY ONE

- Cream or half-and-half
- CoffeeMate, non-dairy creamer
- Condensed milk
- None of these

Do you usually add sugar (or honey) to coffee?  

- No
- Yes

If YES, how many teaspoons each cup?  

- 1
- 2
- 3
- 4

**HOT TEA:** Is your hot tea usually regular or decaf?  

- Decaf
- Regular
- I drink both kinds
- Don't drink tea

What do you usually add to your hot tea? MARK ONLY ONE

- Cream or half-and-half
- CoffeeMate, non-dairy creamer
- Condensed milk
- Any other milk

Do you usually add sugar (or honey) to hot tea?  

- No
- Yes

If YES, how many teaspoons each cup?  

- 1
- 2
- 3
- 4
### If you eat the following foods, what type do you usually eat? MARK ONLY ONE ANSWER FOR EACH QUESTION

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Whole milk, 2% milk, 1% milk (low fat), Skim milk, non-fat, Soy milk, Rice milk, Almond milk, other, Don’t drink</td>
</tr>
<tr>
<td>Smoothies, Ensure, or high protein drinks</td>
<td>Smoothies, Ensure, regular, Smoothies, Ensure, light or low-carb</td>
</tr>
<tr>
<td>High protein drinks, regular</td>
<td>High protein drinks, light or low-carb</td>
</tr>
<tr>
<td>Red 100% orange or grapefruit juice</td>
<td>Calcium-fortified, Not calcium-fortified, Don’t know, Don’t drink</td>
</tr>
<tr>
<td>Ice tea</td>
<td>Home-made, no sugar, Bottled, no-sugar, Don’t drink</td>
</tr>
<tr>
<td>Home-made, with sugar</td>
<td>Bottled, pre-sweetened</td>
</tr>
<tr>
<td>Drinks like Kool-Aid, lemonade, Crystal Light</td>
<td>Low-calorie, sugar-free, Regular, Don’t drink</td>
</tr>
<tr>
<td>Energy drinks like Red Bull, Monster</td>
<td>Sugar-free, Regular, Don’t drink</td>
</tr>
<tr>
<td>Soft drinks, soda, pop</td>
<td>Diet, low-calorie, Regular, Don’t drink</td>
</tr>
<tr>
<td>Beer</td>
<td>Has caffeine, No caffeine, Don’t drink</td>
</tr>
<tr>
<td>Wine or wine cooler</td>
<td>Fruity wine, White wine, Red wine</td>
</tr>
<tr>
<td>Light, Non-alcoholic, Don’t drink</td>
<td></td>
</tr>
<tr>
<td>Cheese</td>
<td>Low-fat, Regular-fats, Don’t eat</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Plain (no sugar or fruit), Washington, With fruit or other flavors</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Low-fat, Non-fat, Regular (whole milk), Don’t eat</td>
</tr>
<tr>
<td>Salad dressing</td>
<td>Low-fat, Lite, Fat-free, Regular, Oil &amp; vinegar, Don’t use</td>
</tr>
<tr>
<td>Spaghetti or lasagna</td>
<td>Minestrone, With meat sauce or meatballs</td>
</tr>
<tr>
<td>Beef or pork</td>
<td>Avoid eating the fat, Sometimes eat the fat, Usually eat the fat, Don’t eat</td>
</tr>
<tr>
<td>Chicken or turkey</td>
<td>Avoid eating the skin, Sometimes eat the skin, Usually eat the skin, Don’t eat</td>
</tr>
<tr>
<td>Hot dogs, dinner sausage</td>
<td>Beef or pork, Chicken or turkey, Don’t eat</td>
</tr>
<tr>
<td>Lunch meats</td>
<td>Beef or pork, Chicken or turkey, Don’t eat</td>
</tr>
<tr>
<td>Cakes, donuts, cupcakes, pastries, muffins, bread, rolls</td>
<td>Low-sugar, low-fat, Low-fat, Regular-fats, Don’t eat</td>
</tr>
<tr>
<td>Ice cream, frozen yogurt</td>
<td>Low-fat, low-sugar, low-calories, Don’t eat</td>
</tr>
<tr>
<td>Energy or protein bars</td>
<td>High energy, High protein, Don’t eat</td>
</tr>
<tr>
<td>Bagels, English muffins</td>
<td>White, Whole wheat, Multi-grain, 100% whole wheat, Eat all kinds</td>
</tr>
<tr>
<td>Burger, hot dog, sub, sandwich</td>
<td>White, Whole wheat, Multi-grain, 100% whole wheat, Eat all kinds</td>
</tr>
<tr>
<td>Meat</td>
<td>White (not whole grain), 100% whole wheat, Multi-grain, Multi-grain, 100% whole wheat, Eat all kinds</td>
</tr>
<tr>
<td>Tortillas</td>
<td>Corn tortillas, Flour tortillas (wheat), Whole wheat, Eat all kinds or don’t know</td>
</tr>
<tr>
<td>Popcorn</td>
<td>Air popped, fat-free, Low-fat or Light, Regular, Caramel corn, Corn</td>
</tr>
<tr>
<td>Crackers, pretzels</td>
<td>Low-fat, round, puffed rice, Cracker Gilroy, puffed rice, Regular, Don’t eat</td>
</tr>
<tr>
<td>Regular-fast crackers or pretzels</td>
<td>Regular, Don’t eat</td>
</tr>
<tr>
<td>Mayonnaise or sandwich spreads</td>
<td>Low-fat, Light, Regular, Don’t eat</td>
</tr>
</tbody>
</table>

### If you eat cold cereal, what do you usually eat? Choose ONE or TWO that you eat most often. If you usually eat just one kind, only choose one.

- All Bran Cinnamon Toast Crunch
- All-Bran Complete, Complete Cinnamon
- Apple Jacks, Country Crock
- Corn Flakes, Corn Puffs
- Bran Flakes
- Cap’n Crunch
- Cheerios, bran or Multi Grain
- Fruit Loops
- Frosted Flakes
- Cheer, Wheet
- Frosted Mini-Wheats
- Cheer, other
- Granola
- Rice Krispies, puffed rice
- Other bran or fiber cereal
- Other unsweetened cereal
- Other sweet cereal
- Other wheat cereal

### Which fats or oils are used most often for cooking or frying (not baking) in your home? MARK ONLY ONE OR TWO

- Non-stick spray or none
- Soft tub margarine
- Corn oil, vegetable oil and blends
- Other oil
- Butter or margarine
- Low-fat margarine
- Peanut oil
- Olive oil
- Lard, lardback, or bacon fat
- Sfoil margarine
- Canola oil, soybean oil
- Vegetable shortening, Crisco
What vitamin supplements do you take fairly regularly?

<table>
<thead>
<tr>
<th>Vitamin Type</th>
<th>A Few Days PER MONTH</th>
<th>1 Day PER WEEK</th>
<th>2-4 Days PER WEEK</th>
<th>5-8 Days PER WEEK</th>
<th>Every Day</th>
<th>Less Than 1 Year</th>
<th>1-4 Years</th>
<th>More Than 4 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal vitamins</td>
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<tr>
<td>Regular One-A-Day, Centrum, &quot;Senior&quot; vitamins or house brands of multiple vitamins</td>
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<tr>
<td>Stress-tabs or B-Complex type</td>
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<tr>
<td>Antioxidant combination, eye formula</td>
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<tr>
<td>Single Vitamins or Minerals, taken alone or in combination. Do not count what is in your multiple vitamins above.</td>
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<tr>
<td>Vitamin A (not beta-carotene)</td>
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<td>Vitamin B-6</td>
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<td>Vitamin B-12</td>
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<td>Vitamin C</td>
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<td>Vitamin D</td>
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<td>Vitamin E</td>
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<td>Folic acid, folate</td>
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<td>Calcium or calcium with calcium, like Tums</td>
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<td>Iron</td>
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<td>Zinc</td>
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<tr>
<td>Cod liver oil, other fish oils, omega-3, flax seed oil, algae</td>
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<tr>
<td>Fiber supplements like Benefiber, Metamucil</td>
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</tbody>
</table>

If you take One-A-Day, Centrum or other types of multiple vitamins, do you usually take types that contain minerals, iron, zinc, etc. or do not contain minerals or don't know?

If you take vitamin C, how many milligrams of vitamin C do you usually take on the days you take it? (Select the closest amount)

- 100
- 250
- 500
- 750
- 1000
- 1500
- 2000
- 3000
- 3000+
- Don't know

If you take vitamin E, how many IU/s of vitamin E do you usually take on the days you take it? (Select the closest amount)

- 100
- 200
- 400
- 600
- 1000
- 2000
- 4000
- 5000+
- Don't know

If you take calcium, how many milligrams of calcium do you usually take on the days you take it? (Select the closest amount)

- 100
- 350
- 600
- 1250+
- Don't know

If you take vitamin D, how many IU/s of vitamin D do you usually take on the days you take it? (Select the closest amount)

- 400
- 600
- 1000
- 2000
- 3000
- 4000
- 5000+
- Don't know

If you take omega-3 supplements, what type do you usually take? Mark all that apply.

- Fish oil
- Flax oil, hemp oil, other seed oil
- Krill oil
- Algae
- Don't know
### SOME LAST QUESTIONS ABOUT YOU

| Question                                                                 | 1-2 Days | 2-4 Days | 5-6 Days | 1 Day | 1.5 Days | 2 Days | 3 Days | 5+ Days |
|-------------------------------------------------------------------------|----------|----------|----------|-------|----------|-------|-------|---------|-------|
| About how many servings of vegetables do you eat, not counting salad or potatoes? 1 serving = 1/2 cup. | [ ]      | [ ]      | [ ]      | [ ]   | [ ]      | [ ]   | [ ]   | [ ]     | [ ]   |
| About how many servings of fruit do you eat, not counting juices? 1 serving = 1/2 cup or 1 medium fruit. | [ ]      | [ ]      | [ ]      | [ ]   | [ ]      | [ ]   | [ ]   | [ ]     | [ ]   |
| How often do you eat foods prepared at home that are cooked or fried in fat or oil? | [ ]      | [ ]      | [ ]      | [ ]   | [ ]      | [ ]   | [ ]   | [ ]     | [ ]   |
| During a regular day, how many meals and snacks do you usually eat?     | Meals per day: | 1 | 2 | 3 | 4 | 5+ |       |       |       |
|                                                                        | Snacks per day: | 1 | 2 | 3 | 4 | 5+ |       |       |       |

### PHYSICAL ACTIVITY SURVEY

Think about the last 6 months. How often did you do the activities listed below?

- Cooking, shopping, light cleaning like doing laundry or dusting, or running errands
- Slow walking like walking the dog, or light work around the house like watering
- Work on the job involving standing, like store clerk, or work involving driving (like truck driver)
- Taking care of children (feeding, dressing), or moderate housework like sweeping, mopping, cleaning the tub
- Weeding, raking, moving the lawn, or light house repairs
- Brick walking, dancing, hunting or fishing, golf (NOT using a golf cart), or 'friendly' outdoor games like softball
- Factory work, mechanic, restaurant work, or work involving walking, like mail carrier
- Construction, painting, feeding livestock, or housecare like caring for an adult family member
- Heavy work like moving boxes, heavy digging or shoveling snow, farm chores like baling hay, or other HARD labor
- Exercising at the gym or at home, aerobics, weight training, jogging, or vigorous sports like basketball, soccer, tennis
- Bicycling or swimming for exercise

Are you
- Hispanic or Latino
- Not Hispanic or Latino
- Do not wish to provide this information

What race do you consider yourself to be? MARK ALL THAT APPLY
- White
- Asian
- Black or African American
- American Indian or Alaska Native
- Native Hawaiian or Other Pacific Islander
- Do not wish to provide this information

Thank you very much for filling out this questionnaire.
Please take a minute to go back and fill in anything you may have skipped.