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The Relationship between Diet Quality and Body Composition in College Women: a Cross-sectional Analysis

Annette Elisabeth Perkins
Brigham Young University - Provo

The Relationship between Diet Quality and Body Composition in College Women:

A Cross-sectional Analysis

Annette E. Perkins

A thesis submitted to the faculty of
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Master of Science

Bruce W. Bailey, Chair
Larry A. Tucker
James D. George

Department of Exercise Sciences

Brigham Young University

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ABSTRACT

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Annette E. Perkins

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Objective. Determine the relationship between dietary quality and body weight/composition in college women. Specific emphasis was made regarding adherence to current MyPyramid guidelines, fruit, vegetable and junk food consumption.

Design/Participants. The study used a cross-sectional design. One hundred and sixty three women were recruited to participate in the study. All participants were university students (20.4 ± 1.6 y). Diet intake was measured using the Dietary History Questionnaire (DHQ) and the Healthy Eating Index (HEI) was calculated to assess diet quality. Body fat percentage was assessed using the Bod Pod and BMI was calculated using height and weight measurements. Physical activity was measured objectively using accelerometers over seven consecutive days.

Results. There was no significant difference in BMI or body fat percentage across university year. There was no relationship between diet quality (as measured using the Healthy Eating Index) and percent body fat or BMI. The number of MyPyramid equivalents of fruit was negatively correlated to body fat percentage ($r = -0.2$, $p \leq 0,05$) but not BMI ($r = -0.093$, $p = 0.26$). The number of MyPyramid equivalents of dairy was also negatively related to both body fat percentage ($r = -0.21$, $p \leq 0.05$) and BMI ($r = -0.21$, $p \leq 0.05$). Percentage of calories from Non Nutrient Dense Foods (NNDF) was positively related to percent body fat ($r = 0.179$, $p = 0.029$). For every 1-percentage increase in NNDF, there was a 0.12 percentage point increase in body fat.

Conclusion. Increasing fruit, dairy, and vegetable intake, and reducing intake from Non Nutrient Dense Foods (NNDF) such as French fries, cookies, and candy, may have a beneficial influence on body composition in college women.

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Introduction

Modern advances in technology and convenience-driven industries often create unhealthy lifestyles at work, school, and during leisure-time activities. Convenience and convenience-prepared foods are often linked to poor dietary quality and may be detrimental to health. College students are especially susceptible to modern-day food conveniences, and thus poor dietary choices, because of environmental cues experienced in college. In addition, accelerated weight gain is often seen among college students.[1] One reason for this accelerated weight gain may be a result of poor diet quality.[2, 3]

Because college students are in a crucial period of their lives, the habits formed during college are significant, as those habits often remain after graduation.[4] Recent research has shown that those who develop poor eating habits during college often follow similar lifestyles later in life.[5] Thus, habits developed during college could be a contributing factor to the current obesity epidemic.

Outside of class time, college students tend to spend the majority of the day in cafeterias, studying, or socializing, and the dietary options available at these on-campus sites may have direct impact on dietary decisions and weight.[6] In addition, stresses from being a college student have been cited by women as triggers for overeating.[6] Thus, in addition to external cues having a possible impact on weight, gender may also play a role in dietary choices related to weight gain.

Because of high-stress situations, social pressures, and convenience experienced during college, women may make decisions related to health differently than men, especially when it involves eating.[7-8] Research shows that women tend to eat based on emotional cues rather than hunger cues, employ unrealistic eating practices, and often base food choices on social factors.[8-11] College women are a unique population when it comes to health because of the behaviors

manifested in response to dietary, exercise, and social circumstances during this transitional period of life.[12] Those behaviors may make adherence to the MyPyramid more difficult, and may in turn negatively affect body weight and body composition in college women. More research is needed to better understand and evaluate what foods college women are eating, and the quality of their diets, and how these choices relate with their body weight and body composition.

To date, studies examining the relationship between body composition and dietary quality, or adherence to MyPyramid recommendations, in college women are lacking. Furthermore, there are no studies that have controlled for the potentially confounding influence of physical activity objectively. Thus, the primary purpose of this study was to examine the relationship between dietary quality and body composition and body weight in college women, with and without statistical adjustment for differences in objectively measured physical activity.

Methods

A total of 163 women were recruited to participate in the study. To be a part of the study, participants had to be between 18-24 years old, full-time students, non-smokers, not pregnant, able to participate in physical activity without restriction and not taking metabolism-altering medication during the study. Participants were recruited through fliers, emails, word of mouth, classroom announcements, and facebook groups. The study was approved by the university's institutional review board, and participants' consent was obtained prior to their involvement in the study.

Design

The study employed a cross-sectional design and the data was collected during the 2009-2010 academic year.

Procedures

Participants were asked to take part in two assessments separated by 8 days. Participation in the study involved completing a Food Frequency Questionnaire (FFQ), wearing an accelerometer for a 7-day period, and body composition testing. No interventions took place.

During the first appointment, height, weight, and body composition were assessed. Following these assessments, participants were issued an Actigraph accelerometer, and instructed on how to properly wear the monitor.

During the week between appointments, participants were asked to wear the Actigraph accelerometer at all times. In addition, participants were asked to complete an online Food Frequency Questionnaire (FFQ). To ensure compliance, each participant was contacted during the week via email and/or by phone. Participants returned the accelerometer at the second appointment. At this time, the accelerometer data were downloaded to the computer, and examined for completeness. After all other data were assessed and checked for completeness, each participant received a $15 cash incentive for participation.

Instrumentation and Measurement Methods

The following methods were used to assess body composition, diet and physical activity.

Anthropometrics

Participants were asked to refrain from eating, drinking, or exercising 3 hours prior to assessing body composition. Body composition was assessed in a standardized bathing suit.

Height- The participant's height was measured to the nearest 0.1 cm using a standard wall-mounted stadiometer.

Weight- Body mass was measured using a digital scale accurate to the nearest 0.05 kg (Tanita Corporation, Japan; modified by Life Measurement, Inc., California). The scale was calibrated

every week to ensure accuracy and decrease variability between participants during the testing period.

Body Composition- The Bod Pod (Concord, California) was used to assess body composition. The Bod Pod has been compared to Dual Energy X-Ray Absorptiometry (DXA) and has been shown to be both validity and reliable.[13] The bivariate correlation between both measures was 0.89 and the intraclass correlation coefficient was 0.92 (99% CI=0.85-0.96).[13] The Bod Pod was calibrated prior to each test. Thoracic lung volume was measured in duplicate, and the average of the two measurements was used for data analysis.

Dietary Intake

Dietary intake was assessed using the Diet History Questionnaire (DHQ). The Healthy Eating Index (HEI) was used to score the participant's dietary quality.

Food Frequency Questionnaire (FFQ). The DHQ was developed by the National Cancer Institute (NCI) and was adapted from both the Block and Willett FFQs. The DHQ was compared against the Block and Willet FFQs in a study.[14] The DHQ had the strongest correlation to actual dietary consumption and caloric intake (r=0.48) when compared to the Block (r=0.45) and Willett (r=0.18) FFQs.

The DHQ included pictures of serving sizes and foods to help participants record diet information properly. The DHQ included questions on fruit and vegetable intake, snack and 'junk foods' (labeled NNDF for Non-Nutrient Dense Foods), and the frequency of those foods eaten in the past year. The questionnaires were analyzed using Diet*Calc.

Dietary Quality. To evaluate and score students' dietary quality, the Healthy Eating Index (HEI) was computed from the DHQ results. The HEI was developed by the United States Department of Agriculture (USDA) to score diets based on suggested consumption amounts in

conjunction with the dietary pyramid recommendations.[15] The HEI components were updated to match the MyPyramid equivalents in 2005; there are 12 HEI components to the HEI-2005 (see Table 1). This index has been used in other studies to evaluate adherence to MyPyramid recommendations.[16-18] In addition the HEI has been validated against nutritional biomarkers.[19]

'Junk food,' or Non-Nutrient-Dense Foods (NNDF) was calculated as a percentage of total calories. NNDF included: hash browns/potato patties/French fries, gravy, salad dressing, mayonnaise, dips, pizza, ice cream, cakes/muffins, pies, cheesecake, chocolate bars, crisps, crackers, sweet biscuits, sweets, popcorn, granola bars, sweetened drinks, carbonated beverages (regular, not diet), butter/margarine, jam/marmalade, and sugar/honey.[20]

Physical Activity

Physical activity was assessed using accelerometry to control for its potential influence on dietary choice and body composition. The Actigraph accelerometer (Actigraph LLC, model GTM1, Walton Beach, FL) was worn to objectively measure steps taken and intensity of activities performed per day. The accelerometers were worn laterally on the right hip. The Actigraph accelerometer is a valid measure of physical activity.[21]

Participants were asked to wear the accelerometer at all times for 7 consecutive days (excluding only swimming and bathing activities). A day was considered complete if the participant wore the monitor 80% of the time between 7 am and 11 pm. Non-wear time was calculated as a string of 20 minutes of consecutive zeros. If the monitor malfunctioned, or if a day's data was incomplete, the participant was asked to wear the monitor for an additional day that was comparable to the day that was missed.

Data Analysis

In the study, the criterion variables were BMI and percent body fat. The predictor variables included HEI, components of the HEI, and NNDF ('junk food'). Means and standard deviations were calculated and reported for all predictor and criterion variables. The general linear model was used to assess relationships between criterion and predictor variables. The influence of potential confounding variables on primary relationships was determined using partial correlations. Control variables included age, year in school, energy consumption, and physical activity. Normally distributed bivariate relationships were determined using Pearson correlations. The total HEI score was used to rank individuals by overall dietary quality, and individual component scores of HEI were used to determine adequacy or inadequacy of dietary intake of specific food groups and nutrients, such as saturated fat, servings of dairy, or servings of vegetables. In addition, dietary quality was classified using the recommended HEI criteria as "Good" (≥ 80), "Needs Improvement" (51-80), and "Poor" (<51).[15, 22] All analyses were performed using PC-SAS (version 9.12) and alpha was set at $p \leq 0.05$.

Results

A total of 163 women were recruited to participate in the study. Of the 163 women recruited for this study, 149 had complete diet, body composition, and activity data. The participants were drawn from all four years of college and were comprised of 30 freshman, 59 sophomores, 39 juniors, and 25 seniors. There was no significant difference in BMI, body fat percentage or physical activity across college year (see Table 2).

Demographic data are shown in Table 2. The mean age was 20.4 ± 1.6 yr, participants' mean body fat percentage was $26.3\% \pm 6.2\%$, and mean fat mass was 16.6 ± 6.0 kg. On average, participants had a normal BMI with a mean score of 22.4 ± 3.0. Six percent of participants were

underweight (BMI < 18.5), 78% were normal weight (BMI = 18.5-24.9), and 16% of participants were classified as being overweight/obese (BMI ≥ 25).

Diet quality for participants in the study was evaluated using the HEI-2005 (see Table 1 and 3). The average HEI score was 70.0 ± 10.3 out of 100. This mean HEI score is classified as "Needs Improvement."[23] Of the women in the study, 14% had diets classified as "Poor," 72% had diets classified as "Needs Improvement" and 14% had diets classified as "Good."[23] Overall, the diet quality in this sample was higher than the general population, but 86% of the women consumed diets that "Needs Improvement."

There was no relationship between adherence to the MyPyramid recommendations (as measured using the HEI) and percent body fat or BMI. Similarly, body fat percentage and BMI were compared against quartiles of HEI scores (highest quartile, middle two quartiles, and lowest quartile) and there were no significant differences among quartiles (p=0.13, see Figure 1). Controlling for objectively measured physical activity or age did not strengthen this relationship.

The 12 components that comprise the HEI are reported in Table 3. Sixty-five percent of the women met the recommendation for fruit, 79% for whole fruit, 29% for vegetables, 16% for dark green and orange vegetables, 59% for total grains, 5% for whole grains, 40% for dairy, 41% for meats and beans, 24% for oils, 9% for saturated fats, <1% for sodium, and 11% for calories from solid fats, alcohol and added sugar.

The relationship between body composition and the components of MyPyramid that comprise the Healthy Eating Index are shown in Table 3. MyPyramind equivalents of fruits and dairy were both negatively related to percent body fat (see Table 4), but only dairy was related to BMI. Women who consumed more than three MyPyramid equivalents of fruit per day had significantly lower body fat than women who consumed fewer than two MyPyramid fruit

equivalents per day (see Figure 2). Women who consumed two or more MyPyramid equivalents

of dairy per day had significantly lower body fat and BMI than women who consumed fewer

than two equivalents per day (see Figure 3). These relationships were independent of age,

physical activity, and energy intake.

Percentage of calories from Non-Nutrient-Dense Foods (NNDF) was positively related to

percent body fat, but not BMI (see Table 4). This relationship was not altered by age or physical

activity. For every 1-percentage increase in NNDF, there was a 0.12 percentage point increase in

body fat.

Discussion

In the U.S., dietary quality among adults has been classified as "Poor," when evaluated

using the 2005-HEI. Based on NHANES III data, the average HEI score was 50.4 out of 100.[23]

While in the general population, dietary quality is poor, there are differences in specific

populations. In a study evaluating the diet quality of healthy women who were of child-bearing

age or pregnant, the mean HEI score was 72.6 and 75.0, respectively;[24] the scores seen in these

studies were similar to those seen in the present study. Thus, the diet quality of this college

population was higher than the general population, yet may not differ from similar, female-

specific populations.[23]

Although the diet quality of the women in the study was higher than the general

population, there were certain areas among the MyPyramid recommendations that were lacking.

For example, few participants in the study met the recommendation for vegetables and whole

grains. In addition, the overwhelming majority of the women in the study consumed an excess

of the following HEI components, saturated fat, sodium, and calories from solid fats and added

sugars. Thus, although the college women's mean HEI score was higher than the general population, there are areas of the diet that could be improved.

The primary purpose of this study was to evaluate the relationship between dietary quality, and body weight (BMI) and body composition in college women. The findings presented in this study do not support a relationship between adherence to the MyPyramid recommendations, and body weight or composition. Furthermore, even while controlling for objectively measured physical activity and energy intake, no significant relationship was seen between adherence to MyPyramid recommendations and body weight or composition in college women.

Contrary to the findings in the present study, Guo et al. found a relationship between adherence to the Food Guide Pyramid and body weight using NHANES III data.[3] Results from the study by Guo et al. demonstrated that individuals, who had diets that were classified as "Poor" or "Needs Improvement," had higher odds of being obese, as compared to those who consumed diets classified as being "Good." However, comparing the results presented by Guo et al. to the current findings is difficult. Guo et al. used the original HEI that was developed to assess adherence to the Food Guide Pyramid. The HEI that was used in the current study was an updated version, which was developed in 2005 to reflect adherence to the MyPyramid recommendations. Guenther et al. evaluated the impact of the change from evaluating adherence to the Food Guide Pyramind to adherence to the MyPyramid recommendations, on HEI score. When evaluating the NHANES III data using the old HEI compared to the 2005 HEI there was a 13-point drop in HEI score when using the 2005 HEI standard, as compared to the older HEI.[23] Thus, the number of people classified as either "Needs Improvement" or "Good" in Guo et al.'s

study was much higher using the original-HEI than would be seen if the newer MyPyramid standards were applied to that study.

Although adherence to MyPyramid recommendations was not related to body composition or BMI, certain components of the MyPyramid did predict body composition and BMI in this population. Fruits and dairy were both negatively related to body composition. Women who consumed 2 or more servings of dairy had the lowest percent body fat and BMI. Similarly, women who consumed 3 or more servings of fruit had the lowest percent body fat, but a similar relationship was not seen with BMI. Also it should be pointed out that consumption of dark green and orange vegetables demonstrated a negative relationship with percent body fat that trended toward significance (p=0.051).

There is mounting evidence that fruit consumption has a beneficial impact on body weight.[25] Several cross-sectional studies have shown an inverse relationship between body weight and fruit intake.[26-28] In a study conducted solely on middle-aged women, Djuric et al. found that increasing fruit and vegetable intake reduced body fat and body weight when fat intake was monitored.[29] In two different populations of women, those who increased fruit intake saw reductions in body weight and body fat over time.[30, 31] Other cross-sectional studies showed either neutral or negative relationships between fruit intake and body weight.[25] The current findings support previous research conducted in women, and maintains a favorable relationship between fruit consumption and body composition.

Similarly, there is increasing evidence that dairy intake is negatively related to body composition and body weight. Poddar et al. found that in college women, dairy consumption helped to prevent weight gain and increases in body fat.[32] Similar results have been seen in adolescents and in the general population as well.[33, 34] Although the design of the current study is

cross-sectional, it suggests further that dairy consumption in a college population may be beneficial for both body weight and composition.

Also beneficial to body weight and body composition could be a reduction in calories consumed from Non-Nutrient-Dense Foods (NNDF), or 'junk food.' Foods that have minimal nutrition, aside from calories, are easily accessible on college campuses and may promote weight gain. This is supported by Levinsky et al., who demonstrated that high levels of 'junk food' were related to weight gain in the first three months of college, and that 'junk food' accounted for 8% of the variance in weight gain.[35] Thus, efforts to decrease the consumption of NNDF may be beneficial for weight and body composition in college students.

While the current study answers important questions regarding diet quality and the relationship to body composition and BMI, there are a few limitations that should be discussed. Due to the demographics of this college's population, the participants were somewhat homogenous, and a lack of racial diversity was noted. Also, in the study only one form of dietary intake was represented using the DHQ. The DHQ has been found to be a reliable and valid instrument to report dietary intakes, yet self-reporting was still involved. Self-report naturally includes human error, and thus there is a tendency to underreport dietary intake, especially in the form of recall from the previous year. Also, the study was a cross-sectional study, allowing for significant relationships to be seen, however, it does not allow for analysis of changes in dietary quality or body fat percentage and BMI over time. Furthermore, cause and effect could not be inferred.

This study does make a number of contributions to the current literature related to dietary predictors of adiposity in college women. First, there are currently no studies evaluating the relationship to adherence to the MyPyramid recommendations and body fat or weight in college

women. In addition, studies that have evaluated diet in college students have not objectively measured physical activity to control for the potential confounding influence this variable might have on energy balance.

Conclusion

Findings from the current study do not support a relationship between adherence to MyPyramid recommendations and lower percent body fat or BMI. However, adherence to certain components of the MyPyramid is related to lower body fat and BMI in college women. Both fruit and dairy consumption were negatively related to percent body fat, and dairy intake was related to BMI. Also of note, consumption of dark green and orange vegetables had a negative relationship with percent body fat that trended toward significance. In addition, diets high in NNDF were associated with higher body fat. Future research should evaluate these relationships longitudinally as well as in populations that have a lower overall diet quality.

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Figure 1. HEI Score Quartiles and its Relationship to Body Fat Percentage
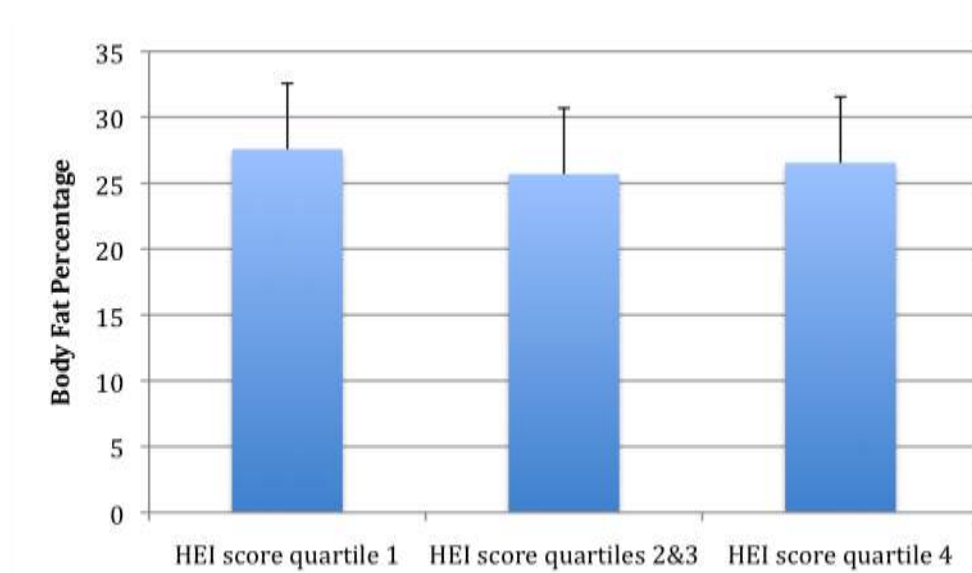
*no significant difference between groups.

Figure 2. Total MyPyramid Equivalent Servings of Fruit in Relation to Body Fat Percentage and BMI
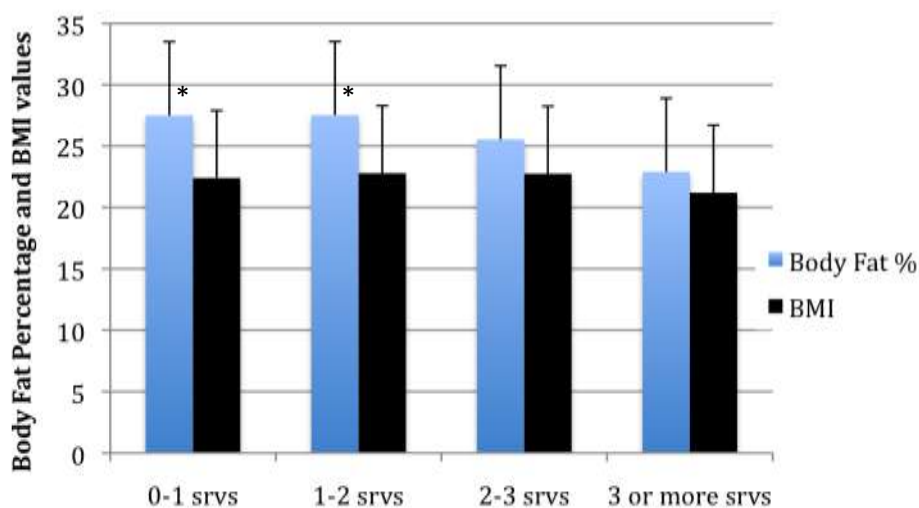
*Significantly higher than participants consuming ≥ 3 servings (p ≤ 0.05).

No difference among any groups for BMI.
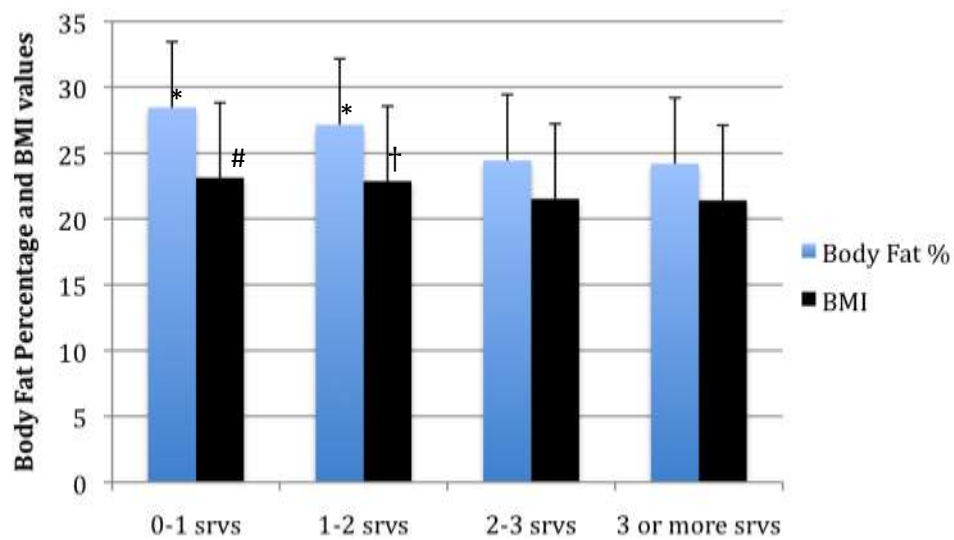
Figure 3. Total MyPyramid Equivalent Servings of Dairy in Relationship to Body Fat Percentage and BMI

* significantly higher than ≥ 3 servings for percent body fat ($p \leq 0.05$).

significantly higher than 2-3 servings and 3 or more servings for BMI ($p \leq 0.05$).

† significantly higher than 2-3 servings for BMI ($p \leq 0.05$).

Table 1. Healthy Eating Index-2005 [36]

Healthy Eating Index-2005 components and standards for scoring[1]			
Component	**Maximum points**	**Standard for maximum score**	**Standard for minimum score of zero**
Total Fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit (not juice)	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Dark Green and Orange Vegetables and Legumes[2]	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green or Orange Vegetables or Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000 kcal	No Grains
Whole Grains	5	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Milk[3]	10	≥1.3 cup equiv. per 1,000 kcal	No Milk
Meat and Beans	10	≥2.5 oz equiv. per 1,000 kcal	No Meat or Beans
Oils[4]	10	≥12 grams per 1,000 kcal	No Oil
Saturated Fat	10	≤7% of energy[5]	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal[5]	≥2.0 grams per 1,000 kcal
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	≤20% of energy	≥50% of energy

[1] Intakes between the minimum and maximum levels are scored proportionately, except for Saturated Fat and Sodium (see note 5).
[2] Legumes counted as vegetables only after Meat and Beans standard is met.
[3] Includes all milk products, such as fluid milk, yogurt, and cheese.
[4] Includes nonhydrogenated vegetable oils and oils in fish, nuts, and seeds.
[5] Saturated Fat and Sodium get a score of 8 for the intake levels that reflect the 2005 Dietary Guidelines, <10% of calories from saturated fat and 1.1 grams of sodium/1,000 kcal, respectively.
Source: Taken from USDA. Healthy Eating Index--2005. (PDF)

Table 2. Means and Standard Deviations of Women Participants' Demographics

Variable	University Year in School				Total
	Freshman N=30	Sophomore N=59	Junior N=39	Senior N=25	
Age	18.7 ± 0.3	20.0 ± 1.2	21.0 ± 1.1	22.6 ± 1.4	20.4 ± 1.6
BMI	22.6 ± 2.8	22.4 ± 3.3	22.4 ± 2.5	22.7 ± 3.6	22.4 ± 3.0
Body Fat Percentage	26.8 ± 6.6	26.8 ± 6.0	26.1 ± 5.9	26.5 ± 7.1	26.3 ± 6.2
Body mass (kg)	60.7 ± 10.1	61.1 ± 8.8	62.6 ± 8.4	63.1 ± 11.5	61.6 ± 9.3
Fat Mass (kg)	16.7 ± 6.4	16.7 ± 5.8	16.7 ± 5.4	17.3 ± 7.6	16.6 ± 6.0
Steps per day	10920 ± 2776	10580 ± 2748	11050 ± 3088	10764 ± 3766	10798 ± 2991
Accelerometer counts per day*	373.5 ± 108.6	374.6 ± 104.3	415.8 ± 138.1	398.6 ± 196.1	391.6 ± 135.2

Mean $\pm$ standard deviation

*original accelerometer counts divided by 1000.

Table 3. HEI Components from the College Women's Dietary Consumption

HEI Component*	MyPyramid Amount Mean $\pm$ SD	HEI Score Mean $\pm$ SD	Maximum HEI score
Total score in points (HEI 2005)		70.0 $\pm$10.3**	100
1: Total Fruit, includes 100% juice (srvs)	1.7 $\pm$ 1.2	4.3 $\pm$ 1.1	5
2: Whole Fruit, not juice (srvs)	1.5 $\pm$ 1.1	4.5 $\pm$ 1.0	5
3: Total Vegetables (srvs)	1.4 $\pm$ 0.9	3.6 $\pm$ 1.2	5
4: Dark Green and Orange Vegetables and Legumes (srvs)	0.3 $\pm$ 0.3	2.5 $\pm$ 1.5	5
5: Total Grains (srvs)	4.8 $\pm$ 2.3	4.5 $\pm$ 0.8	5
6: Whole Grains (srvs)	1.1 $\pm$ 0.9	2.3 $\pm$ 1.2	5
7: Milk (srvs)	1.9 $\pm$ 1.5	7.8 $\pm$ 2.3	10
8: Meat and Beans (oz)	3.5 $\pm$ 1.9	8.5 $\pm$ 2.0	10
9: Oils (g)	14.2 $\pm$ 8.6	6.9 $\pm$ 2.4	10
10: Saturated Fat (g)	18.5 $\pm$ 9.9	6.4 $\pm$ 2.9	10
11: Sodium (mg)	2480.4 $\pm$ 1125.2	3.6 $\pm$ 1.9	10
12: Calories from Solid Fats, Alcoholic beverages, and Added Sugars (SoFAAS)	434.8 $\pm$ 208.8	14.5 $\pm$ 4.0	20

Mean $\pm$ standard deviation

*srv= 1 serving of MyPyramid equivalents.

**National mean HEI score = 50.4 (Source: National Health and Nutrition Examination Survey, 2001-2002).

Table 4. Correlation Matrix of Selected HEI Components and NNDFS (Non Nutrient Dense Foods) in Relation to Body Fat Percentage and BMI

HEI variable	% Body Fat	BMI
Total Fruit	-0.20*	-0.09
Total Dairy (servings)	-0.21*	-0.21*
Green/Orange vegetables	-0.16	-0.03
Meat/Beans	-0.10	-0.06
Whole Grains	-0.14	-0.08
Oils	0.01	-0.03
Saturated fat	-0.08	-0.12
Percent calories from NNDF	0.17*	0.13

*p ≤ 0.05.

The Relationship between College Females' Body Composition and their Dietary Quality: a
Cross-sectional Analysis

Prospectus by

Annette Bailey

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Chapter 1

Introduction

Modern advances in technology and convenience-driven industries often create sedentary and unhealthy lifestyles in work, school, and leisure activities. Convenience and convenience-prepared foods, often linked to poor dietary quality, may be detrimental to the health of Americans, especially college students.

Because college students are in a crucial period of their life, the habits formed during college are significant because those habits often remain even after graduation. (Hoffman DJ, Policastro P, Quick V, & Lee SK, 2006) Research has shown that those who develop sedentary lifestyles and poor eating habits during college often follow similar lifestyles in their later years. (Racette, Deusinger, Strube, Highstein, & Deusinger, 2008) Thus habits developed during college, could be a contributing factor to the current obesity epidemic.

Recent research has shown that college students are often susceptible to modern-day food conveniences and thus poor dietary quality choices because of high demands in school, work, and social spheres. (Economos, Hildebrandt, & Hyatt, 2008) Time and convenience are often the motivating forces for most activity or diet-based decisions among college students. The time spent in cafeterias, studying, or socializing may have direct impact on dietary decisions and weight. (Greaney et al., 2009) In addition, stress was cited by female-only focus groups as a trigger for overeating. Thus, if stress and other environmental factors viewed as barriers to a healthy lifestyle are universally prevalent in college, weight gain and increase in body fat would be the end result.

Though college students often alter behaviors such as diet choices because of high-stress situations, social pressures, and convenience, (Huang TT et al., 2003; Luffey, 1998) the female

college population is even more unique in the way those behaviors are executed, especially when it involves eating. (Hashizume, 2006a) The research shows that females tend to eat based on emotional cues rather than hunger cues, employ strict eating practices, and often base food choices on social factors. (Hashizume, 2006a; Hashizume, 2006b; Malinauskas BM, Raedeke TD, Aeby VG, Smith JL, & Dallas MB, 2006b)(W. Y. Huang, 1999) Thus there is a need to better understand what foods college students are eating and how these choices alter body weight and composition.

Recently there has been interest in better understanding the phenomena of the so-called, "freshman 15." Several studies conclude that in actuality, the weight gain is much less than 15 pounds. (Hodge, Jackson, & Sullivan, 0301; Holm-Denoma, Joiner, Vohs, & Heatherton, 2008) Although there is a modest weight gain trend of about 2-7 pounds in most college students, those same studies note that overall caloric intake does not increase significantly over the freshman year. Both factors, a decrease in physical activity and change in quality of the diet, are often noted in the conclusions as *possible* culprits in freshman weight gain; however, most diet-based studies involving college students do not employ either a measure of physical activity or a measure of dietary quality to test that hypothesis. Of several reviewed studies, the majority evaluated dietary intake using dietary recalls or surveys to estimate caloric content of the diet rather than the quality of calories consumed. Physical activity was usually self-reported or not measured at all. Also, research tends to focus on the freshman year, and often overlooks the other college years. Therefore, research regarding college students' dietary quality across differing university years is needed.

More research needs to be done to assess the relationship between dietary quality and its role in body weight and body composition during the college years. Studies using dietary quality

based on the government-sponsored MyPyramid recommendations rather than total caloric intake, as an explanation of body composition in female college students, are lacking. Furthermore, there are no studies to date that have used objective measures of physical activity as a control in the analysis of dietary quality and body composition.

Statement of the Problem

The purpose of this study is to examine the relationship between dietary quality and body composition in female college students. The following are primary aims of the proposed study:

1. To determine the relationship between dietary quality (adherence to MyPyramid recommendations) and body weight/composition in college females.
2. To determine the relationship between dietary quality as evaluated by both fruit and vegetable intake and 'junk' food (low-nutrient dense food) intake and body weight/composition in college females.
3. To evaluate differences in the above aims by year in college (i.e., freshman, sophomore, junior).

Hypothesis

A negative linear relationship will exist between college females' dietary quality and body weight/composition.

Null Hypothesis

No relationship will exist between college females' dietary quality and body weight/composition.

<p align="center">Assumptions</p>

1.   The participant will accurately and honestly complete the FFQ, ASA24, and information questionnaires on the appointed days.

2.   The participant will wear the accelerometers for the prescribed 7 days accurately and not tamper with the devices.

3.   The participant will be fasting for at least 3 hours prior to body weighing and Bod Pod testing.

<p align="center">Delimitations</p>

The study will include approximately 200 healthy, female full-time BYU students. The participants will not include smokers or women who are pregnant and all participants must be able to participate in physical activity without restriction.

<p align="center">Limitations</p>

1.   It is impossible to eliminate all biases from the study because of possible human, measurement, and statistical error.

2.   The study will use self-reported, web-based questionnaires, such as the FFQ and ASA24, rather than direct dietary measurement. This may limit the research because the final data could be biased by participant interpretation.

3.   The study will employ research assistants to conduct body weight and body composition measurement; a limitation because of human error.

4.   A web-based program will compute FFQ and ASA24 data. This is a limitation because the database may not include all food and drink items participants consume.

5. There will be no interventions in the study, limiting the ability to determine cause and effect.

Definition of Terms

Dietary Quality: a diet that meets participant's nutritional needs in terms of adherence to MyPyramid recommendations.

'Junk' Food: food that is high in total fat, saturated fat, or sugar in proportion to weight of food (e.g. high-fat cakes, cookies, ice cream, and chips)

Obese: having a BMI >30

Chapter 2

Review of the Literature

Introduction

Obesity and overweight is an epidemic in America. Modern advances in technology and convenience-driven industries often create sedentary and unhealthy lifestyles in work, school, and leisure activities. Convenience and convenience-prepared foods, often linked to poor dietary quality, may be detrimental to the health of Americans, especially university students.

Recent research has shown that college students are often susceptible to modern-day conveniences and thus poor dietary quality choices because of high demands in school, work, and social spheres. (Economos et al., 2008)Time and therefore convenience is often the motivating force for most activity or diet-based decisions among college students. Because university students are in a crucial period of their life, the habits formed during college often remain even after graduation. (Hoffman DJ et al., 2006) Research has shown that those who develop sedentary lifestyles and poor eating habits during college often generate similar lifestyles in their later years. (Racette et al., 2008)

College students often alter behaviors such as diet choices because of high-stress situations, social pressures, and convenience. (Huang TT et al., 2003; Luffey, 1998) The female college population is even more unique in how they handle those situations, especially when it involves eating, as compared to college men. (Hashizume, 2006a) The research shows that females, more so than men, tend to eat based on emotional cues rather than hunger cues, employ strict eating practices, and often base food choices on social factors. (Hashizume, 2006a; Hashizume, 2006b; Malinauskas BM, Raedeke TD, Aeby VG, Smith JL, & Dallas MB,

2006b)(W. Y. Huang, 1999) Those dietary habits and practices could have dire implications for weight gain in college females.

Because of this phenomenon, weight gain is an oft-studied topic. For example, there have been a number of studies investigating the phenomenon of the so-called, "freshman 15." Several studies conclude that in actuality, the weight gain is much less than 15 pounds. (Hodge et al., 0301; Holm-Denoma et al., 2008) Some researchers have observed that freshman-year weight gain has been as modest as 2.5 to 3 pounds (Jung, Bray, & Martin Ginis, 2008)(Kasparek, Corwin, Valois, Sargent, & Morris, 2008) or as much as 10.5 pounds. (Hodge, et al, 2006) Although research documents varying totals of weight gain, there is a general weight-gain trend among college students that outpaces the trend in the general population.

Despite the weight gain trend, most studies point out that overall caloric intake does not increase significantly over the freshman year. (Jung et al., 2008) To explain the weight gain despite little change in caloric consumption, investigators have speculated that there is a reduction in physical activity and/or quality of the diet. Unfortunately, most diet-based studies involving college students do not employ either a measure of physical activity or a measure of dietary quality to test this hypothesis.

The quality of the diet could be a contributor to the weight gain and body composition changes. However, studies describing dietary quality, as a rationale for explaining body composition in female college students, are scarce. Furthermore, there are no studies to date that have used objective measures of physical activity to control its influence on energy balance. Thus the independent impact of dietary quality on body composition is not well established, especially in college women.

This review of the literature will examine what is known about diet quality and its relationship to body weight and body composition. Overall diet quality will be examined as well as what is known about some of the individual components that make up a high quality diet (e.g. fruits and vegetables, 'junk' food).

Dietary Quality

A healthy, quality diet is based on variety, balance, nutrient value, and moderation in the diet. (mypyramid.gov) Dietary quality is determined by assessing the food's nutritive contribution based on an accepted standard whereas dietary consumption usually refers simply to the food's caloric content. (Ziegler, 2005) Because dietary consumption is easier to measure using mathematical measures, dietary quality is rarely used in research. However, the U.S. government developed a dietary quality score, the Healthy Eating Index (HEI), which evaluates diets based on 10 components: five food groups (fruits, vegetables, grains, milk, meats) and five subgroup intakes of total fat, saturated fat, cholesterol, sodium, and dietary variety. The 10 components each has a scoring range, based on individual requirements as assessed by the government-accepted MyPyramid standard, of 0-10, with an overall dietary score of 100. (KENNEDY, OHLS, CARLSON, & FLEMING, 1995a) Although the HEI is a good tool when measuring dietary quality, because of the seemingly lacking research in regards to the relationship between HEI score and body composition, further research in that area would be beneficial.

Healthy Eating Index. As already indicated, an individual's diet quality status could be numerically evaluated using fruit and vegetable intake scores and junk food scores, making the research more manageable and meaningful. The MyPyramid database, which measures dietary

intake compared to personalized needs in conjunction with the Healthy Eating Index (HEI), could be used to assess dietary quality. The HEI was developed by the Department of Agriculture as a measure of diet quality and has been found to be valid (KENNEDY, OHLS, CARLSON, & FLEMING, 1995a) and useful in several research studies. (Guo, Warden, Paeratakul, & Bray, 2004; Hiza & Gerrior, 2002; Newby et al., 2003)

In a college population an interactive internet application of the HEI was used to evaluate the quality of the students' diets. (Hiza & Gerrior, 2002) Hiza et al found that younger college students had higher HEI scores compared to older students and that in general, females had higher HEI scores than did males. Hiza et al recommend using the HEI or interactive HEI to score diet quality in a research setting.

Diet Quality Index. The Diet Quality Index (DQI) is used to measure the quality of dietary consumption based on 10 dietary recommendations as noted in US nutrition guidelines. In research the DQI is often used to measure chronic disease risk in the context of dietary quality. Newby et al employed the Diet Quality Index to evaluate the reliability and reproducibility of the DQI-R (revised version) as used with a Food Frequency Questionnaire (FFQ). (Newby et al., 2003) They found that the DQI-R score was directly correlated with biochemical measurements "of α-carotene ($r = 0.43$, $P < 0.0005$), ß-carotene ($r = 0.35$, $P < 0.005$), lutein ($r = 0.31$, $P < 0.005$), and α-tocopherol ($r = 0.25$, $P < 0.05$)." Thus in this study, a DQI was accurate in assessing nutritional intake based on biomarker analysis.

To assess all available dietary quality indexes, Kant et al reviewed all published dietary quality indexes, and especially the DQI and HEI. Patterson et al developed the DQI, which is based on specific nutrient and food intake recommendations from the Food and Nutrition Board,

and is successful because it distinguishes high-quality diets based on the evaluative, specific nutrients and a low intake of dietary total and saturated fat. The Healthy Eating Index (HEI) also measures quality based on total and saturated fat intake, cholesterol, sodium, and dietary variety. Thus in Kant's review, in context of 'junk' food consumption or total and saturated fat intakes, a measure of dietary quality scored by HEI and/or DQI, would be acceptable, valid, and useful. (Kant, 1996)

Fruit and Vegetable Intake in the College Population

Fruits and vegetables are often viewed as nutrient-dense foods because of the many health benefits associated with them. Because of the high nutrient (vitamins, minerals and fiber) content relative to calories consumed, fruits and vegetables can make a significant contribution to overall dietary quality. Two of the components of the HEI are based on the amount of fruits and vegetables consumed; the more fruits and vegetables consumed, the higher the HEI score.

In a review article, Beth Carlton Tohill et al examined 16 epidemiological studies on the correlation between fruit and vegetable intake and adults' body composition/weight that were conducted during the 1966-2003 period. (Tohill, Seymour, Serdula, Kettle-Khan, & Rolls, 2004) The reviewed studies used 24-hour dietary recalls, FFQs, or food records to measure dietary intake. They observed that some of the studies found an association between higher fruit and vegetable consumption and lower body weight, while others did not. One of the possible explanations for the different findings may be based on how fruit and vegetables are defined. The studies differed on how they defined fruits and vegetables such as fruit juice and fried potatoes. Therefore, the association between body composition and fruit and vegetable intake can be inconsistent if fruits and vegetables are not clearly defined or controlled.

In addition to controlling for the type of fruits and vegetables used in the study, controlling for other lifestyle variables when evaluating body composition is important. In a study conducted on smokers vs. nonsmokers, underweight women had a higher intake of fruits and vegetables than did overweight or obese women (Subar, Harlan, & Mattson, 1990) whereas in a study determining chronic disease risk, total fruit and vegetable intake (including fruit juices) was higher among both the obese and normal-weight male subjects compared to underweight male subjects. (Serdula et al., 1996) The researchers deliberately separated fruit juice from fruit consumption in the analysis so as to evade any false associations between consumption, body weight, and disease risk. Both these studies show there is some association between fruit and vegetable intake and body composition when controlling for weight or smoking status.

Although research has been conducted on the association between fruit and vegetable intake and body composition in adult and pediatric populations, only a few studies have been done specifically in the college population. This is surprising given the dietary behaviors of the population.

In a prospective study, Huang et al discovered from dietary records that students were often skipping meals and 80% of them ate a snack daily. (Y. Huang, Song, Schemmel, & Hoerr, 1994) Of the top 40 foods selected by both males and females, few were fruits or vegetables. Males also tended to eat more fast food and less fruits or vegetables than the females. These findings are consistent with Sang-Jin Chung et al's research where they found that eating meals such as breakfast increased the likelihood of students consuming fruits and vegetables. (Chung & Hoerr, 2005) They also found that females ate more fruit than did males but the opposite was true for vegetable consumption. The association was weakened, however, when fruit juice was

included in the fruit category and fried potatoes in the vegetable category. Thus, as the researchers later noted, it is important to either define what constitutes a fruit and vegetable or to statistically control for the research discrepancies.

It is important to evaluate how dietary consumption compares to recommended intakes. In evaluating fruit and vegetable intake among college students, Melby et al conducted a survey at a midwestern university to evaluate dietary and exercise habits in college students. Of the 1,226 students that responded, 69% neglected to consume any fruit and 43% consumed vegetables less than one time daily. (Melby, Femea, & Sciacca, 1986) Furthermore, in a study evaluating fruit, vegetable, and fiber scores, Payne et al used college students' nutrition surveys to screen for high or low intake of fruit, vegetables, and fiber. The mean score of all students for fruit, vegetable, and fiber intake was 12.01 (out of 36). Because the researchers determined a score of lower than 20 to indicate very low intake, the analysis showed that the majority of students had a very low intake of fruits, vegetables, and fiber. (Payne, Bess, & Claypool, 1996) As compared to the overall diet (other food consumed), those students' scores illustrate a poor diet in terms of percentage of food eaten being a fruit, vegetable, or of high-fiber. Based on these findings, few college students meet recommended levels of fruits and vegetables.

College students in other countries may have poor diets as well. A Turkish study showed that in their country fruit and vegetable consumption among college students do not meet recommendations. The researchers used a questionnaire composed of free response questions regarding food intake and a stress scale to determine students' stress levels and fruit and vegetable consumption. They found that as stress levels increased among students, fruit and vegetable intake decreased across both genders. (Unusan, 2006) They also showed that as the students' fruit consumption increased, the number of vegetable servings also increased. This

alludes to the idea that one excellent dietary choice may benefit daily food choices and influence overall diet quality.

Based on these findings it seems that college students' dietary intake may not meet recommended levels for quality nutrient intake. Furthermore, those studies showed that when lifestyle factors were controlled for and food groups defined, college students who ate diets rich in fruits and vegetables tended to be healthier.

'Junk' Food in the College Population

Low-nutrient, energy-dense foods are often known as 'junk food.' Junk food has been defined as food that is either processed, contains little or no nutritional value, or has a relatively high energy density (meaning the food is high in calories and/or fat). Briefel et al, who conducted a study on school children's meal choices noted that the school environment may actually hinder children's eating a high quality meal at lunch by offering vending machines or à la carte options. Those competitive 'junk' food options, such as sugar-sweetened beverages, salty/high-fat chips, high-fat baked goods, and desserts are low-nutrient and high-energy-dense, providing excess energy to the children. (Briefel, Wilson, & Gleason, 2009) Most junk food, as observed by Briefel et al, is eaten as snacks or desserts and often because the food is convenient, fast, and flavorful. In his book, Mindless Eating, Dr. Brian Wansink explains that because the current society is fast-paced and always 'on-the-go,' people tend to consume more calories than they think, thus leading to overweight and obesity. The problem with junk food, he notes, is that the food is loaded with calories, fat, sugar, and cholesterol, but lacks any major nutritional benefit and thus, is 'junk.' (Wansink, 2006)

Dr. Kelly Brownell, an obesity specialist of Yale University noted that Americans live in a "toxic-food environment," in which there are many options to overeat 'junk' food and undereat fruits and vegetables. (Brownell, K.D., & Horgen, K.B., 2004) University students are not excluded from this potentially harmful environment and may even be more at risk because of their stressful schedules and unique lifestyles. (O'Connor DB, Jones F, Conner M, McMillan B, & Ferguson E, 2008) Reasons of convenience, lack of time or cooking skills, and social situations tend to drive their dietary choices, and junk food often plays a major role.

Researchers in Pakistan found that almost 97% of medical-school students at a Pakistanian university reported consuming junk food; of the students, 46.6% were female. (Nisar, Nighat, et al 2009) The measure of whole-grain food consumption was used to assess healthy dietary habits and only 60% of all students reported consuming whole grains. In this particular study, the researchers found that consuming junk food and soft drinks was positively associated with being overweight, while exercise and eating whole grain foods were protective against weight gain. There was no statistically significant difference between dietary habits of male students compared to female students.

Snacking is common among almost all university students. (Goldfield & Lumb, 2008) (Connell, Simmerman, Stewart, Foy, & Nettles, 2005; Luffey, 1998) Rhee et al found in their study that snacking did not differ among students separated by weight category; meaning that regardless of weight status, almost all students snacked. (Rhee, 2008) Ninety-five percent of those students who reported diet information consumed at least 2 servings of discretionary fats or sweets in three days. Thus, snacking and snack foods are universally familiar to the college population.

In addition to 'junk' food being familiar among campuses, college students often emotionally connect with the foods they eat. In a study conducted on 403 university students in Canada, Goldfield et al used a relative reinforcing value of a snack food analog to determine whether students would rather work harder to get a fruit/vegetable or a snack food (cookies, chips). (Goldfield & Lumb, 2008) The results showed that of the female university students who smoked, those who were categorized as restrained eaters and thus consciously controlled eating, were at lower risk for overconsumption of high energy-dense snack foods compared to the female-smoking non-constrained eaters. Thus, female students' psychological prompts and health factors may play a role in consumption of junk food or high energy-dense snacks.

'Junk' Food and Weight Gain

The stressful university setting may exacerbate eating habits. In a study measuring weight gain among university students during an 8-week period, 25% of both male and female students gained > 2.3 kg body weight. (Cluskey & Grobe, 2009) Through focus groups lead by Cluckey et al, participants agreed that food and especially 'junk' food was a major cause and concern in the weight gain. Cluskey et al. found that participants believed the statement that while in college, healthful eating rather than participation in exercise was harder. The participants also noted that campus food didn't seem to offer healthy options among the fast-food courts, all-you-can-eat cafeterias, and snack stores. Furthermore, Cluskey et al found that participants were surprised at the high cost and time needed to eat healthfully. (Cluskey & Grobe, 2009)

The unhealthy options, as regarded by college students, may hinder students' efforts to maintain a healthy weight. Thus students in college may have increased difficulty with dietary

choices not only because of the stress but also because of availability of food and snacking options.

Diet and Body Weight Gain/Body Composition Change in Female College Students

Females are unique when it comes to dietary choices and eating practices because they often use dietary consumption as a way to maintain, control, or alter body mass. (Cox LM, Lantz CD, & Mayhew JL, 1997; Malinauskas BM, Raedeke TD, Aeby VG, Smith JL, & Dallas MB, 2006a) Malinauskas et al found that of 185 female students at a university, 83% used some form of altered dietary practices; with 32% of the 185 skipping breakfast entirely. Specifically, 44% of the normal weight, 57% of the overweight, and 81% of the obese females consciously ate less. These dietary practices may have an unwanted impact on diet quality and risk for weight gain.

Freshman Females. Freshman females are often prone to weight gain because of the abrupt change in environment; dorm situations, social atmosphere, and stress-related emotions all contributing. (Jung et al., 2008; Kasparek et al., 2008) It is a challenging transition in lifestyle and environment. Academic and social pressures can impact physical activity levels and dietary intake. (Jung et al., 2008) Thus, research has focused on the phenomena of college freshman weight gain.

In general, studies have shown that over the past few decades, caloric intake hasn't necessarily increased (due possibly to a rather large influx in availability of low-fat and low-carbohydrate products) but obesity rates continued to rise during the same time period; the phenomenon known as the 'American paradox.' (Heini & Weinsier, 1997) It is a paradox because caloric change is often the culprit in weight gain but in Heini et al's research it was found that though American's mean caloric intake did not increase, there was an overall increase

in body mass and obesity rates. Thus, dietary quality and other contributing factors may play a role in body mass and body composition.

Butler et al explored the 'American paradox' in his study of 54 freshman females. Assessments such as BMI, body composition, cardiovascular fitness, and food frequency were used twice as measurements; once at the beginning of the fall semester of freshman year and again 5 months later. (Butler, Black, Blue, & Gretebeck, 2004) Although the participants were self-selected, the results confirm the 'American Paradox.' In the sample of students, total caloric consumption actually decreased but body mass increased. Because activity level was also used as a variable via physical activity questionnaires, the mean decrease in participants' activity level was found to be a contributing factor to weight gain.

In the same study by Butler et al, across all food groups, the number of servings of food decreased while percent fat of total food intake increased.   This suggests that the sample of freshman students ate fewer servings of food but a greater percentage of the food was high in fat. The fatty foods seem to crowd out the opportunity for consumption of fruits and vegetables because both the servings of fruits and vegetables significantly (P=0.01) decreased by the follow-up period (1.52 to 1.23 servings and 2.30 to 1.96 servings, respectively). Also, the percent of alcoholic calories significantly increased from 0.25% to 1.23% (P=0.05) upon 5-month re-testing.

In the study, overall the students' body mass significantly increased (P=0.01) indicating that a reduction in physical activity was most likely responsible. This assumption is supported by the data because both $\dot{V}O_2$ max and reported 'occupational activity levels' decreased. There was, however, a greater significance in body composition change compared to body weight

change, illustrating that body composition may be a better measure to understand how diet and physical activity influence body mass.

In assessing the relationship between change in body mass and eating habits, Levitsky et al found a significant increase in body mass among freshman students after 3 months (one semester; 1.97 ± 2.4 kg body mass change with $p<0.01$). (Levitsky, Halbmaier, & Mrdjenovic, 2004) In the specific study, the consumption of junk food played a significant role in weight gain among freshman. Junk food consumption, defined as high-fat cookies, chips, cakes, and, ice cream, had direct correlation with body mass gain and it explained 24% of the total variance when body mass was used as a covariate.

The type of food consumed plays a role in body mass but other factors may also contribute to the relationship. Dieting and restrained eating also play a large role in eating behavior and eating habits and thus in predicting weight gain. (Drapeau et al., 2003) Lowe et al studied 69 freshman female students 3 times during their first year of college. Using a multi-factorial model of dieting, Lowe et al found that those females who were dieting to lose weight actually gained twice as much as those former dieters and three times as much as the never dieters. (Lowe et al., 2006)

The interest in college freshman females' dietary habits is warranted in research because of the college-transitional stage and the many factors involved. As was observed, research shows that although the freshman weight gain phenomenon has been studied, there is much opportunity to study factors, such as dietary quality, that play a role in that body weight gain.

College Females excluding the Freshman Population. Several studies looked at the relationship between dietary habits and body composition differences among all college-aged

students. (Hashizume, 2006b; Huang TT et al., 2003; W. Y. Huang, 1999; Malinauskas BM, Raedeke TD, Aeby VG, Smith JL, & Dallas MB, 2006a) The research illustrates that poor dietary habits may continue throughout the college years and may translate into later weight management problems or obesity.

Susan B. Racette and associates at Washington University School of Medicine assessed freshman students' height, weight, BMI, and gathered questionnaires on dietary and exercise habits.(Racette et al., 2008) At the start of the study 15% of the participants were overweight or obese and by the end of the four-year period, the overweight/obesity prevalence increased to 23%. At both the first year and fourth year data collection periods, 71% of the students ate less than the recommended servings of fruits and vegetables and 50% of the students ate high-fat fast foods at least twice every week. This particular study shows that across all university grade levels, students do not consume a high-quality diet in relation to USDA dietary standards. Even though the sample size was fairly small, as it included only 204 students, the results confirm the idea that over time, a significant number of university students do not change poor eating habits and thus gain weight.

In the majority of the reviewed college research, caloric intake, not dietary quality, was the main dietary predictor variable. Evaluating dietary quality could further understanding of the relationship between college females' diets and body composition.

Conclusion

As observed in the review, the correlation between dietary quality and weight gain has not been as extensively studied. Furthermore, because college females are an at-risk population for rapid weight gain, disordered eating, and eventual overweight and obesity, studying college

females' dietary quality in relation to body weight and body composition could be a useful tool in assessing, educating, and improving the obesity epidemic.

Of the studies reviewed, the majority evaluated dietary intake based on the caloric content of the diet rather than the quality of calories consumed. Furthermore, physical activity was usually self-reported (or not measured at all) and dietary intake was assessed using dietary recall or surveys. More research needs to be done to assess the relationship between dietary quality and body weight and body composition during college. In addition, a study using objectively measured physical activity to help control for the influence of energy expenditure could be helpful in determining the extent to which dietary quality plays a role in body composition independent of activity level.

Recommendations

Further research (after our research) is needed in the area of diet quality and college females, to better evaluate whether diet quality is related to body composition and body weight.

Chapter 3

Methods

Female college students are a unique population when it comes to health because of the behaviors manifested in response to dietary, exercise, and social circumstances available to them during this transitional period of life. (Lindner, Hughes, & Fahy, 2008) Those behaviors may in turn negatively affect body weight and body composition status. Thus, the primary purpose of the proposed study is to examine the relationship between dietary quality and university females' body composition and body weight.

Design

The proposed study will employ a cross-sectional design. The data will be collected at Brigham Young University (BYU) in the fall semester 2009 and the analysis will be done in the winter semester 2010. There will not be any interventions or treatments given to participants.

Participants

Participants will be taken from a convenience sample of 200 female students and will include freshman, sophomores, and juniors currently attending BYU. To be a part of the study participants must be between 18-24 years old, full-time students, non-smokers, not pregnant, able to participate in physical activity without restriction and not currently taking medication that alters metabolism.

Recruitment. Participants will be recruited through fliers, emails, word of mouth, classroom announcements, and facebook groups. Recruitment will take place on BYU campus during orientation week and at the beginning of the fall 2009 semester.

Procedures

Participants will be asked to take part in two assessments separated by 8 days. Participation in the study will involve completing three separate Automated Self-administered 24-hour Dietary Recall (ASA24) surveys, a Food Frequency Questionnaire (FFQ), wearing an accelerometer for a 7-day period, and body composition testing. No interventions will take place.

After recruitment the participants will attend an orientation meeting where they will receive detailed information about the study, sign the IRB consent form, and fill out a general information questionnaire. Each participant will then schedule two one-hour assessments separated by 8 days.

During the first appointment the participant will have her height, weight, waist and hip circumferences and body composition assessed. Following these assessments the participant will then complete the first Automated Self-administered 24-Hour Dietary Recall (ASA24) on a provided computer, recalling everything she ate and drank during the prior 24 hours. At the end of the first appointment the participant will receive an actigraph accelerometer and be given operating and wearing instructions.

During the week between appointments, the participant will be asked to complete a Food Frequency Questionnaire (FFQ), an ASA24 and wear an accelerometer at all times. The FFQ is an online questionnaire that will ask the participant how much and how often she consumed the listed food and drink items in the previous year. The FFQ is provided by the NIH and is accessible via the Internet. To ensure compliance in following procedures, each participant will be contacted three times during the week (via email and phone).

The participant will then return the accelerometer to the researcher at the second appointment. At that time the accelerometer activity counts will be downloaded to the computer. The participant will then be asked to complete the final ASA24. While the participant is completing the ASA24, the accelerometer data for the week will be examined for completeness. After the final ASA24 is done, and all other data are completed, the participant will receive a $20 cash incentive for participation.

Instrumentation and Measurement Methods

Measurements will be assessed using the following methods and procedures.

Anthropometrics.

The participant will refrain from eating, drinking, or exercising 3 hours prior to having her body anthropometrics assessed. In addition, at the first appointment, the participant will be asked to use the restroom and wear a standardized bathing suit.

1. *Height-* The participant's height will be measured to the nearest 0.1 cm using a standard wall-mounted stadiometer.

2. *Weight-* Body weight will then be measured using a calibrated Model BWB-627-A digital scale (Tanita Corporation, Japan; modified by Life Measurement, Inc., California). The specific scale will be calibrated via computer prompts before every assessment to ensure accuracy and decrease variability between participants during the testing period.

3. *Body Composition-* The Bod Pod *Gold Standard* model, manufactured by Life Measurement, Inc, (Concord, California) will be used for the body composition testing. The Bod Pod has been found to be a reliable and valid tool for measuring body fat compared to Dual Energy X-Ray Absorptiometry (DXA). The results showed that the

Bod Pod data were correlated with the DXA scan data; the SEE, computed from

regression analyses, showed that Bod Pod measurements of body density (SEE = 0.007,

0.006) and body fat % (SEE = 2.856, 3.157) in both groups (athletes and controls) were

good predictors in terms of accuracy and reliability. (Maddalozzo, Cardinal, & Snow,

2002)

The Bod Pod will be calibrated before each test to reduce any error in the

measurements. To further avoid any inaccuracies, all tests will be done twice until the

two tests are within 1 percentage point of each other and the average of the two tests will

be used for the measure of body fat.

4. *Circumferences*- To assess circumferences following the body-composition testing, the

participant will be asked to stand straight and with the arms extended the researcher will

use a standard, Goleck tape measure; measuring in duplicate at the smallest part of the

abdomen, the largest part of the abdomen, and at the hips at the greatest extension to the

nearest 0.1 cm. The two measurements will be averaged for data analysis purposes

(Booth, Hunter, Gore, Bauman, & Owen, 2000)

Dietary Intake

Dietary Intake will be assessed using the ASA24 and FFQ to determine food and drink

consumption. The Healthy Eating Index (HEI) will then be used to score the participant's

dietary quality based on the index's 10 components.

Automated Self-administered 24-hour Dietary Recall (ASA24)

Dietary intake will be assessed by multiple use of the Automated Self-administered 24-

hour Dietary Recall (ASA24) survey provided by the U.S. National Cancer Institute in

conjunction with the National Institutes of Health (NCI and NIH).   A study conducted on third-grade students showed the survey to be a reliable and valid tool for assessing dietary intake. (BARANOWSKI et al., 2002) Though 24-hour dietary recall assessments are traditionally administered via live-interview sessions, the NCI has recently developed a self-administered web version that would reduce costs, increase participant compliance, and quickly provide complete dietary information to researchers. (http://riskfactor.cancer.gov/tools/instruments/asa24/) During the first appointment participants will be thoroughly instructed on how to accurately complete the ASA24.

Using the web-based ASA24 the participant will be asked to record everything she ate or drank in the previous 24 hours. The ASA24 includes a database of food items separated by food group. The participant will be instructed by both speaking and typed prompts in how to record meals and snacks. The serving size choices are supplemented with pictures. The system ensures the participant has included *all* foods consumed during the previous 24 hours by using repeated prompts for 'oft-forgotten foods,' such as ketchup, soda, and butter.   The complete data will be stored in a study-specific database in which only investigators have access. The data will be computed and analyzed using NCI-provided software and dietary quality will be measured using the MyPyramid consumption equivalents, also provided by the NCI. Standardized groupings to estimate dietary quality using the HEI will also be used. To ensure accuracy and completeness, the three separate ASA24 assessments will be completed on 2 weekdays and 1 weekend day.

Food Frequency Questionnaire (FFQ)

Dietary intake will also be assessed using a Food Frequency Questionnaire (FFQ). In predicting dietary outcomes using a FFQ, research shows that a FFQ is a reliable and valid tool to assess individuals' diets. (Newby et al., 2003; Sebring et al., 2007)(Carithers et al., 2009) The

National Cancer Institute (NCI) developed a FFQ that was adapted from both the Block and Willett FFQs. The NCI's FFQ, named the Diet History Questionnaire (DHQ) was compared in a study against the Block and Willet FFQs to assess its validity and reliability. (Subar et al., 2001) The researchers found that for women, the DHQ had the strongest correlation to actual dietary consumption (0.48) when compared to the Block (0.45) and Willett (0.18) FFQs.

The DHQ includes pictures of serving sizes and foods to help students record the diet information properly. The participant will be asked to complete the questionnaire during the week they wear the accelerometer. Because the questionnaire is administered via the web, the participants will be asked to complete the questionnaire at home prior to the second appointment. The participant must read each question thoroughly, however, so as to appropriately answer the dietary questions. The DHQ includes questions on fruit and vegetable intake, snack and 'junk' foods, and the frequency of those foods eaten in the past year. The questionnaires will be analyzed using the NCI-run web-based program Diet*Calc.

Dietary Quality

To evaluate and score students' dietary quality, the Healthy Eating Index (HEI) will be computed from the DHQ and ASA24 results. The HEI was developed by the United States Department of Agriculture (USDA) to score diets based on suggested consumption amounts in conjunction with the dietary pyramid recommendations. (Kennedy, Ohls, Carlson, & Fleming, 1995b) In a study using the HEI to determine diet quality among preschoolers in Greece, it showed that a high HEI score of >80 indicated a good quality diet, whereas a HEI score of <50 signified a poor quality diet. (Manios et al., 2009) In addition to the total score being used to ranking individuals by overall dietary quality, individual components score of HEI can be used to determine adequacy or inadequacy for dietary intake of specific food groups and nutrients

such as saturated fat or servings of vegetables. In addition the HEI has been shown to be correlated with nutritional biomarkers further validating its use for measuring dietary quality. (Weinstein, Vogt, & Gerrior, 2004)

University-Year Status

University year (freshman, sophomore, or junior) and age of each participant will be recorded at the orientation meeting using the general questionnaire developed by researchers.

Physical Activity

Physical activity will be assessed using accelerometry to control for its potential influence on dietary choice and body composition. Physical activity will be assessed using accelerometers, to evaluate time spent in sedentary, light, moderate and vigorous activity.

The actigraph accelerometer (Actigraph LLC, model GTM1, Walton Beach, FL) is placed on the hip to measure steps taken and intensity of activities performed per day. The accelerometers will be worn laterally on the right hip. In a study using four groups of healthy adults to test validity of various accelerometers during treadmill walking, the researchers found that the MTI actigraph had the least variability and thus was the most reliable device in measuring activity level compared to the other 3 types of accelerometers. The MTI actigraph had both the highest generalizability and intraclass correlation coefficient score.(Welk, Schaben, & Morrow, 2004)

During the test week the student will be asked to wear the accelerometer at all times (excluding only swimming and bathing activities) in order to minimize any error that could occur. Any participants who are avid swimmers will be asked to log minutes swum. If there is

any missing data, the participant will be required to wear the actigraph accelerometer for an additional day.

Data Analysis

Variables. In the proposed study the dependent variables include body weight and body fat. The independent variables include fruit and vegetable consumption, junk food consumption, fiber intake per 1000 kcal consumed, overall dietary quality score, and university-year (i.e., freshman, sophomore, and junior). Control variables will be those variables that may confound the relationship between the independent and dependent variables such as physical activity.

Database Management. All results will remain confidential and be stored in a locked drawer and on a password-protected computer.

Statistical Analysis. Means and standard deviations will be calculated and reported for all independent and dependant variables. The general linear model will be used to assess relationships between criterion and predictor variables. The influence of potential confounding variables on primary relationships will be determined using partial correlations. Normally distributed bivariate relationships will be determined using Pearson correlations. Chi-square will be used to determine associations between categorical variables. All analyses will be done using PC-SAS (currently version 9.12) and alpha will be set at $p \leq 0.05$.

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