FOOD ADDICTION AND BULIMIA

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ABSTRACT

Dr. Julian Williford, Advisor

The purpose of this study was to determine if binge eaters on a college campus showed signs of developing bulimia, as measured by analyzing data from the subjects’ voluntarily completing both *The Yale Food Addiction Scale* and *Bulimia Investigatory Test, Edinburgh*. Analysis of this data will enable the researcher to determine if binge eating appears to be a precursor to bulimia, and if there are nutritional deficiencies or toxicities, such as dietary folate, vitamin D, and calcium, associated with these unhealthy eating behaviors, as compared to those subjects with measured healthy eating behaviors.

This study consisted of a voluntary student sample population from the Introductory to Human Nutrition course at Bowling Green State University. Overall, 525 students voluntarily participated in the study, receiving extra credit for their participation.

The statistical analysis of the YFAS concluded that 5% exhibited behaviors of food addiction. Analysis of the BITE showed that 4% were classified as “high symptom”, indicating that this group had a high probability to be diagnosed with bulimia in the clinical setting.

There were significant differences when comparing the average intakes of folate and vitamin D between the spring and fall semester. The mean intakes of folate, vitamin D, and calcium were all comparable to that of the average intake of the United States population and below the recommended intakes.
This work is dedicated to my parents, family and K.B. Without their love and support, this achievement would not be possible. Thank you for always believing in me and being there for me. I truly could not have done it without you.
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CHAPTER I
Introduction

The phenomenon of binge eating has been plaguing the United States for the past five decades (1). This lifestyle may lead to obesity, which presents a whole gamut of negative health concerns. Binge eating has also been shown to be a precursor to bulimia nervosa (2).

Binge eating and bulimia nervosa are two of the most common types of eating disorders, and have a notable relationship (3). Most eating disorders are mainly associated with women; however, binge eating is split almost in half amongst males and females (2). In addition, the American Dietetic Association has suggested that frequent dieters are more at risk of binge eating, which is also coupled with an increased risk of developing bulimia nervosa (4).

The onset of binge eating is typically seen in late adolescence and early 20s (5). College students experience pressure of all types, and the desire to be thin is among them. For those who are binge eaters, purging may be the counteractive step to excessive food intake, in order to reach their desired weight or body shape.

The term food addiction is synonymous with binge eating. The Yale Food Addiction Scale was developed as a screening tool to determine if people have a food addiction (6). The Bulimic Investigatory Test has been used to screen for bulimia nervosa in populations at high risk of developing eating disorders, like teenage girls and young women (7).

Statement of the Problem

The prevalence of binge eating and food addiction continues to rise across the nation (2). Unhealthy eating behaviors are common on college campuses, and binge eating can lead
ultimately to purging, and thereby, a host of physiological problems. Binge eating may also be a precursor to bulimia (2). Recent research literature has suggested possible vitamin D deficiencies in the United States, as well as folic acid toxicity, either of which can result in many health complications.

Significance of the Study

The purpose of this study was to determine if binge eaters on a college campus showed signs of developing bulimia, as measured by analyzing data from the subjects’ voluntarily completing both *The Yale Food Addiction Scale* and *Bulimia Investigatory Test*. Gender effects, class standing, self-reported body weight and height, calculated BMI, dietary folate, vitamin D, and calcium intakes were also measured from self-reported data. Analysis of this data will enable the researcher to determine if binge eating appears to be a precursor to bulimia, and if there are nutritional deficiencies or toxicities, such as dietary folate and vitamin D, associated with these unhealthy eating behaviors, as compared to those subjects with measured healthy eating behaviors.

Limitations of the Study

This study used a convenient sample of students enrolled in the Introductory to Human Nutrition course at Bowling Green State University. The data that was collected was self-reported from the students, which relied on the subjects to be truthful and honest.
Eating disorders, such as bulimia and binge eating, are becoming more common in American society. According to the National Eating Disorder Association (NEDA), there are millions of people battling some sort of eating disorder, and the majority of these people are women; however, eating disorders are also on the rise in the male population (8). Researchers have estimated that about 10 percent of late adolescent and adult women report having symptoms of an eating disorder (9).

The development of eating disorders can occur for a variety of reasons. Some people need to feel as though they are in control, and they use their diet as a way of feeling in control of their lives (10, 11). Other individuals struggle with negative body images, and they turn to unhealthy weight loss techniques, like bulimia nervosa, to help them achieve the body they desire (10). Some individuals are affected by advertising, marketing, friends’ comments, and begin to believe that a thin frame is what is desired by society for personal acceptance (2, 10). No matter the cause of the eating disorder, the health outcome can be severe.

Many researchers in the nutrition field have reported that those battling an eating disorder are also struggling with some sort of personal psychological issue (2, 9, 10). Depression and different types of anxiety have been thought to go hand-in-hand with eating disorders (4, 12). National Eating Disorder Association (NEDA) pointed out that psychological factors are one of the contributing causes in the development of an eating disorder (8). Within this psychological category are issues with self-esteem, feelings of inadequacy, lack of control in life, depression, and anxiety (8). Interpersonal issues may also contribute to the onset of an eating disorder.
Problems concerning family and personal relationships, inability to express feelings, being teased for weight, and history of physical and sexual abuse all fall into the category of interpersonal issues (8, 10).

Social factors and biological factors can also lead to the development of an eating disorder. There is much research concerning genetics and eating disorders, and some researchers suspect that genetics also plays a large role in eating disorders (8, 9, 10, 12, 13). Chemicals in the brain that control hunger, appetite, and digestion have been found to be unbalanced in patients with eating disorders, which indicates a physiological biochemistry link (8). Saito et al. and Gratacos et al. suggested that brain-derived neurotrophic factor (BDNF), which promotes neuroplasticity and cell survival, is lower in persons with eating disorders (12, 13). Gratacos et al. expanded this idea by stating, “There is a significant association between Val66Met polymorphism of BDNF and eating disorders” (13, pg 920).

**Binge Eating**

Binge eating is characterized by frequent episodes of eating large quantities of food in short periods of time. Binge eaters are also referred to as compulsive overeaters and food addicts (9). Most binge eaters feel out of control over their eating behaviors, and feel ashamed and disgusted by the eating behavior. There are also behavioral indicators, which include both eating when not hungry, and eating in secret (2). Binge eating is categorized as an eating disorder, and is closely linked with bulimia nervosa (2). According to the Diagnostic and Statistical Manual of Mental Disorders, binge eating is defined strictly as the consumption of an objectively large amount of food in a discrete time frame, while experiencing a loss of control over eating (14).
Binge eating was first recognized as an eating behavior over 40 years ago among obese individuals, but was not recognized as a mental disorder until 1994 (5).

BED (Binge Eating Disorder) is recognized as an Eating Disorder Not Otherwise Specified (EDNOS); however, it is still considered to be the most common form of eating disorder (5, 9). It is estimated that 5% of the population are currently, or have previously, experienced binge eating disorder (15). While rates of BED are higher in women, at about 60% compared to 40% in males, there is a much smaller gap between the sexes when compared to other eating disorders (1, 2). The onset of BED typically occurs in late adolescence or in the early 20’s of adulthood (5).

There are many different pathways that lead to the onset of BED. Studies have suggested that frequent dieters are 12 times more likely to binge eat than those who do not diet often (2, 16). Studies also suggest that nearly 90% of females on a college campus attempt to control their weight through dieting (11, 16), which would put college females at greater risk for BED. Spoor et al. suggested that dieting causes the body to shift from physiological control to cognitive control, concerning eating behaviors (17). The dieter typically will experience chronic hunger, which will then leave them at risk for binge eating. Studies have suggested that there are multiple factors that can lead to an episode of binge eating. The most common variables associated with binge eating include being alone, focusing on food and eating, boredom, and dissatisfaction with one’s body shape and weight. The binge eating episode may, therefore, provide some sort of break from these negative thoughts/moods (18).
Health Consequences of BED

Binge eating disorder (BED) potentially has numerous health consequences related with the eating condition. Whether the health consequence is either physical or mental, it can have very serious implications. Within the past four decades, there has been an increased incidence of metabolic syndrome. Included in this illness is insulin resistance, overweight, hypertension, and dyslipidemia (19). According to the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, metabolic syndrome is defined as having at least three of the following five criteria: abdominal obesity; fasting glucose ≥110 <126mg/dL; blood pressure ≥130/85mmHg; triglycerides ≥150mg/dL; or, high-density lipoprotein cholesterol [<40mg/dL for men and <50mg/dL for women] (20). The most common health consequence associated with BED is obesity, but it must be noted that BED occurs in individuals of all weight ranges (5). Overall, BED affects about 8% of overweight individuals, and about 25-50% of obese people trying to achieve weight loss (5, 20). Other health consequences associated with BED are heart disease and gallbladder disease, as well as the cluster of symptoms associated with metabolic syndrome (2). The more obese an individual becomes causes an increase in the negative health consequences of the increased total body fatness.

Mental health effects are related to BED, which include: exposure to negative comments about weight and shape, negative self evaluation, perfectionism, low self-esteem, and low levels of perceived social support (4). Depression is also often related to BED, and it is common for people to feel distress, shame, and guilt over their eating behaviors (2). Johnson et al. found that women with BED showed more psychological distress and depression than NBED women (5).
**Food Addiction**

Within the past 40 years, there have been tremendous increases in the consumption of processed foods with high concentrations of sugar and fat in the United States (19). Studies suggest that people exhibit addictive behaviors to these substances, not unlike that of alcohol and tobacco (19, 21). Research indicates that addictive behaviors involving alcohol, drugs, and food are overlapping and are referred to as ‘cross-addictions’ (21). In a study of 691 students at both public and private universities, researchers found that 6.5% of the subjects had an addiction to food, and nearly 2% had an addiction to both food and alcohol (21). Rogers et al. agreed that binge eating should be labeled as a food addiction, by stating, “it [binge eating] is a severe psychopathological state in which control over eating is lost, and it causes harm to the individual who typically attempts unsuccessfully to refrain from the behavior” (22, page 7). Mathes et al. suggested that the neurobiology of binge eating behavior mirrors that of other substance abuse behavior (15).

**Bulimia Nervosa**

Bulimia is characterized by a cycle of bingeing, and then compensatory food expulsion behaviors to offset the binge eating (2, 23). Bulimia has three common symptoms associated with the disorder. The first symptom is regularly consuming large amounts of food, and then feeling a loss of control over recent eating behaviors. Secondly, those who regularly use inappropriate compensatory behaviors like self-induced vomiting, laxative abuse, fasting, and excessive exercise have a primary symptom of bulimia. The third primary symptom associated with bulimia is the individual’s extreme concern with their personal body weight and shape (8).
According to the Academy for Eating Disorders (AED) the formal diagnosis for bulimia means that the individual must not meet the same criteria for anorexia nervosa (9). Also, individuals must engage in the behaviors associated with bulimia for at least three months (9). There are two subgroups for bulimia. The first group is those who purge to compensate for their binge eating, and they accomplish this by vomiting, or by using laxatives, diuretics, or enemas. The second bulimia subgroup includes those individuals who do not purge, but compensate their binging by over exercising or by subsequent dietary fasting (9).

Bulimia nervosa affects about 2% of adolescents and adult women in the United States. About 80% of people who experience bulimia nervosa are women (2). Studies have differentiated the risk factors of BED and BN; however, many of the risk factors seen with BED overlap with those that lead to BN (3).

The health consequences that can result from having an eating disorder range from mild to extreme. For example, the length of time one battles the disorder and the type of disorder are major factors, and can cause different levels of physiological damage, like weakening of the heart muscle.

There is often an electrolyte imbalance that can lead to arrhythmia and even death in bulimics (8). The electrolyte imbalance is caused by dehydration and the loss of sodium, potassium, and chloride related to the post-eating purging (8). There is also potential for gastric rupture, especially in times of bingeing (8). Self-induced vomiting causes a lot of harm to the body’s gastrointestinal tract: the esophagus can become inflamed and even rupture; a hiatal hernia may develop; the stomach acid will start to stain the teeth and destroy the enamel, which contributes to bacterial decay (8). This deterioration of the oral cavity can also lead to a distinct odor in the mouth, which is often described as moldy and sour smelling, and is offensive to
people. Using laxatives is also a way of purging, and such behavior may also cause large bowel damage (9). The colon can start to depend on the laxatives for bowel movements, and require, over time, larger doses of laxatives in order to expel fecal waste from the body.

_Treatment of Eating Disorders_

There are different ways to treat eating disorders. Some people prefer and recover better by doing outpatient therapy, while others with more severe symptoms of the disorder may require hospitalization or inpatient treatment. No matter what kind of treatment the patient receives, it is almost guaranteed that the treatment will include a primary care physician, dietitian, and a mental health expert (9). Most patients with eating disorders are treated via outpatient therapy because it is typically less invasive and less expensive (5).

Treatments within either place will usually involve psychotherapy, psychopharmacology, nutrition counseling, and in extreme cases residential treatment. Psychotherapy includes cognitive-behavior therapy, interpersonal psychotherapy, family therapy, and behavioral therapy (9). Psychotherapy can be a short process, which lasts only a few months, or it can be a long process that requires many years. Psychopharmacology is when psychiatric medications are prescribed to the patient. As stated before, there are different psychological issues that can accompany eating disorders, so medication may be needed to alleviate some of this type of stress on the body (9).

Nutrition counseling is conducted by a dietitian, and is an essential step for patients’ success in trying to normalize their diet. It is the dietitian’s role to counsel the patient on proper eating habits. The dietitian should assess the patient’s nutrition status, motivation, and current eating and behavior status, and then develop a treatment plan with the patient’s goals in mind.
Often times, motivational interviewing can be used to enhance the desire for dietary improvement of the patient. Because there are so many changes that occur in the body related to the eating disorder, the dietitian also must monitor the patient’s vital signs, electrolytes, hydration status, and weight changes. The main focus of the nutritional intervention is on nutrition education, meal planning, establishing regular eating behaviors, and discouraging dieting and purging (4). Average energy intake should be based on the energy needed for maintenance of weight. This will help minimize the feeling of hunger, which can lead to binge eating.

Residential Care and Inpatient Care for People with Eating Disorders

Residential care and inpatient care are necessary for those persons who have caused life-threatening problems to their body through the eating disorder habits (8). Inpatient care generally has a follow up period that consists of outpatient counseling to address underlying psychological issues (8). Binge eating and bulimia nervosa often follow the same treatment pathway. The extent and duration of the treatment will typically differ with each eating disorder. Hospitalization is needed often in patients with other comorbid factors, like psychiatric disorders, and to assist recovery from physiological issues (4).

Modified Bulimia Nervosa Cognitive Behavior Therapy

Modified bulimia nervosa cognitive behavior therapy has been shown as a successful approach to treating binge eating. Research has shown that about half of BED patients will refrain from binge eating following the treatment (18). This type of treatment makes the patient aware that only they are responsible for their unhealthy behavior, and trains them to view
situations more realistically, and hopefully behave in a healthier manner (24). Patients may also choose pharmacotherapy treatment; however, success rate is higher with the cognitive behavior therapy. Included in the psychotherapy treatment is determining the antecedents and consequences of the binge eating. The antecedents can be both internal and external events that take place preceding the binge eating. Consequences are the events following the binge eating, and are typically either a negative reinforcement like anxiety, or positive reinforcement like satiation (18). There are also support groups, like Overeaters Anonymous, for people with BED (25).

Regardless of the type of treatment, treatment should be individualized for each patient to increase the possibility of individual success. Not all patients are able to recover from the harm they have caused their bodies, and those seeking treatment also have a high chance for relapse. Studies have shown that 35-73% of binge eaters receiving psychotherapy will abstain from binge eating, compared to 0-35% of those receiving pharmacotherapy treatments (18). Fifty to 70 percent of bulimics will recover, 30 percent will improve somewhat, and 20 percent will remain chronically ill (9, 26). These statistics show how difficult recovery from bulimia nervosa can be.

**The Yale Food Addiction Scale**

Developed in 2009, the Yale Food Addiction Scale (YFAS) is a 27-item questionnaire used to measure the dependence of consumption of particular foods; however, only the first 21 questions were used in this study [Appendix A]. The YFAS uses a Likert Scale format, and points range from zero to four, with zero representing never and four representing four or more times daily. The YFAS is broken down into eight subcategories, and a total score in each subcategory greater than or equal to one represents dependency on food (6). Scoring is shown in
Appendix B. The subcategories and survey questions related to each were broken down as follows:

1) Substance taken in larger amount and for longer period than intended:
   Questions 1, 2, and 3.

2) Persistent desire or repeated unsuccessful attempt to quit:
   Questions 4, 24, and 25.

3) Much time/activity to obtain, use, recover:
   Questions 5, 6, and 7.

4) Important social, occupational, or recreational activities given up or reduced:
   Questions 8, 9, 10, and 11.

5) Use continues despite knowledge of adverse consequences (e.g., failure to fulfill role obligation, use when physically hazardous):
   Question 19.

6) Tolerance (marked increase in amount; marked decrease in effect):
   Questions 20, and 21.

7) Characteristic withdrawal symptoms; substance taken to relieve withdrawal:
   Questions 12, 13, and 14.

8) Use causes clinically significant impairment:
   Questions 15, and 16.

The development of the YFAS was based on the American Psychiatric Association (APA) diagnostic criteria for addiction. Different cut-offs were examined to identify certain points that would not over or under identify participants with eating-related problems, and it was determined that rates between 5 and 20% were considered most favorable for diagnostic criteria (27). Analysis indicated that internal reliability for the single factor was adequate (Kuder-Richardson $\alpha= 0.75$), and the YFAS had high convergent validity, meaning that it has a high correlation with other similar eating pathology scales. The preliminary analyses of this questionnaire determined that it is a useful tool to identify persons with addictive eating behaviors towards food (6).
**Bulimic Investigatory Test, Edinburgh**

The Bulimic Investigatory Test, Edinburgh (BITE) is a 33-item self-reported survey and it was designed to identify subjects with symptoms of bulimia or binge eating [Appendix C] (7). The BITE can be used to screen a given population or individuals in a clinical setting. The BITE uses two subscales, which include a Symptom Scale and a Severity Scale. The Symptom Scale measures the degree of symptoms present, and is divided into high, medium, and low, while the Severity Scale provides an index of severity of the bingeing and purging behavior as measured by frequency.

The Symptom Scale has a maximum score of 30. A score greater than or equal to 20 indicates a highly disordered eating pattern, and a score that would most likely fulfill a diagnosis of bulimia (7). A score from 10-19 suggests an unusual eating pattern, but is not necessarily the diagnosis of an eating disorder. Any score below 10 shows normal eating behaviors.

The Severity Scale is comprised of three questions, and within those questions are different scales, which measure the eating behavior severity. Each scale has an assigned point value which correlates with the severity and frequency of eating behaviors. A score of five or more points is clinically significant, and a score of 10 or more indicates a high degree of eating behavior severity (7).

**Diet Analysis 9.0**

Diet Analysis 9.0 is a software program used to record and analyze the self-reported dietary intake of individuals. This program allows the user to see the breakdown of specific essential nutrients within a particular food, and the percent of the daily recommended intake value of that particular nutrient. The user can electronically record their dietary intake and keep
a detailed diet history. If the user guesstimates their portion size correctly, then the user can accurately determine if they are deficient in a particular nutrient, or consuming too much of a nutrient from food intakes.

This software program was chosen for this study solely because the students participating in the current study were required to use this diet analysis program for their class assignments. This ultimately made it more time and cost efficient for both the volunteer subjects and the current project researchers.

**Eating Attitude Test-26**

The Eating Attitude Test (EAT) is a commonly used tool to measure eating disorders that has proven to be very reliable (7, 28). Developed by Garner and Garfinkel, it was originally a 40-item questionnaire, which was later shortened to a 26-item questionnaire. It was designed to measure symptoms in anorexia nervosa, and later determined to be an effective tool in measuring various types of eating disturbances (28).

This questionnaire focuses on both anorexia and bulimia nervosa. The focus of the current study was only on bulimia nervosa, so the BITE was chosen as the more applicable instrument to use to gather data.

**Eating Disorder Inventory**

The Eating Disorder Inventory (EDI) is frequently used to measure the severity of an eating disorder. This self-report questionnaire developed by David Garner in 1983, originally contained 64 items, and was designed to provide information in eight different cognitive and behavioral aspects concerning anorexia and bulimia nervosa (29).
While this tool has been deemed reliable and valid, it has been questioned when used with community samples (29). Considering the current population is college students, it was decided that the EDI would not be used in this study.

Seasonal Variation

Over the course of a calendar year, this study data was collected twice. The administration of the questionnaire was first completed by volunteer college students in the spring semester of 2010, and was administered to a different group of volunteer college students in the fall semester of 2010. Differences in scores of eating behaviors between the two semesters were taken into account to determine a possible seasonal variation effect on the data. Researchers have determined that there is seasonal variation in the intake of folate (5). This is related to the fact that in winter and early spring months the availability of folate-rich fruits and vegetables is decreased (5). Seasonal variation also has an effect on vitamin D. Exposure to sunlight increases the amount of vitamin D that the body produces, so during months with low sunlight exposure, and also in regions with more variable sunlight, the amount of vitamin D produced in the human body is decreased.

Folate

Folate is a water soluble B vitamin that is dietarily essential for the body (30, 31, 32). There are over 100 different forms of folate, which are referred to as vitamers (31). Folate is needed by the body for the biosynthesis of DNA-thymine and de-novo generation of methionine for genomic and non-genomic methylation reactions (30, 31, 32). Simply put, without folate the structural integrity of DNA is compromised. Folate is also responsible for maintaining homocysteine levels within a sub pathologic range (32). Folate is also essential for both the
formation of red and white blood cells in bone marrow and the maturation of these blood cells. Folate is a single-carbon carrier in the formation of heme (30).

The absorption of dietary folate only occurs as the monoglutamate forms, 5-methyltetrahydrofolinic acid and 5-formyltetrahydrofolinic acid (30). Absorption of folate is mostly by active transport in the jejunum, but can also be absorbed through passive diffusion when consumed in large amounts (30). The folate in food is mostly in the polyglutamate form, so it requires hydrolysis to the monoglutamate form for absorption. Conjugases in the brush border and intracellular mucosa are needed for this hydrolysis process to take place (30). Because the folate in food requires hydrolysis, the bioavailability of the folate is half of that of the purified vitamin (30).

Folate is stored mostly in the liver, which contains about half of the body’s total stores (30). Tissues with high rates of cell division typically have small amounts of 5-methyl-FH$_4$, and higher concentrations of 10-formyl-FH$_4$ (30).

**DRI for Folate**

The Dietary Reference Intake (DRI) for folate is expressed as Dietary Folate Equivalents (DFE), which takes into account the bioavailability issues (30). For instance, 1DFE = 1µg = 0.6µg of folic acid = 0.5µg of a folic acid supplement (30). The DRI for infants is expressed as Adequate Intake (AI), while for children and adults it is expressed as Recommended Dietary Allowance (RDA), shown in Table 1. The amount of folate needed varies by age and also by gender. Populations who have higher RDA’s are women of childbearing age and those who are capable of becoming pregnant because of the risk of neural tube defects (30). The Upper Limit
(UL) is not exactly known, but it is typically said to be 300-800µg for children, depending on their age, and 1mg for adults (33).

Folate is found in mostly plant foods, but some animal sources, like liver, provide folate (30). Green, leafy vegetables like spinach, broccoli, and asparagus are commonly known for being good sources of folate, but potatoes and dried beans are also good sources (30).

<table>
<thead>
<tr>
<th>Age</th>
<th>RDA (µg/day)</th>
<th>*UL (µg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>65</td>
<td>Not determined</td>
</tr>
<tr>
<td>7-12 months</td>
<td>80</td>
<td>Not determined</td>
</tr>
<tr>
<td>1-3 years</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>4-8 years</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>9-13 years</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>14-18 years</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>19+ years</td>
<td>400</td>
<td>1000</td>
</tr>
<tr>
<td>≤18 years &amp; pregnant</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>19+ years &amp; pregnant</td>
<td>600</td>
<td>1000</td>
</tr>
<tr>
<td>≤18 years &amp; lactating</td>
<td>500</td>
<td>800</td>
</tr>
<tr>
<td>19+ years &amp; lactating</td>
<td>500</td>
<td>1000</td>
</tr>
</tbody>
</table>

*The ULs for synthetic folic acid apply to forms obtained from supplements, fortified foods, or a combination of the two.

Fifty to 90 percent of the folate available in food is lost during cooking, storing, and/or processing at high temperatures (30). There are about 150 different forms of folate, so the bioavailability of folate in foods varies. This is due to the presence or absence of conjugase inhibitors and folate binders (30).
Fortification

Folate is mostly consumed as the synthetic form, folic acid or pteroylmonoglutamate (33). This form is cheap to produce and stable. Folic acid differs from the naturally occurring form of folate because it has been oxidized, and it only contains one conjugated glutamate residue (33). Folic acid is readily absorbed in the small intestine, but it must first be reduced to dihydrofolate, and then to tetrahydrofolate (33), which occurs in the liver, and must take place before it can enter the folate cycle. According to Smith et al., “theoretically, folic acid could interfere with the metabolism, cellular transport, and regulatory functions of the natural folates that occur in the body by competing with the reduced forms for binding with enzymes, carrier proteins, and binding proteins” (33, pg 518).

Researchers determined that by supplementing folic acid, the rate of neural tube defects decreased (32). The protective effect shown from folic acid led the United States Public Health Services and the Institute of Medicine [IoM] to recommend that all women of child-bearing age, and those who have the ability to become pregnant, should consume 400µg of folic acid each day. In 1998, the United States Department of Agriculture (USDA) made it mandatory that all flour and uncooked grains and cereals be fortified with folic acid (30, 31, 32, 33, 34, 35, 36). The USDA decided that 140µg be added to every 100g of flour, cereal and grains (30, 31, 32). This small amount was chosen because there was a major concern that fortifying these foods with folic acid would mask the symptoms of vitamin B₁₂ deficiency, primarily in the elderly (32). Since the fortification of folic acid in the United States in 1998, neural tube defects have decreased between 20 and 30% (36). Other countries, like Chile and Canada, have also made it mandatory to fortify flour and uncooked grains and cereals with folic acid (37). In just the first year of mandatory fortification, rates of neural tube defects decreased by 40% (37).
Negative Effect of Folic Acid

Along with decreasing the rates of neural tube defects, it was also questioned whether or not the fortification of folate would decrease the rates of certain cancers. While it was known that inadequate folate status showed increased rates of colon, prostate, and breast cancer, it was hypothesized that supplementing the diet with folic acid would cause these rates to decrease. However, as research advances, the supplementation of folic acid has been linked with increased rates of these cancers in some cases (37, 38).

Research in the past has shown that supplementing folate to children with leukemia has accelerated the progression of the disease, and has been coined the “acceleration phenomenon” (33, 34, 35). The increased disease progression has also been linked with other types of cancer. Cole, et al. found that giving 1mg/d of folic acid to patients with a history of colorectal polyps had increased risk for advanced and multiple adenomas in six to eight years of follow up (33). Another study done by Hirsch et al. compared hospital discharges before (1992-1996) and after (2001-2004) the fortification of folic acid (37). The results suggested that there was an increase of 162% of colon cancer among 45-64 year olds, and a 190% increase in colon cancer among 65-79 year olds after fortifying foods with folic acid. They also found that breast cancer rates increased 108% among 45-64 year olds, and 90% among 65-79 year olds (37).

Timing is everything concerning the safety of fortifying foods with folic acid. Animal studies have shown that supplementing with folic acid before the presence of neoplastic lesions decreases rates of cancer (33). However, it must be noted that once neoplastic lesions are present, supplementing with folate may accelerate the progression of the cancer (35).
Vitamin D

Vitamin D acts as a steroid hormone in the body, and can also be produced in the body though the exposure to ultraviolet rays of 7-dehydrocholesterol in the skin (30, 39, 40, 41). Skin exposed to sunlight converts 7-dehydrocholesterol in the skin to pre-vitamin D, pre-cholecalciferol. This compound then gets converted to cholecalciferol by thermal isomerization and is transported to the liver for storage by vitamin D-binding protein (39, 42). 7-dehydro-cholesterol, which is a lipid in animals, and ergosterol, a lipid in plants, both serve as precursors of vitamin D (30). Both of these lipids undergo photolytic ring opening when exposed to UV irradiation and yield vitamin D$_3$ and D$_2$ (30).

Vitamin D is absorbed with other lipids in the small intestine by passive diffusion. Once vitamin D is in the enterocytes, it gets incorporated into chylomicrons, exits the cell into the lymphatic system, and is transported to the liver (30, 39). A liver enzyme, 25-hydroxylase, converts endogenous vitamin D and dietary vitamin D into 25(OH)D, which has weak vitamin D activity. This storage form of vitamin D has a half life of 2-3 weeks (39). A further hydroxylation by 1α-hydroxylase occurs in the kidney and creates 1,25-dihydroxyvitamin D, or 1,25(OH)$_2$D, also known as calcitriol, the most active hormonal form of vitamin D (39).

Vitamin D has multiple roles in the body. For starters, interactions with cell membrane receptors and nuclear vitamin D receptor proteins occur, which affects gene transcription in multiple tissues (30). Vitamin D regulates over 50 genes, including the gene for calcium-binding protein, calbindin; however, most genes regulated by vitamin D play little to no role in mineral metabolism (30). Vitamin D is also an important player in the maintenance of calcium and phosphorus homeostasis in body fluid compartments (30). Without vitamin D, only 10-15% of dietary calcium and 60% of dietary phosphorus is absorbed (43). The maintenance of
homeostasis in body fluid compartments of the two minerals is accomplished in three ways: (1) through gene expression, calcitriol in the small intestine increases active transport of calcium across the gut, which then stimulates synthesis of calcium-binding proteins in the mucosal brush border. This ultimately leads to increased calcium absorption (30); (2) the circulating calcium is maintained via the bones resorption. Vitamin D works with parathyroid hormone (PTH) to move calcium and phosphorus from the bone by osteoclasts, and/or decreases urinary calcium loss to maintain normal blood levels (30, 39); and, (3) calcitriol increases renal tubular reabsorption of calcium and phosphorus in the kidney (30). These mechanisms are conducted in a coordinated fashion to maintain plasma calcium levels in the blood within a narrow range of 2-2.6 mmol/L (30).

**DRI of Vitamin D**

Adequate Intakes (AI) are set for vitamin D to meet the body’s needs when inadequate exposure to the sunlight occurs (30, 40). Serum 25(OH)D concentration is the best indicator for determining adequacy of vitamin D intake, because it represents both total cutaneous production of vitamin D, and also oral ingestion of both D₂ and D₃ (40, 44, 45). The AI, as shown in Table 2, for infants’ is 10µg, and children and adults up to age 70 years of age is 15µg/day. For adults 71 years and older, the AI for both males and females is 20µg/day. Pregnant and lactating women also need 15µg/day (40). Previous literature suggested that 2.5µg/day is a sufficient amount of vitamin D to prevent rickets in children, but increased amounts are recommended to support bone growth (30).
Table 2. Dietary Reference Intakes for Vitamin D (46)

<table>
<thead>
<tr>
<th>Age</th>
<th>*AI (µg/day)</th>
<th>UL (µg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12 months</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>1-18 years</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>19-50 years</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>51-70 years</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>&gt;70 years</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>

*Adequate Intake as cholecalciferol

Vitamin D₃ exists naturally in animal sources. The richest source of vitamin D is in fish liver oil (30). It is also found in small amounts in butter, cream, egg yolk, and liver. Most milk in the United States (98%), is fortified with vitamin D₂ (10µg/qt.), which also makes it a good dietary source. Vitamin D is very stable and does not deteriorate when heated or stored (30). Another intake source of vitamin D is through supplementation. Multivitamins for children typically contain 5µg/tablet, while adult multivitamins contain about 10µg/tablet (39). However, the main source of vitamin D for humans is exposure to sunlight. About 90% of circulating vitamin D is produced in the body through the skin’s exposure to the sun’s UV rays (42).

**Deficiency of Vitamin D**

There is no consensus for the definition of vitamin D deficiency, but most experts generally define it as a 25-dihydroxyvitamin D level less than 20ng/ml in the blood (43). Research has estimated that about one billion people in the world are deficient in vitamin D (43). Scientists have presumed that the normal adult obtained adequate vitamin D from sunlight, but it has recently been determined that vitamin D status of persons in America is low (30). It has long been known that the deficiency of vitamin D leads to rickets in children and osteomalacia in
adults (30, 39, 41, 42, 47). Researchers have reported that vitamin D deficiency may also lead to increased risks of certain cancers, cardiovascular disease, and autoimmune dysfunction (39, 43).

Rickets results from vitamin D deficiency, as well as a dietary calcium and phosphorus imbalance, and is defined as impaired mineralization of growing bones (30). This disease is characterized by structural abnormalities of weight-bearing bones, and results in: bowed legs, knocked knees, beaded ribs, pigeon breast, and frontal bossing skull (30). This occurs because the bones cannot withstand the ordinary weight, gravitational pull, stresses, and movement strains on the body. Rickets is associated with bone pain, tenderness of the muscles, hypocalcemic tetany, and increased serum and plasma alkaline phosphatase (30). Children who are most at risk for this disease are dark-skinned, are breast fed for long periods, and have minimal exposure to the sunlight. Anticonvulsant drugs also decrease circulating levels of 1, 25-dihydroxyvitamin D$_3$. Rickets can be treated with vitamin D supplementation, and other deficient necessary minerals (30).

Osteomalacia develops in adults when their epiphyseal closures make that portion of the bone resistant to vitamin D deficiency. This involves generalized reductions in bone density and the presence of pseudo fractures. Patients with this condition experience muscle weakness and bone tenderness, and have greater chances of fractures. Adequate consumption of vitamin D, calcium, and phosphorus in the diet prevent this condition from occurring. Osteomalacia can be treated with doses of D$_3$ and a balanced diet (30).

Low vitamin D status has recently been linked to cancer. Researchers reported that the proposed mechanism is 1,25 (OH)D binds to vitamin D receptors on cancer cells, leading to better regulation of gene expression and anti-proliferative or anti-metastatic effects (39). When cells become malignant, 1, 25(OH)$_2$D can induce apoptosis and prevent angiogenesis, which
reduces the chance for the malignant cell to survive (43). One study reported that women over the age of 55, taking 25µg of vitamin D daily, had an overall decrease in cancer incidence when followed up four years later (39). A meta-analysis of 17 observational studies examined vitamin D status and colorectal cancer risk, and the researchers reported that subjects in the highest quintile of vitamin D intake were 11% less likely to develop colorectal cancer than subjects in the lowest quintile (39). Another study reported an 11% reduction in breast cancer rates when vitamin D intake was greater than 20µg/day (39). In addition, a study that included 980 women determined that women with the highest vitamin D intake had a 50% lower risk for developing breast cancer (43).

Poor vitamin D status also influences cardiovascular risk (39). This could possibly be through activation of the renin-angiotensin-aldosterone system, which is known to produce hypertension, or possible stimulation of parathyroid hormone, which increases insulin resistance and inflammation (39). A study by Martins et al., with data from 15,000 people from the National Health and Nutrition Examination Survey, found that the risk of hypertension, high serum triglycerides, and diabetes was greater in subjects who had the lowest vitamin D status, when compared to those with the highest vitamin D status (p<0.001) (39). Dobnig et al. followed with a study of 3,258 patients with cardiovascular disease for seven years and measured vitamin D status. All-cause and cardiovascular disease mortality rates were highest in patients with low vitamin D status (39). Low vitamin D status was also found to be associated with inflammation, oxidative burden, and cell adhesion, which are all cardiovascular disease risk factors (39).

Diabetes has recently been linked with low vitamin D status as well. Pittas et al. determined that vitamin D insufficiency appeared to be a risk factor for the development of
diabetes mellitus (39). Liu et al. measured 25(OH)D levels in 808 non-diabetic adults and found that vitamin D status was significantly inversely correlated with fasting glucose, fasting insulin, and insulin resistance (39). Another study also determined that vitamin D deficiency increased insulin resistance, decreased insulin production, and was associated with metabolic syndrome (43). Zhang et al. measured plasma 25(OH)D levels in pregnant women around 16 weeks of gestation, and the researchers determined that women who went on to develop gestational diabetes had significantly lower baseline vitamin D than those women who did not develop this condition (39).

Toxicity of Vitamin D

The Tolerable Upper Intake Levels (UL) for vitamin D is 50µg for children and adults (30, 40). Toxicity is characterized by elevated serum calcium and phosphorus levels and calcification of soft tissues (30). People with toxic vitamin D levels often complain of headaches and nausea, while infants often have gastrointestinal distress, bone fragility, and retarded growth (30). Vitamin D toxicity is linked with excess supplementation of vitamin D, not through the consumption of food alone (30). Reaching toxic levels is much rarer than being deficient in vitamin D (43).
CHAPTER III

Methods

Subjects

This study consisted of a voluntary student sample population of the introductory human nutrition course at Bowling Green State University. There were two sections of the nutrition class, which totaled about 600 students. Overall, 525 students from these classes voluntarily participated in the study. Most students were between 18-23 years of age, and the makeup of the class was predominately female. The class consisted mostly of Caucasians and African Americans. Each student who participated in the study received 20 extra credit points. This incentive was offered to recruit a larger sample size in order to generate a larger N for statistical analysis. Students who agreed to participate in this study signed a consent form that described the details of the study. They had the option to discontinue their involvement in the study at any time. The study was approved by the BGSU human subjects review board [approval number: H10T257GE7].

Materials

Each student completed 3 components for the study. The students used the Diet Analysis Plus 9.0 computer program to complete an individual, self recorded, five day, diet record for analysis of the nutrient content of their food intake, so it was essential that all participants had access to a computer. A five day analysis of each student’s diet would possibly reveal inadequate intakes of a number of nutrients, assuming the student followed the directions provided to keep a 5-day diet record, appropriately [Appendix D]. The Yale Food Addiction
Scale was used to screen the subjects for binge eating, and the participants also completed the 
Bulimic Investigatory Test to screen for bulimia nervosa. Permission was granted to use both 
tools in the current study.

**Procedures**

The Human Subjects Review Board at Bowling Green State University reviewed and 
approved the study to be conducted [HSRB approval number: H10T257GE7]. The study was 
conducted during the spring and fall semesters of 2010 at Bowling Green State University, and 
lasted about seven days. Volunteers in the introductory nutrition course were asked to 
participate in a series of surveys and questionnaires. The students first completed the five-day 
analysis of their diet. Once this was completed, the subjects were asked to complete the Yale 
Food Addiction Scale, and the Bulimic Investigatory Test via computer, online. The dependent 
variables were the scores of the Yale Food Addiction Scale, along with the Bulimic Investigatory 
Test. The independent variable was gender. Students provided their name in order to receive the 
extra credit that was offered, but their names were numerically coded, and remained confidential.

**Statistical Analysis**

When the students completed all the surveys/questionnaires, the data were analyzed using 
SAS. From here the mean, median, and standard deviations were determined. Any \( p \)-value 
\( \leq 0.05 \) was determined to be significant.
CHAPTER IV

Results

A total of 525 students from both the spring and the fall semesters participated in this study. However, only 452 subjects completed all sections of the surveys. Two-thirds of the subjects, 310 students, were female, as shown in Figure 1. The average age of the participants was 19.7 years, with a range of 18-44 years old. The average calculated body mass index for the subjects was 24.73, as shown in Table 3.

![Figure 1. Gender Comparison](image)

Table 3. Age and Body Mass Index Breakdown

<table>
<thead>
<tr>
<th>Mean Age (years)</th>
<th>Range of Age (years)</th>
<th>Mean BMI</th>
<th>Range of BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.7</td>
<td>18-44</td>
<td>24.73</td>
<td>16-56</td>
</tr>
</tbody>
</table>

All subjects were instructed to complete the Yale Food Addiction Scale and Bulimic Investigatory Test, Edinburgh. The subjects were also instructed to complete a five-day diet analysis, which included a personal profile, body mass index, and physical activity records. The
diet analysis is part of the subjects’ course work in the introductory to nutrition class. The students in the fall completed the diet analysis in early September, while the subjects in the spring semester completed the diet analysis in January.

The YFAS indicated that almost 5%, 24 students, met diagnosis criteria for food addiction, which indicated that the majority of the participants did not trigger for having an addiction to food. When examining the gender breakdown for the dichotomous version of the YFAS, 19 females and one male triggered as having met diagnosis criteria for food addiction. The breakdown of the continuous version of the YFAS indicated that the average score for males was 1.3197 and 1.8322 for females ($p<0.0001$).

The YFAS was scored as either diagnosis of food addiction or no diagnosis of food addiction met. The average age for the no diagnosis of food addiction was 19.68, and 19.75 for the group who met diagnosis criteria for food addiction, with no significant difference between the ages ($p=0.8868$). The average BMI of the group with no diagnosis of food addiction was 24.66, and 26.15 for the group who met diagnosis criteria for food addiction. Again, no significant difference between the groups was found ($p=0.2052$).

The BITE was broken down into two subcategories; symptom versus severity. The symptom subcategory is further broken down into three groups: low, medium, and high. The majority of the participants, 69% were in the low symptom group. The medium symptom group consisted of 140 subjects, 27%, and finally, four percent were placed in the high symptom group.

Within the severity subcategory, 85% of the participants were classified as not significant. Thirteen percent of the students triggered as clinically significant, leaving 2% being classified as highly severe.
Comparison of the severity subscale and the symptom subcategory showed there was a statistically significant difference between the groups ($p<0.0001$). The low symptom group consisted primarily, 94.78%, of the not significant group from the severity subscale, 4.95% of the clinically significant group, and 0.27% of the highly severe group. The medium symptom group was made up of 67% labeled as not significant, 30% as clinically severe, and 3% as highly severe. One-third of the high symptom group was made up of the not significant subjects, 43% as clinically severe, and 24% as highly severe.

When comparing the BITE results to gender, there was a statistically significant difference in the symptom subgroup and gender ($p=0.006$). The low symptom subgroup showed that 63% of the group was female, indicating that 37% were males. The medium subgroup consisted of 76% female and 24% males. The high symptom subgroup was 100% female.

The severity subscale showed no significant differences with gender ($p=0.2284$). Sixty-seven percent of the not significant group was female, while 33% were males. The clinically significant group was made up of 72% females and 28% males. The highly severe group was 100% females.

There was a significant difference when comparing BMI to the symptom subgroup of the BITE ($p<0.0001$). The average BMI of the low, medium, and high symptom groups was 23.95, 26.26, and 27.53 respectively. Not only was there a significant difference between the high and low symptom groups, but also between the low and medium symptom group.

There was also a significant difference when comparing body mass index to the severity subgroup ($p<0.0001$). The not significant group had a mean BMI of 24.24, while the clinically significant group had an average of 27.8, and the highly severe group’s BMI was 26.2. The only
statistically significant difference was between the clinically significant group and the not significant group.

The BITE compared to the YFAS showed statistically significant differences ($p<0.0001$). When the symptom subcategory of the BITE was compared to the YFAS, it was determined that 99.7% of the subjects in the low symptom also fell into the no diagnosis of food addiction group from the YFAS. The medium symptom group had nearly 91% labeled as no diagnosis for food addiction. Finally, the high symptom group had a little over half, 52%, as no diagnosis of food addiction, leaving 48% to have met diagnosis criteria for food addiction.

The severity subscale of the BITE was also statistically significant when compared to the YFAS ($p<0.0001$). The three groups from the severity subscale were again compared to both the group with no diagnosis met and those with diagnosis met for food addiction. Ninety-seven percent of the not significant group was also labeled as no diagnosis met for food addiction. The clinically significant subjects consisted of 90% of the participants also being in the no diagnosis of food addiction group. The highly severe group was split almost in half, with 40% of the subjects meeting criteria for diagnosis of food addiction.

Comparison of the symptom subscale of the BITE to the continuous scoring version of the YFAS showed a significant difference of $p<0.0001$, as shown in Table 4. As the symptom level increases, so does the point value in the scoring of the continuous version of the YFAS.
Table 4. Symptom Subcategories (BITE) vs. Continuous Version (YFAS)

<table>
<thead>
<tr>
<th></th>
<th>Low Symptom</th>
<th>Medium Symptom</th>
<th>High Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Points</td>
<td>8.79%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 Point</td>
<td>68.13%</td>
<td>37.14%</td>
<td>4.76%</td>
</tr>
<tr>
<td>2 Points</td>
<td>14.56%</td>
<td>25%</td>
<td>14.29%</td>
</tr>
<tr>
<td>3 Points</td>
<td>6.32%</td>
<td>18.57%</td>
<td>4.76%</td>
</tr>
<tr>
<td>4 Points</td>
<td>1.37%</td>
<td>11.43%</td>
<td>9.52%</td>
</tr>
<tr>
<td>5-7 Points</td>
<td>0.82%</td>
<td>7.86%</td>
<td>66.67%</td>
</tr>
</tbody>
</table>

\[ p < 0.0001 \]

To meet diagnosis of food addiction, a score of three or above must be achieved. When looking at the low symptom subgroup, 8.79% had zero points, 68.13% had one point, 14.56% had two points, 6.32% had three points, 1.37% had four points, and 0.82% had five to seven points. The medium symptom subgroup had no participants in the zero point group, 37.14% had one point, 25% with two points, 18.57% with three points, 11.43% with four points, and 7.86% with five to seven points. The high symptom group also had no subjects score zero points, 4.76% with one point, 14.29% with two points, 4.76% with three points, 9.52% with four points, and 66.67% with five to seven points.

The severity subscale was also compared to the continuous scoring version of the YFAS, as shown in Table 5.

Table 5. Severity (BITE) vs. Continuous (YFAS)

<table>
<thead>
<tr>
<th></th>
<th>Not Significant</th>
<th>Clinically Significant</th>
<th>Highly Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Points</td>
<td>6.73%</td>
<td>2.9%</td>
<td>0</td>
</tr>
<tr>
<td>1 Point</td>
<td>60.76%</td>
<td>40.58%</td>
<td>20%</td>
</tr>
<tr>
<td>2 Points</td>
<td>16.59%</td>
<td>21.74%</td>
<td>20%</td>
</tr>
<tr>
<td>3 Points</td>
<td>8.52%</td>
<td>17.39%</td>
<td>0</td>
</tr>
<tr>
<td>4 Points</td>
<td>4.26%</td>
<td>2.9%</td>
<td>20%</td>
</tr>
<tr>
<td>5-7 Points</td>
<td>3.14%</td>
<td>14.49%</td>
<td>40%</td>
</tr>
</tbody>
</table>

\[ p < 0.0001 \]
Again, zero to two points indicates no diagnosis of food addiction was met, while three to seven points indicates that a diagnosis for food addiction has been met. The not significant severity group consisted of 6.73% with zero points, 60.76% with one point, 16.59% with two points, 8.52% with three points, 4.26% with four points, and 3.14% with five to seven points. The clinically significant group was made up of 2.9% with zero points, 40.58% with one point, 21.74% with two points, 17.39% with three points, 2.9% with four points, and 14.49% with five to seven points. Finally, the highly severe group consisted of no subjects with zero points, 20% with one point, 20% with two points, no subjects with three points, 20% with four points, and 40% with five to seven points.

When examining physical activity levels, 41.5% of the subjects classified themselves as sedentary. Nearly a quarter, 22.3%, of the students labeled their activity level as low, and another 22.3% labeled as active. This left the very active group to be considered the minority, with only 13.9% of the subjects falling into this group.

The breakdown of activity level with the dichotomous version of the YFAS indicated that there were no significant differences ($p=0.2840$). Of the 188 subjects who classified themselves as sedentary, only 10 (5.32%) of the sedentary subjects met criteria for food addiction. The low activity group consisted of 101 subjects, and only five (4.95%) of them triggered for food addiction. The active group was made up of 101 also, with one (0.99%) individual meeting criteria for food addiction. Finally, the very active group consisted of 59 students in the no diagnosis of food addiction group, and four (6.35%) subjects in the food addiction diagnosis group.

The continuous version of the YFAS was also compared to the activity level of the subjects. There were no significant differences found ($p=0.4566$). The average score for the
sedentary group, from one to seven, was 1.64. The low activity group averaged 1.81 points, while the active group averaged 1.54 points. Finally, the very active group had a mean score of 1.76 points out of seven.

When activity level was compared to the symptom subscales of the BITE, no significant differences were found ($p=0.4251$). The low symptom groups were made up of 44% of the subjects labeled as sedentary, 21% as low activity levels, 23% as active, and 12% as very active. The medium symptom subgroup consisted of 37.8% sedentary subjects, 23.6% labeled as low activity level, 19.7% as active, and 18.9% very active subjects. The high symptom group was broken down into 29.4% sedentary participants, 29.4% as low activity levels, 29.4% as active, and 11.8% as very active individuals.

There were also no statistically significant differences found when activity level was compared to the severity subscale of the BITE ($p=0.0692$). The not significant severity group was made up of 43.3% in the sedentary group, 20.4% low activity level, 23.2% active subjects, and 13.1% very active subjects. The clinically significant group consisted of 33.3% sedentary subjects, 31.7% low activity students, 16.7% active students, and 18.3% very active participants. Finally, the highly severe group did not have any sedentary individuals, but had 60% low activity level individuals, 20% active subjects, and 20% very active participants.

Through the five-day diet analysis, the intakes of folate, vitamin D, and calcium were all analyzed. The average intake of folate was 90.65% the RDA. The mean vitamin D intake was 54.52% of the recommended amount, and the average calcium intake was 73.69% of the AI. Seasonal variation was also studied by comparing the two semesters as a whole against one another. Folate and vitamin D showed statistically significant differences in intake when
comparing the spring and fall semester, with \( p=0.0136 \) for folate intake and \( p=0.0028 \) for vitamin D intake.

<table>
<thead>
<tr>
<th>Table 6. Dietary Intakes and Seasonal Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Spring: % DRI - Actual intake -</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fall: % DRI - Actual intake -</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Recommended intake -</td>
</tr>
</tbody>
</table>

\(^a\) folate intakes between semesters are significantly different at the \( p<0.0136 \)

\(^b\) vitamin D intakes between semesters are significantly different at the \( p<0.0028 \)

When comparing the average intakes of the specified nutrients, there was no statistically significant difference found between the subjects that did not qualify as having a food addiction versus the group that did meet diagnosis criteria based off the YFAS, as shown in Figure 2. The average intake of folate for the no food addiction group was 90.73% of the recommendations, and 88.95% of the RDA for the group that did have an addiction to food \( (p=0.9058) \). The mean intake of vitamin D was 54.4% of the AI for the no food addiction diagnosis subjects and 56.8% of the AI for the food addiction group \( (p=0.8588) \). The calcium intake for the no diagnosis of food addiction group averaged 74.1% of the AI, and 64.6% of the recommended value in the food addiction group \( (p=0.2919) \).
When comparing average intakes to the symptom group of the BITE, there were no significant differences found. The average intake of folate in the low symptom group was 91.6% the RDA, 89.1% the RDA in the medium group, and 85.4% the RDA in the high symptom group. Vitamin D intakes were at 52.9%, 57.1%, and 65.1% of the recommendations in the low, medium, and high symptom groups. The mean calcium intake for the low, medium, and high symptom group was 74.6%, 71.4%, and 74.8% of the AI, respectively, as shown in Figure 3.
The average intake of folate, vitamin D, and calcium was also compared to the severity subscale of the BITE, and was broken down into the three categories, as shown in Figure 4. No significant differences were found among the three groups for any of the three nutrients. The not significant group averaged 91.6% of the RDA, while the clinically significant group had 86.4% of the RDA, and the highly severe group had 67.8% of the recommended intake. The vitamin D intake for the not significant group was 53.4%, 63.4% for clinically severe group, and 40.8% for the highly severe group. The calcium intake was 73.8% of the recommendations for the not significant group, 74.5% for the clinically significant group, and 56.2% of the AI for the highly severe group.
Figure 4. Nutrient Intake Breakdown of Severity Subscale (BITE)

Intake Breakdown of Severity Subscale (BITE)

- Folate
- Vitamin D
- Calcium

<table>
<thead>
<tr>
<th></th>
<th>Not Significant</th>
<th>Clinically Significant</th>
<th>Highly Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folate</td>
<td>91.60%</td>
<td>86.40%</td>
<td>67.80%</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>53.40%</td>
<td>63.40%</td>
<td>40.80%</td>
</tr>
<tr>
<td>Calcium</td>
<td>73.80%</td>
<td>74.50%</td>
<td>56.20%</td>
</tr>
</tbody>
</table>
CHAPTER V

Discussion

The YFAS was used to determine if subjects trigger as having a food addiction. Research has suggested that binge eating behaviors are comparable to those of other substance abuse behaviors (15). The current study data analysis indicated that 5% of the subjects exhibited signs of food addiction. Similar studies done on college campuses have shown 6.5% of the subjects had an addiction to food (21). Other studies reviewed did not indicate the time period in which the research was conducted, nor was the length of time to complete the study included.

The analysis of the symptom subscale data on the BITE indicated that 4% of the subjects triggered to be in the high symptom subgroup, indicating they are likely to have bulimia. However, in order to actually be diagnosed with bulimia, the subjects would need to be in a clinical setting. The majority of the subjects fell into the low symptom category. When examining the severity subscale, the majority of the subjects had minimal to no eating behaviors or attitudes to classify them as having bulimia. Nearly 15% triggered as clinically significant and highly severe, indicating that if these students were in a clinical setting, they would trigger for having bulimia and body perception issues, based on their survey scores (7).

There were significant differences found when the BITE was compared to the dichotomous version of the YFAS ($p<0.0001$), as shown in Figure 5. As the symptom group increased from low to high, the percentage of subjects triggering for food addiction also increased, with the majority of food addiction diagnoses falling in the high symptom group. The severity subscale also showed this trend with the percentage of food addiction diagnoses increasing, as the severity level increased to highly severe, as shown in Figure 6.
Figure 5. Symptom (BITE) vs. Dichotomous (YFAS)

\[ p < 0.0001 \]

Figure 6. Severity (BITE) vs. Dichotomous (YFAS)

\[ p < 0.0001 \]
When comparing the symptom and severity subscales to the continuous version of the YFAS, significant differences were also found ($p<0.0001$). As the symptom level increased, so did the percentage of subjects who scored five to seven points, which indicates a food addiction. The same trend was seen with the severity subscale. As the severity level increased, so did the point value on the continuous scale, indicating that the more subjects met criteria for bulimia, they also met criteria for food addiction.

The gender breakdown of the YFAS indicated that nearly all of the subjects who triggered for having a food addiction on the dichotomous version were female. The continuous scoring version showed that females, on average, had an overall higher score than the males. However, the mean score for both the males and females was not significant and did not meet diagnosis criteria for food addiction using the YFAS.

Comparing the gender breakdown to the BITE scores, the symptom subgroup showed statistically significant results ($p=0.006$). All subjects that fell into the high symptom group were female. These results are comparable to those found in another study, which indicated that the majority of subjects with bulimia are women (2). The severity subscale showed no statistically significant differences ($p=0.2284$). However, 100% of the highly severe group was female. The results could have been skewed, considering over half of the studied population was female and there was not an equal breakdown of subjects’ gender wise.

Almost half of the subjects considered themselves to be sedentary. The low activity group consisted of 22% of the students, leaving an additional 22% in the active group and 14% in the very active group.
When comparing physical activity to the YFAS, there were no significant differences found in either the dichotomous ($p=0.2840$) or continuous ($p=0.4566$) scoring versions. This indicated that there was no correlation with physical activity and food addiction in this sample.

Neither the symptom or severity subscale of the BITE indicated statistically significant differences, when considering activity level ($p=0.4250$; $p=0.0692$), as shown in Figure 7 and Figure 8. This again indicated no correlation between diagnosis of bulimia and activity level in this sample. Other studies have not reported data comparing the BITE to activity level.

**Figure 7. Symptom vs. Activity Level**

- **Symptom vs. Activity Level**
  - $p=0.425$
The average BMI of the participants was 24, which falls within normal limits of 18.5-24.9. The national average for BMI for adult males is 26.6, while for adult women it is 26.5, and these values are considered to be high, indicating that the average person is overweight (49). However, it must also be mentioned that BMI does not take into account muscle mass, and therefore, it is not an exact measurement of healthy and unhealthy weight (49).

When examining the BMI breakdown for the YFAS scores, there were no significant differences found ($p=0.2052$). The average BMI for those not triggering for food addiction was 24.66, and 26.16 for those with food addiction. An individual with a BMI greater than 25 is considered to be overweight, indicating that the food addiction group, on average, is overweight (49).
The body mass index breakdown for the BITE with both subscales indicated there were statistically significant results with $p<0.0001$ on both the subscales. The high symptom groups triggered for having the highest BMI indicating that subject’s with bulimia have a higher weight to height proportion. Studies that have used the BITE as a survey tool in the past have not compared body mass index to their data.

With the help of Diet Analysis Plus, the average intakes of folate, vitamin D, and calcium were determined. All three nutrient intakes were below the RDA/AI recommendations.

The national average intake of folate, without the use of supplements, is 304µg, which is equivalent to 76% of the RDA (50). This is lower than the average intake from the current study, which was 90.65% of the RDA. There was a significant difference in folate intake when comparing semesters. This difference could be related to a seasonal variation. The fall semester took the survey in early September, while the spring class completed the survey in January. Foods naturally high in folate are more in season during the months of the fall semester, thereby making these foods more available, abundant, and affordable; however, this is a theory and was not scientifically measured.

Too much folate can have a negative effect on the body. A study by Yang et al. determined that with diet alone, their subjects did not exceed the Upper Limit for folate, which is 1000µg (50). While the majority of the subjects in the current study did not exceed the RDA for folate, a few subjects surpassed recommendations. The current study showed that subjects at the high end of the range consumed 2500µg of folate. Levels this high surpasses the suggested UL for folate, indicating these subjects may be at increased risk for the negative effects of too much folate intake over time.
The analysis of vitamin D indicated that the subjects in the current study, on average, were deficient in vitamin D intake, and consumed less than 55% of the AI. Even with exposure to sunlight, vitamin D intake is essential in northwest Ohio, where exposure to direct sunlight is less than more southern climates. Other research has reported that many people in the US society are vitamin D compromised (51). According to Bailey et al., data from NHANES 2005-2006 determined that on average, men ages 19-30 consume 5.1µg (102%) and women ages 19-30 consume 3.6µg (72%) of vitamin D (52). When comparing vitamin D intake and age groups, Bailey et al. found that the 19-30 year age range had the overall lowest intake of vitamin D (51). With the average age of the students being 19.7 years old, the findings from the current study showed mean intake of vitamin D was well below the recommendations at 55% of the AI, which support Bailey et al. findings (51).

Vitamin D is needed for multiple processes in the body, and an inadequate intake over time may lead to increased risks of cancer, cardiovascular disease, bone disorders, and autoimmune dysfunction (39, 43). Also, there may be a correlation with the increased rates of diabetes mellitus and the lack of vitamin D in the diet (39).

The range of vitamin D intake was 0-516% of the AI. Speaking in terms of micrograms, these levels are equivalent to about 25µg of vitamin D, which still does not reach the suggested UL of 50µg for vitamin D.

Calcium was briefly reviewed in the current study due to its association with vitamin D. Bailey et al. also analyzed the calcium intake using NHANES 2005-2006 data (50). The national average calcium intake in men ages 19-30 years is 1209mg, 121% AI, and 838mg, 84% AI, in women ages 19-30, with diet alone. The mean intake of calcium from both semesters in the current study was 740mg, or 74% the AI, which was considerably lower than the results of
Bailey et al. The lack of calcium in the diets of the subjects from the present study is not all that surprising. Bailey et al. determined that less than 10% of females over the age of 13 years old meet the AI for calcium through diet alone (51). This study exceeds Bailey’s percent in deficient calcium intake, and thereby supports the downward spiral of calcium intake in college age persons.

When reviewing the average intake of the studied nutrients for those who triggered as having a food addiction versus those with no food addiction, there was no statistically significant difference between the groups ($p=2.919$). This suggested that the individuals with a food addiction, on average, do not consume anymore or any less of the nutrients studied.

The average intake of the folate, vitamin D, and calcium also showed no significant differences when analyzed with the symptom and severity subscales of the BITE. Again, this suggests that having bulimia does not put a subject at greater risk for developing a deficiency or toxicity to the studied nutrients.
CHAPTER VI
Conclusion

Binge eating and bulimia are two very common eating disorders in our society (3). Both of these disorders can have very harmful physiological effects on the body if not treated properly. Bulimia is more common in the female gender, as are most eating disorders; however, binge eating disorder is becoming as common in males as it is in females (2). Eating disorders, in general, typically begin in the teenage years to early adulthood, which puts the college student population more at risk (9).

The purpose of the current study was to determine the prevalence of food addiction and bulimia in college students, while also comparing the nutrient intake of these students to the national average. The sample size consisted of 525 students, split between two semesters throughout the course of an academic year. All of the student volunteers were enrolled in the Introductory to Human Nutrition course. The Yale Food Addiction Scale and Bulimic Investigatory Test, Edinburgh, were administered to volunteer subjects both semesters, and the students were also asked to submit a five-day diet analysis through the use of the Diet Analysis 9.0 on-line computer program.

The statistical analysis of the YFAS data concluded that 5% of the subjects exhibited behaviors of food addiction. This was comparable to the estimated 5% in the United States who experience binge eating disorder (15). Analysis of the BITE data indicated that 4% of the subjects were classified as “high symptom”, indicating that this group had a high probability to be diagnosed with bulimia in a clinical setting. When compared to the national average of people diagnosed with bulimia, the current study fell on target with current reported statistics in
the United States, which is around 2%. It was hypothesized that the YFAS and BITE would have similar percentages of students triggering for food addiction and bulimia. The current percentages, 5% with food addiction and 4% with bulimia, support this hypothesis.

Diet Analysis Plus was used to determine the average intake of folate, vitamin D, and calcium, as shown in Table 6. It was determined that the intake of dietary folate was above the national average of the United States. It was hypothesized that the average intake would be above 100%, due to the unknown amount of folate that is actually added to the food products our society purchases and consumes. This study data indicated that the studied population was still below the RDA recommendations for folate. If the use of supplements would have been analyzed with this current study, it is probable that the amount of folate ingested in the subjects would have been well above the recommended amount. However, the purpose of the current study was to determine the intakes of the specific nutrients based solely off the subject’s diet alone.

**Table 6. Dietary Intakes**

<table>
<thead>
<tr>
<th></th>
<th>Folate</th>
<th>Vitamin D</th>
<th>Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td>% RDA/AI</td>
<td>90.64</td>
<td>54.51</td>
<td>73.68</td>
</tr>
<tr>
<td>Actual Intake</td>
<td>363µg</td>
<td>2.7µg</td>
<td>737mg</td>
</tr>
<tr>
<td>Recommended Intake</td>
<td>400µg</td>
<td>5µg</td>
<td>1000mg</td>
</tr>
</tbody>
</table>

There was a significant difference in folate consumption and vitamin D consumption of the subjects when comparing the semesters, which could be related to seasonal variation. While a direct cause and effect relationship cannot be determined, it can be said that seasonal variation affect on the food supply is a plausible cause for the intake difference.

As more and more nutrition research is conducted, researchers are reporting that most people in our society are vitamin D deficient, and it was expected that data from the current study subjects would yield similar results. The recent hype about vitamin D deficiency has
caused the AI of vitamin D to be increased within the last few years. Food intake data from this current study showed that the average intake of vitamin D was 55% of the AI, which is on target with recent studies (51). However, without the proper intakes of vitamin D, the subjects may be at increased risk for certain types of cancer, cardiovascular disease, and autoimmune dysfunctions. It must be noted that vitamin D status is also affected by exposure to sunlight (30, 39, 40, 41). As a self-report/questionnaire study, and lack of monies to support specific biochemical assays of targeted nutrient in subjects, like vitamin D, blood nutrient analysis was not conducted.

Calcium intake status was reviewed in this study because of its direct association with vitamin D to maintain normal human nutrition (30). If there is a vitamin D intake deficiency, which the current study indicated in the volunteer subjects, calcium is not absorbed at its full capacity. Without adequate amounts of vitamin D, only 10-15% of dietary calcium is absorbed (43). When reviewing the calcium intake from the students, it was determined that the majority of the students were consuming less than three-fourths of the recommended amount. It was determined through NHANES data that the average intake of calcium in subjects’ ages 19-30 years is over 80% the AI for both males and females, indicating the subjects in the current study were also below the national average for calcium intake (49). The subjects from the present study may benefit from nutrition education focusing on foods high in calcium and vitamin D, as well as possible low level supplementation of both nutrients.

When the average intake of the studied nutrients was compared to the YFAS and BITE, it was determined that there were no significant differences between those with a diagnosis of food addiction and/or bulimia versus those with no diagnosis of either condition.
The subjects provided their height and weight so BMI could be calculated. The average BMI was 24.7, which is within normal limits for a healthy weight (49). The national average for BMI in the United States is 26, which is higher than the current study data (49). The YFAS showed no significant differences when comparing the two groups, no diagnosis of food addiction versus those with a food addiction. However, when BMI was compared to both the severity and symptom subscales of the BITE survey data, there were significant differences found in both subscales. Researchers have reported that college students do not have the healthiest diet, whether it is related to the lack of availability of nutritious food, poor food choices, or the lack of caring, is unknown. Again, these students may benefit from nutrition education which emphasizes the importance of consuming a balanced diet as well as providing suggestions on how to achieve a balanced diet.

**Table 7. Symptom (BITE) vs. Body Mass Index**

<table>
<thead>
<tr>
<th>Symptom Level</th>
<th>N</th>
<th>Average BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>364</td>
<td>23.95</td>
</tr>
<tr>
<td>Medium</td>
<td>140</td>
<td>26.25</td>
</tr>
<tr>
<td>High</td>
<td>21</td>
<td>27.53</td>
</tr>
</tbody>
</table>

$p<0.0001$

**Table 8. Severity (BMI) vs. Body Mass Index**

<table>
<thead>
<tr>
<th>Severity Level</th>
<th>N</th>
<th>Average BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Significant</td>
<td>446</td>
<td>24.24</td>
</tr>
<tr>
<td>Clinically Significant</td>
<td>69</td>
<td>27.80</td>
</tr>
<tr>
<td>Highly Severe</td>
<td>10</td>
<td>26.20</td>
</tr>
</tbody>
</table>

$p<0.0001$

The majority of the subjects in the current study indicated that they were sedentary. There were no significant differences found with the YFAS or the BITE scores. This indicated
that activity level of those with either food addiction or bulimia was comparable to those without either of these conditions.

**Figure 9. Activity Level**

<table>
<thead>
<tr>
<th>Activity Level</th>
<th>Percent of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>35%</td>
</tr>
<tr>
<td>Low Activity</td>
<td>25%</td>
</tr>
<tr>
<td>Active</td>
<td>15%</td>
</tr>
<tr>
<td>Very Active</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Recommendations**

The current study did not take into account the use of dietary supplements, for reasons already stated, and therefore, the actual amount of the studied nutrients may not represent the actual subject intake of each vitamin and mineral measured. For future studies, it would be beneficial to have supplement intake information to see the actual deficiencies and/or toxicities of the desired nutrients. For more accurate blood levels, blood samples could be taken to determine serum concentrations in the body. Blood samples would also be beneficial for determining vitamin D levels, considering that exposure to sunlight is a factor in vitamin D status. This is recommended for a possible follow-up study, provided that funding is available.
The results of the current study may also have been skewed due to the fact that the results were based off self-reported data from the subjects. The subjects may not have answered truthfully on the YFAS and BITE questionnaires, thereby skewing the data. The five-day diet analyses may have also been inaccurate, if the portion sizes were not reported properly. In order to avoid these possible errors, the subjects, from a smaller sample size, could have been monitored, as a trained researcher records the dietary intake. The use of a Bod-Pod or hydrostatic weighing could also be used in place of simply calculating the BMI. These two methods would take into account muscle mass and would be more accurate in measuring body mass index.

After analysis of the current study, it also appears that a mandatory nutrition education course could be helpful to expose the students to the importance of proper nutrition. Future research could determine if nutrition education affects the average intake of specific vitamins and minerals. There may also be a need for counseling for those students who measure positively for either bulimia and/or food addiction on college campuses.
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29. Garner ----need to find rest of citation


selection and possible Autism prevention? A closer look at a possible link. 


Sempos, C.T., Picciano, M.F. (2010). Estimation of total usual calcium and vitamin
Appendix A

Yale Food Addiction Scale
Gearhardt, Corbin, Brownell, 2009

Contact: ashley.gearhardt@yale.edu

This survey asks about your eating habits in the past year. People sometimes have difficulty controlling their intake of certain foods such as:
- Sweets like ice cream, chocolate, doughnuts, cookies, cake, candy, ice cream
- Starches like white bread, rolls, pasta, and rice
- Salty snacks like chips, pretzels, and crackers
- Fatty foods like steak, bacon, hamburgers, cheeseburgers, pizza, and French fries
- Sugary drinks like soda pop

When the following questions ask about “CERTAIN FOODS” please think of ANY food similar to those listed in the food group or ANY OTHER foods you have had a problem with in the past year.

Point system:
Never: 0; Once a Month: 1; 2-4 times a month: 2; 2-3 a week: 3; 4 or more times daily: 4

**IN THE PAST 12 MONTHS:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I find that when I start eating certain foods, I end up eating much more than planned</td>
</tr>
<tr>
<td>2.</td>
<td>I find myself continuing to consume certain foods even though I am no longer hungry</td>
</tr>
<tr>
<td>3.</td>
<td>I eat to the point where I feel physically ill</td>
</tr>
<tr>
<td>4.</td>
<td>Not eating certain types of food or cutting down on certain types of food is something I worry about</td>
</tr>
<tr>
<td>5.</td>
<td>I spend a lot of time feeling sluggish or fatigued from overeating</td>
</tr>
<tr>
<td>6.</td>
<td>I find myself constantly eating certain foods throughout the day</td>
</tr>
<tr>
<td>7.</td>
<td>I find that when certain foods are not available, I will go out of my way to obtain them. For example, I will drive to the store to purchase certain foods even though I have other options available to me at home.</td>
</tr>
<tr>
<td>8.</td>
<td>There have been times when I consumed certain foods so often or in such large quantities that I started to eat food instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy.</td>
</tr>
<tr>
<td>9.</td>
<td>There have been times when I consumed certain foods so often or in such large quantities that I spent time dealing with negative feelings from overeating instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy.</td>
</tr>
<tr>
<td>10.</td>
<td>There have been times when I avoided professional or social situations where certain foods were available, because I was afraid I would overeat.</td>
</tr>
<tr>
<td>11.</td>
<td>There have been times when I avoided professional or social situations because I was not able to consume certain foods there.</td>
</tr>
<tr>
<td>12.</td>
<td>I have had withdrawal symptoms such as agitation, anxiety, or other physical symptoms when I cut down or stopped eating certain foods. (Please do NOT include withdrawal symptoms caused by cutting down on caffeinated beverages such as soda pop, coffee, tea, energy drinks, etc.)</td>
</tr>
<tr>
<td>13.</td>
<td>I have consumed certain foods to prevent feelings of anxiety, agitation, or other physical symptoms that were developing. (Please do NOT include consumption of caffeinated beverages such as soda pop, coffee, tea, energy drinks, etc.)</td>
</tr>
</tbody>
</table>
14. I have found that I have elevated desire for or urges to consume certain foods when I cut down or stop eating them.

15. My behavior with respect to food and eating causes significant distress.

16. I experience significant problems in my ability to function effectively (daily routine, job/school, social activities, family activities, health difficulties) because of food and eating.

IN THE PAST 12 MONTHS:

<table>
<thead>
<tr>
<th></th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.</td>
<td>My food consumption has caused significant psychological problems such as depression, anxiety, self-loathing, or guilt.</td>
<td>O</td>
</tr>
<tr>
<td>18.</td>
<td>My food consumption has caused significant physical problems or made a physical problem worse.</td>
<td>O</td>
</tr>
<tr>
<td>19.</td>
<td>I kept consuming the same types of food or the same amount of food even though I was having emotional and/or physical problems.</td>
<td>O</td>
</tr>
<tr>
<td>20.</td>
<td>Over time, I have found that I need to eat more and more to get the feeling I want, such as reduced negative emotions or increased pleasure.</td>
<td>O</td>
</tr>
<tr>
<td>21.</td>
<td>I have found that eating the same amount of food does not reduce my negative emotions or increase pleasurable feelings the way it used to.</td>
<td>O</td>
</tr>
<tr>
<td>22.</td>
<td>I want to cut down or stop eating certain kinds of food.</td>
<td>O</td>
</tr>
<tr>
<td>23.</td>
<td>I have tried to cut down or stop eating certain kinds of food.</td>
<td>O</td>
</tr>
<tr>
<td>24.</td>
<td>I have been successful at cutting down or not eating these kinds of food</td>
<td>O</td>
</tr>
</tbody>
</table>

25. How many times in the past year did you try to cut down or stop eating certain foods altogether?

<table>
<thead>
<tr>
<th></th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
</table>

26. Please circle ALL of the following you have a problem with:

<table>
<thead>
<tr>
<th>Ice cream</th>
<th>Chips</th>
<th>Apples</th>
<th>Doughnuts</th>
<th>Broccoli</th>
<th>Cookies</th>
<th>Cake</th>
<th>Candy</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Bread</td>
<td>Rolls</td>
<td>Lettuce</td>
<td>Pasta</td>
<td>Strawberries</td>
<td>Rice</td>
<td>Crackers</td>
<td>Chocolate</td>
</tr>
<tr>
<td>Pretzels</td>
<td>French Fries</td>
<td>Carrots</td>
<td>Steak</td>
<td>Bananas</td>
<td>Bacon</td>
<td>Hamburgers</td>
<td>Cheese burgers</td>
</tr>
<tr>
<td>Pizza</td>
<td>Soda Pop</td>
<td>None of the above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

27. Please list any other foods that you have problems with that were not previously listed:
Appendix B

Instruction Sheet for the Yale Food Addiction Scale
(Gearhardt, Corbin, & Brownell, 2008)
Contact Information: ashley.gearhardt@yale.edu

The Yale Food Addiction Scale is a measure that has been developed to identify those who are most likely to be exhibiting markers of substance dependence with the consumption of high fat/high sugar foods.

Development
The scale questions fall under specific criteria that resemble the symptoms for substance dependence as stated in the Diagnostic and Statistical Manual of Mental Disorders IV-R and operationalized in the Structured Clinical Interview for DSM Disorders.

1) Substance taken in larger amount and for longer period than intended
   Questions #1, #2, #3

2) Persistent desire or repeated unsuccessful attempt to quit
   Questions #4, #22, #24, #25

3) Much time/activity to obtain, use, recover
   Questions #5, #6, #7

4) Important social, occupational, or recreational activities given up or reduced
   Questions #8, #9, #10, #11

5) Use continues despite knowledge of adverse consequences (e.g., failure to fulfill role obligation, use when physically hazardous
   Question #19

6) Tolerance (marked increase in amount; marked decrease in effect
   Questions #20, #21

7) Characteristic withdrawal symptoms; substance taken to relieve withdrawal
   Questions #12, #13, #14

8) Use causes clinically significant impairment
   Questions #15, #16

Cut-offs
Cut-offs were developed for the continuous questions by examining scatterplots of the answers compared to Binge Eating scores, EAT-26 scores, and BMI.

0 = question not significantly met, 1 = question criteria is met

The following questions are scored 0 = (0), 1 = (1): #19, #20, #21, #22
The following question is scored 0 = (1), 1 = (0): #24
The following questions are scored 0 = (0 thru 1), 1 = (2 thru 4): #8, #10, #11
The following questions are scored 0 = (0 thru 2), 1 = (3 & 4): #3, #5, #7, #9, #12, #13, #14, #15, #16
The following questions are scored 0 = (0 thru 3), 1 = (4): #1, #2, #4, #6, #25
The following questions are NOT scored, but are primers for other questions: #17, #18, #23
Questions #26 & #27 provide information on foods that participants have trouble controlling

**SCORING**

After computing cut-offs, sum up the questions under each substance dependence criterion (e.g. Tolerance, Withdrawal, Clinical Significance, etc.). If the score for the criterion is ≥ 1, then the criterion has been met and is scored as 1. If the score = 0, then the criteria has not been met.

Example:
Tolerance: (#20 =1) + (#21 = 0) = 1, Criterion Met
Withdrawal (#12 =0) + (#13 = 0) + (#14 = 0) = 0, Criterion Not Met
Given up (#8 =1) + (#9 = 0) + (#10 =1) + (#11 = 1) = 3, Criterion Met and scored as 1

To score the continuous version of the scale, which resembles a symptom count without diagnosis, add up all of the scores for each of the criterion (e.g. Tolerance, Withdrawal, Use Despite Negative Consequence). Do NOT add clinical significance to the score. This should range from 0 to 7 (0 symptoms to 7 symptoms.)

To score the dichotomous version, which resembles a diagnosis of substance dependence, compute a variable in which clinical significance must = 1, and the symptom count must be ≥ 3. This should be either a 0 or 1 score (no diagnosis or diagnosis criteria met.)

**Norms**

Diagnosis of Food Dependence – 11.6%
Median Symptom Count Score – 1.0
Withdrawal – 16.3%
Tolerance – 13.5%
Continued Use Despite Problems – 28.3%
Important Activities Given Up – 10.3%
Large Amounts of Time Spent – 24.0%
Loss of Control – 21.7%
Have Tried Unsuccessfully to Cut Down or Worried About Cutting Down – 71.3%
Clinically Significant Impairment - 14%
Appendix C

Bulimic Investigatory Test, Edinburgh

1. Do you have a regular daily eating patter? Yes No
2. Are you a strict dieter? Yes No
3. Do you feel like a failure if you break your diet once? Yes No
4. Do you count the calories of everything you eat, even when not on a diet? Yes No
5. Do you ever fast for a whole day? Yes No
6. …If yes, how often is this?
   - Every second day 5
   - 2-3 times a week 4
   - Once a week 3
   - Now and then 2
   - Have once 1
7. Do you do any of the following to help you lose weight? (circle number)
   - Take diet pills 0 2 3 4 5 6 7
   - Take diuretics 0 2 3 4 5 6 7
   - Take laxatives 0 2 3 4 5 6 7
   - Make yourself vomit 0 2 3 4 5 6 7
8. Does your pattern of eating severely disrupt your life? Yes No
9. Would you say that food dominated your life? Yes No
10. Do you ever eat and eat until you are stopped by physical discomfort? Yes No
11. Are there times when all you can about is food? Yes No
12. Do you eat sensibly in front of other and make up in private? Yes No
13. Can you always stop eating when you want to? Yes No
14. Do you ever experience overpowering urges to eat and eat and eat? Yes No
15. When you are feeling anxious do you tend to eat a lot? Yes No
16. Does the thought of becoming fat terrify you? Yes No
17. Do you ever eat large amounts of food rapidly (not a meal)? Yes No
18. Are you ashamed of your eating habits? Yes No
19. Do you worry that you have no control over how much to eat? Yes No
20. Do you turn to food for comfort? Yes No
21. Are you able to leave food on the plate at the end of a meal? Yes No
22. Do you deceive other people about how much you eat? Yes No
23. Does how hungry you feel determine how much you eat? Yes No
24. Do you ever binge on large amounts of food? Yes No
25. … If yes, do such binges leave you feeling miserable? Yes No
26. If you binge, is this only when you are alone? Yes No
27. If you binge, how often is this?
   Hardly ever 1 Once a month 2
   Once a week 3 2-3 times a week 4
   Daily 5 2-3 times a day 6
28. Would you go to great lengths to satisfy an urge to binge? Yes No
29. If you overeat do you feel very guilty? Yes No
30. Do you ever eat in secret? Yes No
31. Are your eating habits what you would consider to be normal? Yes No
32. Would you consider yourself to be a compulsive eater? Yes No
33. Does your weight fluctuate by more than 5 pounds in a week? Yes No

Appendix D

Tracking Your Diet

Track your diet by recording everything you eat and drink during the day. Record everything you consume, including water, drinks, condiments, cooking oils, and alcoholic beverages.

Getting Started Tracking Your Diet

Step 1. On the main menu, click the Track Diet tab. The Track Diet page will open.

Step 2. Click the calendar icon next to the Select a Date field. The Select a Date dialog will open.

Step 3. Click on a day to select it. The day you select will be highlighted in red.

Step 4. Use the drop-down menu to make a selection to change the month or year.

Finding a Food

Step 1. In the Find Foods field, type the name of a food.

Step 2. Click the Go button.

A Food List will appear which provides a list of foods that contain the word or words you typed.

Selecting Portions

Step 1. In the Food List, click on the food name that most closely matches what you ate. You will see a pop-up dialog for adding the food to a meal.

Step 2. Check the serving size of the food, and the units of measurement.

Step 3. Carefully estimate the amount of food you ate.

- If you measured all the food in your meals before you ate them and kept a record, this is an excellent practice. This is the most accurate way to track your diet.

- If you did not measure all the food you ate, it is important to try to estimate the amounts you ate accurately. All the reports you use for your assignments will be based on the information you enter about each food.

Step 4. Choose a food category by clicking on the food that is most similar to what you ate. A Food Gallery provided by the My Pyramid web site will open.
(The USDA does not endorse any products, services, or organizations. The Food Gallery and other useful My Pyramid tools can be found at www.mypyramid.gov.)

Step 5. Type in the amount you ate.

Step 6. Click the meal to which you want to add the food: Breakfast, Lunch, Dinner, or Snack.

Step 7. Click the Save button and you will see the food added to your Food List.

Step 8. Go back to Step 1, and Search for your next food. Continue with these steps until you have listed everything you ate each day. Be as thorough as possible for best results.