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**The Freshmen Weight Gain:  
Is it More About Body Composition than Weight?**

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**THE FRESHMEN WEIGHT GAIN:  
IS IT MORE ABOUT BODY COMPOSITION THAN WEIGHT?**

by

**GABRIELLE MIFSUD**

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## Abstract

**Objective:** The purpose of the study was to examine predictors of change in body weight and composition among freshmen during an academic year.

**Research methods and procedure:** Twenty-nine freshmen, 16 females ( $58.2 \pm 10.4$  kg; BMI  $21.2 \pm 2.9$  kg/m<sup>2</sup>) and 13 males ( $74.6 \pm 11.9$  kg; BMI  $23.2 \pm 2.8$  kg/m<sup>2</sup>) completed the study. Body weight and composition (DEXA), waist circumference (WC), energy intake (7-day food diary) and activity-related energy expenditure (accelerometry) were measured in September, December and March. The TFEQ and VO<sub>2</sub>peak were assessed at baseline.

**Results:** Significant increases in body weight ( $1.9 \pm 2.0$  kg,  $P < 0.05$ ), BMI ( $0.6 \pm 0.7$  kg/m<sup>2</sup>,  $P < 0.05$ ), WC ( $2.7 \pm 3.0$  cm,  $P < 0.05$ ), % body fat (BF) ( $3.1 \pm 2.3\%$ ,  $P < 0.01$ ) and fat mass ( $2.6 \pm 1.8$  kg,  $P < 0.01$ ) were noted in males, especially over the 1<sup>st</sup> semester. No significant changes were observed in females. Correlations with females and males pooled together showed that over the academic year, baseline % body fat was associated with changes in weight and %BF ( $r = -0.53$ ,  $P < 0.01$ ;  $r = -0.41$ ,  $P < 0.05$ , respectively). Baseline %BF predicted 27% ( $P < 0.05$ ) of the change in weight. Baseline alcohol intake was related with changes in WC ( $r = 0.45$ ,  $P < 0.05$ ) and %BF ( $r = 0.58$ ,  $P < 0.01$ ). It explained 34% ( $P < 0.01$ ) and 17% ( $P < 0.05$ ) of the changes respectively. The change in weight and %BF were also associated with baseline VO<sub>2</sub>peak ( $r = 0.51$ ,  $P < 0.01$ ;  $r = 0.48$ ,  $P < 0.01$ ; respectively). Dietary restraint also effected the change in % body fat ( $r = -0.43$ ,  $P < 0.05$ ).

**Discussion:** Males, leaner freshmen, physically fit freshmen experienced greater increases in body weight, adiposity and abdominal fat. The best predictor of change in BF was baseline alcohol intake.

**Keywords:** freshmen, weight gain, body composition, waist circumference, energy balance

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## CHAPTER 1: INTRODUCTION

### The Obesity Epidemic

Overweight and obesity refer to adipose tissue stores. The prevalence of overweight and obesity has increased especially in the last 20 years (Millar & Stephans, 1993; Tremblay, Katzmarzyk, & Willms, 2002; Tremblay & Willms, 2000), and has today reached epidemic proportions in Canada, USA and many other industrialised countries (Caterson & Gill, 2002; Katzmarzyk, 2002; Mokdad et al., 2001; WHO, 1998). The 2004 Canadian Community Health Survey (CCHS) reported an increase since 1978/79, with 36.1% of Canadians aged 18 and older being overweight (BMI 25-29.9 kg/m<sup>2</sup>) and 23.1% obese (BMI ≥ 30 kg/m<sup>2</sup>) (Table 1).

| BMI category | All (%) |       | Men (%) |       | Women (%) |       |
|--------------|---------|-------|---------|-------|-----------|-------|
|              | 1978/79 | 2004  | 1978/79 | 2004  | 1978/79   | 2004  |
| Overweight   | 35.4    | 36.1  | 42.5    | 42.0  | 28.7      | 30.2  |
| Obese        | 13.8    | 23.1* | 11.5    | 22.9* | 15.9      | 23.2* |

Table 1: Prevalence of overweight and obesity in Canada (Tjepkema, 2006)

\* Significantly different from the estimate in 1978/79

The increased prevalence of obesity is a major health concern due to the associated increased risk of coronary heart disease, hypertension, high blood cholesterol, non-insulin dependent diabetes mellitus, cancer (primarily colorectal, breast, endometrial, esophagus, pancreatic, hepatocellular and gallbladder), back and joint problems as well as a higher rate of mortality (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999; Chambers & Swanson, 2006; Colditz, Willett,

Rotnitzky, & Manson, 1995; Donahue, Fuster, & Califf, 2001; Eckel & Krauss, 1998; NIH, 1998; Rubenstein, 2005; Tjepkema, 2006).

### **Obesity during the adolescent years**

Since 1978/79 the prevalence of overweight and obesity among Canadian's aged 2 to 17 years, has increased from 12% to 18% and from 3% to 8% respectively, for both boys and girls. Adolescents aged 12 to 17 years have shown the most significant increase, with rates increasing from 14% to 29%. The percentage of adolescents who were obese tripled, increasing from 3% to 9% (Tjepkema, 2006). Such findings are alarming as overweight and fatness in the young adolescent years have been significantly associated with changes in blood pressure, blood lipids and lipoproteins, plasma insulin, later elevated health risk and increased mortality in adulthood among others (Baumgartner, Siervogel, Chumlea, & Roche, 1989; Freedman et al., 1987; Kotchen, Kotchen, Guthrie, Cottrill, & McKean, 1980; Must, Jacques, Dallal, Bajema, & Dietz, 1992).

In Canada, the average BMI of adolescents between 12 and 17 years has risen from 20.8 kg/m<sup>2</sup> in 1978/79 to 22.1 kg/m<sup>2</sup> in 2004, with the most pronounced increases being recorded for those whose BMI exceeded 25 or 30 kg/m<sup>2</sup>. In examining the predictive value of childhood and adolescent BMI, the age of 18 was identified as a more sensitive period for predicting BMI at age 35 than the earlier ages of 3, 8 and 13 years (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002). Such findings make this period of life a critical one for future health. The body mass of obese adolescents

tends to continue increasing, resulting in 25% to 50% of obese adolescents becoming obese adults (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Must & Strauss, 1999). Weight gained at age 18 is therefore more likely to be maintained or increased, increasing the risk for becoming or remaining obese. In the study by Guo *et al.*, overweight was considered as a BMI value  $> 28 \text{ kg/m}^2$  for males and  $> 26 \text{ kg/m}^2$  for females. With a BMI of  $24 \text{ kg/m}^2$  at age 18, white males have a 20-29.9% greater chance for being overweight at age 35, whereas with a BMI equal to or over  $25 \text{ kg/m}^2$  the odds are 40-80% greater when compared to those with a BMI of  $20 \text{ kg/m}^2$ . Conversely, 18-year-old females with a BMI of  $23 \text{ kg/m}^2$  are at 30-39.9% greater chance of being overweight at 35, while having a BMI of  $25 \text{ kg/m}^2$  increases this chance to 40-80% (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994). A follow-up study in 2002 supports their previous work, concluding that for both sexes, those overweight or obese at age 35 had significantly higher BMI in childhood and adolescence (Guo, Wu, Chumlea, & Roche, 2002). Increased weight gain following young adulthood is further supported by a longitudinal study involving 17,276 males and females aged 20-56 years. Over an 8-year period, one-third of normal weight participants (BMI  $18.5\text{-}24.9 \text{ kg/m}^2$ ) at baseline became overweight (BMI  $25.0\text{-}29.9 \text{ kg/m}^2$ ), while overweight individuals tended to continue gaining weight. By the end of the 8 year follow-up, a quarter of overweight participants had become obese (BMI  $30.0 \text{ kg/m}^2$  or more) (Le Petit & Berthelot, 2006). Once an adult is overweight, very few lose enough weight to return to normal weight (Le Petit & Berthelot, 2006), making weight gain in adolescence even more critical.

## **University years as a critical period for health**

In 1995, the National College Health Risk Behaviour Survey (NCHRBBS) reported that among a representative sample of 4,609 undergraduate university students over the age of 18, 20.5% were overweight (BMI  $\geq 27.8$  kg/m<sup>2</sup> for males; BMI  $\geq 27.3$  kg/m<sup>2</sup> for females) (CDC, 1997). The highest prevalence was among students older than 25 years (28.8%) compared to those between 18-24 years (15.5%). Among the younger cohort, males were more likely to be overweight (17.2%) than their female counterparts (13.9%). When overweight and obesity were defined using the National Institute of Health (NIH) cut-off points, 23.6% were overweight (BMI 25.0-29.9 kg/m<sup>2</sup>) and 11.4% were obese (BMI  $\geq 30$  kg/m<sup>2</sup>) (Lowry et al., 2000). Males (30.6%) were still more likely to be overweight than females (17.9%). Interestingly, the female students however reported trying to loss weight more often than males. Nevertheless, more females (12%) than males (10.7%) were obese. It has been widely reported that adolescents tend to underreport their body weight thus increasing the likelihood that the prevalence of overweight and obesity is even higher (Brener, McManus, Galuska, Lowry, & Wechsler, 2003; Himes & Faricy, 2001).

## **Rationale**

In light of the increased prevalence of weight gain during young adulthood and its impact on future weight gain, attention goes to what is best known as the 'Freshmen 15'. Allegedly, students are likely to gain 15 lbs (6.8 kg) during their first year at university (Hodge, Jackson, & Sullivan, 1993; Levitsky, Halbmaier, &

Mrdjenovic, 2004). Starting university may therefore be a critical period affecting body weight. It seems that this has since become a concern among freshmen themselves (Graham & Jones, 2002). To-date there are only a few studies looking at this phenomenon. Some studies have focussed solely on females while others included both sexes and have varied in their observational period between 12 weeks and 8 months. To our knowledge, there has not yet been a study involving both female and male freshmen where variables such as body weight, BMI, waist circumference (WC), body composition, activity-related energy expenditure (EE), energy intake (EI) and macro-nutrient composition of the diet, are all followed over a freshmen's academic year, while also considering eating behaviour and physical fitness.

## **Objectives**

The objectives of this study are (1) to measure changes in body weight and body composition among female and male freshmen; (2) to determine whether being heavier at baseline is a factor predisposing freshmen to gain more weight; and (3) to examine predictors of change.

## **Hypotheses**

Based on current knowledge, we hypothesize that: (1) students will gain a mean of 2.7 kg over six and a half months, and (2) those heavier at baseline will be those gaining more. Our secondary hypothesis is that those students with lower EE will show a greater increase in FM and decrease in FFM.

**Definitions**

For the purpose of this study, EE will be defined as average daily physical activity-related EE computed from 7-day energy expenditure data. EI will be defined as average daily energy intake calculated from 7-day nutritional data.

**Assumptions, Limitations and Delimitations**

Throughout the study it will be assumed that all the participants answer truthfully to all questionnaires and follow the requested protocol (i.e. fasting for 2 hours prior to the laboratory session, no alcoholic beverages and exercise for the six hours prior to the fitness test, record all dietary intake and wear the accelerometer during all hours awake).

It must be assumed that the data collection methods are accurate and have been previously validated. This includes the accuracy in which the Three-Factor Eating Questionnaire (TFEQ) assesses restraint, disinhibition and hunger. It must be assumed that the dual-energy x-ray absorptiometry (DEXA), the Vmax and the accelerometers are accurately able to measure body composition, maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) and EE, respectively.

Due to the nature of the study, participants will be involved in the research for a period of 7 months and may therefore experience some degree of maturation and adapt their behaviour accordingly. Since students move to residence only in September, participants were recruited then, and any immediate changes may therefore not be observed. Although the sample was randomly selected, findings from this study are limited to first year students and



those living in residence. Furthermore, the generalizability of the study is diminished due to the small sample size.

### **Significance of the study**

Obesity is a major health concern, not only because of the co-morbidities associated with this condition, but also because of the fast rising incidence of obesity in children, youth and adults (Flegal, Carroll, Ogden, & Johnson, 2002; Ogden et al., 2006; Tremblay, Katzmarzyk, & Willms, 2002; Tremblay & Willms, 2000). With young adulthood identified as a critical period in life (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002; Must & Strauss, 1999), attention needs to focus on specific populations more at risk for weight gain, as there is an obvious need to identify factors related to such critical changes.

## CHAPTER 2: LITERATURE REVIEW

### Freshmen weight gain

It is believed that freshmen students gain 6.8 kg during their first year at university. Nevertheless, research to-date does not support such belief. A significant weight gain of 1.1 kg (57 female freshmen) (Megel et al., 1994), 1.7 kg (135 freshmen - 57% female) (Anderson, Shapiro, & Lundgren, 2003), 2.1 kg (72 female freshmen) (Lowe et al., 2006) and 2.5 kg (118 freshmen - 56% female) (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005) were reported. A weight loss of 0.7 kg was also observed (81 freshmen – 80% female) (Graham & Jones, 2002). Both Anderson *et al.* and Graham & Jones reported no effect of sex on weight changes. Hodge *et al.* followed 110 female freshmen for 6 months and reported that 18 of the 61 students returning for weighing gained approximately 3.3 kg (29% of returnees), 32 students (52%) maintained their weight within  $\pm 1.8$  kg of their baseline weight, and 11 (18%) lost a mean 2.5 kg (Hodge, Jackson, & Sullivan, 1993). Hajhosseini *et al.* followed 27 freshmen (5 males and 22 females) for their first 16 weeks at university (1<sup>st</sup> semester) and reported a mean weight gain of 1.4 kg.

### The impact of one's place of residence

Some studies went further by specifying the place of residence of the freshmen, some of which also considered university residence as a possible confounding variable. Hovel *et al.* observed that female students attending local or state colleges and hence living at home, gained significantly less weight than

| Place of residence               | Research project          | Estimated mean weight gain per week (g/wk) <sup>1</sup> |
|----------------------------------|---------------------------|---------------------------------------------------------|
| Place of residence not specified | Megel <i>et al.</i>       | 38 g/wk                                                 |
|                                  | Anderson <i>et al.</i>    | 53 g/wk                                                 |
|                                  | Lowe <i>et al.</i>        | 66 g/wk                                                 |
|                                  | Racette <i>et al.</i>     | 78 g/wk                                                 |
|                                  | Hajhosseini <i>et al.</i> | 85 g/wk                                                 |
|                                  | Hodge <i>et al.</i>       | 137 g/wk                                                |
|                                  | Hovell <i>et al.</i>      | 2 g/wk<br>(students living at home)                     |
|                                  | <b>Mean</b>               | <b>66 g/wk</b>                                          |
| University residence             | Butler <i>et al.</i>      | 35 g/wk                                                 |
|                                  | Morrow <i>et al.</i>      | 38 g/wk                                                 |
|                                  | Hovell <i>et al.</i>      | 83 g/wk                                                 |
|                                  | Levitsky <i>et al.</i>    | 158 g/wk                                                |
|                                  | Hoffman <i>et al.</i>     | 186 g/wk                                                |
|                                  | <b>Mean</b>               | <b>100 g/wk</b>                                         |

Table 2: Freshmen mean weight gain per week

<sup>1</sup> Approximate value calculated from mean weight gain and study period as reported in the publication

From a linear regression equation using data from studies on spontaneous weight gain, Levitsky *et al.* concluded that 17 to 18-year-olds are expected to gain less than 15 g/wk (Levitsky, Halbmaier, & Mrdjenovic, 2004), however students seem to be gaining significantly more. Although there is evidence suggesting weight gain over the freshmen year, this gain seems to be less than the alleged 15 lbs (6.8 kg). Studies observing weight change over the whole freshmen year (7-8 months) have reported a mean weight gain between 1.1 kg (Megel *et al.*, 1994) and 2.5 kg (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). When studies investigating a shorter period of time are included and an estimate weight gain over 7 months is computed, freshmen

weight gain varies between 0.9 kg (Butler, Black, Blue, & Gretebeck, 2004) and 5.2 kg (Hoffman, Policastro, Quick, & Lee, 2006). During their freshmen year, students living in residence gained significantly more than those living at home (3.6 kg vs 0.5 kg) (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985).

Megel *et al.* reported that 31% of the female students gained 0.1 to 1.8 kg, 19% gained 2.3 to 4.6 kg, and 11% gained as much as 4.6 to 7.6 kg (Megel *et al.*, 1994). When breaking down weight gain into sub-categories, Hajhosseini *et al.* observed that over the first 16 weeks of university, 26% (7 students) of freshmen remained within 0.5 kg or less of their initial weight, 59% (16 students) gained  $\geq 1.4$  kg and 22% (6 students) gained  $\geq 2.7$ .

### **BMI, waist circumference and body composition**

A few of the studies on the 'Freshmen 15' have investigated changes in BMI and body composition along with changes in body weight, indicating that body weight is not the sole variable changing during the freshmen year. Over the first 12 weeks, female freshmen increased in BMI from 20.8 to 21.5 kg/m<sup>2</sup> (Levitsky, Halbmaier, & Mrdjenovic, 2004). A similar increase was observed over the first 16 weeks (23.5 to 24.1 kg/m<sup>2</sup>) (Hajhosseini *et al.*, 2006). Butler *et al.* observed an increase from 23.6 to 23.9 kg/m<sup>2</sup> over 5 months (Butler, Black, Blue, & Gretebeck, 2004). Over the full academic year, Racette *et al.* observed a shift from a BMI of 22.4 to 23.3 kg/m<sup>2</sup>, Morrow *et al.* reported an increase from 21.9 to 22.3 kg/m<sup>2</sup>, while Hoffman *et al.* noticed an increase by 0.5 kg/m<sup>2</sup> among normal weight freshmen. In the latter study, the BMI of the female participants increased

more than that of the males ( $0.5 \text{ kg/m}^2$  and  $0.4 \text{ kg/m}^2$  respectively) (Hoffman, Policastro, Quick, & Lee, 2006).

Despite the important changes in body weight and BMI, these measures do not detect the changes in fat mass (FM) and fat free mass (FFM) (Kyle, Zhang, Morabia, & Pichard, 2006). In a longitudinal study of 575 Caucasian males and females aged 20 to 74 years, FM increased significantly along with weight gain (Kyle, Zhang, Morabia, & Pichard, 2006). During the first year of follow-up, FM as calculated from BIA results, increased 1.4, 1.9 and 3.1 kg respectively with weight gains of 1.0-1.9, 2.0-2.9, and  $\geq 3.0$  kg. They concluded that even a weight gain of  $<1.9$  kg can reveal a significant positive change in body fat. The association between weight change and body fat change was similar for males and females even on the longer term (3 years).

Using Bioelectrical Impedance Analyses (BIA), Hajhosseini *et al.* observed an increased percentage body fat from 30.1 to 32.2 % (BIA) in a cohort of predominantly female participants over the first 16 weeks of university (Hajhosseini *et al.*, 2006). When considering a longer period of time, Butler *et al.* also observed an increase in FM from 14.5 to 15.9 kg, as calculated from 3 skinfold measures (triceps, iliac crest, thigh) (Butler, Black, Blue, & Gretebeck, 2004). Using BIA, Hoffmann *et al.* also reported an average increase by 0.7% in 7 months among their group 48% male (Hoffman, Policastro, Quick, & Lee, 2006). Over the same duration Morrow *et al.* used DEXA and observed an increase from 28.9 to 29.7 % in their female freshmen (Morrow *et al.*, 2006). The increase in body fat recorded in this study contributed to 73% of the change in

body weight of the students. The latter also observed an increase in WC from 69.4 cm to 70.3 cm. WC is an independent risk factor for disease as well as a factor increasing the risk of obesity-related morbidity and mortality (Li, Ford, McGuire, & Mokdad, 2007). A 1 cm increase in WC was associated with a 2% increased risk of future CVD (de Koning, Merchant, Pogue, & Anand, 2007). It is therefore important to monitor such changes in freshmen students along with body weight and body composition changes.

Hajhosseini *et al.* noted that along with an increase in FM, FFM decreased from 69.9 to 67.8% over 16 weeks (Hajhosseini *et al.*, 2006). Butler *et al.* also reported a decrease in FFM from 49.5 to 48.9 kg over a 5 month period (Butler, Black, Blue, & Gretebeck, 2004). Following a decrease in FFM, the increase observed in percentage body fat becomes even more noteworthy. In contrast, Hoffman *et al.* observed an increase in FFM by 0.5 kg over the freshmen year, with females experiencing a greater increase than males (0.9 and 0.1 kg respectively) (Hoffman, Policastro, Quick, & Lee, 2006). This contributed partly to the increase in weight and BMI of these students. It can be speculated that these students were engaged in more physical activity (PA), as observed by Morrow *et al.* (Morrow *et al.*, 2006). The latter observed an increase in FFM from 38.1 kg to 38.4 kg, likely attributable to the fact that 50% of the freshmen were physically active (Morrow *et al.*, 2006).

**Weight gain beyond the freshmen year**

When following freshmen into their 2<sup>nd</sup> year, Hoffmann *et al.* reported a continued weight gain of another 1.6 kg from the end of the freshmen year to the end of the sophomore year, resulting in a total weight gain of 4.1 kg in 70% of the returnees (38% of initial sample). From the returnees, 29% lost weight and 3% maintained their weight. BMI also increased in 69% of returnees by a mean 0.6 kg/m<sup>2</sup> (Hoffman, Policastro, Quick, & Lee, 2006). Hovell *et al.* observed a decrease in the rate of weight gain and a reversal of this trend for those students who moved out of the university residence to their own apartments or sorority houses for their 2<sup>nd</sup> year. These students were no longer eating daily from the cafeteria food services (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985). The estimated rate of weight gain during their 2<sup>nd</sup> year was 7.5 g/wk as opposed to 83 g/wk when living in residence. This further highlights the likelihood that weight gain is increasingly associated with living in residence.

**Increased prevalence of overweight among freshmen**

The freshmen year seems to be a critical period in a students' life, marked with changes in body composition along with positive changes in body weight. The likelihood of becoming overweight or obese has increased along with increases in body weight and FM. Hajhosseini *et al.* reported that 2 more students (7.4 %) became overweight by the 16<sup>th</sup> week of university, while those being overweight or obese remained so (Hajhosseini *et al.*, 2006). By mid-December, Anderson *et al.* observed that 14% of students with normal weight in

September became overweight or obese, while 86% remained in the normal weight category, which however does not imply an absence of weight gain (Anderson, Shapiro, & Lundgren, 2003). One third of the total sample was at least overweight by mid-December compared to one-fifth in September. Forty-six of these students (17 males and 29 females) were followed until the end of their freshmen year, showing a decreased rate of weight gain which however was not statistically significant. Nevertheless, 10.8% of freshmen starting in September at normal weight were classified as overweight or obese by the end of their freshmen year (Anderson, Shapiro, & Lundgren, 2003). In the study by Racette *et al.* 5% of the 764 freshmen were underweight, 76% were normal weight, and 18% were overweight at baseline. Although the prevalence of underweight, normal weight and overweight was not reported for the end of the freshmen year or the end of the sophomore year, BMI increased in 69% of the returnees (290 students). As a result, it can be assumed that the percentage of students becoming overweight or obese increased (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). With the increased prevalence of overweight or obesity, the students risk for obesity-related health problems also increases. Huang *et al.* reported that the chance of experiencing at least one component of the metabolic syndrome is almost 3 times as likely in overweight compared to normal weight students (Huang *et al.*, 2003).

Although health problems are less severe than in adults, the relative risk for obesity-related health problems is higher for those adolescents who are overweight or obese and those gaining weight than for those being of normal



weight (Wadden, Brownell, & Foster, 2002). Morrow *et al.* observed an increase in the prevalence of overweight from 9% to 14%, with those students who weighed more at baseline, having a greater amount of FM and being less physically active, gaining more weight over the year than other freshmen (Morrow *et al.*, 2006). A longitudinal study involving 5,115 African American and white males and females aged between 18 and 30 years, also showed that among the general population, those heavier at baseline were likely to gain more weight than the leaner ones (Lewis *et al.*, 1997). Over a 7-year period, those who were already overweight or obese experienced the greatest increase in BMI (2.4 and 5.1 kg/m<sup>2</sup> among white males and females, respectively) when compared to leaner individuals. Another longitudinal study involving 8,726 females aged 18-23 at baseline also showed that those who were overweight or obese were 30% more likely to gain weight over the 4 years (Ball, Brown, & Crawford, 2002). On the other hand, those who maintained their BMI within 5% of baseline BMI at year 4, were more likely to be in the healthy weight range (BMI  $\leq$  25 kg/m<sup>2</sup>) and have lower body fat at baseline, as well as experience fewer fluctuations in weight and spend less sitting time during the follow-up period. The First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study followed 9,862 individuals over a 10-year period and concluded that greater weight gains occurred among those who were heaviest and that females are twice as likely as males to experience major weight gain (Williamson, Kahn, Remington, & Anda, 1990). They conclude that young women are one of the groups most at risk for weight gain and obesity.

## **Obesity and energy balance**

Weight gain and obesity have been associated with several environmental risk factors which affect energy balance, primarily eating patterns and the level of physical activity (Caterson & Gill, 2002; Chambers & Swanson, 2006; Wadden, Brownell, & Foster, 2002). Obesity is characterised by a long term positive energy imbalance (Doucet & Tremblay, 1997). EI is influenced by the composition of the diet, that is, the amount of fat, carbohydrate, protein and alcohol in the diet and the energy density of the food consumed. It is therefore better defined as a state of equilibrium between diet composition, the composition of the fuel being oxidized and stored, and the food consumed (Flatt, 1987a, , 1987b). Non-nutritional factors such as portion size, meal frequency and snacking also determine ones EI (Kemper, Stasse-Wolthuis, & Bosman, 2004). Total daily EE is regulated with resting metabolic rate (RMR), the thermic effect of food (TEF) and activity-induced EE (van Baak, 1999). Variations in RMR and TEF are small and therefore EE is primarily regulated with PA as this is the most variable of the three, possibly accounting for 25-35% to 75% of average daily EE (Westerterp, 1998). To prevent weight gain, EI must therefore be attuned to EE (Kemper, Stasse-Wolthuis, & Bosman, 2004), by reducing EI or increasing EE through physical activity. A small positive energy imbalance maintained over a long period of time will likely lead to major changes in body weight (Kemper, Stasse-Wolthuis, & Bosman, 2004).

University students engage in lifestyle behaviours that place them at increased risk for developing serious health problems (CDC, 1997). Several

studies have investigated the eating patterns, macro-nutrient composition, the consumption of alcoholic beverages and PA practices of young adults and more specifically university students, identifying factors associated with weight gain and the shift towards overweight and obesity.

### **Energy intake and dietary patterns of freshmen students**

While investigating the 'Freshmen 15' phenomenon, Levitsky *et al.* reported the dietary habits of their female freshmen students to identify dietary patterns associated with the observed weight gain of 1.9 kg during 12 weeks of the 1<sup>st</sup> semester. Figure 1 presents variables found to be statistically significant and accounting for 58% of the total variance of weight gain (Levitsky, Halbmaier, & Mrdjenovic, 2004). The highest variance was associated with the consumption of high-fat foods (12%), the number of evening snacks (12%), followed by eating at 'all-in-one' facilities at breakfast (10%) and lunch (10%). When adjusted for baseline body weight (figure 2), a higher percentage (71%) of the total variance of weight gain was then explained. This supports other research which found that initial body weight is a factor affecting successive weight gain, with those being heavier likely to gain more weight (Ball, Brown, & Crawford, 2002; Kuczmarski, Flegal, Campbell, & Johnson, 1994; Le Petit & Berthelot, 2006; Lewis *et al.*, 1997; Williamson, Kahn, Remington, & Anda, 1990). With this model, the majority of the variance in body weight was explained by the consumption of junk foods (24%) and meal frequency on weekends (17%). Research in the general population have also found an association between being heavier and showing a

preference for eating more sugary foods, foods high in fat and fast food in particular (Ebbeling et al., 2004; French, Harnack, & Jeffery, 2000; Miller, Lindeman, Wallace, & Niederpruem, 1990). After adjusting for baseline body weight, only 29% of the variance in weight gain was still unexplained (Levitsky, Halbmaier, & Mrdjenovic, 2004). The consumption of junk food, recent dieting, the number of evening snacks and the number of meals consumed on weekends remained statistically significant even when initial body weight was taken as a covariate.

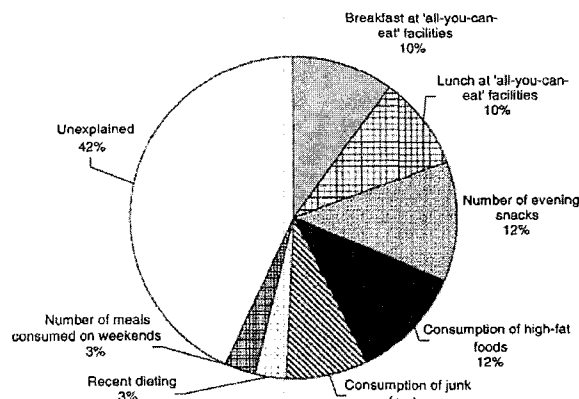


Figure 1: Percentage of total variance of weight gain attributed to specific variables (Levitsky, Halbmaier, & Mrdjenovic, 2004)

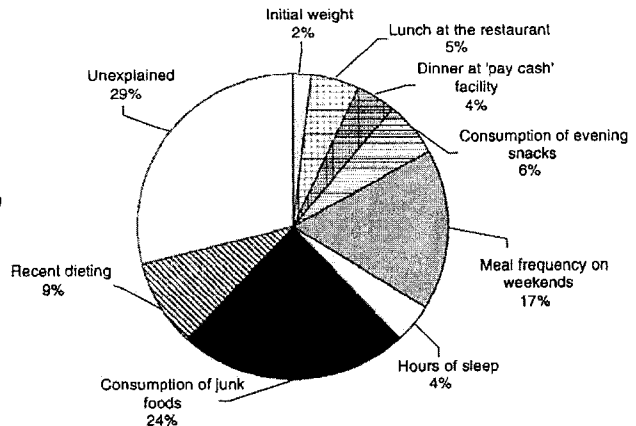


Figure 2: Percentage of total variance of weight gain attributed to specific variables with initial weight as a covariate (Levitsky, Halbmaier, & Mrdjenovic, 2004)

It seems that students tend to have irregular meal patterns. Huang *et al.* observed that out of 1,912 university students, 22% skipped breakfast, 8% skipped lunch, 5% skipped dinner and 80% snacked at least once per day (Huang, Song, Schemmel, & Hoerr, 1994). DeBate *et al.* reported that out of a sample of 630 freshmen students, 44.2% never/rarely ate breakfast while only 36.6% always/often consumed breakfast (Debate, Topping, & Sargent, 2001). In

a more recent study mostly composed of students living in residence (75%), Driskell *et al.* observed that 57.1% ate breakfast, 19.9% had a morning snack, 87.4% had lunch, 54.4% had an afternoon snack, 95% had dinner and 72.8% had an evening snack. Levitsky *et al.* found that such irregular meal patterns contributed to freshmen weight gain (Levitsky, Halbmaier, & Mrdjenovic, 2004). Megel *et al.* also observed that the more overweight the female freshmen, the less they followed healthy nutritional practices (Megel et al., 1994).

An association between meals at 'all-you-can-eat' facilities like the university cafeterias and eating larger portions, longer meal duration due to communal eating and having an increased feeling of fullness at the end of the meal were also reported by the freshmen (Levitsky, Halbmaier, & Mrdjenovic, 2004). The students pointed out that the university cafeteria was most likely a contributor to their weight gain as they provided high calorie meals and an opportunity for communal eating which in turn encourages overeating (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985). Findings from both these studies are however limited to an over-representation of females. Nevertheless, cafeteria food services make high calorie meals highly accessible and create a communal eating environment which encourages over-eating (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985), and this is a situation which both male and female freshmen living in residence may face throughout the freshmen year. As a matter of fact, studies have shown that male freshmen also experience weight gain (Anderson, Shapiro, & Lundgren, 2003; Graham & Jones, 2002; Hajhosseini et

al., 2006; Hoffman, Policastro, Quick, & Lee, 2006; Levitsky, Halbmaier, & Mrdjenovic, 2004; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

### **Students' consumption of high-fat foods**

The consumption of high-fat foods and junk food has been associated with freshmen weight gain (Levitsky, Halbmaier, & Mrdjenovic, 2004). DeBate *et al.* reported that 32% of a sample of 630 freshmen students reported always/often eating fast food, while 42% ate fast food sometimes. On average males consumed 2.5 fast food meals per week while females consumed 1.9 per week (Debate, Topping, & Sargent, 2001). The occurrence of meals eaten at fast food restaurants was between 6 to 8 meals per week for 95.1% of a sample of 114 freshmen mid-semester through an introductory nutrition course (Driskell, Kim, & Goebel, 2005). Twenty-one point one percent of the sample was male and three quarters of the students lived in university residence.

In a study involving 2,636 university students (62% female and 38% male) 22 years or younger, 34% reported eating high fat meats, snacks and/or desserts at least once on the previous day. The male students were more likely to consume high fat meats and snacks (Dinger & Waigandt, 1997). However, as previously suggested, this could be related to an effect of sex and/or an effect of body weight. Seventy-eight percent of 4,609 male and female undergraduate students (55.5% female and 44.5% male) taking part in the National College Health Risk Behavior Survey (NCHRBBS) ate less or equal to 2 servings per day of high-fat foods, even though half of the sample reported trying to loose body

weight and 20.1% were trying to maintain their current body weight (Lowry et al., 2000). These results must therefore be treated with caution as they are limited to students who were concerned with their body weight. The NCHRBBS reports that 21.8% of students consumed at least 3 high-fat foods during the preceding day (CDC, 1997). Females were more likely than males to eat 2 or less servings per day of high-fat foods. This may be related to the fact that the females were less likely to be overweight but more likely to perceive themselves as overweight. Trying to loose weight was associated with eating 2 or less servings of high-fat foods per day (Lowry et al., 2000).

Racette *et al.* observed a sex difference in the consumption of high-fat foods and fried foods (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). At the beginning of the academic year, 41% of 764 freshmen consumed  $\geq 3$  fried foods during the previous week. This occurred significantly more often among female (51%) than male freshmen (29%). Furthermore, 46% of the freshmen consumed  $\geq 3$  high-fat fast foods. Again, this was true for significantly more female (56%) than male freshmen (35%). Towards the end of the 1<sup>st</sup> semester, more students consumed  $\geq 3$  fried foods and  $\geq 3$  high-fat fast foods (54% and 50% respectively). A reversal of this trend was observed by the end of the sophomore year when significantly fewer students (43%) consumed  $\geq 3$  fried foods during the previous week. Fewer students (47%) consumed  $\geq 3$  high-fat fast foods although this was not statistically significant. These reductions did not allow for a correlation between the changes in body weight and dietary behaviour to be identified.

The consumption of high-fat foods by university students is of major concern as fat provides almost twice the energy per gram as carbohydrate or protein, making such foods high in energy density. Consecutively, the energy density of food determines daily caloric intake and energy balance. A positive energy balance of 55 kcal/day (Hajhosseini et al., 2006), 112 kcal/day (Hoffman, Policastro, Quick, & Lee, 2006) and 174 kcal/day (Levitsky, Halbmaier, & Mrdjenovic, 2004) was observed in freshmen students along with an increase in body weight.

### **Macro-nutrient composition of the students' diet**

Several studies have shown that dietary fat is positively correlated to adiposity (Colditz et al., 1990; Klesges, Klesges, Haddock, & Eck, 1992; Miller, Lindeman, Wallace, & Niederpruem, 1990; Tremblay, Plourde, Despres, & Bouchard, 1989; Tucker & Kano, 1992). The macro-nutrient composition of the diet of university students seems to favour a higher percentage of energy obtained from fat. Self-reported data collected from 5-day food diaries showed that female freshmen obtained 37.3% of energy from fat, 53.2% from carbohydrates and 14.1% from protein (Megel et al., 1994). Horwath *et al.* found no significant sex difference in the intake of fat. Males obtained 34% of energy from fats, 47% from carbohydrates and 14.7% from protein. Females obtained 33.4%, 48.9% and 14.5% of their energy from fats, carbohydrates and protein, respectively (Horwath, 1991). Anding *et al.* also found that on average, 60 undergraduate female students obtained 37% of their energy from fat (90% lived



off campus and one third attended aerobics classes with the intention of losing weight) (Anding, Suminski, & Boss, 2001). Results from the Block Food Frequency Questionnaire administered to 82 female freshmen living in residence showed that the percentage of energy obtained from fat significantly increased from 27.9% to 29.0% over a 5-month period of the 1<sup>st</sup> academic year (Butler, Black, Blue, & Gretebeck, 2004). A reduction in EI was here observed along with a weight gain of 0.7 kg over 5 months. The researchers attribute such weight gain to the decrease in PA observed over this period. The increase in energy obtained from fat may also contribute to such weight gain. Here one can only speculate about the factors contributing to weight gain since no correlation analysis was performed with this data.

Brevard *et al.* distinguished between students living on campus and those living off campus (Brevard & Ricketts, 1996). Females living on campus obtained more energy from fat (35%) than those living off campus (31%). On the other hand, males living off campus obtained more from fat (36%) than those living on campus (32%). This pattern may be associated with the weight status of these students as females living on campus and males living off campus were also the ones being heavier. This study clearly puts forward the likely effect of the place of residence of the students on their food consumption and macro-nutrient composition of the diet.

### **Alcohol as a contributor to university students' energy intake**

The American College Health Association (ACHA, 2006) reported that 84.4% of university students consumed alcoholic beverages. Forty point nine percent (40.9%) consumed 1 to 4 alcoholic drinks the last time they were out to party/socialise, 27% consumed 5 to 8, while 13.3% consumed 9 or more alcoholic beverages. More females consumed 1 to 4 drinks (48% vs 29%), whereas more males consumed 9 or more (24.7% vs 6.4%). The consumption of 4 or 5 drinks in a row at least on one occasion during a 2-week period, also known as binge drinking (Wechsler, Dowdall, Davenport, & Castillo, 1995), has been escalating (Johnston, O'Malley, & Bachman, 2003; Wechsler, Lee, Kuo, & Lee, 2000), although this seems to be more pronounced among university students and males (Johnston, O'Malley, & Bachman, 2003). Females have however shown increases (Wechsler, Dowdall, Davenport, & Castillo, 1995).

Considering the prevalence of alcohol consumption among students, alcohol is a contributor to the students' EI along with fat, carbohydrates and proteins. When alcohol is ingested, alcohol calories seem to become the primary source of energy, which in turn leads to a reduction in the oxidation of other fuels mainly fat (Doucet & Tremblay, 1997). As a result fat is more likely to be stored, increasing the likelihood of an increase in body fat and more specifically abdominal fat (Suter & Tremblay, 2005).

Using 3-day food diaries, Horwath *et al.* found that 1<sup>st</sup> year male students obtained 3.7% of their daily EI from alcohol while this was 2.6% for their female counterparts (Howarth, Murphy, Wilkens, Hankin, & Kolonel, 2006). Despite the

high prevalence of alcohol drinking documented by three U.S. national studies (Johnston, O'Malley, & Bachman, 1986-2002; Presley, Meilman, & Cashin, 1996; Wechsler et al., 2002), Brevard *et al.* found that alcohol contributed to 0% of EI for males living in residence and 8.7% for those living off campus. On the other hand, 4.4% of EI of females living in residence and 1.8% for those living off campus was obtained from alcohol. The small sample of in-residence males involved in this study reported no consumption of alcohol over that 3-day period, however considering national findings on student drinking habits this is likely to be higher if measured for a longer time period. Drinking may have occurred more often on other days not included in the 3-day period, such as weekend days. It is also known that students tend to underestimate the amount they drink (White, Kraus, & Swartzwelder, 2006) making it plausible that more of the students' EI was actually obtained from alcohol. In their study on freshmen weight gain, Butler *et al.* observed a significant increase in the number of alcoholic beverages per day (0.04 to 0.16) over a 5 month period. This lead to an increase in energy obtained from alcohol from 0.3% to 1.2% (Butler, Black, Blue, & Gretebeck, 2004).

### **Cognitive restraint and the students' eating patterns**

Restrained eating refers to the tendency to restrict ones food intake in order to control or loose body weight (Stunkard & Messick, 1985). On the other hand, disinhibition refers to how easily external factors, such as environmental events and emotional reactions, disinhibit the control of eating (Drapeau et al.,

2003). Among a sample of 62 female university students at normal weight and not dieting, those who were highly restrained (score  $\geq 13$  as measured by the TFEQ (Stunkard & Messick, 1985)) had a significantly lower total EI than students with low restraint (score  $\leq 5$ ) (2095 vs 2423 kcal respectively), ingested less fat (50.5 vs 71.7 gr respectively) and obtained a smaller percentage of energy from fat (21.2 vs 25.5 % respectively) (Rideout, McLean, & Barr, 2004). No significant differences in EI and macronutrient intake were however reported through a study involving 65 females 18-25 years old from institutes, universities and surrounding areas (Beiseigel & Nickols-Richardson, 2004). Nevertheless, those with high restraint (score  $\geq 9$  on the TFEQ) limited or avoided high-fat foods, consumed more 'diet foods', and experienced more weight fluctuations. Those with a high restraint eating score did show a significantly higher FM (17.0 vs 14.5 kg) and percentage body fat (28.0 vs 25.0 %) than those with low restraint (score of  $< 9$ ).

In a sample of 271 adolescents and young adults aged 14 to 24, of whom 89.7% were at normal weight, initial restraint was also positively and significantly correlated with adiposity (de Lauzon-Guillain *et al.*, 2006). In the study by de Lauzon-Guillain *et al.*, subsequent adiposity change was however not correlated with initial restraint, uncontrolled or emotional eating. Neither of these conditions predicted weight gain. McLean *et al.* found that the highest BMI among 596 female students was found in those with high (score of 13-21 on the TFEQ) or medium restraint (score of 6-12) (McLean & Barr, 2003). In this study, 80% of the restraint eaters were trying to loose weight, 90% had tried to loose weight at

some point and 77% had a history of eating disorders. Nevertheless, along with a weight gain of 2.1 kg (8-month period) observed among female freshmen students, Lowe *et al.* noted that restraint, as measured by The Revised Restraint Scale (Herman & Polivy, 1980) and the TFEQ (Stunkard & Messick, 1985), did not predict freshmen weight gain. On the other hand, dieting behaviours did (Lowe *et al.*, 2006).

Some studies have shown that the prevention of weight gain was more successful when eating control was flexible not rigid in nature (Lawson *et al.*, 1995; Westenhoefer, Broeckmann, Munch, & Pudel, 1994). Flexible control is characterised by the ability to plan and self-regulate calorie intake which includes small amounts of sweets, while rigid control is characterised by an all or nothing approach to eating (Westenhoefer, Broeckmann, Munch, & Pudel, 1994). A sample of 630 university students (74% female and 26% male) showed that male students had significantly lower rigid control than the females (Timko & Perone, 2005). They observed that female students high in rigid control had a higher BMI and higher disinhibition scores whereas those with high flexible control had a lower BMI and lower disinhibition scores. High rigid control was also associated with higher BMI and disinhibited eating for the male students, however high flexible control was here not associated with lower BMI and lower disinhibition. To our knowledge, the study of restraint in male students has been fairly neglected.

Examining restraint scores is thus likely to enhance the understanding of students eating patterns. In fact, Drapeau *et al.* reported that among adults 18

years and over, initial restraint eating predicted subsequent weight gain in women over a 6-year period but was negatively related to weight change in men. In order to observe the association between restraint eating behaviour and weight changes, a longer study period may thus be necessary (Drapeau et al., 2003).

### **Physical activity and energy expenditure**

Activity-induced EE is the most variable of the three components of EE. It is therefore a key factor in the prevention of obesity. Several studies have observed an inverse relationship between PA and body weight, increase in BMI, body fat and percentage of overweight and obesity (Bell & Rolls, 2001; Droyvold, Holmen, Midthjell, & Lydersen, 2004; Guo, Zeller, Chumlea, & Siervogel, 1999; Haapanen, Miilunpalo, Pasanen, Oja, & Vuori, 1997; Hu, Li, Colditz, Willett, & Manson, 2003; Kahn et al., 1997; Klesges, Klesges, Haddock, & Eck, 1992; Koh-Banerjee et al., 2003; Owens, Matthews, Wing, & Kuller, 1992; Schmitz, Jacobs, Leon, Schreiner, & Sternfeld, 2000; Sherwood, Jeffery, French, Hannan, & Murray, 2000; Wagner et al., 2001; Wenche, Holmen, Kruger, & Midthjell, 2004). Higher baseline levels of PA or improvements in PA have been associated with attenuated weight gain (Coakley, Rimm, Colditz, Kawachi, & Willett, 1998; DiPietro, Kohl, Barlow, & Blair, 1998; French et al., 1994; Klesges, Klesges, Haddock, & Eck, 1992; Owens, Matthews, Wing, & Kuller, 1992; Paeratakul, Popkin, Keyou, Adair, & Stevens, 1998) and lower odds of a significant weight gain (Ching et al., 1996; DiPietro, Kohl, Barlow, & Blair, 1998; Rissanen, Heliovaara, Knekt, Reunanen, & Aromaa, 1991; Williamson et al., 1993).

Chambers *et al.* observed that those taking part in regular PA, particularly moderate or vigorous intensity were less likely to be overweight or obese (Chambers & Swanson, 2006). Statistics Canada reported that those who were sedentary were more likely than those physically active to be obese (Tjepkema, 2006). Among the men, 39.4% of those being sedentary were overweight, while 27% were obese. The rate of obesity in men was significantly different between those being sedentary and those engaging in a high level of leisure-time PA (27 vs 19.6%). Among the women, 30.6% of those sedentary were overweight as opposed to 27% of those engaging in a high level of leisure-time PA. The prevalence of obesity in women was significantly higher in those being sedentary (26.8%) or moderately active (20.8%) when compared to those being highly active in their leisure time (13.5%). Such figures draw attention to the importance of PA in the prevention of weight gain and obesity. One study also reported a reverse association, where higher baseline BMI predicted future low levels of PA (Petersen, Schnohr, & Sorensen, 2004).

Despite the evidence of an inverse relationship between PA and body weight, Haapanen *et al.* only observed such relationship in males (Haapanen, Miilunpalo, Pasanen, Oja, & Vuori, 1997). Similarly, Westerterp *et al.* observed an inverse relationship between PA, FM and percentage body fat only for males. The authors concluded that this relationship may not have been observed in females as a result of a lower percentage of fat lost with higher levels of PA (Westerterp, 1998).

### **Physical activity during university years**

Despite the health recommendations put forward by several health organisations and institutes (Blair, LaMonte, & Nichaman, 2004; Pate et al., 1995; Saris et al., 2003), a high percentage of university students do not reach the recommended level of PA. From a sub sample of students involved in the 1995 NCHRBBS, Lowry *et al.* reported that 37.6% of students participated in vigorous PA (20 or more minutes of exercise which causes sweat and hard breathing) on 3 or more days of the week, 19.5% participated in moderate PA (walk or bicycle for at least 30 minutes at one time) on 5 or more days of the week and only 29.9% engaged in strength training 3 or more times a week (Lowry et al., 2000). Forty-two percent (42%) of undergraduates aged 18 to 24 participating in the 1995 NCHRBBS engaged in vigorous activity, while 20% engaged in PA of moderate intensity (Douglas et al., 1997). The 2006 ACHA survey (ACHA, 2006), which involved 54,111 students (63.8% female), reported that 43.6% of students engaged in moderate activity for at least 30 minutes or vigorous PA for at least 20 minutes on a minimum of 3 out of the 7 previous days. Forty-nine point three percent (49.3%) also engaged in strength training on at least 2 of the previous 7 days. Similarly Dinger *et al.* reported that 45% of students engage in vigorous activity on at least 3 days during the previous week while 46% engaged in moderate activity (Dinger & Waigandt, 1997). The average days per week when students engaged in aerobic exercise was 2.8 days/wk and 2.2 days/wk for strength training (Huang et al., 2003). Gyurcsik *et al.* reported similar results, as students performed vigorous activity for at least 20 minutes on an average 2.8 sessions per week (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006).



Lowry *et al.* also observed that those more likely to engage in moderate to vigorous physical activity were students who believed they were experiencing weight problems, especially among females (Lowry *et al.*, 2000).

The above studies highlight the high prevalence of inactivity among university students. The 1995 NCHRBBS showed that 36% of students did not engage in adequate amounts of PA (Douglas *et al.*, 1997). Other studies found an even higher percentage (40-50%) of students who were not physically active (Leslie, Fotheringham, Veitch, & Owen, 2000; Leslie, Owen, Salmon, Bauman, & Sallis, 1999; Pinto & Marcus, 1995; Stone, Strikwerda-Brown, & Gregg, 2002; Wallace, Buckworth, Kirby, & Sherman, 2000). Gyurcsik *et al.* found that 47% of students failed to meet recommended levels of vigorous weekly PA (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006) and Dinger *et al.* concluded that 22% of students did no vigorous activity while 30% did not do any moderate activity during the previous week (Dinger & Waigandt, 1997). Among 60 female students of whom a third wanted to loose weight, two thirds of the sample did not participate in regular PA (Anding, Suminski, & Boss, 2001). Brevard *et al.* found no significant difference in the percentage of students being inactive or lightly active when comparing those living on or off campus (29% and 28% respectively). Weekly EE, mode of exercise and activity level was found to be similar between students living on and off campus. Though not statistically significant, males living on campus had a weekly EE lower than those living off campus, whereas females living on campus had a higher weekly EE than those living off campus (Brevard & Ricketts, 1996).

Some studies have specifically reported PA patterns among freshmen students. Among 242 freshmen students (60% female), 58% were found to be physically active (engaging in vigorous or moderate activity) while 42% were sedentary (Pinto, Cherico, Szymanski, & Marcus, 1998). Fifty-six percent (56%) of female freshmen were not vigorously active, of whom over 30% had become inactive during the transition from high school to university (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006). In their study of 54 female freshmen living in residence, results from the Baecke Questionnaire of Habitual Physical Activity showed a significant decrease in total PA, work and sport activity (Butler, Black, Blue, & Gretebeck, 2004). When considered along with the increase in leisure activity and the decrease in EI over 5 months, PA was primarily associated with the weight gain experienced by these students. At the beginning of the freshmen year, Racette *et al.* observed that 59% of freshmen engaged in aerobic activity on 3 to 5 days per week for 20 to 60 minutes (60% of females and 58% of males), while 45% engaged in strength training on 2 to 3 days per week (35% of female and 55% of males) (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Although aerobic activity slightly declined during their second year (55%), overall exercise participation did not change. Investigating PA patterns using questionnaires does not allow for noticing small changes in exercise behaviour. This may be a reason why there was no correlation observed between changes in body weight and changes in exercise behaviour (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

A number of studies observed that male students were more active than their female counterparts (Dinger & Waigandt, 1997; Huang et al., 2003; Lowry et al., 2000; Pinto, Cherico, Szymanski, & Marcus, 1998). In a sub-sample from the 1995 NCHRBBS (Lowry et al., 2000), females were less likely than males to engage in vigorous PA (33% and 43.7% respectively) and strength training (26.8% and 33.9% respectively). An association between using exercise for weight control and participation in vigorous PA and strength training was observed. This was greater among female students (Lowry et al., 2000). Despite the low prevalence of aerobic and strength training, males performed aerobic exercise more often than the females (3.1 vs 2.5 days/wk respectively) (Huang et al., 2003). This was also true for strength training (2.3 vs 2.0 days/wk respectively). Pinto *et al.* also observed that fewer female students were in the active group. These females were younger and heavier compared to the non-active group (Pinto, Cherico, Szymanski, & Marcus, 1998).

### **The progressive decline in physical activity**

Notwithstanding the low levels of PA among university students, it seems that PA declines with age (Le Petit & Berthelot, 2006) and that the most drastic declines take place during adolescence and young adulthood (Leslie, Sparling, & Owen, 2001; Malina, 2001; Stone, McKenzie, Welk, & Both, 1998). Caspersen *et al.* observed that participation in vigorous and resistance training declined progressively between the ages of 12 and 18. The greatest deterioration was observed between the ages of 15 and 18, followed by a continuous decline common between 18 and 29 years of age (Caspersen, Pereira, & Curran, 2000).

Establishing an active lifestyle as a student is therefore important as it is likely that PA patterns established during university are maintained for a long time (Fish & Nies, 1996). Sparling *et al.* found that 84.7% of those exercising regularly as university seniors were still physically active 5 or 10 years later. Similarly 81.3% of those who were inactive maintained a sedentary lifestyle (Sparling & Snow, 2002). Huang *et al.* also observed that students aged 19 and younger engaged more often in aerobic and strength training than those aged 20 and older (Huang *et al.*, 2003). This difference was however not statistically significant. Driskel *et al.* compared upper-level and lower-level students. They found that lower-level students were more likely to engage in walking (45.6 vs 28.6 % respectively) and other aerobic activities on 3 or more days per week (47.8 vs 42 % respectively) than upper-level students. Approximately 30% of both upper-level and lower-level students engaged in resistance training for more than 31 minutes per day. It thus seems that adolescents and young adults tend to decrease their physical activity level, and that they subsequently follow a progressive decline with age.

## **Conclusion**

To-date research on freshmen weight gain does not support the 'Freshmen 15'. Several studies have observed weight gain during the 1<sup>st</sup> year at university, however, this ranged from 1.1 kg (Megel *et al.*, 1994) to 2.5 kg (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Although the age-related weight gain at age 17-18 should be no more than 15 g/wk (Levitsky, Halbmaier, & Mrdjenovic, 2004), freshmen students have shown weight gain of 2

g/wk (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985) to 186 g/wk (Hoffman, Policastro, Quick, & Lee, 2006). Along with weight gain, few studies have examined changes in body composition and observed increases in FM and decreases in FFM for those not physically active. Dietary patterns, the high intake of fat, and the lack of adequate levels of PA have been associated with weight gain. Considering the campus environment, those students living in residence seem to be the ones being more at risk, as are those being heavier at the start of their 1<sup>st</sup> academic year. To better understand freshmen weight fluctuations, there is still need for a comprehensive study which brings together the examination of all these different factors in both males and females over the 1<sup>st</sup> as well and the 2<sup>nd</sup> semester of their 1<sup>st</sup> year at university. To our knowledge, research to-date has focussed mostly on weight changes, with little attention devoted to changes in body composition and WC. No study has yet analysed all three components - body weight, body composition and WC changes - while considering the students' eating behaviour, as well as daily EI, macro-nutrient intake and EE from PA. A comprehensive study which includes both males and females with a varied BMI and body fat percentage is likely to offer a better understanding of the changes occurring in body weight, body composition and WC, while understanding their relationship with EI and EE.

### **CHAPTER 3 AND 4: METHODOLOGY AND RESULTS**

To avoid redundancy, the methodology and results sections are presented in the form of a paper. The paper is entitled: 'The Freshmen Weight Gain: is it more about Body Composition than Weight?' Research findings will be presented at the North American Association for the Study of Obesity (NAASO) 2007 conference in New Orleans. The paper will be submitted for publication.

**ARTICLE - THE FRESHMEN WEIGHT GAIN: IS IT MORE ABOUT BODY  
COMPOSITION THAN WEIGHT?**

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## Abstract

**Objective:** The purpose of the study was to examine predictors of change in body weight and composition among freshmen during an academic year.

**Research methods and procedure:** Twenty-nine freshmen, 16 females ( $58.2 \pm 10.4$  kg; BMI  $21.2 \pm 2.9$  kg/m<sup>2</sup>) and 13 males ( $74.6 \pm 11.9$  kg; BMI  $23.2 \pm 2.8$  kg/m<sup>2</sup>) completed the study. Body weight and composition (DEXA), waist circumference (WC), energy intake (7-day food diary) and activity-related energy expenditure (accelerometry) were measured in September, December and March. The TFEQ and VO<sub>2</sub>peak were assessed at baseline.

**Results:** Significant increases in body weight ( $1.9 \pm 2.0$  kg,  $P < 0.05$ ), BMI ( $0.6 \pm 0.7$  kg/m<sup>2</sup>,  $P < 0.05$ ), WC ( $2.7 \pm 3.0$  cm,  $P < 0.05$ ), % body fat (BF) ( $3.1 \pm 2.3\%$ ,  $P < 0.01$ ) and fat mass ( $2.6 \pm 1.8$  kg,  $P < 0.01$ ) were noted in males, especially over the 1<sup>st</sup> semester. No significant changes were observed in females. Correlations with females and males pooled together showed that over the academic year, baseline % body fat was associated with changes in weight and %BF ( $r = -0.53$ ,  $P < 0.01$ ;  $r = -0.41$ ,  $P < 0.05$ , respectively). Baseline %BF predicted 27% ( $P < 0.05$ ) of the change in weight. Baseline alcohol intake was related with changes in WC ( $r = 0.45$ ,  $P < 0.05$ ) and %BF ( $r = 0.58$ ,  $P < 0.01$ ). It explained 34% ( $P < 0.01$ ) and 17% ( $P < 0.05$ ) of the changes respectively. The change in weight and %BF were also associated with baseline VO<sub>2</sub>peak ( $r = 0.51$ ,  $P < 0.01$ ;  $r = 0.48$ ,  $P < 0.01$ ; respectively). Dietary restraint also effected the change in % body fat ( $r = -0.43$ ,  $P < 0.05$ ).

**Discussion:** Males, leaner freshmen, physically fit freshmen experienced greater increases in body weight, adiposity and abdominal fat. The best predictor of change in BF was baseline alcohol intake.

**Keywords:** freshmen, weight gain, body composition, waist circumference, energy balance



## Introduction

The increased prevalence of overweight and obesity over the past few decades has now reached epidemic proportions (Caterson & Gill, 2002; Katzmarzyk, 2002; Mokdad et al., 2001; WHO, 1998). As the non-surgical treatment of obesity is at best partly successful (Serdula et al., 1994; Williamson, Serdula, Anda, Levy, & Byers, 1992), this has nurtured the importance of research focusing on the prevention of weight gain and on the identification of populations at risk for weight gain. Freshmen university students are believed to be likely to gain 15 pounds (6.8 kg), an observation also coined the 'Freshmen 15'. This weight gain is thought to result from exposure to the university environment, in that it promotes a more sedentary lifestyle (ACHA, 2006; Douglas et al., 1997; Gyurcsik, Spink, Bray, Chad, & Kwan, 2006; Lowry et al., 2000) and the consumption of energy dense foods mostly from cafeteria diets (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985; Levitsky, Halbmaier, & Mrdjenovic, 2004).

Studies following freshmen throughout their first academic year observed a significant weight gain that varied from from 1.1 (Megel et al., 1994) to 2.5 kg (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Those focussing solely on the 1<sup>st</sup> semester reported weight gains of 1.4 kg (16 weeks) and 1.9 kg (12 weeks) (Hajhosseini et al., 2006; Levitsky, Halbmaier, & Mrdjenovic, 2004). Studies involving both females and males reported no effect of sex (Anderson, Shapiro, & Lundgren, 2003; Graham & Jones, 2002; Hoffman, Policastro, Quick, & Lee, 2006; Levitsky, Halbmaier, & Mrdjenovic, 2004; Racette, Deusinger,

Strube, Highstein, & Deusinger, 2005). The evaluation of body composition performed in three of the studies of freshmen weight gain, using Bioelectrical Impedance Analysis and dual-energy x-ray absorptiometry (DEXA)<sup>1</sup>, also revealed an increase in percentage body fat (Hajhosseini et al., 2006; Hoffman, Policastro, Quick, & Lee, 2006; Morrow et al., 2006). Only Morrow *et al.* examined waist circumference (WC), reporting an increase over the freshmen year (Morrow et al., 2006).

The 1<sup>st</sup> year of university is associated at least in part with changes in dietary intake, physical activity patterns or both. Levitsky *et al.* found that weight gain was mostly associated with the consumption of high-fat foods (12%), the number of evening snacks (12%), followed by eating at all-you-can-eat facilities for breakfast (10%) and lunch (10%) (Levitsky, Halbmaier, & Mrdjenovic, 2004). In contrast, dietary restraint was negatively related to the freshmen energy intake (Rideout, McLean, & Barr, 2004). Among university students there is also a high prevalence of inactivity (Douglas et al., 1997; Leslie, Fotheringham, Veitch, & Owen, 2000; Leslie, Owen, Salmon, Bauman, & Sallis, 1999; Pinto & Marcus, 1995; Stone, Strikwerda-Brown, & Gregg, 2002; Wallace, Buckworth, Kirby, & Sherman, 2000). Butler *et al.* observed a significant decline in total physical activity among female freshmen (Butler, Black, Blue, & Gretebeck, 2004). Racette *et al.* also noted a decrease in aerobic exercise during the first two years of university (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

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<sup>1</sup> Abbreviations used: DEXA, dual-energy x-ray absorptiometry; EE, physical activity energy expenditure; EI, energy intake; FFM, fat free mass; FM, fat mass; MET, metabolic equivalent; TFEQ, three-factor eating questionnaire; VO<sub>2</sub>max, maximal oxygen uptake; VO<sub>2</sub>peak, peak oxygen uptake; WC, waist circumference; %BF, percentage body fat.

The main purpose of this study was therefore (1) to measure changes in body weight and body composition among female and male freshmen; (2) to determine whether being heavier at baseline is a factor predisposing freshmen to gain more weight; and (3) to examine predictors of change. We hypothesized that: (1) the freshmen will gain approximately 2.7 kg over a six and a half month period; (2) those heavier at baseline will be those gaining more; and (3) those students with lower EE will show a greater increase in FM and decrease in FFM.

## **Methods**

### *Participants.*

Thirty-three freshmen students were recruited from the University of Ottawa through advertisements (i.e. posters and mail) and from a stand set-up at the University Center to inform students about the study. Four freshmen dropped out due to time constraints. Twenty-nine freshmen thus completed the study. Sixteen of these freshmen were females (age  $18.4 \pm 0.7$  years; height  $165.4 \pm 7.6$  cm; weight  $58.2 \pm 10.4$  kg; BMI  $21.2 \pm 2.9$  kg/m<sup>2</sup>; WC  $71.8 \pm 8.6$  cm; percentage body fat (%BF)  $27.7 \pm 7.3\%$ ; fat mass (FM)  $16.5 \pm 7.3$  kg; fat free mass (FFM)  $41.1 \pm 4.6$  kg) and thirteen were males (age  $18.2 \pm 0.4$  years; height  $179.2 \pm 6.1$  cm; weight  $74.6 \pm 11.9$  kg; BMI  $23.2 \pm 2.8$  kg/m<sup>2</sup>; WC  $77.4 \pm 8.7$  cm; % body fat  $16.1 \pm 7.2\%$ ; FM  $12.7 \pm 8.2$  kg; FFM  $62.1 \pm 5.4$  kg). The freshmen were predominantly Caucasian (n=27), with two students classified as other ethnicity. Twelve were in the Faculty of Arts, ten in Social Sciences and seven in Health Sciences. Participants were included if they were 18 years or older, attending their 1<sup>st</sup> year

at university, currently living in residence, previously lived at home, body weight did not vary more than 2 kg in the last 6 months, apparently healthy, non-smokers, not taking medications that could impact on energy intake and expenditure, did not diet during the previous 6 months, and were not pregnant or intending to become pregnant in the next 7 months. Those taking oral contraception were allowed to participate in the study on condition that they had been doing so for more than 6 months. Ethical approval was granted by the University of Ottawa Research Ethics Committee and all participants gave their written consent.

*Design and procedure.*

This study followed a repeated-measures mixed-design. Participants were recruited on the University campus over a 2-week period. Throughout the same period, participants met the researchers for one screening session on campus. During this 40-minute session, participants were required to give their written consent, as well as complete a socio-demographic and a medical and dietary history questionnaire. Thereafter, participants visited the laboratory on three separate occasions, in September and December 2006, and late March beginning of April 2007. All three periods of testing lasted 2 weeks. This allowed for measurements to be taken as early as possible in the year and close to the Christmas break and the end of the 2<sup>nd</sup> semester without overlapping with end of term examination periods. The first session was one and a half hours long. Participants were first required to fill-out the Three-Factor Eating Questionnaire

(TFEQ), they were then weighed and their height, WC and body composition were measured. A  $\text{VO}_2$ peak test was then performed. A CSEP (Canadian Society of Exercise Physiology) certified exercise physiologist administered this test. The two subsequent testing sessions were identical and lasted 30 minutes. This allowed for their weight, WC and body composition to be measured. The same researcher performed the measurements at each follow-up session. At the end of each of the three testing sessions participants were instructed to complete a 7-day food diary and asked to concurrently wear an accelerometer for 7 days. The study was conducted over a period of 7 months at the Behavioural and Metabolic Research Unit (BMRU) located at Montfort Hospital.

#### *Anthropometric measures.*

Body weight was measured with a BWB-800AS digital scale from Tanita Corporation of America, Inc. All participants were weighed wearing a hospital gown following a 2-hour fast following their last meal. Height was measured during the first laboratory session with an HR-100 height rod. A conventional measuring tape abiding to CSEP standards was used to measure WC. An average of two WC measurements was taken. This was measured at the mid-point between the last floating rib and the upper part of the iliac crest. The same researcher performed all the measurements. Body composition was measured using dual-energy x-ray absorptiometry (DEXA) (Lunar Prodigy, GE Medical System). Coefficients of variation and correlation for percent body fat measured in 12 subjects tested in our laboratory were 1.8% and  $r=0.99$ , respectively.

*VO<sub>2</sub>Peak measurement.*

Direct measurement of oxygen consumption with a maximal exercise test provides the most accurate assessment of aerobic power (Maud & Foster, 1995; Ward, Ebbeling, & Ahlquist, 1995). Participants were asked not to eat or have coffee for two hours before the fitness test, and not to consume alcoholic beverages or exercise for the six hours before. A high ramped protocol with a consistent and continuous increase in speed and grade was used to measure maximal oxygen uptake (VO<sub>2</sub>max). The initial speed was 2.6 km/h at 5% gradient (3.3 metabolic equivalents [MET]s). Speed and gradient progressively increased every 30, 40 or 60 seconds to reach a maximum of 9.6 km/h at 22% gradient (19.2 METs) by the 25<sup>th</sup> stage (15 minutes). The criteria used to determine whether VO<sub>2</sub>max was reached include: (1) no further increase in oxygen uptake or an increase  $\leq 150$  ml/min with an increase in workload; (2) a respiratory quotient (RQ)  $\geq 1.1$ ; and (3) a heart rate equal to or greater than the predicted maximum heart rate (220 – age). Those reaching VO<sub>2</sub>max attained at least two of the criteria. Participants also used the Borg Scale of Perceived Exertion and could stop the test at any time. Due to physical discomfort some participants stopped before reaching VO<sub>2</sub>max. Peak oxygen uptake (VO<sub>2</sub>peak) was therefore measured and reported for all participants. Analyzers were calibrated before every test to further ensure the reliability of the measurement. The VO<sub>2</sub>peak test was conducted during the first session only.

*Eating behaviour.*

The TFEQ by Stunkard and Messick (1985) was used to measure dietary restraint, disinhibition and hunger (Stunkard & Messick, 1985). This 54-item questionnaire included 36 true/false questions and 18 likert-scale type questions. The validity of this questionnaire has been supported for both adolescents and adults (Simmons, Smith, & Hill, 2002; Westenhoefer, Stunkard, & Pudel, 1992). The TFEQ was administered during the first session to obtain baseline scores.

*Energy intake.*

Average daily energy intake (EI) was measured using a 7-day food diary, which several studies have suggested produces more reliable information than food frequency questionnaires or dietary recall (Toeller et al., 1997; van Staveren, de Boer, & Burema, 1985; Wheeler, Rutishauser, Conn, & O'Dea, 1994). Participants recorded all dietary intake including beverages and the respective quantity consumed. A guide sheet on portions for different foods and a sample diary for a day were attached with the food diary for guidance. Nutritional data were analysed using the computer program Food Processor SQL, V 9.6.2 (ESHS Research, Salem, Oregon).

*Accelerometry.*

Activity-related energy expenditure (EE) was examined using biaxial accelerometry units (Actical - Mini Mitter Co., Inc. Bend, OR 97701, USA). Participants wore the accelerometers upon waking up and took it off just before

going to bed for a 7-day period. Such duration was chosen as it is estimated to result in 90% reliability for the measurement of physical activity in both males and females (Matthews, Ainsworth, Thompson, & Bassett, 2002). The accelerometer was worn at lower back level since this was evaluated as the best predictor of EE ( $r=0.92-0.97$ ), compared to lower leg/foot, upper leg, head and trunk, lower arm/hand, and upper arm (Brouten, Sauren, Verduin, & Janssen, 1997).

#### *Data analysis.*

All statistical analyses were performed using the Statistical Product and Service Solution software, version 11.5 (SPSS Inc., Chicago, IL). Values are expressed as means  $\pm$  standard deviation, unless otherwise indicated. For anthropometric measures as well as for EE and EI, the effect of time and time by sex interaction were examined using a 3 (time: September, December and March)  $\times$  2 (sex: female and male) repeated measures ANOVA. Participants were included in these analyses if they completed all three successive measurements. Pearson correlations were performed between baseline variables and changes in anthropometric variables from September to December and then again for September to the end of March. To identify the best predictors of change, stepwise regression analyses were conducted for the variables showing a significant simple correlation to the changes observed. Effects were considered significant at  $P<0.05$ .



## Results

Thirty of the 33 freshmen recruited in September returned in December and 29 in March. The mean and SD for anthropometric measures, eating behaviour, physical fitness, EI and EE of freshmen completing the study are presented in tables 1 and 2. Significant main effects of time were observed through the 1<sup>st</sup> semester for body weight (0.8 kg,  $P<0.05$ ), BMI (0.3 kg/m<sup>2</sup>,  $P<0.05$ ), WC (1.7 cm,  $P<0.01$ ), %BF (1.3%,  $P<0.01$ ) and FM (1.1 kg,  $P<0.01$ ). Significant main effects of time were also observed over their 1<sup>st</sup> year for WC (1.5 cm,  $P=0.01$ ), %BF (1.4%,  $P<0.01$ ) and FM (1.3 kg,  $P<0.01$ ). A non-statistically significant decrease in FFM was observed over the 1<sup>st</sup> semester (0.2 kg,  $P>0.05$ ) as well as until the end of the year (0.4 kg,  $P>0.05$ ). A significant sex by time interaction was revealed for all anthropometric measures (**Table 1**). Over the 1<sup>st</sup> semester males significantly increased in weight (1.4 kg,  $P=0.05$ ), WC (2.9 cm,  $P<0.01$ ), %BF (1.9%,  $P<0.01$ ) and FM (1.8 kg,  $P<0.01$ ). From September until the end of the academic year, significant increases were observed for weight (1.9 kg,  $P<0.05$ ) (**Figure 1**), BMI (0.6 kg/m<sup>2</sup>,  $P<0.05$ ), WC (2.7 cm,  $P<0.05$ ) (**Figure 2**), %BF (3.1%,  $P<0.01$ ) (**Figure 3**) and FM (2.6 kg,  $P<0.01$ ). During the 1<sup>st</sup> semester, 8 male freshmen gained body weight while 5 lost (range: -1.0 kg to +4.1 kg). Between September and the end of the academic year, 10 male freshmen gained while 3 lost body weight (range: -1.0 kg to +5.9 kg) (**Figure 4**). No significant changes were noted in the female freshmen for body weight, BMI, WC, percentage BF and FM. Six female freshmen gained body weight during the 1<sup>st</sup> semester, while 9 lost weight (range: -1.6 kg to +3.3 kg). Over the full

academic year, 5 female freshmen gained and 9 lost body weight (range: -3.7 kg to + 4.0 kg) (**Figure 5**). No significant effect of time for daily EE, daily EI, macronutrient consumption and alcohol were observed for both males and females ( $P>0.05$ ) (**Table 2**). A significant sex by time interaction was identified only for the percentage of energy from protein consumed by the females during the 1<sup>st</sup> semester (1.7%,  $P<0.05$ ).

*The relationship between baseline measures and changes in body weight, WC and body fat.*

In order to identify associations between changes in body weight, WC, body fat and baseline measures, as well as the best predictors of change, male and female freshmen were pooled together for the Pearson correlation analyses and for the stepwise regression analyses. We decided to pool all subjects for these analyses because of the small sample size, the uneven number of male and female freshmen and because we observed a lot of variability in body weight changes in both sexes (Figure 4 and 5). Results from the Pearson correlation analyses are presented in **table 3** while **table 4** illustrates results from the stepwise regression analyses.

Baseline alcohol intake and  $VO_{2peak}$  showed a positive correlation with changes in body weight ( $r=0.48$ ,  $P=0.01$ ;  $r=0.36$ ,  $P=0.05$ , respectively) and WC ( $r=0.51$ ,  $P<0.01$ ;  $r=0.39$ ,  $P=0.03$ , respectively) during the 1<sup>st</sup> semester (Table 3). The change in WC was also negatively correlated with baseline %BF ( $r=-0.38$ ,  $P=0.04$ ). A positive correlation was observed between change in %BF and

baseline alcohol intake ( $r=0.63$ ,  $P<0.01$ ). Stepwise regression analyses revealed that, during the 1<sup>st</sup> semester, 44% of the change in body weight was explained by baseline carbohydrate and alcohol consumption ( $P<0.01$ ) (Table 4). Baseline alcohol intake alone also explained 26% ( $P=0.01$ ) and 40% ( $P<0.01$ ) of changes in WC and %BF respectively. Together, baseline WC and alcohol intake predicted 60% of the change in FM ( $P<0.01$ ). When considering the full academic year, the change in body weight was significantly negatively correlated with baseline %BF ( $r=-0.53$ ,  $P<0.01$ ), which alone explained 27% of this change ( $P=0.01$ ). Baseline alcohol intake remained positively correlated to the change in WC ( $r=0.45$ ,  $P=0.02$ ) and %BF ( $r=0.58$ ,  $P<0.01$ ). The change in %BF was also positively correlated with baseline  $VO_{2peak}$  ( $r=0.48$ ,  $P<0.01$ ) and negatively correlated with baseline %BF ( $r=-0.41$ ,  $P=0.03$ ). Alcohol alone explained 20% of the change in WC ( $P=0.02$ ). Baseline alcohol consumption and FFM explained 46% of the change in %BF ( $P<0.01$ ) and 50% of the change in FM ( $P<0.01$ ). Dietary restraint showed a negative correlation with the change in WC, %BF and FM over the 1<sup>st</sup> semester ( $r=-0.46$ ,  $P=0.01$ ;  $r=-0.42$ ,  $P=0.02$ ;  $r=-0.44$ ,  $P=0.02$ , respectively), as well as for the change in %BF and FM over the full academic year ( $r=-0.43$ ,  $P=0.02$ ;  $r=-0.43$ ,  $P=0.02$ , respectively).

Through the socio-demographic questionnaire we gathered information regarding the freshmen's place of residence prior to university residence (urban, rural or other), the type of residence they live in (apartment style, shared room, etc.), the number of televisions available, their Faculty (Arts, Social Sciences or Health Sciences), as well as their income and their parents income, and whether

they subscribed to a university meal plan to eat at the cafeteria or not. None of these variables were found to correlate with changes in body weight, WC and body fat among our cohort.

## Discussion

Similar to results from previous studies, we report that during the 1<sup>st</sup> semester, our cohort of freshmen living in residence increased in body weight, BMI, WC, %BF and FM. Of note is the observation that over the full academic year, males experienced significant gains in body weight, body fat and WC whilst the females lost weight and body fat, and increased slightly their WC. Those with lower percentage body fat and higher VO<sub>2</sub>peak at baseline also showed greater gains in body weight, body fat and WC than those starting university with more BF and with lower physical fitness. Among the variables examined, alcohol intake was the major contributor to such gains. On the other hand, higher dietary restraint resulted in less gain in body fat and WC.

In our sample of 29 freshmen living in residence, we found a significant weight gain of 0.8 kg during the 1<sup>st</sup> semester, followed by a slower gain over the 2<sup>nd</sup> semester resulting in a non-significant weight gain of 0.9 kg (Figure 1). This weight gain was less than that reported in previous studies (Anderson, Shapiro, & Lundgren, 2003; Hoffman, Policastro, Quick, & Lee, 2006; Lowe et al., 2006; Megel et al., 1994; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005), however it supports the conclusion put forward by Anderson *et al.* that weight gain occurred predominately during the 1<sup>st</sup> semester (1.3 kg), with freshmen

showing a slower weight gain during the 2<sup>nd</sup> semester (0.5 kg). Levitsky *et al.* and Hajhosseini *et al.* also reported a significant weight gain of 1.9 kg (12-weeks) and 1.4 kg (16-weeks) respectively during the 1<sup>st</sup> semester (Hajhosseini *et al.*, 2006; Levitsky, Halbmaier, & Mrdjenovic, 2004). Although some studies have only focussed on female freshmen (Butler, Black, Blue, & Gretebeck, 2004; Hodge, Jackson, & Sullivan, 1993; Hovell, Mewborn, Randle, & Fowler-Johnson, 1985; Lowe *et al.*, 2006; Megel *et al.*, 1994; Morrow *et al.*, 2006), while others reported no effect of sex (Anderson, Shapiro, & Lundgren, 2003; Graham & Jones, 2002; Hoffman, Policastro, Quick, & Lee, 2006; Levitsky, Halbmaier, & Mrdjenovic, 2004; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005), an important finding of this study is that males experienced more significant changes for all anthropometric measures than did females. Graham and Jones revealed that students who heard about the 'Freshmen 15' were concerned about gaining weight (a sample 80% female), and this was especially true among female freshmen (Graham & Jones, 2002). Students, especially females, may thus have modified their physical activity and dietary practices throughout the year as a preventive measure. Female freshmen in our study did show a higher dietary restraint score than the males, which may in part reflect an effort to prevent gaining weight.

The increase in BMI (0.3 kg/m<sup>2</sup>) was similar to that reported by Morrow *et al.* (0.4 kg) and Hoffman *et al.* (0.5 kg) (Hoffman, Policastro, Quick, & Lee, 2006; Morrow *et al.*, 2006). As reported by Guo *et al.* the higher the BMI at the age of 18, the higher the BMI is likely to be at the age of 35 (Guo, Roche, Chumlea,

Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002). This elicits further apprehension with the increase in BMI occurring among freshmen as it was observed that the greater the BMI is from 20 kg/m<sup>2</sup>, the more likely white males and females are to be overweight at the age of 35 (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994).

Few studies have yet examined the changes in percentage body fat and FM among freshmen students (Butler, Black, Blue, & Gretebeck, 2004; Hajhosseini et al., 2006; Hoffman, Policastro, Quick, & Lee, 2006; Morrow et al., 2006). This study revealed that male freshmen gained 1.9% body fat and 1.8 kg fat during the 1<sup>st</sup> semester, and continued to increase at a slower rate, reaching a total gain of 3.1% (Figure 3) and 2.6 kg by the end of the 2<sup>nd</sup> semester. This supports the conclusion made by Kyle *et al.* suggesting that even a weight change of <1.9 kg can have a significant positive impact on body fat (Kyle, Zhang, Morabia, & Pichard, 2006). Body fat has been inconsistently associated with obesity-related health risks, the reason being that its distribution seems to play an important role (Shen et al., 2006).

On the other hand, WC reflects the deposition of fat around the abdominal area, and was found to be a stronger predictor of all-cause mortality than BMI, %BF or FM (Simpson et al., 2007). To-date only one study on the 'Freshmen 15' examined changes in WC, reporting an increase from 69.4 to 70.3 cm over a 7-month period (Morrow et al., 2006). The increase in WC in our study was more pronounced, with males showing a significant increase of 2.9 cm during the 1<sup>st</sup> semester and a total of 2.7 cm during the 1<sup>st</sup> year (Figure 2). Despite the fact that

WC for both the females and males was below the National Institute of Health (NIH) cut-off points of 88 cm and 102 cm, respectively (NIH, 1998), a linear relationship between WC and all-cause mortality was recently observed for males and U-shaped relationship for females (Simpson et al., 2007). This highlights the significance of the increase in WC among freshmen in terms of the increased health-risks. We observed greater gains in the males, supporting the notion that abdominal fat is more common among males (Koh-Banerjee et al., 2003). From an analysis of studies of abdominal obesity and cardiovascular outcomes, de Koning *et al.* concluded that a 1 cm increase in WC was associated with a 2% increased risk for CVD (de Koning, Merchant, Pogue, & Anand, 2007). These findings raise concern about the increased risk-factors freshmen are exposed to with an increase in their WC.

An interesting finding of this study is that freshmen who may seem to be less at risk for weight gain and increased accumulation of body fat due to their leaner state and higher physical fitness at the start of university, showed the greatest gains in body weight, WC and body fat. Previously, Morrow *et al.* had concluded that although normal weight freshmen had gained weight, those weighing more, having greater FM and being less active at baseline, gained more weight during their 1<sup>st</sup> year (Morrow et al., 2006). In contrast, results from our study suggest that being heavier at baseline was not associated with an increase in body weight. Freshmen with less %BF experienced greater increases in body weight, BMI, WC and %BF than freshmen with more %BF at the start of university. Baseline percentage body fat explained 27% and 26% of the change

in body weight and BMI, respectively. As suggested by Chambers *et al.* lighter people may feel less need to control their EI and the type of food they eat (Chambers & Swanson, 2006). One may speculate that, the greater positive energy balance experienced by leaner freshmen may be associated with the transition into the university environment, one that promotes the consumption of high-fat food (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985; Levitsky, Halbmaier, & Mrdjenovic, 2004) and a more sedentary lifestyle (ACHA, 2006; Douglas *et al.*, 1997; Gyurcsik, Spink, Bray, Chad, & Kwan, 2006; Lowry *et al.*, 2000). Leaner may undergo more changes in their behaviours in favour of such trends than students who started university having more body fat and where thus likely to consume more high-fat foods and be more sedentary even prior to university (French, Harnack, & Jeffery, 2000; Treuth *et al.*, 1994).

This speculation is further supported by the finding that freshmen with higher baseline  $\text{VO}_{2\text{peak}}$  gained more body weight, BMI, WC, %BF and FM than those less physically fit. Higher physical fitness at the start of university is likely to reflect a more active lifestyle prior to university, although this was not measured in our study. Since there was no significant change in EE over the year, it seems that a change in behaviour may have occurred during the transition to university. The effect on energy balance will be greater for those freshmen who were more active before university, and become relatively more sedentary, than for those freshmen who were already sedentary prior to starting university and remain sedentary. The period between the ages of 15 and 18 seems to be a critical period in the decline of PA (Caterson & Gill, 2002). Gyurcsik *et al.* observed a



decline in the percentage of female freshmen being vigorously active, and this occurred during the transition from high-school to university (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006). Monitoring food intake and physical activity before the start of university may possibly facilitate further understanding of the association between %BF, physical fitness and anthropometric changes observed in this study.

As reported by the American College Health Association, 84.4% of university students consume alcohol (ACHA, 2006). Alcohol was positively correlated with all changes in anthropometric markers observed in this cohort. During the 1<sup>st</sup> semester, alcohol explained 44% of weight gain, 26% of the change in WC, 40% of the change in percentage body fat and 45% of the change in FM. During the 2<sup>nd</sup> semester, alcohol explained 20% of the change in WC, 34% of the change in percentage body fat and 17% of the change in FM. The consumption of alcohol seems to increase EI and promote little or no compensation for its caloric content, while inhibiting the oxidation of other substrates, particularly fat (Doucet & Tremblay, 1997; Murgatroyd, Van De Ven, Goldberg, & Prentice, 1996). In turn, non-oxidized fat seems to be preferentially stored in the abdominal region (Suter & Tremblay, 2005). Using 3-day diet records among 135 freshmen, Horwath *et al.* reported that male freshmen obtained 3.7% of their daily energy from alcohol while this was 2.6% for their female counterparts (Horwath, 1991). With the use of 7-day dietary records we found an equal percent of energy obtained from alcohol for the males (3.7%) and less for the females (1.5%). Although not significant, females in our study also

showed an increase in alcohol consumption and the percentage of energy obtained from alcohol (Table 2). Males on the other hand showed a decrease in alcohol consumption during the 1<sup>st</sup> semester, and although not reaching baseline levels, their alcohol intake increased once again during the 2<sup>nd</sup> semester. Our findings suggest that the intake of alcohol may be an important contributor to EI among freshmen students, one that promotes increased body weight and adiposity. The evaluation of alcohol consumption may therefore be a valuable factor to be considered for the prevention of obesity.

Female restrained eaters typically consume less energy than their less restrained counterparts (Klesges, Isbell, & Klesges, 1992; Mulvihill, Davies, & Rogers, 2002). Indeed, a study with female freshmen found that those with high restraint (score  $\geq 13$  on the TFEQ) had consumed significantly less kilocalories than those with low restraint (score  $\leq 5$ ), ingested less fat and obtained less energy from fat (Rideout, McLean, & Barr, 2004). Our results also showed that freshmen with higher initial restraint (including both females and males) consumed significantly less kilocalories and alcohol per day at baseline. De Lauson-Guillain *et al.* concluded that among adolescents and young adults ( $n=271$ ), baseline restraint was positively correlated with initial adiposity but not with subsequent change (de Lauzon-Guillain *et al.*, 2006). Results from our study did not show such difference at baseline, however there was a difference in changes in WC, percentage body fat and FM, with those having higher restraint gaining less. Lowe *et al.* did not find a correlation between restraint and weight

gain (Lowe et al., 2006). Although not significant, we found higher restraint showed less change in weight and BMI among our freshmen students.

### **Strengths and limitations of the study**

In this study, a group of both female and male freshmen were followed over their 1<sup>st</sup> academic year, with measurements taken at the beginning of the year, as well as at the end of both semesters. Furthermore, the use of the DEXA as well as the inclusion of 7-day food diaries and accelerometry enhances the reliability of our results. The small sample size does however limit the generalizability of our findings. Due to availability of equipment and time constraints (2-week testing window), a bigger sample was not feasible for the purpose of the study. Females and males were not equally represented. Since freshmen could not be recruited before September, any immediate changes occurring before the first laboratory session could not be recorded. Also, our measures reveal the freshmen's dietary and activity practices at 3 time-points over the academic year, and therefore may not reflect the freshmen's behaviour between sessions.

### **Conclusion**

Previous observations, as well as results from this study, show that freshmen weight gain is less than the alleged 15 pounds (6.8 kg). The increase in WC and adiposity was however noteworthy. Furthermore, this study highlights the possibility that male, lean, physically fit freshmen need to be considered as a population at risk for weight gain and increased BMI, WC, percentage body fat

and FM. Further research involving both lean and overweight freshmen, as well physically fit and unfit freshmen, is likely to shed more light on the differences in their behaviour and its relationship with any changes occurring during their first year at university.

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Table 1: Female and male freshmen anthropometric measurements, TFEQ scores and VO<sub>2</sub>peak (Females n=16, Males n=13)

|                                  | September   |             | December   |             | March       |             | Time    | Time x Sex |
|----------------------------------|-------------|-------------|------------|-------------|-------------|-------------|---------|------------|
|                                  | Female      | Male        | Female     | Male        | Female      | Male        | P value | P value    |
| Weight (kg)                      | 58.2 ± 10.4 | 74.6 ± 11.9 | 58.4 ± 9.9 | 76.0 ± 12.6 | 58.1 ± 10.2 | 76.5 ± 10.8 | .03*    | .03*       |
| BMI (kg/m <sup>2</sup> )         | 21.2 ± 2.9  | 23.2 ± 2.8  | 21.3 ± 2.8 | 23.6 ± 3.0  | 21.2 ± 3.0  | 23.8 ± 3.0  | .04*    | .05        |
| WC (cm)                          | 71.8 ± 8.6  | 77.4 ± 8.7  | 72.4 ± 8.6 | 80.4 ± 8.6  | 72.1 ± 8.9  | 80.1 ± 8.9  | .004**  | .03*       |
| % BF                             | 27.7 ± 7.3  | 16.1 ± 7.2  | 28.4 ± 7.1 | 18.0 ± 7.3  | 27.5 ± 7.3  | 19.2 ± 7.8  | .001**  | .001**     |
| FM (kg)                          | 16.5 ± 7.3  | 12.7 ± 8.2  | 17.0 ± 7.3 | 14.5 ± 8.9  | 16.5 ± 7.2  | 15.3 ± 8.8  | .001**  | .001**     |
| FFM (kg)                         | 41.1 ± 4.6  | 62.1 ± 5.4  | 41.0 ± 4.3 | 61.8 ± 5.4  | 41.1 ± 4.7  | 61.4 ± 4.7  | .28     | .36        |
| Age (years)                      | 18.4 ± 0.7  | 18.2 ± 0.4  |            |             |             |             |         |            |
| Height (cm)                      | 165.4 ± 7.6 | 179.2 ± 6.1 |            |             |             |             |         |            |
| Restraint                        | 7.8 ± 4.3   | 4.1 ± 3.3   |            |             |             |             |         |            |
| Disinhibition                    | 5.4 ± 3.1   | 4.5 ± 2.1   |            |             |             |             |         |            |
| Hunger                           | 5.8 ± 3.2   | 6.5 ± 3.3   |            |             |             |             |         |            |
| VO <sub>2</sub> peak (ml/kg/min) | 41.8 ± 5.1  | 57.4 ± 6.4  |            |             |             |             |         |            |

Data are mean and standard deviation.

Values are absolute values.

\*  $P < 0.05$  \*\*  $P < 0.01$

Table 2: Female and male freshmen energy expenditure (EE) and energy intake (EI)

|                    | September     |              | December      |              | March         |              | Time    | Time x Sex |
|--------------------|---------------|--------------|---------------|--------------|---------------|--------------|---------|------------|
|                    | Female (n=16) | Male (n=13)  | Female (n=16) | Male (n=13)  | Female (n=16) | Male (n=13)  | P value | P value    |
| EE (kcal)          | 596.0±182.1   | 875.4±218.8  | 575.0±193.5   | 749.7±159.6  | 574.8±162.9   | 878.4±278.5  | .23     | .34        |
| EI (kcal)          | 1952.3±380.2  | 2632.2±435.4 | 1948.1±331.5  | 2387.9±596.3 | 1960.7±356.4  | 2456.1±627.8 | .50     | .51        |
| Carbohydrates (gr) | 264.9±51.0    | 336.6±66.6   | 266.1±46.8    | 301.0±76.9   | 269.9±67.1    | 311.0±76.4   | .45     | .37        |
| Fats (gr)          | 67.8±19.7     | 89.6±25.0    | 65.0±20.4     | 87.7±25.3    | 67.4±16.2     | 84.4±28.7    | .84     | .84        |
| Proteins (gr)      | 71.9±14.8     | 96.0±23.9    | 59.7±19.4     | 88.0±24.6    | 67.9±14.0     | 96.2±33.9    | .10     | .88        |
| Alcohol (gr)       | 3.7±8.0       | 18.1±19.2    | 4.0±6.4       | 9.9±11.9     | 6.0±7.6       | 12.8±18.0    | .15     | .08        |
| Carbohydrates (%)  | 53.7±7.2      | 50.7±7.2     | 54.2±7.7      | 49.9±4.9     | 53.6±6.6      | 50.4±7.6     | .98     | .80        |
| Fats (%)           | 30.4±4.3      | 30.1±5.6     | 31.4±7.2      | 32.7±4.3     | 30.6±6.7      | 30.8±4.9     | .21     | .73        |
| Proteins (%)       | 14.6±2.3      | 14.4±2.3     | 12.9±1.9      | 14.6±2.6     | 13.7±2.3      | 15.4±3.1     | .11     | .03*       |
| Alcohol (%)        | 1.3±2.9       | 4.9±5.7      | 1.5±2.1       | 2.7±3.4      | 2.1±2.6       | 3.4±4.6      | .25     | .08        |

Data are mean and standard deviation.

Values are absolute values.

\*  $P < 0.05$  \*\*  $P < 0.01$

Table 3: Correlation of absolute changes in body weight, BMI, WC, % body fat and FM with baseline measures<sup>1</sup>

|                                  | Δ Weight         |                  | Δ BMI       |        | Δ WC        |      | Δ % BF <sup>2</sup> |       | Δ FM        |       |
|----------------------------------|------------------|------------------|-------------|--------|-------------|------|---------------------|-------|-------------|-------|
|                                  | September -      |                  | September - |        | September - |      | September -         |       | September - |       |
|                                  | Dec <sup>3</sup> | Mar <sup>4</sup> | Dec         | Mar    | Dec         | Mar  | Dec                 | Mar   | Dec         | Mar   |
| <b>Anthropometry</b>             |                  |                  |             |        |             |      |                     |       |             |       |
| Weight (kg)                      | .18              | -.01             | .08         | -.02   | .15         | .15  | .24                 | .35   | .41*        | .40*  |
| BMI (kg/m <sup>2</sup> )         | .02              | -.11             | -.08        | -.10   | .07         | .09  | .13                 | .27   | .26         | .29   |
| WC (cm)                          | .15              | -.19             | .03         | -.18   | .04         | -.09 | .22                 | .27   | .39*        | .24   |
| % BF (%)                         | -.30             | -.53**           | -.27        | -.51** | -.38*       | -.33 | -.34                | -.41* | -.27        | -.43  |
| FM (kg)                          | -.15             | -.44*            | -.17        | -.42*  | -.25        | -.22 | -.13                | -.14  | .01         | -.14  |
| FFM (kg)                         | .33              | .30              | .22         | .28    | .36         | .33  | .38*                | .52** | .49**       | .58** |
| <b>Energy</b>                    |                  |                  |             |        |             |      |                     |       |             |       |
| EI (kcal)                        | .47*             | .35              | .24         | .34    | .25         | .26  | .36                 | .50*  | .39*        | .45*  |
| Carbohydrates (g)                | .51*             | .33              | .36         | .32    | .22         | .19  | .28                 | .38   | .32         | .34   |
| Fats (g)                         | .20              | .07              | -.03        | .08    | .08         | .07  | .12                 | .25   | .13         | .19   |
| Proteins (g)                     | .17              | .21              | -.02        | .21    | .02         | .16  | .21                 | .37   | .20         | .36   |
| Alcohol (g)                      | .48**            | .49**            | .38         | .45*   | .51**       | .45* | .63**               | .58** | .67**       | .57** |
| <b>Respiration</b>               |                  |                  |             |        |             |      |                     |       |             |       |
| EE (kcal)                        | .29              | .21              | .20         | .19    | .42*        | .18  | .26                 | .19   | .35         | .19   |
| VO <sub>2</sub> peak (ml/kg/min) | .36*             | .51**            | .21         | .48**  | .39*        | .36  | .35                 | .48** | .38*        | .53** |
| <b>Behavior</b>                  |                  |                  |             |        |             |      |                     |       |             |       |
| Restraint                        | -.31             | -.29             | -.12        | -.29   | -.46*       | -.13 | -.42*               | -.43* | -.44*       | -.43  |

<sup>1</sup> Values are *P*. \* *P* < 0.05 \*\* *P* < 0.01

<sup>2</sup> BF, body fat.

<sup>3</sup> Dec, December.

<sup>4</sup> Mar, March.

Table 4: Stepwise regression analysis examining predictors of changes in body weight, BMI, WC, percentage BF and FM among freshmen (N=29)

| Dependent variable   | Step no. | Predicting variable      | $r^2$ | $P$ value |
|----------------------|----------|--------------------------|-------|-----------|
| September - December |          |                          |       |           |
| $\Delta$ Weight      | 1        | Carbohydrates (gr)       | .26   | .01       |
|                      | 2        | Alcohol (gr)             | .44   | .01       |
| $\Delta$ WC          | 1        | Alcohol (gr)             | .26   | .01       |
| $\Delta$ % BF        | 1        | Alcohol (gr)             | .40   | .01       |
| $\Delta$ FM          | 1        | Alcohol (gr)             | .45   | .01       |
|                      | 2        | Waist circumference (cm) | .60   | .01       |
| September - March    |          |                          |       |           |
| $\Delta$ Weight      | 1        | % BF                     | .27   | .01       |
| $\Delta$ BMI         | 1        | % BF                     | .26   | .01       |
| $\Delta$ WC          | 1        | Alcohol (gr)             | .20   | .02       |
| $\Delta$ % BF        | 1        | Alcohol (gr)             | .34   | .01       |
|                      | 2        | FFM (kg)                 | .46   | .01       |
| $\Delta$ FM          | 1        | FFM (kg)                 | .33   | .02       |
|                      | 2        | Alcohol (gr)             | .50   | .01       |

## FIGURE LEGENDS

Figure 1: Result for the repeated measures ANOVA testing the effect of time and time by sex on freshmen (N=29) body weight. The main effect of time and the interaction of time by sex were significant ( $p<0.05$ ).

Figure 2: Result for the repeated measures ANOVA testing the effect of time and time by sex on freshmen (N=29) waist circumference. A significant main effect of time ( $p<0.01$ ) and a significant interaction of time by sex ( $p=0.03$ ) were observed.

Figure 3: Result for the repeated measures ANOVA testing the effect of time and time by sex on freshmen (N=29) percentage body fat. The main effect of time and the interaction of time by sex were significant ( $p<0.01$ ).

Figure 4: Absolute body weight (kg) of each male freshmen as measured by the BWB-800AS digital scale from Tanita Corporation of America, Inc.

Figure 5: Absolute body weight (kg) of each female freshmen as measured by the BWB-800AS digital scale from Tanita Corporation of America, Inc.

Figure 1: Change in body weight (kg) during the freshmen year

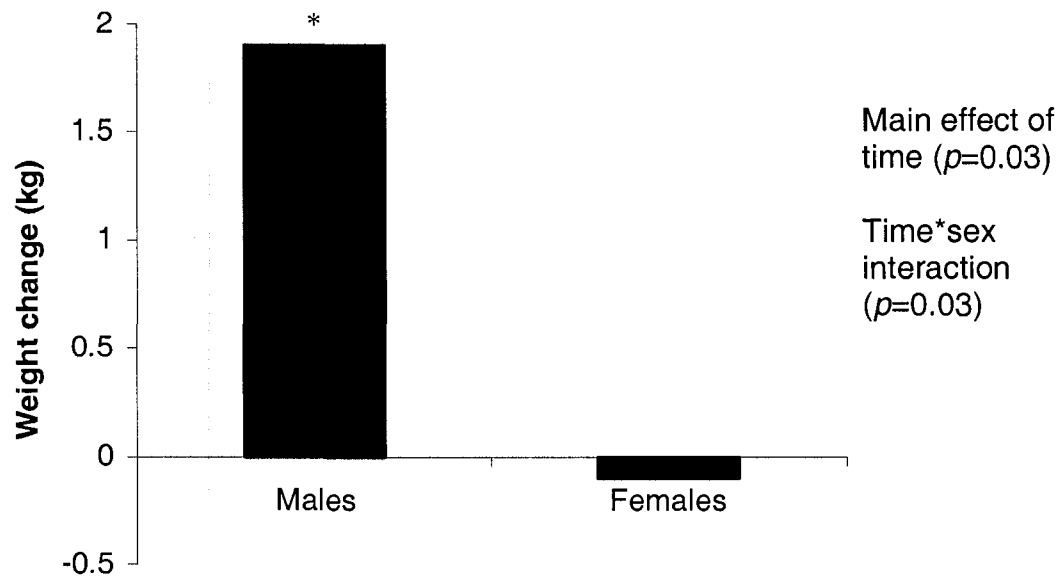


Figure 2: Change in waist circumference (cm) during the freshmen year

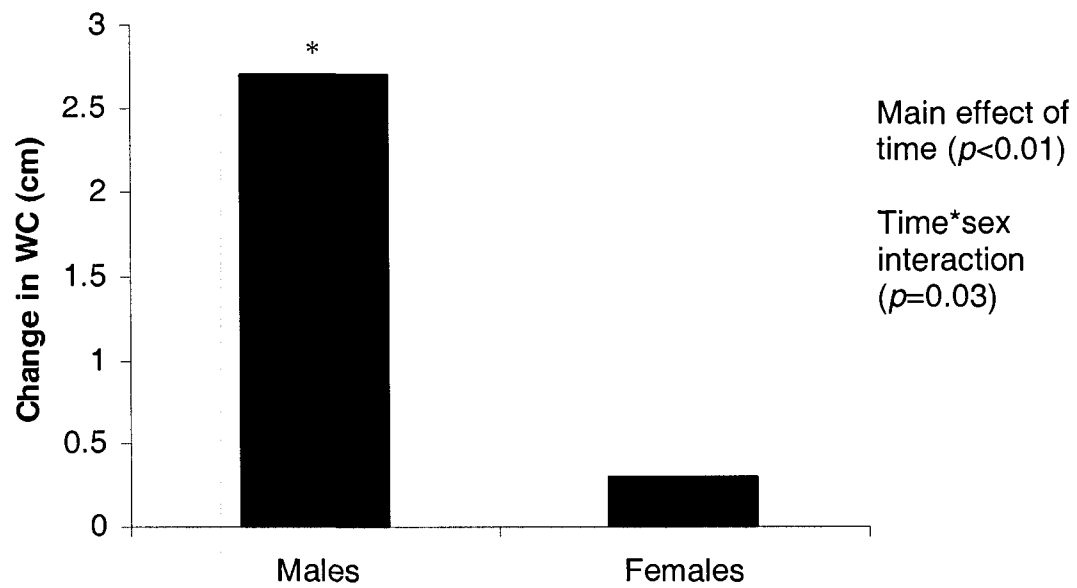


Figure 3: Change in percentage body fat (%) during the freshmen year

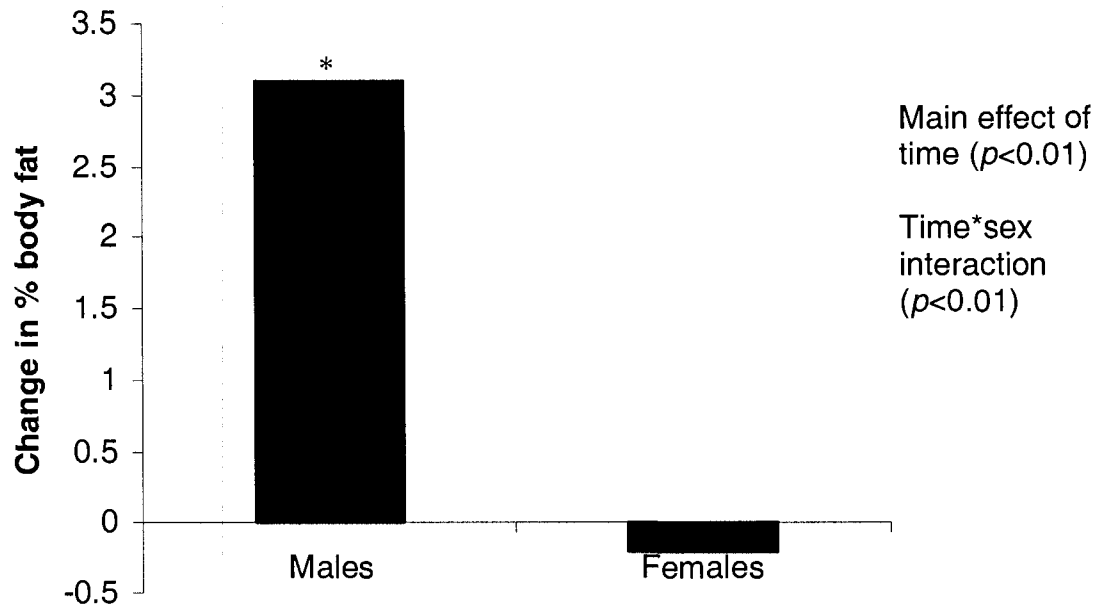


Figure 4: Absolute body weight (kg) of each male freshman at September, December and late March (n=13)

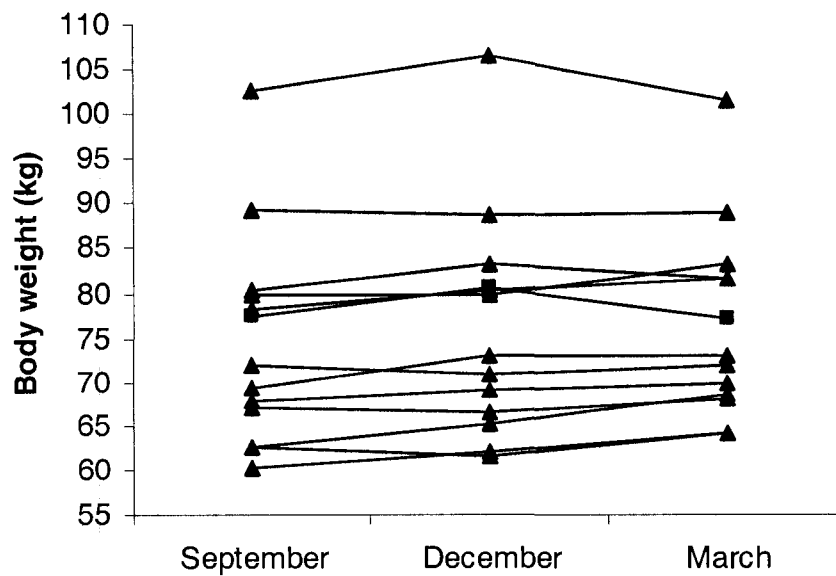
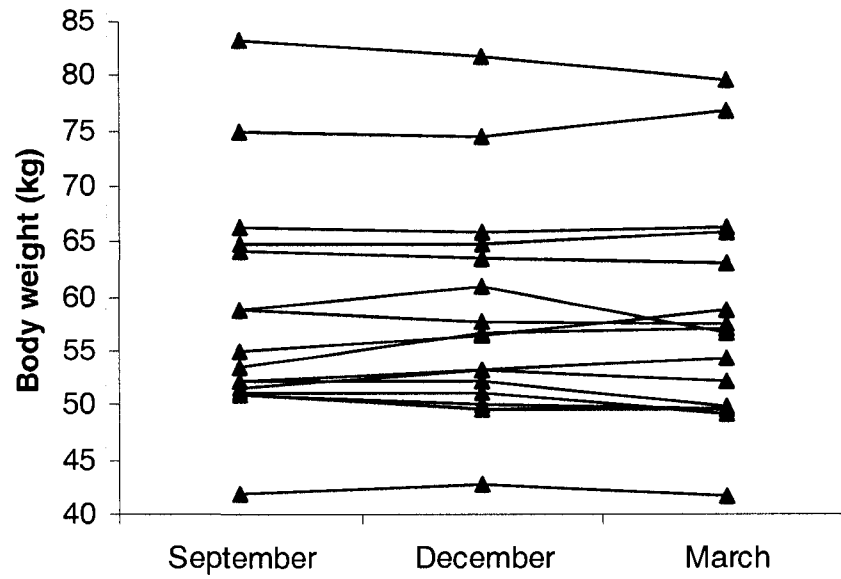


Figure 5: Absolute body weight (kg) of each female freshman at September, December and late March (n=16)





## CHAPTER 5: FUTURE PERSPECTIVES

The period when students enter university seems to be a critical one affecting both their current and future health-status. Despite the observation that freshmen weight gain was less than the expected 15 lbs, as suggested by the frequently heard of 'Freshmen 15', any significant weight gain warrants attention as it is likely to have an impact on future weight gain and health. Weight gain at this age (18 years) is likely to increase the chance of being overweight at the age of 35. BMI at the age of 18 was in fact found to be more sensitive at predicting BMI at age 35 than BMI at the age of 3, 8 and 13 (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994). In a more recent study, Guo *et al.* again observed that those heavier at the age of 35 were heavier at the age of 18 (Guo, Wu, Chumlea, & Roche, 2002). The increased prevalence of overweight and obesity reflects upon an increased risk for coronary heart disease, hypertension, high blood cholesterol, non-insulin dependent diabetes mellitus, cancer, back and joint problems as well as a higher rate of mortality (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999; Chambers & Swanson, 2006; Colditz, Willett, Rotnitzky, & Manson, 1995; Donahue, Fuster, & Califf, 2001; Eckel et al., 2006; NIH, 1998; Rubenstein, 2005; Tjepkema, 2006).

Regardless of weight gain, this study revealed stronger gains in body fat, and in particular abdominal obesity. Measuring overall obesity using BMI does not reflect measures of abdominal obesity, which appear to be more strongly associated with metabolic risk factors (Despres & Lemieux, 2006; Wang, Rimm, Stampfer, Willett, & Hu, 2005), CVD and all cause-mortality (Bigaard et al., 2005;

Lahmann, Lissner, Gullberg, & Berglund, 2002). Visceral adipose tissue promotes insulin resistance, dyslipidaemia and hypertension (Despres et al., 1990; Pouliot et al., 1992), hence abdominal obesity is in itself considered a risk factor for the metabolic syndrome. The increase in WC observed among this group of young adults thus promotes an increased health-risk at an age as young as 18 years.

Although to-date there is little research on the secular trends of change in WC, a recent study comparing results from several NHANES showed an increase in the age-adjusted prevalence of abdominal obesity for both men (14.6%) and women (10.9%) between 1988-1994 and 2003-2004 (Li, Ford, McGuire, & Mokdad, 2007). Such trends reveal that as adults between the ages of 20 and 29, these freshmen are likely to experience further gains in abdominal obesity which may keep accumulating throughout the years that follow. These young adults are therefore not only a population at increased risk for weight gain and abdominal obesity during their 1<sup>st</sup> year at university, but also a population at-risk for increased obesity-related health problems in the years following their freshmen year.

Our study revealed that baseline alcohol intake was strongly associated with increased abdominal obesity. Longitudinal research following young adults into adulthood could clarify other factors related to EI, macro-nutrient consumption and EE, associated with more long-term gains in visceral adipose tissue. Although it may seem that lean young adults are not as much at-risk as heavier young adults, results from this study suggest that leaner freshmen may

engage in less healthy-behaviours, promoting greater gains in body fat. Thus, it is essential that research on abdominal obesity among young adults considers the lean as well as those overweight. This may underline different patterns associated with increased abdominal obesity. In turn, this could facilitate the development of differential preventive interventions aimed at decreasing the progressive increase in abdominal obesity within different BMI categories.

### **General conclusion**

The results seem to support the notion of freshmen weight gain, especially during the 1<sup>st</sup> semester, while identifying additional increases in WC and overall body fat. Since abdominal obesity is considered as an independent risk factor for obesity-related health problems, the significant gains observed over the freshmen year raise concern about the associated health-risks and possible future gains in visceral adipose tissue during adulthood. Further, being male, having less body fat and a higher level of physical fitness upon starting university seem to be factors predisposing freshmen to be more prone to such gains. Male, lean and active young adults entering university thus seem to be a population at increased health-risks. Further research is however required.

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## **APPENDIX A – POSTER, FORMS & QUESTIONNAIRES**

## FREE BODY COMPOSITION & FITNESS TESTING

## A STUDY ON FIRST YEAR UNIVERSITY STUDENTS

(School of Human Kinetics, University of Ottawa)

### SELECTION CRITERIAS:

- 1<sup>st</sup> year student
- Living in residence
- Previously living at home
- 18 years and over
- Males and females
- No major health problems
- Non-smokers
- Stable body weight & no dieting for the last 6 months
- No plans to change dietary habits in the coming 7 months

For more information,  
contact Gabrielle Mifsud (Study Coordinator) or Karine Duval  
(co-investigator) (613) 746-4621 ext. 6029

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**PRE-SCREENING QUESTIONNAIRE**  
**Mifsud, G., Duval, K., & Doucet É.**

***Inclusion criteria questionnaire for the FRISK study:***

- 1) Are you a first year university student? Oui ☐ Non ☐
- 2) Where are you living during your first year at university? \_\_\_\_\_
- 3) Do you have access to the meal plan at the university cafeteria? Oui ☐ Non ☐
- 4) Where did you live before beginning university? \_\_\_\_\_
- 5) How old are you? \_\_\_\_\_
- 6) What is your weight? \_\_\_\_\_
- 7) What is your height? \_\_\_\_\_
- 8) Are you a smoker? Oui ☐ Non ☐
- 9) Have you had a stable ( $\pm 2$  kg) body weight for at least the last 6 months? Oui ☐ Non ☐
- 10) Do you have plans to change your dietary habits in the coming 7 months? Oui ☐ Non ☐
- 11) Are you sedentary? Oui ☐ Non ☐
- If not, how many minutes of physical activity do you do each week? \_\_\_\_\_
- 12) Do you take medication? Oui ☐ Non ☐
- If yes, which ones? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- 13) Are you diabetic? Oui ☐ Non ☐
- 14) Do you suffer from heart disease? Oui ☐ Non ☐
- 15) Do you suffer from hypertension? Oui ☐ Non ☐
- 16) Do you suffer from asthma or other respiratory problems? Oui ☐ Non ☐
- 17) Has your doctor ever said that you suffered from thyroid gland disorder? Oui ☐ Non ☐
- 18) Do you have a regular menstrual cycle? Oui ☐ Non ☐
- 19) Do you take oral contraceptives? Oui ☐ Non ☐
- For how long? \_\_\_\_\_
- 20) Are you pregnant? Oui ☐ Non ☐
- 21) Do you plan to become pregnant with in the coming 7 months? Oui ☐ Non ☐

|                                      |
|--------------------------------------|
| <b>SOCIO-DEMOGRAPHIC INFORMATION</b> |
|--------------------------------------|

**Civil Status:**

- |                                              |                                    |                                           |
|----------------------------------------------|------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Married             | <input type="checkbox"/> Divorced  | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Living with someone | <input type="checkbox"/> Separated | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Widowed             | <input type="checkbox"/> Single    | Other _____                               |

**Education:**

Highest level of education obtained?

- |                                    |                                           |             |
|------------------------------------|-------------------------------------------|-------------|
| <input type="checkbox"/> Primary   | <input type="checkbox"/> University       |             |
| <input type="checkbox"/> Secondary | <input type="checkbox"/> Don't know       |             |
| <input type="checkbox"/> College   | <input type="checkbox"/> Refuse to answer | Other _____ |

**Current Education:**

What faculty do you form part of? \_\_\_\_\_

Program of studies? \_\_\_\_\_

**Parents education:**

Highest level of education obtained?

Family member 1:

- |                                    |                                           |             |
|------------------------------------|-------------------------------------------|-------------|
| <input type="checkbox"/> Primary   | <input type="checkbox"/> University       |             |
| <input type="checkbox"/> Secondary | <input type="checkbox"/> Don't know       |             |
| <input type="checkbox"/> College   | <input type="checkbox"/> Refuse to answer | Other _____ |

Family member 2:

- |                                    |                                           |             |
|------------------------------------|-------------------------------------------|-------------|
| <input type="checkbox"/> Primary   | <input type="checkbox"/> University       |             |
| <input type="checkbox"/> Secondary | <input type="checkbox"/> Don't know       |             |
| <input type="checkbox"/> College   | <input type="checkbox"/> Refuse to answer | Other _____ |

**Occupation:**

Are you presently employed?

- |                                         |                                                 |                                     |                                           |
|-----------------------------------------|-------------------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Employed       | <input type="checkbox"/> Social assistance      | <input type="checkbox"/> Yes        | <input type="checkbox"/> No               |
| <input type="checkbox"/> Unemployed     | <input type="checkbox"/> On strike or lock-out  | <input type="checkbox"/> Don't know | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Student        | <input type="checkbox"/> Unemployment insurance | Other _____                         |                                           |
| <input type="checkbox"/> Work from home |                                                 |                                     |                                           |

**Hours devoted:**

- |                                                |                                             |                                         |
|------------------------------------------------|---------------------------------------------|-----------------------------------------|
| <input type="checkbox"/> Less than 20 hours    | <input type="checkbox"/> More than 60 hours | <input type="checkbox"/> Not applicable |
| <input type="checkbox"/> Between 20 - 40 hours | <input type="checkbox"/> Don't know         |                                         |
| <input type="checkbox"/> Between 41 - 60 hours | <input type="checkbox"/> Refuse to answer   | Other _____                             |

**Transportation:**

- |                                           |                                     |                                           |
|-------------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Car              | <input type="checkbox"/> By foot    | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Public transport | <input type="checkbox"/> Bicycle    | <input type="checkbox"/> Not applicable   |
| <input type="checkbox"/> Taxi             | <input type="checkbox"/> Don't know | Other _____                               |

**Time of transportation:**

- |                                                  |                                                  |                                           |
|--------------------------------------------------|--------------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Less than 15 minutes    | <input type="checkbox"/> Between 60 - 90 minutes | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Between 15 - 30 minutes | <input type="checkbox"/> More than 90 minutes    | <input type="checkbox"/> Not applicable   |
| <input type="checkbox"/> Between 30 - 60 minutes | <input type="checkbox"/> Don't know              | Other _____                               |

**Income:**

- |                                               |                                               |                                             |
|-----------------------------------------------|-----------------------------------------------|---------------------------------------------|
| <input type="checkbox"/> Less than 20 000\$   | <input type="checkbox"/> 30 000\$ to 39 999\$ | <input type="checkbox"/> More than 50 000\$ |
| <input type="checkbox"/> 20 000\$ to 29 999\$ | <input type="checkbox"/> 40 000\$ to 49 999\$ | <input type="checkbox"/> Don't know         |
|                                               |                                               | <input type="checkbox"/> Refuse to answer   |

**Financial situation:**

I consider myself to be...

- |                                                  |                                    |                                           |
|--------------------------------------------------|------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Financially comfortable | <input type="checkbox"/> Poor      | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Sufficient income       | <input type="checkbox"/> Very poor | <input type="checkbox"/> Refuse to answer |

Economic evolution (compared with past years):

- |                                       |                                             |                                           |
|---------------------------------------|---------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> More at ease | <input type="checkbox"/> Not more, not less | <input type="checkbox"/> Don't know       |
|                                       | <input type="checkbox"/> Less as ease       | <input type="checkbox"/> Refuse to answer |

**Family Income:**

- |                                               |                                               |                                             |
|-----------------------------------------------|-----------------------------------------------|---------------------------------------------|
| <input type="checkbox"/> Less than 20 000\$   | <input type="checkbox"/> 30 000\$ to 39 999\$ | <input type="checkbox"/> More than 50 000\$ |
| <input type="checkbox"/> 20 000\$ to 29 999\$ | <input type="checkbox"/> 40 000\$ to 49 999\$ | <input type="checkbox"/> Don't know         |
|                                               |                                               | <input type="checkbox"/> Refuse to answer   |

**Financial situation:**

I consider the family to be...

- |                                                  |                                    |                                           |
|--------------------------------------------------|------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Financially comfortable | <input type="checkbox"/> Poor      | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Sufficient income       | <input type="checkbox"/> Very poor | <input type="checkbox"/> Refuse to answer |

Economic evolution (compared with past years):

- |                                       |                                             |                                           |
|---------------------------------------|---------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> More at ease | <input type="checkbox"/> Not more, not less | <input type="checkbox"/> Don't know       |
|                                       | <input type="checkbox"/> Less at ease       | <input type="checkbox"/> Refuse to answer |

**Housing:**How many adults ( $\geq 18$  yrs) living with you? \_\_\_\_\_

How many teenagers (12 to 18 yrs) living with you? \_\_\_\_\_

How many children ( $< 12$  yrs) living with you? \_\_\_\_\_**Residence:**

- |                                               |                                      |                                           |
|-----------------------------------------------|--------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Room                 | <input type="checkbox"/> Condominium | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Apartment            | <input type="checkbox"/> House       | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> University residence |                                      | Other _____                               |

**Property:**

- |                                     |                                     |                                           |
|-------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Tenant     | <input type="checkbox"/> Landlord   | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> University | <input type="checkbox"/> Don't know | Other _____                               |

**Access (outside):**

- |                                 |                                   |                                         |
|---------------------------------|-----------------------------------|-----------------------------------------|
| <input type="checkbox"/> Stairs | <input type="checkbox"/> Elevator | <input type="checkbox"/> Not applicable |
|---------------------------------|-----------------------------------|-----------------------------------------|

**Previous place of residence:**

Where do you come from?

- |                                     |                                     |                                           |
|-------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Rural town | <input type="checkbox"/> Urban city | <input type="checkbox"/> Refuse to answer |
|                                     | <input type="checkbox"/> Don't know | Other _____                               |

**Leisure Activities:**

How much time do you allow for leisure activities each day?

- |                                                  |                                                   |                                           |
|--------------------------------------------------|---------------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Between 0 - 30 minutes  | <input type="checkbox"/> Between 90 - 120 minutes | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Between 30 - 60 minutes | <input type="checkbox"/> More than 120 minutes    | <input type="checkbox"/> Not applicable   |
| <input type="checkbox"/> Between 60 - 90 minutes | <input type="checkbox"/> Don't know               | Other _____                               |

Time of transportation to practice leisure activities per day?

- |                                                  |                                                  |                                           |
|--------------------------------------------------|--------------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Less than 15 minutes    | <input type="checkbox"/> Between 60 - 90 minutes | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> Between 15 - 30 minutes | <input type="checkbox"/> More than 90 minutes    | <input type="checkbox"/> Not applicable   |
| <input type="checkbox"/> Between 30 - 60 minutes | <input type="checkbox"/> Don't know              | Other _____                               |

**Television and computer:**

How many televisions are there in your home?

**Television time/week**

- |                                              |                                              |                                           |
|----------------------------------------------|----------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Less than 2 hours   | <input type="checkbox"/> Between 4 – 6 hours | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Between 2 – 4 hours | <input type="checkbox"/> More than 6 hours   | <input type="checkbox"/> Refuse to answer |

**Computer time/week (usage other than for internet):**

- |                                              |                                              |                                           |
|----------------------------------------------|----------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Less than 2 hours   | <input type="checkbox"/> Between 4 – 6 hours | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Between 2 – 4 hours | <input type="checkbox"/> More than 6 hours   | <input type="checkbox"/> Refuse to answer |

**Internet time/week:**

- |                                              |                                              |                                           |
|----------------------------------------------|----------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Less than 2 hours   | <input type="checkbox"/> Between 4 – 6 hours | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Between 2 – 4 hours | <input type="checkbox"/> More than 6 hours   | <input type="checkbox"/> Refuse to answer |

**Eating habits:**

Number of meals per day: \_\_\_\_\_

Number of snacks per day: \_\_\_\_\_

**Breakfast:**

- |                                               |                                          |                                           |
|-----------------------------------------------|------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> House                | <input type="checkbox"/> Work            | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Restaurant           | <input type="checkbox"/> Other cafeteria | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> University cafeteria |                                          |                                           |

**Lunch:**

- |                                               |                                          |                                           |
|-----------------------------------------------|------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> House                | <input type="checkbox"/> Work            | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Restaurant           | <input type="checkbox"/> Other cafeteria | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> University cafeteria |                                          |                                           |

**Dinner:**

- |                                               |                                          |                                           |
|-----------------------------------------------|------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> House                | <input type="checkbox"/> Work            | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Restaurant           | <input type="checkbox"/> Other cafeteria | <input type="checkbox"/> Refuse to answer |
| <input type="checkbox"/> University cafeteria |                                          |                                           |

**Who does the groceries?**

- |                                   |                                  |                                           |
|-----------------------------------|----------------------------------|-------------------------------------------|
| <input type="checkbox"/> Me       | <input type="checkbox"/> Kid(s)  | <input type="checkbox"/> Employee         |
| <input type="checkbox"/> Spouse   | <input type="checkbox"/> Parents | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Roommate |                                  | <input type="checkbox"/> Refuse to answer |

**Who prepares the meals?**

- |                                 |                                  |                                           |
|---------------------------------|----------------------------------|-------------------------------------------|
| <input type="checkbox"/> Me     | <input type="checkbox"/> Kid(s)  | <input type="checkbox"/> Employee         |
| <input type="checkbox"/> Spouse | <input type="checkbox"/> Parents | <input type="checkbox"/> Don't know       |
| <input type="checkbox"/> Other: |                                  | <input type="checkbox"/> Refuse to answer |

## MEDICAL AND DIETARY HISTORY

| <b>PARTICIPANT HISTORY:</b>                            | <b>YES</b>               | <b>NO</b>                |
|--------------------------------------------------------|--------------------------|--------------------------|
| Have you ever participated in a research study before? | <input type="checkbox"/> | <input type="checkbox"/> |
| Where? _____                                           |                          |                          |
| Are you in a study now other than the present study?   | <input type="checkbox"/> | <input type="checkbox"/> |

| FAMILY HISTORY | YES                      | NO                       | If « yes » : specify<br>Code : 1-Father 2- Mother 3- Siblings 4- Grandparents |
|----------------|--------------------------|--------------------------|-------------------------------------------------------------------------------|
| Diabetes       | <input type="checkbox"/> | <input type="checkbox"/> | _____                                                                         |
|                |                          |                          | _____                                                                         |
| Heart disease  | <input type="checkbox"/> | <input type="checkbox"/> | _____                                                                         |
|                |                          |                          | _____                                                                         |
| Other          | <input type="checkbox"/> | <input type="checkbox"/> | _____                                                                         |
|                |                          |                          | _____                                                                         |

[illegible]

[illegible]

\* If medication is continuing, check box and leave date ended blank.

**MEDICAL AND DIETARY HISTORY continued...****SMOKING HISTORY:**

|                      | <b>CURRENT/SMOKERS</b>   | <b>QUIT SMOKING</b>      | <b>NEVER SMOKED</b>      |
|----------------------|--------------------------|--------------------------|--------------------------|
| <b>A.</b> Cigarettes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>B.</b> Cigars     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <b>C.</b> Pipes      | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Age when you first started? \_\_\_\_ years

Duration? \_\_\_\_ years

A) How many of the above per day (last year)? \_\_\_\_/day

B) How old were you when you stopped smoking? \_\_\_\_ years

C) If you quit smoking, how long ago did you stop smoking? \_\_\_\_ years

D) Number of trial? \_\_\_\_

**EXERCISE PROGRAM:**

Do you exercise 30 minutes (continuous moderate physical activity « higher than 60 % of  $VO_{2max}$  ») or more per week?

YES ☐ NO ☐If **YES**, what type of exercise? \_\_\_\_\_If **YES**, how many times per week? \_\_\_\_\_ per week**DIETARY PATTERN (SELECT ONLY ONE ITEM):**

|                       |                          |                     |                          |            |                          |
|-----------------------|--------------------------|---------------------|--------------------------|------------|--------------------------|
| Unrestricted          | <input type="checkbox"/> | Low fat/cholesterol | <input type="checkbox"/> | Low sodium | <input type="checkbox"/> |
| Watching what you eat | <input type="checkbox"/> |                     |                          |            |                          |
| Low calorie           | <input type="checkbox"/> | Diabetic            | <input type="checkbox"/> | Vegetarian | <input type="checkbox"/> |

**WEIGHT CYCLING HISTORY BEFORE TRIAL MEDICATION:**Have you ever been on a diet (weight loss  $\geq 4$  kg or 10 lbs)?YES ☐ NO ☐

If «YES», weight before the first diet: \_\_\_\_\_ kg

Your age at that period: \_\_\_\_\_ years

If «YES», specify how many times did you follow a diet: \_\_\_\_\_



**MEDICAL AND DIETARY HISTORY continued...**

| SPECIFICATION OF THE DIET                         |              |                                           |                            |                                                   |                                                    |
|---------------------------------------------------|--------------|-------------------------------------------|----------------------------|---------------------------------------------------|----------------------------------------------------|
| <input type="checkbox"/> None                     |              |                                           |                            |                                                   |                                                    |
| Name of the diet                                  | Age<br>(yr.) | Period<br>on diet<br>(days /weeks/months) | Weight<br>lost<br>(kg/lbs) | Weight<br>regain<br>after the<br>diet<br>(kg/lbs) | Time until<br>weight regain<br>(days/weeks/months) |
| <input type="checkbox"/> Weight Watcher           | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Scarsdel                 | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Nutri-bars               | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Diuretics                | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Laxative                 | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Pills                    | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Protein diet             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Chirurgical intervention | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Montignac                | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| <input type="checkbox"/> Other, specify           | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |
| _____                                             | _____ yr.    | _____                                     | _____                      | _____                                             | _____                                              |

**HEIGHT and BODY WEIGHT****HEIGHT AND BODY WEIGHT**

Height \_\_\_\_\_ cm

BMI \_\_\_\_\_ kg/m<sup>2</sup>

Weight \_\_\_\_\_ kg

**FOOD HABITS QUESTIONNAIRE**  
(Stunkard et Messick, 1984)

*This questionnaire contains a certain number of propositions.*

*If you agree with the statement or if you feel like it can be applied to you, check the case TRUE.*

*If you disagree with the proposition or if you feel like it cannot be applied to you, check the case FALSE.*

*You have the choice to answer or not certain questions.*

- |                                                                                                                                                          | TRUE                     | FALSE                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| 1. When I smell a sizzling steak or see a juicy piece of meat, I find it difficult to keep from eating, even if I have just finished a meal.             | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. I usually eat too much at social occasions, like parties and picnics.                                                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. I am actually so hungry that I eat more than 3 times per day.                                                                                         | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. When I have eaten my quota of calories, I am usually good about not eating any more.                                                                  | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Dieting is so hard for me because I just get too hungry.                                                                                              | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I deliberately take small helpings as a means of controlling my weight.                                                                               | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry.                                                            | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I had enough or that I can have something more to eat. | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. When I feel anxious, I find myself eating.                                                                                                            | <input type="checkbox"/> | <input type="checkbox"/> |

|                                                                                                                     | <i>TRUE</i>              | <i>FALSE</i>             |
|---------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| 10. Life is too short to worry about dieting.                                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Since my weight goes up and down, I have gone on reducing diets more than once.                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. I often feel so hungry that I just have to eat something.                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. When I am with someone who is overeating, I usually overeat too.                                                | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. I have a pretty good idea of the number of calories in common food.                                             | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. Sometimes when I start eating, I just can't seem to stop.                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. It is not difficult for me to leave something on my plate.                                                      | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. At certain times of the day, I get hungry because I have gotten used to eating then.                            | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. While on a diet, if I eat food that I'd allowed, I consciously eat less for a period of time to make up for it. | <input type="checkbox"/> | <input type="checkbox"/> |
| 19. Being with someone who is eating often makes me hungry enough to eat also.                                      | <input type="checkbox"/> | <input type="checkbox"/> |
| 20. When I feel « blue », I often overeat.                                                                          | <input type="checkbox"/> | <input type="checkbox"/> |
| 21. I enjoy eating too much to spoil it by counting calories or watching my weight.                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 22. When I see a real delicacy, I often get so hungry that I have to eat right away.                                | <input type="checkbox"/> | <input type="checkbox"/> |
| 23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.           | <input type="checkbox"/> | <input type="checkbox"/> |

|                                                                                                                  | <i>TRUE</i>              | <i>FALSE</i>             |
|------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| 24. I get so hungry that my stomach often seems like a bottomless pit.                                           | <input type="checkbox"/> | <input type="checkbox"/> |
| 25. My weight has hardly changed at all in the last 10 years.                                                    | <input type="checkbox"/> | <input type="checkbox"/> |
| 26. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 27. When I feel lonely, I console myself by eating.                                                              | <input type="checkbox"/> | <input type="checkbox"/> |
| 28. I consciously hold back at meals in order not to gain weight.                                                | <input type="checkbox"/> | <input type="checkbox"/> |
| 29. I sometimes get very hungry late in the evening or at night.                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 30. I eat anything I want, anytime I want.                                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| 31. Without even thinking about it, I take a long time to eat.                                                   | <input type="checkbox"/> | <input type="checkbox"/> |
| 32. I count calories as a conscious means of controlling weight.                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| 33. I do not eat some foods because they make me fat.                                                            | <input type="checkbox"/> | <input type="checkbox"/> |
| 34. I am always hungry enough to eat at any time.                                                                | <input type="checkbox"/> | <input type="checkbox"/> |
| 35. I pay a great deal of attention to changes in my figure.                                                     | <input type="checkbox"/> | <input type="checkbox"/> |
| 36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. | <input type="checkbox"/> | <input type="checkbox"/> |

**PART 2**

*Please answer the following questions by circling the number that best corresponds to you*

**37. How often are you dieting in a conscious effort to control your weight ?**

|               |                  |                |               |
|---------------|------------------|----------------|---------------|
| <b>Rarely</b> | <b>Sometimes</b> | <b>Usually</b> | <b>Always</b> |
| 1             | 2                | 3              | 4             |

**38. Would a weight fluctuation of 5 lbs (2 kgs) affect the way you live your life ?**

|                   |                 |                   |                  |
|-------------------|-----------------|-------------------|------------------|
| <b>Not at all</b> | <b>Slightly</b> | <b>Moderately</b> | <b>Very much</b> |
| 1                 | 2               | 3                 | 4                |

**39. How often do you feel hungry ?**

|                              |                                    |                                |                          |
|------------------------------|------------------------------------|--------------------------------|--------------------------|
| <b>Only<br/>At mealtimes</b> | <b>Sometimes<br/>between meals</b> | <b>Often<br/>between meals</b> | <b>Almost<br/>always</b> |
| 1                            | 2                                  | 3                              | 4                        |

**40. Do your feelings of guilt about overeating help you control your food intake ?**

|              |               |              |               |
|--------------|---------------|--------------|---------------|
| <b>Never</b> | <b>Rarely</b> | <b>Often</b> | <b>Always</b> |
| 1            | 2             | 3            | 4             |

**41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next 4 hours ?**

|             |                               |                                 |                           |
|-------------|-------------------------------|---------------------------------|---------------------------|
| <b>Easy</b> | <b>Slightly<br/>Difficult</b> | <b>Moderately<br/>Difficult</b> | <b>Very<br/>Difficult</b> |
| 1           | 2                             | 3                               | 4                         |

**42. How conscious are you of what you are eating ?**

|                   |                 |                   |                  |
|-------------------|-----------------|-------------------|------------------|
| <b>Not at all</b> | <b>Slightly</b> | <b>Moderately</b> | <b>Extremely</b> |
| 1                 | 2               | 3                 | 4                |

43. How frequently do you avoid « stocking up » on tempting foods ?

|                 |        |         |                  |
|-----------------|--------|---------|------------------|
| Almost<br>Never | Seldom | Usually | Almost<br>always |
| 1               | 2      | 3       | 4                |

44. How likely are to shop for low calorie foods ?

|          |                      |                      |                |
|----------|----------------------|----------------------|----------------|
| Unlikely | Slightly<br>Unlikely | Moderately<br>likely | Very<br>likely |
| 1        | 2                    | 3                    | 4              |

45. Do you eat sensibly in front of others and splurge alone ?

|       |        |       |        |
|-------|--------|-------|--------|
| Never | Rarely | Often | Always |
| 1     | 2      | 3     | 4      |

46. How likely are you to consciously eat slowly in order to cut down on how much you eat ?

|          |                      |                      |                |
|----------|----------------------|----------------------|----------------|
| Unlikely | Slightly<br>Unlikely | Moderately<br>likely | Very<br>likely |
| 1        | 2                    | 3                    | 4              |

47. How frequently do you skip dessert because you are no longer hungry ?

|                 |        |                           |                     |
|-----------------|--------|---------------------------|---------------------|
| Almost<br>Never | Seldom | At least<br>once per week | Almost<br>every day |
| 1               | 2      | 3                         | 4                   |

48. How likely are you to consciously eat less than you want ?

|          |                      |                      |                |
|----------|----------------------|----------------------|----------------|
| Unlikely | Slightly<br>Unlikely | Moderately<br>likely | Very<br>likely |
| 1        | 2                    | 3                    | 4              |

49. Do you go on eating binges though you are not hungry ?

|       |        |           |                           |
|-------|--------|-----------|---------------------------|
| Never | Rarely | Sometimes | At least<br>Once per week |
| 1     | 2      | 3         | 4                         |

**50. On a scale of 1 to 5, where :**

- **0 (zero) means no restraint in eating (eating whatever you want, whenever you want it) and,**
- **5 means total restraint (constantly limiting food intake and never “giving in”),**

**What number you give yourself?**

- **Eat whatever you want, whenever you want it**  
**0**
- **Usually eat whatever you want, whenever you want it**  
**1**
- **Often eat whatever you want, whenever you want it**  
**2**
- **Often limit food intake, but often « give in »**  
**3**
- **Usually limit food intake, rarely « give in »**  
**4**
- **Constantly limiting food intake, never « giving in »**  
**5**

**51. To what extent does this statement describe your eating behavior ?**

**“I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow”**

|                        |                           |                                          |                                   |
|------------------------|---------------------------|------------------------------------------|-----------------------------------|
| <b>Not like<br/>Me</b> | <b>Little<br/>like me</b> | <b>Pretty<br/>good description of me</b> | <b>Describes<br/>me perfectly</b> |
| <b>1</b>               | <b>2</b>                  | <b>3</b>                                 | <b>4</b>                          |

## FRISK STUDY

### *7-day food diary*

INITIALS : \_\_\_\_\_ ID: \_\_\_\_\_ DOB (D/M/Y): \_\_\_\_\_

AGE : \_\_\_\_\_ WEIGHT : \_\_\_\_\_ kg HEIGHT: \_\_\_\_\_ cm

**Objective:** To obtain a better understanding of your personal dietary habits, in order obtain an accurate profile of your diet.

#### **Instructions:**

- It is very important that you be as specific as possible in your descriptions of food intake and when recording precise **quantities of measurement (ml, tablespoons, teaspoons, grams, ounces, etc...)**. To aid in this process, questions to trigger your memory have been placed on the right hand side of the page for each meal and snack period
- Cut out food label (nutrition information) if possible and include them with this journal
- Give a detailed description of all food (main ingredients).
- Specify quantity of each main ingredient of recipes or complex meals (e.g. shepherd's pie, lasagna, salads...).
- Indicate Brand of products if possible (e.g. Kraft, Smuckers...).
- If you eat out, specify the restaurant.
- Indicate cooking method (e.g. boiled, grilled, roasted, raw...).
- We ask that you indicate **your entire** food intake (**including water and nutritional supplements (i.e., vitamins & minerals)**) for seven full days in the tables provided on the following pages.

***The more precise your food diary, the easier it is for us to get an accurate profile of your diet***

Date of submission (d/m/y): \_\_\_\_\_

If you have any questions, please do not hesitate to ask

Gabrielle Mifsud & Karine Duval (613) 746-4621 x 6029

DATE : (D/M/Y) \_\_\_\_\_



| DAY _                    |      |       |                              |          | Week-end? <input type="checkbox"/> Yes <input type="checkbox"/> No                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|--------------------------|------|-------|------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| MEAL                     | TIME | PLACE | NAME AND DESCRIPTION OF FOOD | QUANTITY | DID YOU REMEMBER THE FOLLOWING?                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Breakfast                |      |       |                              |          | <ul style="list-style-type: none"> <li>• <u>Juice?</u> Real juice, sugar/no-sugar, dry mix, cocktail</li> <li>• <u>Bread?</u> white, whole-wheat, cereal</li> <li>• <u>Garniture?</u> <u>Quantity of:</u> peanut butter, margarine, jam, cheese</li> <li>• <u>Muffin?</u> 1) <u>Size:</u> small,, medium, large</li> <li>2) <u>Type:</u> homemade or store bought 3)</li> <li><u>Contents:</u> fruits, chocolate chips, raisins, nuts etc...</li> </ul>               |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Snack<br>before<br>lunch |      |       |                              |          | <ul style="list-style-type: none"> <li>• <u>Crepes/pancakes?</u> Diameter in cm or inches</li> <li>• <u>Eggs?</u> Fried, boiled, poached</li> <li>• <u>mg % milk fat ?</u> Milk, cheese, yogurt, Cream</li> <li>• <u>Sugar, cream and added syrup?</u> In coffee, cereals, on crepes,...</li> <li>• <u>Added fat to cooking ?</u> Quantity of butter, Margarine, or oil</li> <li>• <u>Cereal bars?</u> Nuts, peanuts, marshmallows, fruits, chocolates,...</li> </ul> |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                          |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |

| Units of measurement |      |            |                  |           |                 |             |       |      |       |
|----------------------|------|------------|------------------|-----------|-----------------|-------------|-------|------|-------|
| tsp                  | tbsp | oz (fluid) | millilitres (ml) | grams (g) | milligrams (mg) | oz (weight) | slice | each | whole |

DAY \_ (continued)

| MEAL            | TIME | PLACE | NAME AND DESCRIPTION OF FOOD | QUANTITY |  <b>DID YOU REMEMBER THE FOLLOWING?</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------|------|-------|------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lunch           |      |       |                              |          | <ul style="list-style-type: none"> <li>• <b>Soup?</b> homemade, condensed, packaged</li> <li>• <b>Salad?</b> 1) <b>Contents</b> : quantity of vegetables, cheese, croutons, grains and nuts,...</li> <li>2) <b>Vinaigrette</b> : a) <b>type</b> : cream, Italian,...</li> <li>b) <b>quantity</b> : ml, tsp, tbsp, gram</li> <li>• <b>Sandwich?</b> 1) <b>Pain</b>: white, whole-wheat, cereals</li> <li>2) <b>Condiments</b>: quantity of mayonnaise, butter, mustard,...</li> <li>• <b>Meat?</b> 1) <b>Cooked</b>: oven, microwave, grill,...</li> <li>• <b>Skin?</b> Did you eat the skin?</li> <li>• <b>Added fat by cooking?</b> Quantity of butter, margarine or oil</li> <li>• <b>Dessert?</b> 1) <b>Size</b> : in centimeters, in inches</li> <li>2) <b>Filling/ topping</b> : icing, cream, ice cream, syrup, sauce...</li> <li>• <b>Cereal bars?</b> Nuts, peanuts, marshmallows, fruits, chocolate,...</li> <li>• <b>Snacks?</b> 1) <b>Type</b>: chips, Pretzels, Salted crackers,...</li> <li>2) <b>Quantity</b> : in grams or in units</li> </ul> |
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| Afternoon snack |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| Units of measurement |      |            |                  |             |                 |
|----------------------|------|------------|------------------|-------------|-----------------|
| tsp                  | tbsp | oz (fluid) | millilitres (ml) | grams (g)   | milligrams (mg) |
|                      |      |            |                  | oz (weight) |                 |
|                      |      |            |                  | slice       | each            |
|                      |      |            |                  |             | whole           |

DAY \_ (continued)

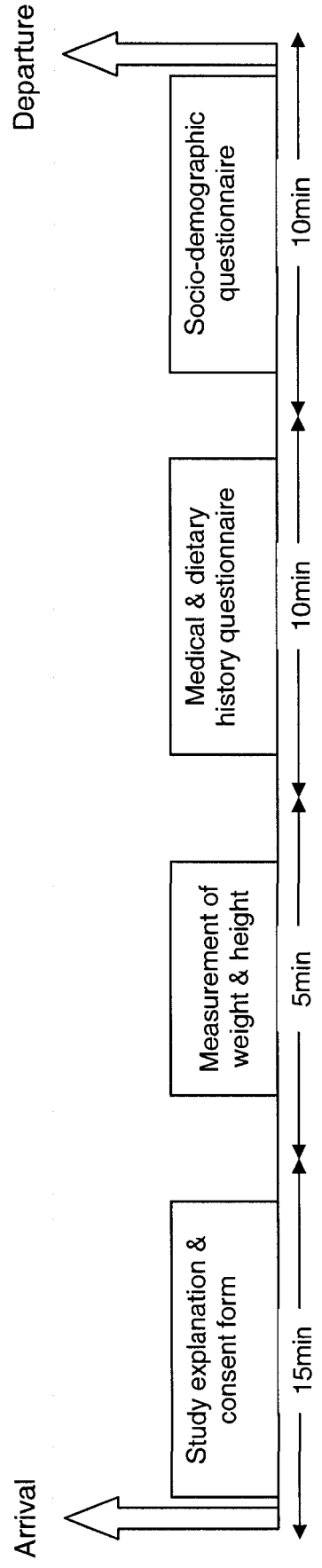
| MEAL          | TIME | PLACE | NAME AND DESCRIPTION OF FOOD | QUANTITY |  DID YOU REMEMBER THE FOLLOWING?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Supper        |      |       |                              |          | <ul style="list-style-type: none"> <li>• <u>Soup</u>? homemade, condensed, packaged</li> <li>• <u>Salad</u>? 1) <b>Contents</b>: quantity of vegetables, cheese, croutons, grains and nuts,...</li> <li>2) <b>Vinaigrette</b>: a) <b>type</b>: cream, Italian,...</li> <li>b) <b>quantity</b>: ml, tsp, tbsp, gram</li> <li>• <u>Sandwich</u>? 1) <b>Pain</b>: white, whole-wheat, cereals</li> <li>2) <b>Condiments</b>: quantity of mayonnaise, butter, mustard,...</li> <li>• <u>Meat</u>? 1) <b>Cooked</b>: oven, microwave, grill,...</li> <li>• <u>Skin</u>? Did you eat the skin?</li> <li>• <u>Added fat by cooking</u>? Quantity of butter, margarine or oil</li> <li>• <u>Dessert</u>? 1) <b>Size</b>: in centimeters, in inches</li> <li>2) <b>Filling/ topping</b>:<br/>icing, cream, ice cream, syrup, sauce...</li> <li>• <u>Cereal bars</u>? Nuts, peanuts, marshmallows, fruits, chocolate,...</li> <li>• <u>Snacks</u>? 1) <b>Type</b>: chips, Pretzels, Salted crackers,...</li> <li>2) <b>Quantity</b>: in grams or in units</li> </ul> |
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| Evening Snack |      |       |                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| Units of measurement |      |            |                  |             |                 |
|----------------------|------|------------|------------------|-------------|-----------------|
| tsp                  | tbsp | oz (fluid) | millilitres (ml) | grams (g)   | milligrams (mg) |
|                      |      |            |                  | oz (weight) | slice           |
|                      |      |            |                  | each        | whole           |

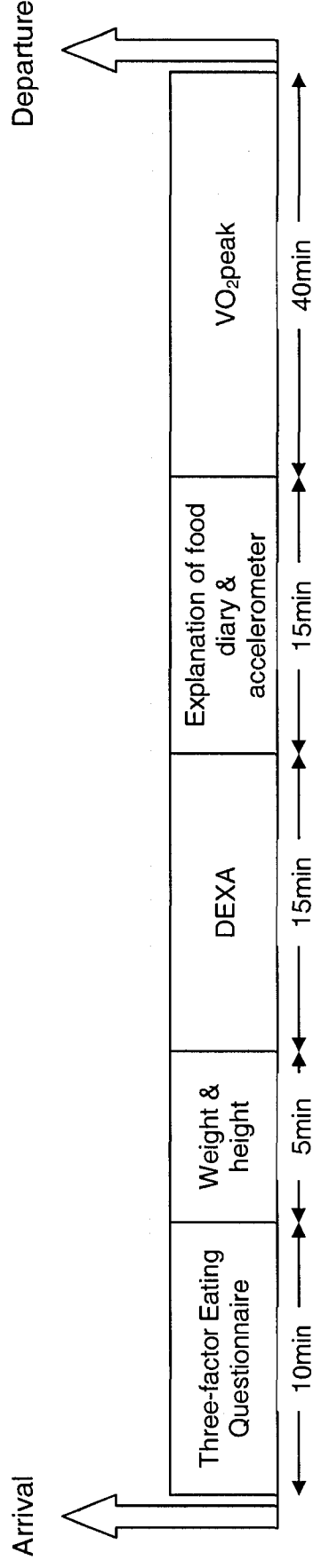
## **APPENDIX B – TIMELINE**

# FRISK STUDY

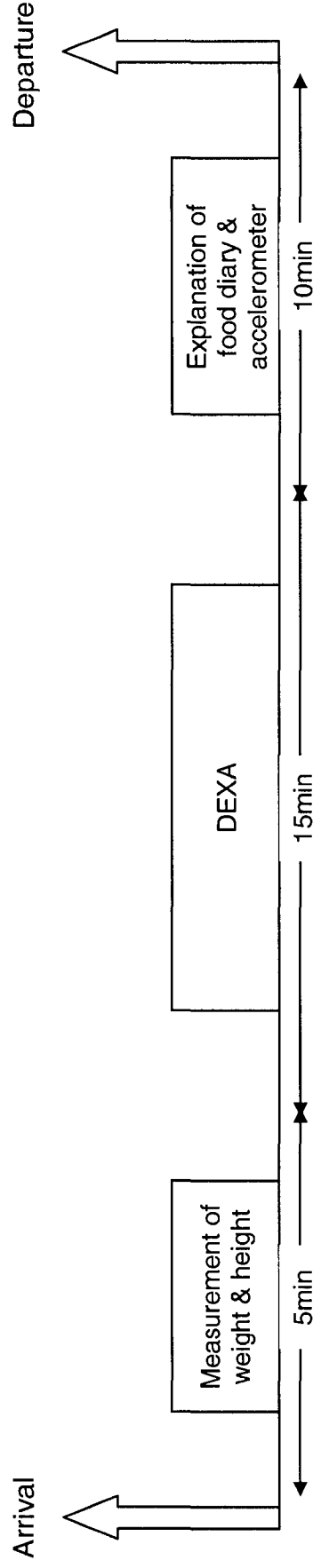
## Timeline for the screening session (40 minutes)



**Timeline for session 1: September (90 minutes)**



**Timeline for sessions 2 and 3: December & end of March (30 minutes)**



## **APPENDIX C – CONSENT FORM**



# Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé  
École des sciences de l'activité physique

Faculty of Health Sciences  
School of Human Kinetics

## **CONSENT FORM A STUDY ON FIRST YEAR UNIVERSITY STUDENTS Masters Thesis Research Project**

**Principal Investigator:** Éric Doucet (Ph.D)  
**Research Coordinator and Masters student:** Gabrielle Mifsud (B.Ed. Hons.)  
**Co-investigator and Ph.D. student:** Karine Duval (M.Sc.)  
**Faculty of Health Sciences, University of Ottawa  
School of Human Kinetics**

**1. INVITATION TO PARTICIPATE:** You are invited to participate in the above named research study conducted by Gabrielle Mifsud B.Ed. Hons., Masters' candidate with the help of Karine Duval M.Sc. and supervised by Éric Doucet Ph.D.

**2. PURPOSE OF THE STUDY:** The aim of this study is to 1) measure student's weight during the 1<sup>st</sup> and 2<sup>nd</sup> semester of university; 2) examine how the weight of students differs between males and females and students with different body types; 3) measure fat mass and fat free mass. Therefore, if you wish to take part in this study, the intended duration of your participation will be of 7 months, including 4 short visits to the research unit at the University of Ottawa and 3 visits at the research unit at Montfort Hospital.

**3. DESCRIPTION OF THE STUDY:** You will be asked to visit the research unit at the University of Ottawa for an initial meeting of approximately 40 minutes during which the study as well as the consent form will be explained to you. You can then bring the consent form to your residence so further reading and discussion with significant others is made possible. Your height and weight will be measured for screening purposes. You will be asked to fill out a socio-demographic questionnaire followed by some medical and nutritional questions so that a medical and nutritional history questionnaire is filled out. Results from these measurements will then be analyzed in order to determine if you correspond to the inclusion criteria of this present study. If you do correspond and agree to participate in this study, you will be asked to come to the Behavioral and Metabolic Research Unit (BMRU) at Montfort Hospital for your first testing session which will last approximately 120 minutes. A day and time will be scheduled with the research coordinator or co-investigator from the 14 testing days available, which include weekdays and weekends. You may be asked to visit the research unit at the University a second time to pick-up a food diary and an accelerometer unit to use over the 7-days following the meeting, that is, prior to the testing day. This will take up to 15 minutes. During the visit to Montfort Hospital, your weight, height and waist circumference will be measured, you will be asked to fill out a questionnaire and either to return your food diary and accelerometer unit or to take a food diary and accelerometer unit for data collection during the following 7-days. You will then be asked to return these to the University



research unit on a day agreed upon with the research coordinator or co-investigator. This will only take about 5 minutes so that any questions you might have can be answered. Your body composition and physical fitness level will also be assessed during this 1<sup>st</sup> testing session. You will be asked to go through the same procedure in the same order for a second time between late November and mid-December and in March. Day and time will always be scheduled with the research coordinator or co-investigator. During the 2<sup>nd</sup> and 3<sup>rd</sup> testing sessions you do not need to fill out any questionnaire and to perform the physical fitness test. These will only be done during the 1<sup>st</sup> session. This research project involves a recruitment meeting, 3 meetings to return or collect the food diary and accelerometer unit, and 3 testing sessions. A detailed description of each meeting and testing session is found below.

### **INITIAL MEETING FOR RECRUITMENT (University of Ottawa) - 40 minutes**

**A. Informed Consent (15 min)** – You will meet the research coordinator who will explain the study and read with you the consent form which you will then be asked to sign in the case that you want to give consent. A copy can be taken to the residence to be read and discussed further with any significant others.

**B. Anthropometric Measures (5 min)** – Height and weight measurements will be taken for recruitment purposes.

**C. Medical History Questionnaire (10 min)** – In order to complete a medical history questionnaire necessary for recruitment, you will be asked a number of pre-set questions to check your health status and your involvement in physical activity.

**D. Socio-Demographic Questionnaire (10 min)** – You will be asked to fill out a socio-demographic questionnaire to provide information about your university program and faculty, occupation, income, background and family.

**E. Testing schedule (5 min)** - Participants will be scheduled for their testing session and told when to pick up the food diary and accelerometer unit.

### **END OF INITIAL MEETING**

### **FOOD DIARY AND ACCELEROMETER UNIT PICK-UP (University of Ottawa) - 15 minutes**

**A.** You may be asked to visit the research unit at the University another time before your testing day to take the food diary and accelerometer unit.

**B. 7-Day Food Diary Explanation (8 min)** - The research coordinator or co-investigator will explain how you should record dietary intake on the diary, where you need to write detail such as time, precise quantities, ingredients, brand of products, cooking method eating out, and when possible attach food labels. The research coordinator or co-investigator will answer any questions you may have. You can return the food diary at Montfort Hospital when you go for your testing session.

**C. Accelerometer unit (7 min)** - The research coordinator or co-investigator will explain when and how to wear the accelerometer unit. You will wear the

accelerometer from the moment you get out of bed to the moment you go to bed for 7 consecutive days. The actual accelerometer is a small pager-like device you will wear at the hip to monitor physical activity.

**TESTING SESSIONS 1, 2 and 3 (BMRU Montfort Hospital) – (session 1 - 90 minutes, sessions 2 and 3 – 30 minutes)**

Testing sessions 1 (September), 2 (late November to mid-December) and 3 (March) will involve the same assessments and the same procedures in the same order, except for the TFEQ and the physical fitness test which will be required only during testing session 1.

**A. Anthropometric Measures (5 min)** – Weight, height and waist circumference will be measured.

**B. Three-Factor Eating Questionnaire (10 min)** – You will be asked to fill out an eating questionnaire to examine your eating behaviour.

**C. 7-Day Food Diary Explanation (5-10 min)** - If you already recorded your dietary intake, you will now return it to the research coordinator or co-investigator, who will answer any questions you may have. If you are scheduled to record your dietary intake after the testing session, you will be given a food diary. The research coordinator or co-investigator will give you an explanation on how to keep a 7-day record of dietary intake, where you need to write detail such as time, precise quantities, ingredients, brand of products, cooking method, eating out, and when possible attach food labels. You will agree when to return the food diary at the University research unit.

**D. Accelerometer unit (5 min)** - If you already wore the accelerometer for 7 consecutive days, you will now return it to the research coordinator or co-investigator, who will answer any questions you may have. If you are scheduled to wear it following the testing session, you will be given an accelerometer unit. The research coordinator or co-investigator will explain how and where to wear it. You will need to wear the accelerometer from the moment you get out of bed to the moment you go to bed for the next 7 days. The Actual accelerometer unit is a small pager-like device that is worn at the hip to monitor physical activity.

**E. Body composition (20 min)** - A method called dual-energy x-ray absorptiometry (DEXA) will be used to measure fat mass and fat free mass. You will have to lie on an examination table, fully clothed, while a low intensity x-ray will scan the entire body. The measurement takes 20 minutes. The only risk is a minimal x-ray exposure of less than 0.5 millirem. This exposure is less than the natural background from 1 day of exposure to sunlight.

**F. Physical fitness assessment (40 min)** - A maximal fitness test will be used to estimate physical fitness ( $\text{VO}_{2\text{max}}$ ). You will have to walk/run on a treadmill starting at 1.6 km/h with 0% gradient. Speed will increase gradually to a maximum of 9.6 km/h. Gradient will also increase gradually from 0% to a maximum of 22%. You need to keep on walking/running for as long as possible.

## **END OF TESTING SESSION**

### **RETURNING THE FOOD DIARY AND ACCELEROMETER UNIT (University of Ottawa) - 5 minutes**

**A.** If you record your dietary intake and wear the accelerometer unit after your testing session, you will have to return the food diary and accelerometer on the day agreed upon with the research coordinator or co-investigator. The research coordinator or co-investigator will answer any questions you may have.

## **END OF MEETING**

### **TELEPHONE CONTROLS (WEEKS WHEN PARTICIPANTS ARE RECORDING THEIR DIETARY INTAKE AND WEARING THE ACCELEROMETER)**

**A.** The research coordinator or co-investigator will call you to assess your adherence to the study requirements for the food diary and the accelerometer unit and to answer questions you may have.

## **TELEPHONE REMINDER**

**A.** The research coordinator or co-investigator will call to remind you to pick-up your food diary and accelerometer unit on the scheduled date and to remind you the date and time of your testing session, previously scheduled with the research coordinator or co-investigator.

**4. POSSIBLE RISKS/DISCOMFORTS:** The risks associated with this project are low and minimal. The measure of body composition (DEXA) presents a low risk to you. However, it is important to underline that this apparatus will expose you to a minimal radiation (the equivalent of a day in the sun - 0.02-0.05 millirem). As for the maximal treadmill test, you may feel tired and out of breath. Following the test you may feel muscle soreness for a day or two. Measurements of weight and height do not represent a risk to health.

**5. BENEFITS:** Your participation in this study will allow you to gather information on your weight, body composition, eating patterns, physical activity and physical fitness. In addition the results of this study will help us understand further the weight, fat mass and fat free mass changes experienced by freshmen students. It will also give us the opportunity to explore freshmen students' dietary habits and physical activity. Such investigation may lead to targeted health programs for university students. University health policy can also benefit from this study as it will help universities become more aware of their students' health.

**6. MONETARY COMPENSATION:** Parking at the research center at Montfort Hospital is free if you would like to use your own vehicle. If you make use of public transport, you will be provided with bus tickets to travel to Montfort Hospital and back to the University

of Ottawa. All scientific tests are free. You will receive a total compensation of \$75.00, \$25.00 for the completion of each of the 3 testing sessions. The compensation will be paid at the completion of the study depending on the number of sessions you attend.

## **7. CONFIDENTIALITY AND ANONYMITY:**

In order to guarantee you confidentiality and anonymity, all precautions and necessary measures will be taken to ensure that results and personal information are kept under the strictest of confidentiality.

- Only the following persons will have access to the material: Principal Investigator, Research Coordinator Gabrielle Mifsud and co-investigator Karine Duval. Any other individuals involved in the study will not have access to your personal information and results.
- Your name will not appear on any reports. A number code will be used to identify you on all research documents.
- All material and information which can be linked to you will not be made public and will be kept under the strictest confidentiality.
- You will not be identified in any way in publications or reports.
- The data collected will be kept in a locked cabinet in the Behavioral and Metabolic Research Unit (Montfort Hospital) with restricted access where your folder will be kept. In addition, the computer files will be protected by a password.
- Data will be destroyed five years after publication of study results.

## **8. VOLUNTARY PARTICIPATION**

- You are free to refuse to participate and if you choose to participate, you are free to withdraw from the study at any time for any reason. At any moment during this study, the best interests of participants will always prevail upon the objectives of the study.
- If you choose to withdraw from the study at any point, the data which has been collected since the start of the study will be kept to be used in the analysis for control purposes. This data will be destroyed 5 years after publication as all other data.
- You will be made aware of any new findings that might influence your decision to take part in the present study.

Any information about your rights as a research participant may be addressed to: Protocol officer for ethics in research, University of Ottawa, 550 Cumberland, Tabaret Hall, room 159, Ottawa, Ontario, K1N 6N5; Phone: (613) 562-5841, email: [ethics@uottawa.ca](mailto:ethics@uottawa.ca).

If I have any questions about the conduct of the research project, I may contact the research coordinator, Gabrielle Mifsud, (613) 746-4621 ext. 6029, [gmifs017@uottawa.ca](mailto:gmifs017@uottawa.ca).

There are two copies of the consent form, one of which I may keep.

**Researcher' signature**

Eric Doucet, Ph.D.: \_\_\_\_\_ Date: \_\_\_\_\_

**Research coordinator's signature**

Gabrielle Mifsud, M.Sc.(candidate): \_\_\_\_\_

Date: \_\_\_\_\_

OR

**Research co-investigator's signature**

Karine Duval, M.Sc.: \_\_\_\_\_

Date: \_\_\_\_\_

***PARTICIPANT'S SIGNATURE:***

I agree to participate in this study,

\_\_\_\_\_  
Printed name

\_\_\_\_\_  
Signature

Date: \_\_\_\_\_

## **APPENDIX D – ETHICS APPROVAL**



# Université d'Ottawa University of Ottawa

Université d'Ottawa / University of Ottawa

## HEALTH SCIENCES AND SCIENCE RESEARCH ETHICS BOARD

### CERTIFICATE OF ETHICAL APPROVAL

This is to certify that the University of Ottawa Health Sciences and Science Research Ethics Board has examined the application for ethical approval of the research project entitled **The 'Freshmen 15' Phenomenon – Weight Gain Trends in 1<sup>st</sup> Year University Students Living in Residence (file H 05-06-04)** submitted by Gabrielle Mifsud and supervised by Éric Doucet of the School of Human Kinetics. Karine Duval is a co-investigator. The Board found that this research project met appropriate ethical standards as outlined in the Tri-Council Policy Statement and in the Procedures of the University of Ottawa Research Ethics Boards, and accordingly gave it a Category 1a (approval). This certification is valid one year from the date indicated below.

\_\_\_\_\_  
Rita D'Alessandro  
Protocol Officer for Ethics in Research  
For Dr. Daniel Lagarec, Chair of the  
Health Sciences and Science REB

June 29, 2006  
Date

550, rue Cumberland 550 Cumberland Street  
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada

(613) 562-5841 • Téléc./Fax (613) 562-5338  
<http://www.uottawa.ca/services/research/reb/index.html>