

College Freshmen Weight Gain: Residency Effects

by

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Abstract

Objective: Academic year changes in weight, body mass index (BMI), percent (%) body fat, and fat free mass were examined in freshmen based on residency. Subjects: 277 freshmen living on campus and 183 living off campus participated. Methods: Height, weight, and body composition (using bioelectrical impedance) were assessed first semester (beginning and end) and second semester (end). Results: Females living on (n=203) campus gained significantly more weight, BMI, and fat free mass (3.6 ± 4.7 lbs, 0.6 ± 0.8 kg/m², 1.3 ± 3.7 lbs, respectively) the first semester than females living off (n=97) campus (1.5 ± 6.0 lbs, 0.3 ± 1.0 kg/m², 0.0 ± 4.1 lbs, respectively). By second semester, freshmen living on campus gained significantly more percent body fat ($0.4 \pm 2.0\%$) than freshmen living off campus ($0.0 \pm 1.8\%$) and tended to lose significantly more fat free mass (-0.1 ± 3.6 lbs) than freshmen living off campus (0.6 ± 3.6 lbs). Conclusions: Freshman year on campus college residency by women is associated with greater initial weight, BMI, and fat free mass gains than off campus residency.

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Chapter 1

Introduction

Obesity is considered epidemic in the United States with increases in obesity rates seen in all age, gender, racial, and ethnic groups over the last several decades (CDC 2009d, Ogden and others 2006, Ogden and others 2008). The prevalence of obesity in the United States has more than doubled from 15% of Americans in 1976-1980 to 32.9% in 2003-2004 according to two NHANES reports (CDC 2009d). This is particularly a problem in the state of Alabama, which has the nation's second highest percentage of obese residents with 35.7% of Alabamians being classified as overweight and 32.2% being obese (CDC 2009e). This trend is also true in younger adults as well with 53.3% of adults, aged 18-24 years, living in Alabama being classified as either overweight or obese (CDC 2009f).

In the college-aged population, weight gain during the freshman year has been fairly extensively examined, with over a dozen studies published in the last eight years (Anderson and others 2003, Butler and others 2004, Crombie and others 2008, Economos and others 2008, Graham and Jones 2002, Gropper and others 2008, Gropper and others 2009, Hajhosseini and others 2006, Hodge and others 1993, Hoffman and others 2006, Holm-Denoma and others 2008, Hovell and others 1985, Jung and others 2008, Kasparek and others 2008, Levitsky and others 2004, Lloyd-Richardson and others 2008, Lowe and others 2006, Megal and others 1994, Mihalopoulos and others 2008, Morrow and others 2006, Pliner and Saunders 2008, Racette and

others 2005, Racette and others 2008). The popularized “freshman 15” appears to be more accurately the “freshman three, four or five”, or if only those freshmen who gained weight are included, it is the “freshman seven” (Anderson and others 2003, Butler and others 2004, Crombie and others 2008, Economos and others 2008, Graham and Jones 2002, Gropper and others 2008, Gropper and others 2009, Hajhosseini and others 2006, Hodge and others 1993, Hoffman and others 2006, Holm-Denoma and others 2008, Hovell and others 1985, Jung and others 2008, Kasperek and others 2008, Levitsky and others 2004, Lloyd-Richardson and others 2008, Lowe and others 2006, Megal and others 1994, Mihalopoulos and others 2008, Morrow and others 2006, Pliner and Saunders 2008, Racette and others 2005).

Factors contributing to the observed weight and/or body mass index (BMI) gain also have been studied. Factors found most often to be positively associated with weight (and/or BMI) gain among first year or first semester college students include: snacking behaviors (Levitsky and others 2004), all-you-can-eat dining (Levitsky and others 2004), alcohol consumption (Economos and others 2008, Lloyd-Richardson and others 2008), physical inactivity (Butler and others 2004, Jung and others 2008, Holm-Denoma and others 2008), workload (women) (Economos and others 2008), BMI (Kasperek and others 2008), dietary restraint (Pliner and Saunders 2008), and specific dieting strategies (Lowe and others 2006). Another possible contributor to freshman year weight gain is residency, that is where (on versus off campus) the freshmen live while attending college (Crombie and others 2008, Pliner and Saunders 2008). Yet, in the one study which examined residency as a factor contributing to freshman year BMI gain, significantly greater gains in BMI were shown among college freshmen who were restrained eaters and living on campus versus restrained eaters living at home with their parents

(Pliner and Saunders 2008). Further, in the only other published study which accounted for residency, weight change was examined in two groups of female freshmen, one living on campus and one living off campus but attending different universities (Hovell and others 1985). Missing from the literature is an examination of weight changes in male and female students related to residency: living on campus versus off campus but not at home with parents and attending the same university. Such a study is important given the increasing prevalence of obesity in the United States, which has been shown to be greatest in young, college-aged adults (Mokdad and others 1999). Further, the identification of factors, such as residency, associated with weight gain in college students may facilitate intervention strategies to promote healthier lifestyles. The purpose of this study was to examine changes in weight, BMI, percent body fat, and fat free mass between college freshmen living on campus versus living off campus (e.g. in apartments, duplexes, houses or trailers).

Chapter 2

Literature Review

This literature review discusses the definition and prevalence of obesity in the United States (U.S.), weight gain among college freshmen, as well as factors contributing to the development of obesity / weight gain, with an emphasis on factors common in the lives of college students. Specific dietary intake factors that will be examined include food choices, junk food intake, fast food intake, eating out, and alcohol consumption. In addition, the effects of social dining and stress on dietary intake along with other lifestyle issues that may influence energy balance such as sleep duration, physical activity, and college residency will be discussed.

Definition of Obesity

Obesity is defined by the World Health Organization (WHO) as a condition or disease in which excess body fat has accumulated to such an extent that health may be adversely affected (WHO 2006). Similarly, the Centers for Disease Control and Prevention (CDC) define obesity as a label for a range of weight that is greater than what is generally considered healthy for a given height (CDC 2009a). The range used to define obesity, as well as other classifications of body weight (underweight, healthy weight, overweight), is determined by using a person's height and weight to derive a value known as the body mass index (BMI). BMI is calculated by dividing overall body weight in kilograms by height in meters squared.

For adults, there are four BMI classifications. A BMI less than 18.5 kg/m² is considered underweight, 18.5 to 24.9 kg/m² is healthy weight, 25.0 to 29.9 kg/m² is overweight, and 30.0

kg/m² or higher is considered obese (CDC 2009a). Although the BMI for children and teens is calculated in the same manner, its interpretation is somewhat different. The amount of body fat differs between the sexes and the levels of body fat also change with age due to growth. Thus, BMI is plotted on gender specific BMI-for-age growth charts in order to obtain a percentile ranking. The percentile approximates the relative position of the child's BMI-for-age against other children of the same sex and age. Children and teens from the ages of 2 to 20 years old are considered underweight if they are less than the 5th percentile, healthy weight from 5th percentile to less than the 85th percentile, at risk of overweight from the 85th to less than 95th percentile, and overweight if at the 95th percentile or higher (CDC 2009b).

Although BMI correlates well with the amount of body fat for most people, it does not directly measure body fat (CDC 2009a). However, since other methods of measuring body fat, such as underwater weighing, skinfold measurements, bioelectrical impedance, computed tomography, magnetic resonance imaging, or dual energy x-ray absorptiometry are more invasive, expensive, and usually more time consuming, BMI is often used for larger populations and is widely accepted as an indicator of health. Due to the fact that BMI does not distinguish between the weight associated with fat and weight associated with muscle, the correlation between BMI and body fat somewhat varies according to body build, sex, ethnicity, and age (CDC 2009c). For example, an athlete or person with a high body weight for their height due to increased muscle mass may have a deceptively high BMI and technically be classified as overweight or obese even if they have a low percentage of body fat. In addition, at an equivalent BMI, body fat tends to increase with age and also tends to be higher in females than males (CDC 2009c).

Prevalence of Obesity

Over the past thirty years, the prevalence of overweight and obesity has increased for both adults and children (CDC 2009d, Ogden and others 2006, Ogden and others 2008). Comparing data from two National Health and Nutrition Examination Surveys (NHANES) show that among adults 20 to 74 years old the prevalence of obesity more than doubled from 15.0% in the 1976-1980 survey to 32.9% in the 2003-2004 survey (CDC 2009d). Data from NHANES surveys (1976-1980 and 2003-2006) show that the prevalence of obesity has increased for children aged 2-5 years from 5.0% to 12.4%, for those aged 6-11 years it increased from 6.5% to 17.0%, and for those aged 12-19 years obesity prevalence increased the most from 5.0% to 17.6% (CDC 2009d).

Fairly recent data from the Behavioral Risk Factor Surveillance System (BRFSS) showed that 36.6% of adults in the U.S. were overweight, and an additional 26.6% were obese (CDC 2009e). Thus, adding these percentages together means nearly two thirds of adults in the U.S. are either overweight or obese. According to the American Heart Association based on the NHANES data from the 2003-2006 survey 145 million Americans are overweight or obese and of those, 74.1 million are obese (AHA 2009). Alabama has the second highest percentage of obese residents in the country, behind only Mississippi, with 35.7% of adults living in Alabama being classified as overweight and 32.2% being obese (CDC 2009e). These findings are considerably higher than the less than 10% of adult Alabamians found to be obese in 1986.

While the trend of increasing obesity prevalence has been shown in all age groups, the greatest increase in prevalence of overweight and obesity has been found to be in young adults, 18 to 29 years of age, which is a common age bracket for college students (Mokdad and others

1999). In Alabama, 53.3% of young adults, aged 18-24 years, are classified as either overweight or obese (CDC 2009f). A 2007 National College Health Assessment based on over 90,000 students found that 22.2% of college students were overweight and 10.7% were obese (ACHA-NCHA 2008). Varying percentages also have been reported in smaller studies. For example, Huang and coworkers (2003) assessed 736 college students and found that 21.6% were overweight and 4.9% were obese.

While childhood obesity often persists into adolescence and adulthood (Charney and others 1976; Lloyd and others 1961; Abraham and Nordsieck 1960), few studies, with varying results, have examined differences in weight gain based on BMI in adults. Kasperek and others (2008) found that weight change the freshman year in 150 students with an initial BMI < 25.0 kg/m² was 6.21 lbs and significantly less than that by 43 students with an initial BMI ≥ 25.0 kg/m² who gained an average of 10.96 lbs. In contrast, Mihalopoulos and others (2008) reported that 96 students with a BMI < 25.0 kg/m² gained an average of 3.3 lbs which was significantly greater than a group of 30 students with a BMI ≥ 25.0 kg/m² who gained an average of 0.8 lbs over the course of the study. Further evidence of this discrepancy was shown in a study by Lowe and others (2006) who reported that BMI at baseline was not a predictor of weight change over the course of the school year. Thus, weight gain appears to occur in young adults irrespective of BMI classification.

Weight Gain Among College Freshmen

The popular phrase “the freshman 15” can strike fear in students on college campuses and gain headlines in the press. However, studies to date suggest that the phenomena is not true, at least for most college students (Anderson and others 2003; Butler and others 2004; Economos

and others 2008; Graham and Jones 2002; Gropper and others 2008; Gropper and others 2009; Hajhosseini and others 2006; Hodge and others 1993; Hoffman and others 2006; Hovell and others 1985; Jung and others 2008; Kasparek and others 2008; Levitsky and others 2004; Megal and others 1994; Mihalopoulos and others 2008; Racette and others 2005). Sixteen studies examining weight gain in college students, primarily during the freshman year, will be reviewed.

Hovell and colleagues (1985) examined a group of 158 freshmen females at a large private university in California to track their weight over a three year period. The females' heights and weights were first collected in October and then reassessed in March. Over this 5 month period there was shown to be a 0.73 lbs per month average weight gain. This average was then projected over 12 months with the authors concluding that there would be an 8.8 lbs weight gain over an entire year. These freshmen's weight gain rates were compared to other freshmen women who were attending local community or state colleges who were not living on campus. It was found that the rate of weight gain of the freshmen women living on campus was 36 times faster than the community compared group of freshmen not living on campus (Hovell and others 1985).

Hodge and colleagues (1993) assessed a sample of 110 female college freshmen attending Michigan State University. They were weighed during the first month of the semester and then reweighed 6 months later. There was a follow up return rate of 64%, and out of these 61 students to return, 18 freshmen (29%) gained weight while 11 freshmen (18%) lost weight. A 0.88 lb weight gain was reported for all subjects, and a 7.0 lb average gain for just those who gained weight. Participants were classified as weight gainers if they gained 4 lbs or more (Hodge and others 1993).

Megal and researchers (1994) investigated weight change in 57 female college freshmen at a small private women's college in the Midwest. Out of the sample, 62% gained weight, while 38% either maintained or lost weight. Weight gain averaged 2.45 lbs, range -9.7 to 16.7 lbs over the course of the academic year (Megal and others 1994).

Graham and Jones (2002) followed 49 freshmen (10 males; 39 females) at a small Midwestern college in order to determine if the perception of the freshmen 15 was related to either actual or a perceived weight gain. Weight did not significantly change, yet there was a significant change in perceived weight. The participants reported they believed they gained an average of 4.1 lbs, when they had actually lost an average of 1.5 lbs throughout the school year (Graham and Jones 2002).

Anderson and researchers (2003) recorded weights on a group of 135 freshmen (58 males; 77 females) at the beginning (September) of the semester in New York. At the end (December) of the semester, they were reweighed. A significant weight gain of 2.86 lbs, range of 7.9 lbs loss to a 11.4 lbs gain, was found over the fall semester with no gender effect. A majority, 74%, of the students gained weight while 20% of the students lost weight. Forty six of these students returned at the end of the spring semester in May to be weighed for a third time. The weight change over the spring semester was not significant in this group. The overall mean weight gain over the entire school year was 3.74 lbs.

Butler and others (2004), in a group of 52 female college freshmen in a large Midwestern University, examined the dietary, physical activity, and weight change over a 5 month period. A significant average 1.59 lbs weight gain was found. Percentage of body fat also increased

significantly by 1.79%. Additionally, fat mass significantly increased by 2.89 lbs while lean body mass significantly decreased by 1.35 lbs. Dietary intake records showed a significant decrease in energy intake per day from 2,205 kcal at the beginning of the study to 1,857 kcal at the conclusion (Butler and others 2004).

Levitsky and others (2004) measured the weights of 60 Cornell University freshmen (9 males; 51 females) at the beginning of the school year. The subjects were also given a questionnaire regarding their lifestyle habits from when they were in high school. During the follow up 12 weeks later, a second questionnaire was given regarding habits on eating, sleeping, and exercising during their first semester at college. A mean weight gain of 4.18 lbs at the end of the semester was reported for the group as a whole. It was also found that some of the variance could be attributed to the consumption of junk food, evening snack, and high fat food. Furthermore, eating breakfast and lunch in on campus “all-you-can-eat” cafeterias also was found to account for some variance in weight (Levitsky and others 2004).

Hajhosseini and coworkers (2006) investigated a sample of 27 freshmen (5 males; 22 females) who were attending San Jose State University to examine changes in body weight and composition. Body weight increased significantly by 3.0 lbs and percent body fat increased significantly by 2.1% over the 16 week study. Specifically, 16 subjects (59%) gained ≥ 3.0 lbs, and 6 subjects (22%) gained ≥ 6 lbs. There was an increase in mean BMI from 23.5 to 24.1 kg/m². Lean body mass decreased significantly from 69.9% to 67.8%. Two (7.4%) subjects lost weight (Hajhosseini and others 2006).

Hoffman and colleagues (2006) examined changes in body weight and fat mass in a sample of 67 college freshmen (32 males; 35 females) at Rutgers University in New Jersey. The starting sample was taken from 217 volunteers who previously participated in a health assessment during the last 3 weeks of September; 67 students were reassessed during the last 2 weeks in April. Mean weight gain was 2.86 lbs for the entire group and 8.82 lbs for only the students who gained weight. No differences in weight changes were found between males and females, or between any ethnic or racial groups (Hoffman and others 2006).

Economos and colleagues (2008) carried out a survey based study to examine weight change and possible factors associated with weight change. A sample of 396 college freshmen (140 males; 256 females) who were attending a private university in New England participated in the study. The heights and weights were self reported for the initial measurements in August at the beginning of fall semester. The follow up measurements were conducted towards the end of the spring semester in April. These measurements were taken as self reports but were also measured by researchers. There was found to be a good agreement ($r=0.997$; $p<0.001$) between reported heights and weights and measured heights and weights ($p<0.001$). There was also found to be a significant average weight gain of 5.3 lbs for the entire sample over the freshman year. Also, 80% of the students were found to gain weight and there was no significant difference in weight change between males and females. Weight gain was associated with an increased workload (studying, class assignments, etc.) in females ($p<0.001$) and alcohol consumption in males ($p=0.014$). Furthermore, 7.9% of males and 4.9% of females who were either underweight or normal weight at the beginning of the year moved into an at-risk or overweight status by the end of the year (Economos and others 2008).

Gropper and others (2008) conducted a small study on 35 first year college freshmen (10 males; 25 females) at Auburn University in Auburn, Alabama. Body weight and body composition were measured along with select dietary and lifestyle habits. During the fall semester, weight gain averaged 1.9 lbs with no differences between genders. BMI and percent body fat also increased significantly during the fall semester. In those subjects who gained weight, the mean weight gain was 3.7 lbs with no difference between genders. The average weight gain over the course of the scholastic year was 3.8 lbs for the 29 subjects who returned at the end of the spring semester. BMI and percent body fat were also shown to significantly increase over the entire scholastic year (Gropper and others 2008).

Gropper and colleagues (2009) examined changes in body weight, composition, and size in college freshmen (initial, n= 240; 84 males; 156 females) at the beginning and end of fall semester 2007 (n=214) and the end of spring semester 2008 (n=205) at Auburn University in Auburn, Alabama. Mean weight, BMI, absolute body fat, and percent body fat all increased significantly over fall semester and the academic year; however, 31% of freshmen lost weight. Mean academic year weight gain was 2.6 lbs (entire group) and 6.0 lbs (weight gain group). For the entire group, body fat and percent body fat increased significantly (1.6% and 2.7 lbs, respectively) over the academic year. Mean waist and hip circumferences also increased significantly with gains of 0.84 inches in both waist and hip circumference occurring in the weight gain group. A significant correlation ($r=0.509$) was found between weight change and waist circumference change (Gropper and others 2009).

Jung and others (2008) examined weight changes in a sample of 133 female college freshmen in Ontario, Canada. Over the course of the whole year, weight gain averaged 3.08 lbs for the entire sample, and 7.54 lbs for just those who gained weight. Also, those who gained weight significantly increased their body fat percentage. Additionally, 34% of the sample actually lost weight during their freshman year (Jung and others 2008).

Kasperek and colleagues (2008) carried out a survey-based study in Winthrop, South Carolina using self-reported height, weight, diet, and physical activity data from a sample of 193 freshmen (24 males; 169 females) to determine weight changes. Overall, 57% of participants reported gaining an average of 2.5 lbs, range of 1 to 35 lbs, over the 6 month study. Weight gain averaged 7.1 lb in the subjects who gained weight. Weight loss was reported by 23.8% of the subjects (Kasperek and others 2008).

Mihalopoulos and researchers (2008) conducted surveys to determine self-reported weight gain in a group of 126 college freshmen (64 males; 62 females) attending a private university in the northeastern U.S. during fall semester. Over half, 52%, of the students reported weight gain, which significantly increased by 2.7 lbs (Mihalopoulos and others 2008).

Racette and others (2005) examined dietary patterns, exercise, and weight changes during the freshman and sophomore years of college in a sample of 764 freshmen attending Washington University in St. Louis, Missouri. Weight and BMI changes were examined in a subset (n=118; 52 males; 66 females) of the sample during the freshman year. A significant average increase in body weight of 5.5 lbs was found. Additionally, 88 (75%) freshmen had an increase in BMI which tended (p=0.12) to increase more in females than males (Racette and others 2005).

The findings of these studies, shown in table 2.1, clearly suggest that the popularized “freshman 15” appears to be more accurately the “freshman three, four or five”, or if only those freshmen who gained weight are included, it is the “freshman seven”. Further, only about 5% of freshmen gain the dreaded “freshman 15” (Gropper and others 2009). Multiple factors are thought to contribute to the observed weight and/or BMI gains in college freshmen. Some of these factors will be reviewed next.

Table 2.1. Summary of studies examining weight change in first year college students.

Author	Subjects	Significant Weight Change Findings	Other Findings
Hovell and others 1985	158 females	0.73 lb gain/mon	Projected 8.8 lb gain/yr
Hodge and others 1993	110 females	0.88 lb gain over 6 mon 7 lb gain over 6 mon wt gain group	
Megal and others 1994	57 females	2.45 lb gain over acad yr	
Graham and Jones 2002	39 females 10 males	No significant wt change	
Anderson and others 2003	77 females 58 males	2.86 lb gain fall semester 3.74 lb gain over academic yr	
Butler and others 2004	52 females	1.59 lb in 5 mon	1.79% body fat increase 2.89 lb fat mass increase 1.32 lb lean mass decrease
Levitsky and others 2004	51 females 9 males	4.18 lb gain fall semester	
Racette and others 2005	66 females 52 males	5.5 lb gain over academic yr	
Hajhosseini and others 2006	22 females 5 males	3.0 lb gain fall semester	2.1% body fat increase 2.1% lean mass decrease
Hoffman and others 2006	35 females 32 males	2.86 lb gain over academic yr 8.82 lb gain over academic yr wt gain group	
Economos and others 2008	256 females 140 males	5.3 lb gain over academic yr	
Gropper and others 2008	25 females 10 males	1.9 lb gain fall semester 3.7 lb gain fall semester wt gain group 3.8 lb gain over academic yr	
Jung and others 2008	133 females	3.08 lb gain over yr 7.54 lb gain over yr wt gain group	
Kasperek and others 2008	169 females 24 males	2.5 lb gain over 6 mon 7.1 lb gain over 6 mon wt gain group	
Mihalopoulos and others 2008	62 females 64 males	2.7 lb gain fall semester	
Gropper and others 2009	156 females 84 males	2.6 lb gain over academic yr 6.0 lb gain over academic yr wt gain group	1.6% body fat increase 2.7 lb fat mass increase

Abbreviations wt = weight, lb = pounds, acad = academic, yr = year, mon = months

Factors Contributing to the Development of Obesity / Weight Gain

From an energy balance approach, the cause of obesity or weight gain is relatively simple when expressed from a mathematical perspective. Weight gain occurs when energy intake is greater than energy expenditure or, stated alternately, when energy expenditure is less than energy intake. Energy is derived from food intake (diet) and energy is expended primarily associated with basal (vital life) functions and physical activity. However, genetics along with the behavioral and psychosocial environment also contribute to obesity (Astrup and others 2004, Cole 2007). This section of the literature review will focus on energy intake, and will examine some of the dietary habits of college students including food choices, junk food intake, fast food intake, eating out and alcohol consumption along with a few other lifestyle factors such as social dining and stress that may contribute to excess energy intake.

Dietary Habits of College Students

Food Choices - The dietary habits of college students typically fail to meet many of the recommendations promoted in the U.S. The 1996 National College Health Risk Behavior Survey (NCHRBS) found that out of 4,609 college students polled, only 26.3 % of the students ate at least 5 servings of fruits and vegetables (as recommended by the National Cancer Institute) on the day before the survey was given (Douglas and others 1997). Huang and others (2003) reported that 69.4% of the 736 college students (382 males; 354 females) surveyed ate less than 5 servings of fruits and vegetables. More recent data from the 2007 ACHA-NCHA reported that only 6.7% of college students (n=4,679) ate five or more servings of fruits and vegetables daily (ACHA-NCHA 2008). Fruits and vegetables are not the only foods groups that are often under

consumed by college students. Haberman and Luffey (1998) found that more than 80% of 302 college students reported consuming less than the minimum number of recommended daily servings for grains, dairy, fruits, and vegetables.

Guidelines for intakes of energy from fat and sugar are also often exceeded by college students. A study by Schuette and others (1996) found that only 4% of the 2,489 college students consumed 30% or less energy from fat and consumed 10% or less energy from sugar per day. In a study by Huang and others (2003), 67.1% of the 736 college students (382 males; 354 females) surveyed consumed less than 20 g of fiber daily. The 1996 NCHRBS found that out of 4,609 college students polled, students aged 18-24 years were more likely than those aged 25 years or older to eat more than two servings of high fat foods per day (Douglas and others 1997).

Junk Food Intake - The term “junk food” is an informal label applied to foods with little or no nutritional value, or to foods with nutritional value but that also contains high amounts of unfavorable ingredients so that they are no longer considered healthy if consumed on a regular basis. Foods likely to be labeled as a junk food are foods that are convenient (often obtained from vending machines) and in ready to eat prepackaged forms. Some examples of junk food include candy, chips, cookies, and soda. Junk foods tend to be energy dense and high in sugar and or fat while containing few other nutrients. Consumption of these foods often displaces consumption of healthy foods or food groups in the diet. A diet consisting of a variety of fruits and vegetables, whole grains, low fat dairy products, and high in fiber is associated with lower energy intakes and smaller BMI gains over time compared to lower intakes (Drapeau and others

2004). Consuming greater amounts of high energy/low nutrient foods is associated with a greater risk of weight gain (Newby and others 2004).

Two studies have investigated food intake and weight gain in college students. Levitsky and others (2004) examined factors associated with weight change in 60 college freshmen (9 males; 51 females) over a 12 week fall semester. Weight increased significantly an average of 1.9 kg (~4.19 lbs) and BMI increased significantly 0.7 kg/m². The two variables that best and significantly predicted this weight gain were an increase in the consumption of evening snacks and the consumption of high fat foods, with their totals accounting for about 24% of the weight gain. The term “junk food” was not defined in the questionnaire and was left up to the subject; therefore, some food items could have been listed under any of the three discussed variable types. Despite the open definition, junk food significantly explained an additional 8% of the weight variance. Furthermore, when initial body weight was controlled for, it was found that the consumption of junk foods significantly explained 24% of the weight variance (Levitsky and others 2004).

Hajhosseini and others (2006) conducted another study on 27 first semester college freshmen (5 males; 22 females) that looked at body composition and weight changes along with dietary patterns. Significant changes over the 16 week fall semester included an average weight gain of 3.0 lbs, body fat percentage increase of 2.1%, BMI increase of 0.5 kg/m², and lean body mass decrease of 2.1%. It was also found that the mean energy intake increased from 1905 kcal per day to 1960 kcal per day over the duration of the semester. Although this 55 kcal per day

increase was not significant, it was in the range necessary to support the observed average 3.0 lb weight gain (Hajhosseini and others 2006).

Fast Food Intake - College freshmen may not know how to cook, have the amenities to cook and store food, or have the time to cook meals for themselves. If you are not cooking for yourself, then you must get food for consumption elsewhere. One possible alternative to cooking meals at home is fast food. “Fast food” has been defined as food purchased in self service or carry-out eating places without wait service (Lin and others 1999). College students reported that the main reasons they choose to eat at fast food restaurants are for its convenience, cost, and menu choices (Sneed and Holdt 1991). Fast food has become a growing staple of the American diet with the frequency of fast food consumption increasing dramatically in the past 30 years, amid sales upwards of \$125 billion (Paeratakul and others 2003). In 1991, college students were found to eat at fast food restaurants 2.1 times per week on average (Sneed and Holdt 1991). More recently this frequency was found to be higher, at approximately 2.5 days per week on average in 9,919 individuals aged 18-27 years during the week the survey was administered (Niemeier and others 2006). Perhaps most startling, are the findings of Driskell and coworkers (2005), who documented that 95.1 % of lower classmen and 91.9% of upper classmen college students (n=258; 144 underclassmen; 114 upperclassmen) ate meals at fast food restaurants 6 to 8 times per week.

In both adolescents and young adults there has been a decrease in the percentage of energy obtained from foods consumed at home and an increase in the total percentage of energy obtained from foods purchased from fast food restaurants and other restaurants (Nielsen and

others 2002). Guthrie and others (2002) examined data from nationwide surveys of food consumption conducted by the USDA in 1977-1978 and 1994-1996 and deduced that the average contribution of overall daily energy intake obtained from outside the home increased from 18% to 32% over that time period. Young adults aged 19-39 years consumed over half the total energy needs from foods obtained from restaurants and fast food locations (Nielsen and others 2002). Bowman and Vinyard (2004) noted that young adults aged 20-29 years were about 4 times more likely than adults 55 years of age or older to visit a fast food restaurant on a particular day.

The frequency of eating at fast food restaurants has been linked with higher total daily energy and fat intakes (Bowman and Vinyard 2004, Jeffery and French 1998). French and coworkers (2000) determined that the frequency of fast food consumption was positively correlated with an increased body weight. Duffey and colleagues (2007), using data from 3,394 young adults aged 18-30 years in the Coronary Artery Risk Development in Young Adults Study, determined that fast food consumption was positively associated with BMI. An increase in fast food consumption by 1 meal per week was significantly associated with a 0.13 kg/m² to 0.24 kg/m² increase in BMI (Duffey and others 2007). Somewhat similar findings were reported by Jeffery and coworkers (1998) in a study involving 1,059 adults (198 males; 861 females) where a positive association with fast food consumption and BMI was discovered in both high income ($r=0.50$) and low income ($r=0.97$) women; however, this was not seen in the smaller sample size of men. A three year study which included 891 females found that on average, an increase in one fast food meal per week was associated with a significant increase of 56 kcal per day, a significant increase of 0.6% in fat energy per day, and a significant total weight gain of 5.3

lbs over the three year period (French and others 2000). Large portion sizes, high energy density, favorable palatability, high concentrations of saturated and trans fat, high glycemic load, and a low fiber content have been suggested as contributory factors in fast foods which may contribute to weight gain (Ebbeling and others 2002).

Eating out - Eating away from home is becoming more and more prevalent. In 1970, money spent on food away from home represented just 25% of total food spending, but by 1995, it comprised 40% of total food spending, and by 2009, it rose to 48% of the total food spending dollar (Lin and others 1999, NRA 2009a). It is estimated for 2009 that out of the \$565.9 billion in projected sales nationally, that \$5.6 billion will be spent in Alabama's nearly 7,200 restaurants (NRA 2009b). For young adults (n=1,648) aged 19-29 years, almost half, 47.3%, of total energy intake came from foods eaten out (Nielsen and others 2002).

The increased consumption of food prepared outside the home is occurring at the same time as the national obesity epidemic. Some restaurants may even endorse gluttonous behavior by sponsoring food challenges and unlimited dining specials such as "all you can eat" wing nights or three pound burger challenges in order to win a t-shirt or to get your name on a wall. When meals are consumed from restaurants, energy consumption tends to be greater than if foods are consumed from home. Food at restaurants is typically higher in energy, cholesterol, and fat than it's at home counterpart (Guthrie and others 2002). In a study conducted by Diliberti and coworkers (2004) on 85 adults, increasing the portion size of a restaurant's pasta entrée caused an increase in caloric intake of that entrée by 43% as well as a 25% caloric increase for the entire meal. McCrory and colleagues (1999) found that the frequency of

restaurant dining was significantly associated ($r=0.36$) with energy intake and body fatness in a group of 73 adults.

University dining halls provide an alternative to restaurants for many college students living on campus. Some schools require students to purchase a meal plan. Hovell and coworkers (1985) did a comparison study pairing 158 freshmen females at a university, who all lived on campus with easy access to the school cafeteria, to another group of 158 females at a smaller state or community college where 85% of them lived off campus. The university students gained significantly more weight and approximately 36 times faster ($p<0.001$) than their off campus peers. The on campus students had a one year projected 8.8 lb weight gain versus the community college women who had a projected less than 1 lb gain for their freshman year. Both the subjects and researchers attributed this difference in the weight gain to the on campus cafeteria (Hovell 1985). Levitsky and coworkers (2004) also deduced that 20% of the average 4.18 lb weight gain seen in 60 freshmen (9 males; 51 females) was associated with eating meals in all-you-can-eat styled cafeterias. Moreover, in a small study of 42 college students, Bryant and Dundes (2005) found that 88% of the college students thought that cafeteria style dining halls led to both taking more food as well as eating larger portion sizes.

Alcohol Consumption - Results of the National College Health Risk Behavior Survey showed that more than one third of college students reported having consumed five or more alcoholic drinks during one sitting on at least one occasion in the previous month (Douglas and others 1997). The results of the 2008 Behavioral Risk Factor Surveillance System surveys (45 states reporting) found that 49.9 % of adults aged 18-24 years in the U.S. have had at least one drink in

the past 30 days, 7.2 % of 18-24 year olds would be considered heavy drinkers defined as more than two drinks per day for men and more than one per day for women, and 24.7 % of individuals aged 18-24 years (49 states reporting) would be considered binge drinkers defined as having five or more drinks per occasion for males and four or more drinks per occasion for females (CDC 2009j). The 2008 BRFSS data from Alabama showed that 47.0 % of Alabamians aged 18-24 years have had at least one alcoholic drink in the past 30 days, 9.8 % would be considered heavy drinkers, and 24.7 % would be considered binge drinkers (CDC 2009g, CDC 2009h, CDC 2009i).

The American College Health Association National College Health Assessment (ACHA-NCHA) also investigated the drinking habits of 18,339 college students (5,989 males; 12,350 females). These data showed that about 36.3% (n=6,987) of students reported consuming between 1-4 drinks, 27.7% (n=5,331) reported having 5-8 drinks, and 14.5% (n=2,799) stated that they had 9 or more drinks during their most recent drinking session. Only 17.5% (n=3,388) of the college students reported that they had never used alcohol (ACHA-NCHA 2003).

Alcohol in comparison with carbohydrate and protein is more energy dense providing 7.1 kcal per gram. Thus, in a typical 12 ounce can of beer, 4 ounce glass of wine, or a 1.0 ounce shot of liquor, the alcohol content alone can contribute upwards of 90 kcal without factoring in the non-alcoholic sources of energy in the drink (Rumpler 1995). A study by Yanovitzky and coworkers (2006) conducted primarily on college freshmen found that on average students drank 3 alcoholic drinks in a single sitting when they were drinking in a social setting. If each drink contained 100 kcal just from alcohol, the student consumed 300 kcal from alcohol alone. In

addition to actually providing energy to the diet, alcohol consumption may have appetite enhancing effects which can cause an individual to consume an even greater amount of calories (Suter 2005).

Alcohol also may contribute extra energy that could lead to weight gain since most individuals fail to compensate for the ingested alcohol energy by decreasing their nonalcohol derived energy intake. Essentially alcohol energy is usually added to total food energy intake, except for alcoholics who often decrease their overall daily energy consumption (Jequier 1999). This means that moderate drinkers tend to consume more energy than their nondrinking counterparts (Jequier 1999). In a study of alcohol intake and weight change in 12,669 adults by Rissanen and colleagues (1991), weight gain was significantly positively associated with alcohol intake over a six year period. Part of the Framingham study investigating 1,910 men also reported a positive relationship between weight gain and alcohol intake over a 2 year time period (Suter 2005). Mannisto and coworkers (1996) reported a significant positive relationship between alcohol consumption and BMI in a group of 27,215 middle-aged Finnish male smokers. Economos and coworkers (2008) found that weight gain (5.04 lbs/academic year) was significantly associated with alcohol consumption in a group of 140 freshmen males.

In summary, several dietary habits of college students including junk food intake, fast food intake, restaurant/dining out, and alcohol consumption may be contributing to weight gain. However, dietary habits are not thought to be the only factors affecting weight gain in college students.

Lifestyle Habits of College Students

Lifestyle can promote changes in an individual's energy intake as well as energy expenditure. Several lifestyle habits that may influence energy balance will be reviewed in this section of the literature review. The habits include social dining, stress, sleep duration, physical activity, and college residency.

Social Dining - Many factors associated with social dining affect food intake. Some of these factors include the number of dining companions, the mood of the meal, as well as the overall duration of the meal. In a review of social dining by Herman and colleagues (2003), the social effects of dining on food intake are classified into three areas. The first, social facilitation, states that when people eat in groups they tend to eat more than they would eat when they are alone. The second category, modeling, occurs when individuals eat in the presence of a particular model who either consistently eats a lot or a little and in turn the individual tends to eat like the model eats. Finally there is impression management in which if individuals eat in the presence of others who they believe are observing or evaluating them, they tend to eat less than they would if dining alone (Herman and others 2003).

Several studies have examined eating behaviors of individuals when eating alone and with others and have examined the effects of meal duration on eating behaviors. A few of these studies will be presented in this section. In a study involving 133 undergraduate students (29 males; 104 females) it was found that as the number of dining companions increased there was a statistically significant increase in overall energy, carbohydrate, fat, and protein that was

consumed at the meal. The students also reported feeling that they felt more excited and elated during a meal as the number of people they dined with increased (Stroebele and others 2006).

A study by Pliner and coworkers (2006) investigated in 132 college students (70 males; 62 females) the effect of dining with companions as well as the duration of the meal on the amount of food consumed at a meal. Individuals who ate for a longer amount of time ate more food compared to those individuals who ate meals that were a shorter time duration. However, this study did not find that group size affected the amount of food consumed (Pliner and others 2006). It is possible though, that social dining increases the amount of food consumed because as the size of the dining group increases, so too does the duration of the meal. Therefore, the number of dining partners could indirectly have an influence on the amount of food consumed at a meal by causing the meal to have a longer extent of time.

In a similar study involving 120 undergraduate females, it was found that students who ate in pairs or in groups of four ate significantly more food when compared to those students who ate alone. No difference was found in food consumption between the paired eaters and the foursome eaters. Those who dined in pairs or in a group of four had longer durations of eating than those that dined alone (Clendenen and others 1994).

A study of 515 adults by de Castro (1994) investigated the effects of social facilitation of various types of dining partners on food intake during meals. It was found that the presence of dining companions increased both food intake as well as longer meal durations. This occurred regardless of the type of dining companion that was accompanying them. It was also found that meals tended to be larger but eaten faster if eaten with a family member or spouse, and that

meals eaten with friends were larger and were of longer duration (de Castro 1994). A similar smaller study conducted on 37 university students and staff (21 males; 16 females) found that eating in the presence of familiar people increased energy intake 18% compared to baseline. It was also found that individuals tended to eat more dessert type foods when dining in a social setting with friends compared to eating with strangers (Hetherington and others 2006).

In a study of freshman weight gain by Saunders (2008), 45 (21%) of 214 first semester college freshmen reported eating at all-you-can-eat buffet style dining halls; weight change in this group was significantly associated ($r=0.285$) with the number of dining companions. Moreover, students who dined at all-you-can-eat campus dining halls with three or more companions gained significantly more weight (3.9 ± 3.2 lbs) than the students who dined at these facilities with two or fewer companions (1.8 ± 3.5 lbs) (Saunders 2008).

In summary, both meal duration and increased dining companions (friends) may contribute to increased energy intake. Should the energy intake exceed energy expenditure over a period of time, weight gain could result. Another factor that may contribute to excess energy intake and ultimately weight gain in college students is stress.

Stress - Attending college for the first time can be a stressful experience for many new college students. It is believed that stress affects a person's health not only through direct psychophysiological processes, but also by modifying other behaviors that affect health, such as food choices or patterns (Oliver and Wardle 1999). The term stress has been defined as the internal and external bodily responses of humans trying to adapt to the challenges of everyday life (Selye and others 1976). Stress refers to the actual reaction or adaptation by a person, where

as the stressor is the cause of that reaction. Stress is a part of a student's existence and can impact how they cope with the new and changing demands of college life (Arthur and others 1998). Academic load, illness, degree of comfort in residence halls, conflicts, sexual life events, family life events, and developing a new social network are considered key stressors for college students (Economos and others 2008). Research has shown that there is a relationship between stressful life events and poor health related quality of life among college students (Damush and others 1997).

During the first year of college, students may be more vulnerable to weight changes because of the inherent differences in lifestyle to which they must adapt to (Anderson and others 2003). The beginning of college may also be a period of increased stress, which in turn may cause students to be more susceptible to weight changes (Serlachius and others 2007). Overall, the results of studies examining the effects of stress on eating behaviors and food choices are generally inconsistent. For example, some studies have found higher energy and fat intakes during stressful periods of life; others found no significant differences in the intakes of energy and fat during high and low stressed time frames. Furthermore, some studies report decreases in appetite and, thus, food intake with stress. A possible explanation for these varying results may be that stress has bidirectional effects on food intake and thus weight and so it can cause some individuals to eat more and gain weight, but cause others to eat less and lose weight (Kivimaki and others 2006). A few studies examining stress, food intake, and or weight gain in college students will be presented.

A study by Serlachius and coworkers (2007) investigated weight change and stress in 268 college freshmen (100 males; 168 females) in London. Students were found to have significantly gained weight (1.53 ± 2.70 kg) during the first year of college, but there was considerable fluctuation. Approximately 55% of the sample reported gaining weight, 12% lost weight, and 33% remained stable. A higher proportion of women (61%) versus men (44%) reported gaining weight. Most interesting though, out of all the variables examined, it was the stress frequency and stress severity scores that were the highest among both the weight loss and the weight gain groups compared to those with stable weights. The weight gain group also consumed significantly more snacks between meals than the other groups. Other health factors such as exercise, alcohol use, and sleep were found to change significantly during the transition period into the first year of college, but they were not found to be significantly associated with weight change, nor did any of them explain the association between stress and weight change. Stress levels were found to be associated with both weight gain and weight loss, but since the study was cross sectional and not prospective, it was unable to be determined whether there was a causal relationship between stress and the weight change. Studies have shown that stress is associated with both increased and decreased intakes of food. This may explain the bidirectional relationship between stress and weight change, depending on how a particular person reacts to stress.

A study by Oliver and Wardle (1999) looked at the perceived effects of stress on food choices in 212 undergraduates (63 males; 149 females) at three different universities in London. Stress was found to influence the amount of food consumed, with 42% of students reporting that stress caused them to eat more, and 38% of students reporting it caused them to eat less. Women

were slightly more likely than men to report eating more during times of stress, and also slightly less likely to have no change in eating patterns during times of stress. However, the gender differences in overall eating patterns in response to stress were not quite statistically significant ($p=0.08$). Meal type foods were consistently reported to be eaten less, while snack-type foods were eaten more by both men and women during periods of stress. The researchers suggested that for the majority of college students, stress is perceived as changing the intake patterns towards more snacks, and food choices towards more energy dense snack foods. This could be due to either a changing appetite for snack foods over meal type foods, or from a changing time pressure so that convenience of foods takes a higher priority than nutritional quality when stressed (Oliver and Wardle 1999).

In summary, students beginning college may experience several stressors which appear to have bidirectional effects on weight, with some individuals reported to lose weight and others reported to gain weight or experience no change in weight. Most individuals, especially females, eat more during times of stress and those females who eat more typically chose sweet foods and mixed dishes (Kandiah and others 2006, Kivimaki and others 2006, Serlachius and others 2007).

Sleep Habits - The attainment of an adequate amount of sleep is important for health.

Insufficient sleep is associated with numerous chronic diseases and conditions including diabetes, cardiovascular disease, depression, and obesity (CDC 2009k). Insufficient sleep may lead to weight gain through effects on factors that influence energy balance such as impaired glucose metabolism, increased appetite, more time to eat, and inadequate physical activity (Knutson and others 2007). Average sleep times have been decreasing during the same period as

the increased prevalence of overweight and obesity in the U.S. (Patel and others 2006).

According to Knutson and others (2007), average sleep durations dropped from 8-8.9 hours in 1960 to 7 hours in 1995. It also was noted that a larger percentage of adults reported sleeping 6 hours or less in 2004 compared to 1985. Currently, more than 30% of adults in the U.S. report sleeping less than 6 hours per night (Knutson and others 2007).

Multiple studies have examined the effects of sleep on BMI and body weight. Knutson and colleagues (2007) conducted a clinical review of 21 large epidemiological studies from North America, Europe, and Asia. A significant negative association (no r values given) was found between sleep duration and BMI in both adults and children. The association was seen in studies that enrolled subjects with varying BMIs, from lean or slightly overweight to morbidly obese (Knutson and others 2007).

Data from the Nurses' Health Study which included 68,183 females in 1986 was analyzed by Patel and coworkers (2006). The researchers found that 4.3% of participants slept 5 hours or less, 25.5% slept 6 hours, 42.1% slept 7 hours, 23.5% slept 8 hours, and 4.5% slept 9 hours or more. The women who slept less tended to be slightly older, drank less alcohol, and were more likely to smoke and consume more caffeine. Of note, despite their greater average weights at baseline, the short duration sleepers reported a lower energy intake than did the long duration sleepers. After adjusting for age, a relationship between sleep time and body weight was found. Compared to individuals who slept for 7 hours, those individuals who slept for 5 hours or less on average weighed 5.3 lbs more, and those that slept for 6 hours weighed 2.7 lbs more. Individuals who slept less tended to have higher baseline weights as well as gaining more weight

at a faster rate than the individuals who got more sleep. During the 16 year follow up, it was found that the individuals who slept for 7-8 hours per night had the lowest risk for major weight gain, those sleeping 6 hours were 12% more likely, and finally those sleeping for 5 hours or less were 32% more likely to gain at least 30 lbs (Patel and others 2006).

A study by Taheri and coworkers (2004) also examined sleep and BMI in a group of 1,040 adults. Individuals who received 7.7 hours of sleep had the lowest BMI while those who received 6.2 hours of sleep had the highest BMI. For people sleeping less than 8 hours per night, BMI increased in proportion to the decreased sleep (Taheri and others 2004). A similar study by Knutson (2005) conducted on 4,486 adolescents (2,199 males; 2,287 females) which investigated BMI and sleep duration found that sleep time predicted BMI z-score and a risk of overweight in the males. It was also found in males that every hour increase in sleep duration was associated with a 10% reduction in risk of being overweight (Knutson 2005).

The sleep schedules of college students may be particularly negatively affected by lifestyle habits such as changing schedules, living arrangements, and/or stress. A few studies have examined sleep patterns in college students and are reported hereafter. While these studies do not relate sleep duration with weight or BMI changes, the studies provide information on college student's sleep habits. Alapin and others (2000) examined the sleep habits of 136 college students (63 males; 73 females). Students who were classified as good sleepers slept for 7.28 hours on average and the poor sleepers slept for 6.14 hours (Alapin and others 2000). The classifications of good versus poor sleepers were based off sleep questionnaires which inquired about typical sleep experiences such as hours of sleep per night, duration of nocturnal arousals,

and time spent attempting to fall asleep. Similar average sleep times of 6.68 hours and 7.07 hours have been reported in other studies of college students (Pilcher and others 1997). A study of 237 college students found that males (n=127) received an average of 6.40 hours while females (n=110) received an average of 6.35 hours of sleep per weeknight (Tsai and others 2004). These sleep duration statistics for college students seem to indicate a potential for less than what is likely considered beneficial sleep duration and may be a contributing factor to weight gain during college.

Physical Activity Habits - Physical activity is defined as any bodily movement produced by the contraction of skeletal muscle that increases the energy expenditure of the body above its resting level (CDC 2008a). Examples of physical activity include daily chores or activities such as walking to class, carrying groceries, or climbing a flight of stairs. Exercise is considered a subset of physical activity. Exercise is typically more planned, structured, repetitive, and purposeful in a sense of improving or maintaining physical fitness or health, and is usually conducted during leisure time (CDC 2008a). Some examples of exercise include jogging, bike riding, or lifting weights at the gym. Physical activity permits an energy expenditure that is greater than the body's basal level and thus promotes more energy to be burned when compared to resting alone.

Physical activity has numerous beneficial effects on health. Regular physical activity is positively associated with weight control, muscle and bone strengthening, reduced risk of cardiovascular disease, reduced risk of type 2 diabetes and metabolic syndrome, as well as reducing the risk of some cancers (CDC 2008b). Along with the physiological benefits it has

been documented that physical activity also has favorable links to psychological health factors such as anxiety, depression, mood, stress, and cognitive function (Bray and Born 2004).

The American Heart Association (AHA) and the American College of Sports Medicine recommend a minimum of 30 minutes of moderately intense activity or 20 minutes of vigorously intense activity on most days of the week in order to achieve health related benefits (Haskell and others 2007). Specifically, a minimum of 30 minutes of moderate physical activity five days per week or 20 minutes of vigorous physical activity three days per week is recommended for weight maintenance as long as there is no significant increase in energy consumption (Haskell and others 2007). Increasing the duration and/or frequency of the activities can provide even greater benefits. Despite these recommendations, as many as 70% of American adults are sedentary or inactive with lifestyle habits below the recommended activity level for health benefits (Booth and others 2000). In 2005, only 43% of Alabamians achieved their recommended level of physical activity (CDC 2009I).

Several studies have found that the physical activity habits of students decline after graduating high school and that the physical activity habits of college students do not meet recommendations (Bray and Born 2004, Butler and others 2004, Douglas and others 1997, Grunbaum and others 2004, Haberman and others 1998, Huang and others 2003, Kilpatrick and others 2005, Racette and others 2005). Douglas and colleagues (1997), using data from the 1995 National College Health Risk Behavior Survey, found that only 38% of college students participated in regular vigorous activity, and only 20% participated in regular moderate activity (Douglas and others 1997). In contrast, 65% of high school students participated in regular

vigorous activity, and 26% participated in regular moderate activity (Grunbaum and others 2004). A study of 145 freshman university students (39 males; 106 females) assessed the vigorous physical activity level of the student's last two months at high school and compared it with that of their first two months at college (Bray and Born 2004). It was found that 66.2% (n=96) of the students met the recommended levels of activity while in high school, but this percentage significantly decreased to only 44.1% (n=64) of students meeting the requirement while in college. More specifically, 33.1% (n=48) of students were sufficiently active in both time frames, 22.8% (n=33) were insufficiently active in both time frames, and 33.1% (n=48) were active in high school but were insufficiently active while in college (Bray and Born 2004).

In a larger study of 738 college students (384 males; 354 females), Huang and coworkers (2003) found that students participated in aerobic exercises 2.8 ± 2.1 days during the previous week and found that female students were less likely to participate in the aerobic exercises than their male peers. Similar results were reported by Haberman and colleagues (1998) in a group of 301 college students (140 male; 161 female) where only 39% of the students reported exercising a minimum of three times per week, and 12.3% reported that they did not exercise at all. A large study on 764 college freshmen (359 males; 405 females) conducted by Racette and others (2005) examined exercise patterns and found that 29% of the freshman did not participate in any type of exercise.

While physical activity/exercise habits of college students appear to be less than desirable, weight gain is not dependent on adequacy of activity as it relates to guidelines but instead on the relationship between energy expenditure versus energy intake. A few studies

examining physical activity and weight gain in college students are reported. In a study of 54 female college freshmen during the first five months at school, Butler and coworkers (2004) found a significant decrease in energy intake despite a significant weight gain. This paradox was concluded to be associated with a significant reduction in all forms of physical activity including leisure, sport, occupational, and total activity (Butler and others 2004). Another study involving 193 college freshmen (24 males; 169 females) found that the percentage of students who participated in moderate and high intensity strength training decreased from 62.5% to 45.9% in men, but it increased from 37.8% to 42.1% in women (Kasperek and others 2008). Despite the fact that the changes were not correlated with weight gain (which averaged 2.5 lbs over the freshman year), it was noted that subjects with the lowest frequency of physical activity were more likely to be classified as overweight, and those that participated in 0-1 or 2-3 exercise sessions per week had a significantly higher follow up BMI compared to those who participated in physical activities 4 or more times per week (Kasperek and others 2008).

In summary, multiple factors appear to be contributing to the observed weight and/or BMI gain in college students. Factors found most often to be positively associated with weight (and/or BMI) gain among first year or first semester college students include: junk food intake/snacking behaviors, fast food/eating out/all-you-can-eat dining, alcohol consumption, physical inactivity, and workload (women). Another possible contributor to freshman year weight gain is residency, that being on campus versus off campus living/housing.

Residency – The on campus college environment has been speculated to be a contributory factor to weight gain among college students (Hull and others 2007, Levitsky and others 2004).

Students living on campus have extremely limited food storage and cooking facilities; a small refrigerator and microwave oven are often the only appliances available. Auburn University provides on campus housing in three main areas. The “Hill” area includes 12 residence halls. Leischuck hall houses only female freshmen students and Hall M houses only females. The remaining 10 dorms, Hollifield, Toomer, Graves, Boyd, Knapp, Dunn, Duncan, Dobbs, Dowell, and Sasnett, are coed by floors. The “Quad” area includes 10 residence halls. Two of the Quad halls, Keller and Owen, are female only. Harper, Little, Broun, Teague, Dowdell, Glenn, Lane, and Lupton are all coed residence halls also located in the Quad. The Extension provided coed housing in two-bedroom two person apartments until about 2007, after which a new area, the “Village” was built. The Village, which opened fall 2009, has eight residence halls. Three of the halls, Magnolia, Oak, and Willow, provide housing for female sorority members, and one hall, Talon, provides housing for students of the Honors College. The remaining four halls of the Village, Aubie, Eagle, Tiger, and Plainsman, are coed. Student athletes are housed primarily in Sewell hall.

Campus dorm rooms provide limited space for food storage and food preparation for students living on campus. The residence halls usually provide one community kitchen area in each building, although the Village provides a microwave and refrigerator in each suite. Non-village residents are allowed to purchase a microwave and small refrigerator for individual rooms if they wish. In a study by Nelson and Story (2009) it was reported that over 70% of college students (n=100) kept salty snacks, cereal or granola bars, main dishes, desserts, or candy, and sugar sweetened beverages in their dorm rooms, and reported an average of 22,888 kcal per dorm room.

Campus meal plans may also contribute to weight gain. Most universities require students, especially those living on campus, to purchase a meal plan. Several meal plans, varying in cost, are usually available to students attending a university. Meal plan dollars, however, expire if not used in a designated time frame; this expiration date may lead students to use dollars and purchase food, even when not hungry, to avoid losing the money. Students typically may use meal plan dollars at a variety of restaurants or dining halls located on campus. Dining options at Auburn University include mostly fast food type restaurants with a few dining halls. Until about 2008, Sewell dining hall provided all-you-can-eat cafeteria style dining to dorm residents (primarily athletes). Terrell dining hall, located on the Hill area of campus, had both cafeteria type dining and fast food; however, the cafeteria type dining closed in about 2007. Terrell Food Court now has several fast food type restaurants including Habaneros, Players Grill, Sub Generation, and Evolutions. Foy Center has a food court with Southern Grill, Simply Salads, Salsaritas, and Mondo Subs. The new Student Center has several more dining options including Au Bon Pain, Chef's Table, Out-takers, Mamma Leones, Chick-Fil-A, Coyote Jacks Grill, Starbucks, and Chef Yan Can Cook. The Village also has a new food area with a more traditional all-you-can-eat dining hall, Tiger Zone, along with several fast food options including Cub Stop Store C, End Zone Diner, O & B Grill, Home Plate, Rye of the Tiger, and Plainsmen Pizza and Pasta. Throughout campus other fast food type restaurants are found including Lupton Deli, Einsteins, Dudley Hall Drawing Board Café, Library Stacks Caribou Coffee, and Haley Center Coffee and Smoothie shops. It has been suggested that the daily opportunities for freshmen living on campus to choose from a multitude of on campus restaurants and all-you-can-eat dining halls linked to the meal plan may provide a "toxic environment" (Hull and others 2007, Levitsky

and others 2004). Food intake has been shown to be enhanced with increased variety and choice in food selection (Norton and others 2006; Pliner and others 1980). Similar to other universities, students at Auburn University may use meal plan dollars at over 20 different campus dining establishments (mostly fast food restaurants but also a few dining halls). While students living both on and off campus frequent fast food restaurants, because students living off campus usually have access to better food storage and cooking facilities, it can be speculated that students living off campus may eat out less frequently than students living on campus.

Few studies have examined whether or not residency affects weight or BMI gains in college students. In a study by Pliner and Saunders (2008) significantly greater gains in BMI were shown among college freshmen who were restrained eaters and living on campus versus restrained eaters living at home with their parents. In the only other published study considering residency, weight change was examined in two groups of female freshmen, one living on campus and one living off campus but attending a different university (than the on campus students) (Hovell and others 1985). The rate of weight gain of the women living on campus was 36 times faster than the community compared group of women not living on campus and attending another university (Hovell and others 1985). The results of these two studies, however, cannot clearly answer the question whether or not living on versus off campus impacts weight gain in college freshmen.

Conclusions and Justification

While the Hovell study (1985) found that the rate of weight gain of the female freshmen living on campus was faster than the community college compared group of freshmen not living

on campus, the study did not include males and also did not include a sample of female students attending the same university as the on campus group but residing off campus. Further, while the study by Pliner and Saunders (2008) showed significantly greater gains in BMI among college freshmen who were restrained eaters and living on campus versus restrained eaters living at home with their parents, a sample of college freshmen living off campus but not at home was not included in the study. Thus, missing from the literature is an examination of weight changes in male and female students attending the same university but differing in residency, that is with freshmen living both on campus and off campus but not at home with parents. Such a study is important (1) given the increasing prevalence of obesity in the United States, which has been shown to be greatest in young, college-aged adults (Mokdad and others 1999) and (2) given that many universities across the United States require freshmen to live on campus.

Objective

The objective of this study was to examine changes in weight, BMI, percent body fat, and fat free mass between college freshmen living on campus versus living off campus.

Chapter 3

Freshman year weight gain: does residency matter?

Abstract

Objective: Academic year changes in weight, body mass index (BMI), percent (%) body fat, and fat free mass were examined in freshmen based on residency. Subjects: 277 freshmen living on campus and 183 living off campus participated. Methods: Height, weight, and body composition (using bioelectrical impedance) were assessed first semester (beginning and end) and second semester (end). Results: Females living on (n=203) campus gained significantly more weight, BMI, and fat free mass (3.6 ± 4.7 lbs, 0.6 ± 0.8 kg/m², 1.3 ± 3.7 lbs, respectively) the first semester than females living off (n=97) campus (1.5 ± 6.0 lbs, 0.3 ± 1.0 kg/m², 0.0 ± 4.1 lbs, respectively). By second semester, freshmen living on campus gained significantly more percent body fat ($0.4 \pm 2.0\%$) than freshmen living off campus ($0.0 \pm 1.8\%$) and tended to lose significantly more fat free mass (-0.1 ± 3.6 lbs) than freshmen living off campus (0.6 ± 3.6 lbs). Conclusions: Freshman year on campus college residency by women is associated with greater initial weight, BMI, and fat free mass gains than off campus residency.

Introduction

Obesity is considered epidemic in the United States with increases in obesity rates seen in all age, gender, racial, and ethnic groups over the last several decades (CDC 2009a, Ogden and others 2006, Ogden and others 2008). In the college-aged population, weight gain during the

freshman year has been fairly extensively examined, with over a dozen studies published over the last eight years (Anderson and others 2003, Butler and others 2004, Crombie and others 2008, Economos and others 2008, Graham and Jones 2002, Gropper and others 2008, Gropper and others 2009, Hajhosseini and others 2006, Hodge and others 1993, Hoffman and others 2006, Holm-Denoma and others 2008, Hovell and others 1985, Jung and others 2008, Kasperek and others 2008, Levitsky and others 2004, Lloyd-Richardson and others 2008, Lowe and others 2006, Megal and others 1994, Mihalopoulos and others 2008, Morrow and others 2006, Pliner and Saunders 2008, Racette and others 2005, Racette and others 2008). The popularized “freshman 15” appears to be more accurately the “freshman three, four or five”, or if only those freshmen who gained weight are included, it is the “freshman seven” (Anderson and others 2003, Butler and others 2004, Crombie and others 2008, Economos and others 2008, Graham and Jones 2002, Gropper and others 2008, Gropper and others 2009, Hajhosseini and others 2006, Hodge and others 1993, Hoffman and others 2006, Holm-Denoma and others 2008, Hovell and others 1985, Jung and others 2008, Kasperek and others 2008, Levitsky and others 2004, Lloyd-Richardson and others 2008, Lowe and others 2006, Megal and others 1994, Mihalopoulos and others 2008, Morrow and others 2006, Pliner and Saunders 2008, Racette and others 2005).

Factors contributing to the observed weight and/or body mass index (BMI) gain also have been studied. Factors found most often to be positively associated with weight (and/or BMI) gain among first year or first semester college students include: snacking behaviors (Levitsky and others 2004), all-you-can-eat dining (Levitsky and others 2004), alcohol consumption (Economos and others 2008, Lloyd-Richardson and others 2008), physical inactivity (Butler and others 2004, Holm-Denoma and others 2008, Kasperek and others 2008), workload (Economos

and others 2008), BMI (Kasperek and others 2008), dietary restraint (Pliner and Saunders 2008), and specific dieting strategies (Lowe and others 2006). Another possible contributor to freshman year weight gain is residency, that being where (on versus off campus) the freshmen live while attending college (Crombie and others 2008, Pliner and Saunders 2008). Yet, in the one study which examined residency as a factor contributing to freshman year BMI gain, significantly greater gains in BMI were shown among college freshmen who were restrained eaters and living on campus versus restrained eaters living at home with their parents (Pliner and Saunders 2008). Further, in the only other published study which accounted for residency, weight change was examined in two groups of female freshmen, one living on campus and one living off campus but attending different universities (Hovell and others 1985). Missing from the literature is an examination of weight changes in male and female students related to residency: living on campus versus off campus but not at home with parents and attending the same university. Such a study is important given the increasing prevalence of obesity in the United States, which has been shown to be greatest in young, college-aged adults (Mokdad and others 1999). Further, the identification of factors, such as residency, associated with weight gain in college students may facilitate intervention strategies to promote healthier lifestyles. The purpose of this study was to examine changes in weight, BMI, percent body fat, and fat free mass between college freshmen living on campus versus living off campus (e.g. in apartments, duplexes, houses or trailers).

Methods

The research design was a prospective, observational study following a convenience sample of freshmen attending Auburn University, Auburn, AL. Policies at Auburn University

facilitated the study design since freshmen could chose to live either on or off campus. Freshmen were recruited to participate at the start of fall semester in 2007 and 2008, and are being followed longitudinally over the next several years. Recruitment was accomplished by email to newly admitted freshmen who attended summer advising sessions at the university. In addition, oral announcements were made and emails were sent to students enrolled in introductory level courses typically taken by first year students. Recruited participants were 17-19 years of age, unmarried, had no children, and had no reported eating disorder. Freshmen received \$25 for participating in the beginning of fall and end of spring semester assessments and \$20 for the end of fall semester assessment; the initial and end of spring assessments paid more money since participation time was longer. The study was approved by the Institutional Review Board for the Use of Human Subjects in Research at Auburn University. Signed, informed consent was obtained from each participant and from a parent or guardian if the participant was under 19 years of age.

Assessments were conducted between 8 and 11 am during the first four weeks and the last four weeks of fall semester and during the last four weeks of spring semester. Body weight was measured with a digital scale (Healthometer, Pelstar, LLC, Model 500KL, Bridgeview, IL) to the nearest 0.2 lbs. Height was measured to the nearest one-quarter inch using standard techniques with a height rod (Healthometer, Pelstar, LLC, Model 500KL, Bridgeview, IL). Participants removed shoes, hats, belts, and outer garments, and emptied pockets before being weighed and measured. Body mass index was calculated as weight divided by height squared (kg/m^2). The adult BMI criteria for classification (CDC 2009b), instead of the BMI-for-age growth curves that end at age 20 years, were used since the college students are being followed

longitudinally. Body composition was measured using bioelectrical impedance analysis as described by Gropper and associates (2009). Waist circumference was assessed at the beginning and end of the academic year using an NX16 three-dimensional body scanner (TC², Raleigh, NC). The scanner captures silhouette images and multiple body measurements of standing, stationary subjects wearing close-fitting scanwear specified to maintain measurement accuracy. Using white light technology, the scanner obtains measurements with a point accuracy of 1 mm and a circumference accuracy of < 3 mm.

A demographic questionnaire was used to obtain self-reported information from participants regarding sex, race/ethnicity, date of birth, state of permanent residence, and location of residence at college (e.g. on campus residence hall, off campus apartment, trailer, duplex or house, fraternity/sorority house, or at home with parents). Demographic information was also obtained from the Office of Institutional Research and Assessment for all freshmen at Auburn University. Auburn University's 2007 incoming freshman class (from which the subjects of the first cohort were recruited) consisted of 4,191 students (53% female, 47% male) who were mostly Caucasian (81.7%), followed by African American (11.3%), Hispanic (2.9%), Asian (1.9%), and other/unreported (0.8%). Auburn University's 2008 incoming freshman class (from which the subjects of the second cohort were recruited) consisted of 3,984 students (52% female, 48% male) who were mostly Caucasian (88.1%), followed by African American (5.6%), Hispanic (2.4%), Asian (1.9%), and other/unreported (2%). This study was part of a larger study also assessing body shape and size, along with psychosocial traits.

Statistical analyses

Statistical analyses were performed using InStat 3.0 (GraphPad Software, San Diego, CA) and SPSS Statistics 17.0 (SPSS Inc., Chicago, IL). Differences in ethnicity/race between the university freshman population and the study population were examined using chi-square tests. Cohort effects on outcome measures were evaluated using regression analysis and t-tests. Changes in outcome measures (weight, BMI, percent body fat, and fat free mass) between male and female participants living on campus versus off campus were assessed using t-tests. Changes in outcome measures for both fall semester and spring semester were evaluated using paired t-tests. Analysis of variance was used to examine weight change based on initial BMI classification. Results are presented as mean \pm standard deviation. Statistical significance was set at p value of <0.05 .

Results

A total of 240 freshmen were recruited at the beginning of fall 2007 (cohort 1) and an additional 295 freshmen were recruited at the beginning of fall 2008 (cohort 2). Five students were excluded in this study's analyses because they were living at home with their parents. Thus, the total initial sample included 530 students. A total of 460 students returned after one semester (87% retention rate). Of the 460 participants, 300 (65.4%) were female and 160 (34.3%) were male, with 213 students (46.3%) from cohort 1 and 247 students (53.7%) from cohort 2. Table 3.1 shows the mean age, height, weight, and BMI of the male and female study participants. Changes in outcome measures (weight, BMI, % body fat, and fat free mass) did not differ significantly between the two cohorts; therefore, data were combined in analyses. Of the

460 participants, 277 students (60%) lived on campus and 183 students (40%) lived off campus in an apartment, trailer, house, or duplex (but not at home with parents or in a fraternity/sorority house).

The majority of the participants were Caucasian (85.8%), followed by African American (8.0%), Hispanic (3.0%), Asian (2.4%), and other (<1%). This racial/ethnic distribution did not significantly differ from the university's freshman population. Most participants had permanent residency in Alabama (62.8%), followed by Georgia (12.6%), Tennessee (5.2%), Texas (3.3%), Florida (2.6%), and Virginia (2.2%) with lesser numbers of students from 18 other states.

Thirty-one participants (6.7%) were initially classified as underweight, 351 (76.3%) were normal weight, 67 (14.6%) were overweight, and 11 (2.4%) were obese. By the end of the first semester, 22 (4.8%) were classified as underweight, 348 (75.7%) were normal weight, 76 (16.5%) were overweight, and 14 (3.0%) were obese. The 70 participants who did not return at the end of first semester had similar initial BMI classifications as those who returned: four (5.7%) were underweight, 52 (74.3%) were normal weight, 13 (18.6%) were overweight, and one (1.4%) was obese.

First semester changes in body weight, BMI, percent body fat, and fat free mass of participants living on versus off campus

Compared to the beginning of fall semester, weight, BMI, percent body fat, and fat free mass were significantly higher at the end of fall semester in both females and males and in participants living on and off campus. Participants gained a mean of 3.2 ± 5.6 lbs weight, 0.5 ± 0.9 kg/m² BMI, $1.0 \pm 2.6\%$ body fat, and 1.1 ± 4.5 lbs fat free mass after one semester of college.

Weight change ranged from -19.4 lb loss to 29.6 lb gain. Ten participants (2.2%) gained ≥ 15 lbs, 51 participants (11.1%) gained ≥ 10 lbs, and 158 participants (34.3%) gained ≥ 5 lbs after the first semester of college.

Several differences were found between participants living on versus off campus and between males and females. Data are shown in Table 3.2 as change in weight, BMI, percent body fat, and fat free mass based on gender and residency. Participants living on campus gained significantly more weight (3.8 ± 5.3 lbs), BMI (0.6 ± 0.8 kg/m²), and fat free mass (1.5 ± 4.4 lbs) than those living off campus (2.4 ± 6.0 lbs, 0.4 ± 0.9 kg/m², 0.4 ± 5.0 lbs respectively). When separated based on gender, females living on campus (but not males) gained significantly more weight (3.6 ± 4.7 lbs), BMI (0.6 ± 0.8 kg/m²), and fat free mass (1.3 ± 3.7 lbs) than females living off campus (1.5 ± 6.0 lbs, 0.3 ± 1.0 kg/m², and 0.0 ± 4.1 lbs respectively). Changes in weight, BMI, percent body fat, and fat free mass did not significantly differ between males living on and off campus. Females were more likely to live on campus than males. Males tended ($p=0.1026$) to gain more weight (3.8 ± 6.2 lbs) than females (2.9 ± 5.3 lbs), and males tended ($p=0.0719$) to gain more fat free mass (1.7 ± 5.6 lbs) than females (0.8 ± 3.9 lbs). Males living off campus (3.3 ± 5.8 lbs, $n=86$) gained significantly ($p=0.0327$) more weight than females living off campus (1.5 ± 6.0 lbs, $n=97$). No significant difference in weight change was found between males and females living on campus. The rate of weight change was significantly ($p=0.0075$) greater in participants living on campus (0.24 ± 0.33 lbs/week) versus off campus (0.15 ± 0.38 lbs/week).

Weight change did not significantly differ among participants classified by BMI as underweight, n=31, (4.0 ± 5.4 lbs), normal weight, n=351, (3.0 ± 5.1 lbs), overweight/obese, n=78, (3.8 ± 7.8 lbs). Changes in weight among participants classified by residency and BMI are shown in Table 3.3. Weight gain did not significantly differ in underweight, overweight/obese participants living on versus off campus. Participants classified as normal weight living on campus (3.5 ± 5.1 lbs) gained significantly ($p=0.0177$) more weight than participants classified as normal weight living off campus (2.2 ± 4.9 lbs). When analyzed based on gender, female participants, but not males, classified as normal weight and living on campus (3.2 ± 4.4 lbs) gained significantly ($p=0.0048$) more weight than female participants classified as normal weight and living off campus (1.4 ± 4.4 lbs).

Second semester changes in body weight, BMI, percent body fat, and fat free mass of participants living on versus off campus

Of the 460 freshmen who participated the first semester, 414 freshmen returned for assessment at the end of the second semester, a retention rate of 90%. Of the 414 participants, 243 students (59%) lived on campus and 171 students (41%) lived off campus.

Weight, BMI, and percent body fat (but not fat free mass) were significantly higher at the end of spring semester than at the end of fall semester in females and males (n=414) living both on and off campus. Participants gained a mean weight of 0.7 ± 4.9 lbs (range -21.8 to 24.5 lbs) by the end of the second semester of college. BMI and fat free mass gains were 0.1 ± 0.8 kg/m² and 0.2 ± 3.6 lbs, respectively. Percent body fat increased by $0.2 \pm 1.9\%$. Mean height increased ($p<0.001$) slightly from 66.46 ± 3.6 " to 66.51 ± 3.6 ". Of the 414 participants, 64

(15.5%) gained ≥ 5 lbs, 11 (2.7%) gained ≥ 10 lbs, and 5 (1.2%) gained ≥ 15 lbs during the second semester.

Weight, BMI, percent body fat, and fat free mass changes did not significantly differ between 143 males (0.5 ± 4.9 lbs, 0.04 ± 0.7 kg/m², $0.06 \pm 2.0\%$, 0.3 ± 4.5 lbs, respectively) and 271 females (0.9 ± 4.8 lbs, 0.1 ± 0.8 kg/m², $0.3 \pm 1.9\%$, 0.1 ± 3.0 lbs, respectively). Data are shown in Table 3.4 as change in weight, BMI, percent body fat, and fat free mass based on gender and residency. Second semester changes in weight, BMI, and fat free mass did not significantly differ between freshmen living on versus off campus (Table 3.4); however, freshmen living on campus gained slightly but significantly more percent body fat ($0.4 \pm 2.0\%$) versus freshmen living off campus who had no change in percent body fat ($0.0 \pm 1.8\%$). Gains in fat free mass tended ($p=0.070$) to be greater in participants living off campus (0.6 ± 3.6 lbs) versus on campus (-0.1 ± 3.6 lbs).

The rate of weight change did not significantly differ in participants living on campus (0.04 ± 0.22 lbs/week) versus off campus (0.03 ± 0.27 lbs/week) during the second semester of college; however, the rate of weight change was significantly ($p < 0.0001$) greater during the first semester (0.20 ± 0.35 lbs/week) than during the second semester (0.04 ± 0.24 lbs/week). Academic year weight gain for the group ($n=414$) averaged 3.9 ± 7.1 lbs (range -21.8 to 30.7 lbs). If only participants who gained weight are included ($n=303$), weight gain averaged 6.9 ± 5.4 lbs. Twenty-two participants (5.3%) gained ≥ 15 lbs during the freshman year, while 68 participants (16.4%) gained ≥ 10 lbs, and 166 (40.1%) gained ≥ 5 lbs.

Waist circumference change averaged $0.5 \pm 1.6''$ for on campus participants (n=215) versus $0.3 \pm 1.6''$ for off campus participants (n=152) with no significant difference between the two groups. On campus females (n=154) gained $0.5 \pm 1.7''$ at the waist which did not significantly differ from the $0.3 \pm 1.6''$ of waist gain by off campus females (n=86). Similarly, on campus males gained $0.7 \pm 1.3''$ at the waist which did not significantly differ from the $0.4 \pm 1.6''$ gain at the waist by off campus males (n=66).

Discussion

This study is one of the first to examine weight gain and body composition changes in male and female college freshmen based on residency on versus off campus. While significant gains in weight, BMI, percent body fat, and fat free mass were observed in males and females living both on and off campus after one semester of college, females living on campus appear to be at greater risk for higher weight and BMI gains than females living off campus. However, fat free mass gains also were significantly higher in females living on campus than off campus suggesting favorable changes in body composition. The finding that the significant weight gains were found in the normal weight females living on campus versus normal weight females living off campus, and not in underweight and overweight/obese females living on campus versus underweight and overweight/obese females living off campus, may be due to the smaller sample sizes of the underweight and overweight/obese groups and thus limited statistical power.

Second semester findings in the present study showed weight and BMI gains did not significantly differ between freshmen living on or off campus and showed a significantly slower rate of weight change than that observed during the first semester. However, during the second

semester, percent body fat slightly and significantly increased and fat free mass tended to decrease in those living on campus. In contrast, percent body fat did not change and lean body mass tended to increase in freshmen living off campus. These findings suggest unhealthier changes in body composition occurring during the second semester in those living on campus.

Few other published studies have investigated the effects of campus residency on weight gain. This study, like that of Hovell and coworkers (1985) and Pliner and Saunders (2008), found that female college students living on campus gained significantly more weight than those living off campus. The rate of weight gain the first semester also was significantly greater for on campus students than off campus students in both the present study and the Hovell study (Hovell and others 1985). In the one other study examining residency and body composition changes, Hull and coworkers (2007) investigated only females during their sophomore year. These researchers found that females living off campus (n=26) experienced no change in weight but had significant decreases in percent body fat (-2%) and fat mass (-2.6 lbs) and gains in fat free mass (2.4 lbs), while females living on campus (n=22) experienced slight but significant gains in weight (0.9 lbs), percent body fat (0.1%), and fat free mass (0.9 lbs) during their sophomore year (Hull and others 2007). The findings by these researchers suggest healthier changes in body composition in sophomore females living off campus versus on campus.

Like the studies by Hull (Hull and others 2007) and Hovell (Hovell and others 1985), the present study did not directly investigate the eating or physical activity habits of participants living on versus off campus; such investigations were thought to decrease retention and

recruitment of study volunteers. Thus, reasons for the differences in weight, BMI, and body composition changes between the two groups are not clear.

Several factors are speculated to influence college weight gain including changes in energy intake related to unhealthy eating habits. Differences in eating habits could account for the differences in weight gain that was observed in the females living on campus versus those living off campus. Living in on campus housing has been thought to be a possible contributory factor of weight gain (Hull and others 2007, Levitsky and others 2004). Students living on campus have rather limited space to dedicate to food storage and typical cooking equipment. The usual appliances found in a dorm room are a microwave oven and perhaps a small refrigerator. This may lead students to keep prepackaged food or ready to eat snacks that do not require certain storage conditions or much if any preparation. It has been reported that over 70% of college students (n=100) kept salty snacks, cereal or granola bars, main dishes, desserts, or candy and sweetened beverages in their dorm rooms (Nelson and Story 2009). Many universities also require students, especially those who live on campus, to purchase a meal plan. This is also true at Auburn University which has multiple meal plans of varying costs which can be used at several dining halls and restaurants located throughout campus. This plethora of dining locations may be viewed as positive for offering variety but also may be negative. It has been suggested that the daily opportunities for freshmen living on campus to choose from a multitude of on campus restaurants linked to the meal plan may provide a “toxic environment” (Hull and others 2007). Increased food intake has been shown to be enhanced with increased variety and choice in food selection (Norton and others 2006, Pliner and others 1980). Students at Auburn University may use their meal plan money at the more than 20 different campus dining locations. These

tend to be mostly fast food or grab and go style but there are a few dining halls. The frequency of dining at fast food restaurants has been linked with higher total energy and fat intakes (Bowman and Vinyard 2004, Jeffery and French 1998, McCrory and others 1999), with body weight (French and others 2000), and with BMI (Duffey and others 2007). Fast food portion sizes, high energy density, high fat content, and favorable palatability, are thought to contribute to weight gain (Ebbeling and others 2002). Driskell and colleagues (2005) reported that 95.1% of 144 college freshmen and sophomores ate meals at fast food restaurants six to eight times per week. Moreover, although not a focus of this study, participants were asked how many times per week they ate at full-service and fast food restaurants. Interestingly it was reported that females living on campus reportedly ate at restaurants significantly ($p < 0.001$) more frequently (7.0 ± 4.8 times per week) than did females living off campus (4.4 ± 2.8 times per week) (Appendix E). No differences were found in the frequency of dining out between males living on campus versus the males living off campus.

Weight gain in college freshmen has also been attributed to eating at all-you-can-eat dining halls (Levitsky and others 2004) as well as eating in a social setting (Bell and Pliner 2003, Clendenen and others 1994, de Castro and others 1990, de Castro 1994, Hetherington and others 2006, Klesges and others 1984, Pliner and others 2006, Saunders 2008). Levitsky and colleagues (2004) found that in a sample of 60 freshmen, who had an average 4.18 lb weight gain over the academic year, that 20% of their gain was attributable to dining at all-you-can-eat style cafeterias on campus. Additionally, several studies have shown that individuals consume more food when dining with others as compared to dining alone, and more specifically, as the number of dining companions increases so does meal duration and overall food intake (Bell and Pliner 2003,

Clendenen and others 1994, de Castro and others 1990, de Castro, Hetherington and others 2006, Klesges and others 1984, Pliner and others 2006). In a study by Saunders (2008) looking at freshmen weight gain, it was found that 45 (21%) of 214 freshmen reported dining at all-you-can-eat buffet style dining halls. The weight change in that group was significantly associated ($r=0.285$) with the number of dining companions. Furthermore, students who dined at all-you-can-eat campus dining halls with three or more companions gained significantly more weight (3.9 ± 3.2 lbs) than the students who dined at these facilities with two or fewer companions (1.8 ± 3.5 lbs). Thus, although speculative, the campus dining setup and social dining, especially in all-you-can-eat dining halls, may be factors that contribute to weight gain in students living on campus.

Another factor known to have effects on eating behavior, and as a result body weight, is stress. Students beginning college may experience several stressors including increased academic workloads, new social networks, new and additional responsibilities, as well as new living and dining environments, among others (Economos and others 2008). However, males and females experience these stressors differently, and they may react to them in a different manner (Economos and others 2008). Stress appears to have bidirectional effects on weight, with some individuals reporting weight loss and others reporting to have weight gain (Kivimaki and others 2006, Oliver and Wardle 1999, Serlachius and others 2007). Most individuals though, especially females, eat more during times of stress and those females who do eat more tend to choose sweet foods and mixed dishes (Kandiah and others 2006, Oliver and Wardle 1999, Serlachius and others 2007). As a consequence, the difference in weight gain experienced by males versus

females in the present study may be related to stressors in the lives of the freshmen and the differences in how the males and females react to that stress.

In addition to changes in energy intake, which may be related to the campus food environment and reactions to, differences in energy expenditure associated with physical activity may also account for the differences in weight gain that were found between females living on and off campus as well as those between males and females in general. Results from both national surveys and from university specific studies have examined physical activity among college students and have shown that the majority of college students do not meet recommended exercise guidelines (Anding and others 2001, Douglas and others 1997, Haberman and others 1998). Furthermore, decreases in physical activity and/or increases in leisure time have been associated with weight gain in first year college females (Butler and others 2004, Jung and others 2008).

While studies examining weight gain and the factors related to weight gain are important given the obesity epidemic, it is also important to look at the accompanying changes in body composition. Gains in fat mass, particularly in the abdominal region, can increase the risk of heart disease, type 2 diabetes, as well as some cancers. In the present study, while weight gain and BMI gains were higher in female participants living on campus versus off campus, first semester gains in fat free mass also were greater. These findings suggest that perhaps greater physical activity occurred during the first semester in females living on campus versus those living off campus. Physical activity often leads to gains in fat free mass, and gains in fat free mass are associated with greater gains in weight than are those of gains in fat mass.

By the end of the second semester, some of the gains in fat free mass that had been obtained in the first semester were lost in on campus residents while off campus residents tended to gain fat free mass. Since other studies have not investigated the effects of residency on changes in body weight and composition in college freshmen, direct comparisons with other studies are not feasible. Possible reasons for the observed fluctuations may include deliberate actions by some participants to change their dietary and/or physical activity habits to improve health. Participants who wished to receive their body weight and composition data were given their findings, however only a few dozen participants actually asked for this information. It has been found that females living on campus during their sophomore year gained less weight, gained more fat free mass, lost percent body fat, and decreased fat mass compared to their freshman year; these findings lead the investigators to suggest that over time students may make healthier choices (Hull and others 2007). However, the reasons in the present study of why fat free mass increased in one group but decreased in the other group during the second semester are not clear. Also unclear are the future trends.

The findings from this study provide a unique and important contribution to the literature since many universities throughout the United States require freshmen to live on campus. It was found that on campus residency resulted in greater weight, BMI, and fat free mass gains in female freshmen compared to those who lived off campus. However, shifts towards higher percent body fat in participants living on campus during the second semester suggest unhealthy changes and additional studies throughout subsequent semesters are recommended.

Limitations

The results of this study must be interpreted with caution since this study is not without limitations. First, participants in this study attended a major public university, and therefore the results may not be applicable to those students attending private universities. Furthermore, the study did not include a comparison or control group of young adults who moved away from home after high school but did not enter college. A study by Georgiou and associates (1997) suggested that among young adults aged 18-24 years, female nonstudents were more prone to being overweight than female students. A comparison group in this study would have helped to identify the effect of university attendance on weight gain and body composition changes during the first year of living away from home. Another limitation is self-selection bias since only students who may have felt secure enough with their weight or were comfortable enough to be measured again may have returned. Lastly, weight goals of the participants were not controlled for and may have influenced the results.

Conclusions

On campus residency is associated with first semester weight gain in college females. The campus environment has great potential to promote healthy lifestyle habits for its residents. As a consequence of any university policies that may require freshmen to live on campus, the administration has a responsibility to the students to promote healthy eating habits and to provide an environment that promotes a healthy lifestyle. The creation of pedestrian campuses which encourage walking, the provision of healthy dining options, and the creation of student activity and wellness centers represent some initial steps taken by a number of universities; however, this

is just the beginning and further studies and efforts appear to be needed. Specifically, the examination of college students' food intake, food preparation, and cooking methods should be conducted. Future studies also need to look more closely at the physical activity habits and the effects of stress on college students. This includes investigating both males and females in order to account for possible gender differences. A more clear identification of the specific factors associated with freshman year weight gain along with any other circumstances in the students' lives that can be changed, will better allow for the provision of services aimed at helping students to achieve a healthier lifestyle.

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Table 3.1 Mean (\pm standard deviation) age, height, weight, and body mass index (BMI) of the male and female study participants.

	Males (n=160)	Females (n=300)
Age (yrs)	18.2 \pm 0.4	18.1 \pm 0.3
Height (in)	70.04 \pm 2.60	64.54 \pm 2.33
Weight (lbs)	163.0 \pm 25.7	130.9 \pm 24.0
BMI (kg/m ²)	23.4 \pm 3.4	22.1 \pm 3.6

Table 3.2. Changes in weight, body mass index (BMI), percent (%) body fat, and fat free mass from the beginning to the end of the first semester in college freshmen living on campus versus off campus.

Parameter	Students Living On Campus ^a	Students Living Off Campus ^b	P value
Weight Change (lbs)			
All	3.8 ± 5.3	2.4 ± 6.0*	0.009
Females	3.6 ± 4.7	1.5 ± 6.0*	0.002
Males	4.3 ± 6.7	3.3 ± 5.8	0.329
BMI Change (kg/m ²)			
All	0.6 ± 0.8	0.4 ± 0.9*	0.004
Females	0.6 ± 0.8	0.3 ± 1.0*	0.002
Males	0.6 ± 0.9	0.5 ± 0.9	0.409
%Body Fat Change (%) ^c			
All	1.1 ± 2.5	1.0 ± 2.8	0.755
Females	1.0 ± 2.4	1.0 ± 2.9	0.793
Males	1.1 ± 3.0	1.0 ± 2.7	0.801
Fat Free Mass Change (lbs) ^c			
All	1.5 ± 4.4	0.4 ± 5.0*	0.014
Females	1.3 ± 3.7	0.0 ± 4.1*	0.006
Males	1.9 ± 5.8	0.8 ± 5.8	0.225

*Significantly ($p < 0.05$) less than students living on campus, ^aStudents living on campus $n=277$ (203 females, 74 males),

^bStudents Living Off Campus $n=183$ (97 females, 86 males), ^cmissing %body fat and fat free mass data on 5 males on campus and 1 male off campus

Table 3.3. Changes in weight based on initial body mass index (BMI) classification from the beginning to the end of the first semester in college freshmen living on campus versus off campus.

Initial BMI (kg/m ²) Classification by gender	n	Weight Change (lbs) Students Living On Campus	n	Weight Change (lbs) Students Living Off Campus	P value
<18.5					
All	22	4.5 ± 5.2	9	2.7 ± 6.2	0.4242
Females	19	5.4 ± 4.9	7	1.7 ± 6.4	0.1292
Males	3	-1.3 ± 2.4	2	6.3 ± 5.7	0.1188
18.5-24.9					
All	219	3.5 ± 5.1	132	2.2 ± 4.8*	0.0239
Females	167	3.2 ± 4.4	68	1.4 ± 4.4*	0.0048
Males	52	4.3 ± 6.8	64	3.1 ± 5.2	0.2948
≥ 25.0					
All	36	5.0 ± 6.5	42	2.7 ± 8.7	0.1984
Females	17	4.7 ± 6.6	22	1.7 ± 9.5	0.2819
Males	19	5.3 ± 6.5	20	3.8 ± 7.7	0.5252

*Significantly ($p < 0.05$) less than students living on campus

Table 3.4. Changes in weight, body mass index (BMI), percent (%) body fat, and fat free mass from the end of the first semester to the end of the second semester of college in freshmen living on campus versus off campus.

Parameter	Students Living On Campus ^a	Students Living Off Campus ^b	P value
Weight Change (lbs)			
All	0.7 ± 4.5	0.7 ± 5.3	0.937
Females	0.9 ± 4.3	0.8 ± 5.8	0.862
Males	0.3 ± 5.1	0.6 ± 4.8	0.692
BMI Change (kg/m ²)			
All	0.1 ± 0.7	0.1 ± 0.9	0.824
Females	0.1 ± 0.7	0.1 ± 1.0	0.909
Males	0.0 ± 0.7	0.1 ± 0.7	0.672
%Body Fat Change (%)			
All	0.4 ± 2.0	0.0 ± 1.8*	0.016
Females	0.5 ± 1.9	0.1 ± 1.8	0.147
Males	0.4 ± 2.2	-0.2 ± 1.7	0.110
Fat Free Mass Change (lbs)			
All	-0.1 ± 3.6	0.6 ± 3.6**	0.070
Females	0.0 ± 3.0	0.4 ± 3.2	0.343
Males	-0.3 ± 5.0	0.8 ± 4.1	0.144

*Significantly (p=0.0155) less than students living on campus, **Trend (p=0.070) towards a difference from students living on campus, ^a n=243 (181 females, 62 males), ^b n=171 (90 females, 81 males).

Chapter 4

Summary

Students living off campus had significantly less weight gain than students living on campus after one semester of college. Females living off campus had significantly less weight gain than females living on campus after the first semester.

Students living off campus had significantly less BMI gain than students living on campus after one semester. Females living off campus had significantly less BMI gain than females living on campus after the first semester.

Students living off campus had a significantly less gain in fat free mass than students living on campus after the first semester.

Students classified as normal weight who lived off campus gained significantly less weight after one semester than those classified as normal weight who lived on campus. Females classified as normal weight who lived off campus gained significantly less weight than those females classified as normal weight who lived on campus after the first semester.

Students living off campus gained significantly less percent body fat than those living on campus from the beginning of the first semester to the end of the second semester

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Appendices

Appendix A. Institutional Review Board approval form.



AUBURN
UNIVERSITY

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July 10, 2009

MEMORANDUM TO: Dr. Sareen Gropper & Dr. Lenda Connell
Nutrition & Food Science

PROTOCOL TITLE: "Longitudinal Collegiate Study of Body Composition/Size and Related
Environmental, Behavioral and Psychological Factors"

IRB AUTHORIZATION NO.: 07-153 EP 0707

ORIGINAL APPROVAL DATE: July 9, 2007
RENEWAL DATE: July 2, 2009
EXPIRATION DATE: July 8, 2010

The renewal for the above referenced protocol was approved as Expedited by IRB procedure under 45 CFR 46.110 (Category #6 & #7):

"Collection of data from voice, video, digital, or image recordings made for research purposes.

Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies."

You should report to the IRB any proposed changes in the protocol or procedures and any unanticipated problems involving risk to subjects or others. Please reference the above authorization number in any future correspondence regarding this project.

If you will be unable to file a Final Report on your project before July 8, 2010, you must submit a request for an extension of approval to the IRB no later than June 22, 2010. If your IRB authorization expires and/or you have not received written notice that a request for an extension has been approved prior to July 8, 2010, you must suspend the project immediately and contact the Office of Human Subjects Research for assistance.

A Final Report will be required to close your IRB project file. Please note that the approval, stamped version of your informed consent should be provided to participants during the consent process. You are reminded that you must keep signed consents for three years after your study is completed.

If you have any questions concerning this Board action, please contact the Office of Human Subjects Research at 844-5966.

Sincerely,

Kathy Jo Ellison, RN, DSN, CIP
Chair of the Institutional Review Board
for the Use of Human Subjects in Research

cc: Dr. Doug White

Appendix B. Selected demographic characteristics of initial sample population – Cohort 1.

	Beginning of Fall (n=240)
Age (years)	18.12 ± 0.40
Height (inches)	66.64 ± 3.49
Gender*	
Male	84 (35%)
Female	156 (65%)
Race*	
Caucasion	196 (81.7%)
African American	29 (12.1%)
Hispanic	7 (2.9%)
Asian	4 (1.7%)
Other	4 (1.7%)
Parents' Income	
\$10-30,000	5 (2.1%)
\$30-50,000	12 (5.0%)
\$50-70,000	20 (8.3%)
\$70-90,000	22 (9.2%)
\$90-110,000	30 (12.5%)
\$110-130,000	25 (10.4%)
\$130-150,000	11 (4.6%)
>\$150,000	41 (17.1%)
Don't know	74 (30.8%)
Permanent Residence*	
Alabama	149 (62.1%)
Georgia	37 (15.4%)
Tennessee	11 (4.6%)
Texas	9 (3.8%)
North Carolina	7 (2.9%)
Florida	4 (1.7%)
Louisiana	2 (0.4%)
Arizona	2 (0.4%)
Maryland	2 (0.4%)
Illinois	2 (0.4%)
Mississippi	2 (0.4%)
Ohio	2 (0.4%)
Virginia	2 (0.4%)
Others (1 each)	9 (3.8%)
22 different states	
School Residence*	
Campus dorm	147 (61.3%)
Apartment, house, duplex, or trailer	90 (37.5%)
With parents	2 (1.2%)

*Data are presented as n (%) except for age and height which are expressed as mean ± S.D.

Appendix C. Selected demographic characteristics of initial sample population – Cohort 2.

	Beginning of Fall (n=295)
Age (years)	18.10 ± 0.38
Height (inches)	66.25 ± 3.60
Gender*	
Male	105 (36%)
Female	191 (64%)
Race*	
Caucasion	262 (88.8%)
African American	11 (3.7%)
Hispanic	11 (3.7%)
Asian	10 (3.4%)
Other	1 (<1.0%)
Parents' Income	
\$10-30,000	7 (2.4%)
\$30-50,000	13 (4.4%)
\$50-70,000	22 (7.4%)
\$70-90,000	38 (12.8%)
\$90-110,000	39 (13.2%)
\$110-130,000	22 (7.4%)
\$130-150,000	18 (6.1%)
>\$150,000	52 (17.6%)
Don't know	84 (28.6%)
Permanent Residence*	
Alabama	180 (61.0%)
Georgia	38 (12.8%)
Tennessee	17 (5.7%)
Texas	7 (2.4%)
North Carolina	3 (1.0%)
Florida	12 (4.1 %)
Louisiana	4 (1.4%)
Maryland	5 (1.7%)
Mississippi	2 (<1.0%)
Ohio	3 (1.0%)
Virginia	8 (2.7%)
Wisconsin	3 (1.0%)
New Jersey	2 (<1.0%)
Pennsylvania	2 (<1.0%)
Kentucky	3 (1.0%)
Others (1 each)	6 (2.0%)
21 different states	
School Residence*	
Campus dorm	168 (56.0%)
Apartment, house, duplex, or trailer	124 (42.0%)
With parents	3 (1.0%)

*Data are presented as n (%) except for age and height which are expressed as mean ± S.D.

Appendix D. Cohort 1 versus Cohort 2. Height, weight, changes in weight, body mass index (BMI), percent body fat, and fat free mass as first semester freshmen.

	Cohort 1	Cohort 2	P value
Height (inches)	66.55± 3.49	66.25± 3.60	0.322
Weight (lbs)	144.1± 32.1	140.5 ± 24.8	0.1398
Weight change (lbs)	2.8± 5.4	3.5± 5.8	0.173
BMI change (kg/m ²)	0.4 ± 0.8	0.6 ± 0.9	0.139
% Body fat change (%)	1.2 ± 2.3	0.9 ± 2.9	0.174
Fat free mass change (lbs)	0.7± 4.2	1.4±4.7	0.096

Appendix E. First semester junk food intake, dining out, sugar-sweetened beverage consumption, and physical activity of freshmen living on versus off campus.

	Students living on campus	n	Students living off campus	n	P-value
Junk food intake (servings/day)					
All	1.8 ± 1.5	275	1.6 ± 1.6	183	0.047
Females	1.9 ± 1.5	201	1.6 ± 1.7	97	0.039
Males	1.6 ± 1.6	74	1.5 ± 1.3	86	0.903
Eating out (times/week)^a					
All	6.7 ± 4.8	271	4.8 ± 3.6	177	0.001
Females	7.0 ± 4.8	199	4.4 ± 2.8	94	0.001
Males	6.0 ± 4.6	72	5.3 ± 4.4	83	0.547
Fast food intake (times/week)					
All	5.7 ± 4.6	254	4.0 ± 3.5	172	0.001
Females	5.9 ± 4.7	186	3.6 ± 2.8	91	0.001
Males	5.2 ± 4.5	68	4.5 ± 4.1	81	0.721
Sugar-sweetened beverage intake (servings/day)					
All	0.9 ± 1.3	274	1.3 ± 2.1	183	0.050
Females	0.8 ± 1.2	201	0.9 ± 1.4	97	0.466
Males	1.4 ± 1.4	73	1.7 ± 2.6	86	0.345
Physical activity (minutes/week)^b					
All	438 ± 317	275	410 ± 325	181	0.089
Females	390 ± 281	201	309 ± 231	95	0.003
Males	571 ± 368	74	522 ± 375	86	0.408

^aIncludes fast food dining and full service restaurant dining

^bIncludes vigorous activities + moderate activities + strength training