The Relationship between Fruit and Vegetable Intake of Adolescents Before Sleeve Gastrectomy and Success with Weight Loss Six Months Post-Surgery

Abby L. Johnson

Georgia State University

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ABSTRACT

THE RELATIONSHIP BETWEEN FRUIT AND VEGETABLE INTAKE OF ADOLESCENTS BEFORE SLEEVE GASTRECTOMY AND SUCCESS WITH WEIGHT LOSS SIX MONTHS POST-SURGERY

by

Abby Johnson

Importance: Childhood and adolescent overweight and obesity have more than tripled over the past two decades. Bariatric surgery is becoming more common for adolescents. Currently, there are few studies that describe outcomes after bariatric surgery in adolescents and no studies that describe nutritional behaviors that predict sustained weight loss in this population post-surgery.

Objective: To describe pre-surgery dietary intake in adolescents who underwent a sleeve gastrectomy between 2011 and 2013 at an outpatient pediatric weight loss clinic. This study specifically aims to determine whether there is a correlation between fruit and vegetable intake before surgery and weight loss post-surgery in adolescents.

Design, Setting, and Participants: The participants in this study received the sleeve gastrectomy procedure. Patients were between the ages of 13-17 years old and had a BMI between 35 kg/m² to 60 kg/m². All patients had undergone extensive counseling and assessment by a team of medical professionals (pediatrician, psychologist, exercise physiologist, nurse, and dietitian) for at least six months before surgery. Weekly number of servings of fruits and vegetables, cups of sweetened beverages (separated as fruit juice or soda), servings of fried foods eaten, and meals eaten from or at restaurants as reported at the initial consultation were collected and analyzed.
**Results:** The mean age of participants (n=11) was 17.1 ± 1.51 years. Mean servings of vegetables consumed at baseline was 7.32 ± 4.38 servings per week and mean weekly consumption of fruits was 6.0 ± 4.16 servings per week. There were no statistically significant correlations between baseline fruit (p = 0.50) and vegetable (p = 0.44) consumption with weight (kg) lost six months after surgery.

**Conclusion:** While the relationship between fruit and vegetable consumption with weight lost six months post-surgery failed to reach significance, there was a trend such that patients who consumed more servings of fruits and vegetables at baseline had lost more weight at 6 months. It is interesting to note that none of the patients in the study consumed the recommended daily servings of fruits or vegetables at baseline in accordance with the USDA guidelines. A longer study may reveal a more significant relationship between dietary patterns before surgery and changes in weight after surgery.
THE RELATIONSHIP BETWEEN FRUIT AND VEGETABLE INTAKE OF ADOLESCENTS BEFORE SLEEVE GASTRECTOMY AND SUCCESS WITH WEIGHT LOSS SIX MONTHS POST-SURGERY

by

Abby Johnson

A Thesis

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Atlanta, Georgia

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<tr>
<td>AGB</td>
<td>Adjustable Gastric Banding</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<td>CVD</td>
<td>Cardiovascular Disease</td>
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<td>CDC</td>
<td>Center for Disease Control</td>
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<tr>
<td>ED</td>
<td>Energy Density</td>
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<tr>
<td>EWL</td>
<td>Estimated Weight Loss</td>
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<tr>
<td>FFQ</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>HDL</td>
<td>High Density Lipoprotein</td>
</tr>
<tr>
<td>INTERMAP</td>
<td>The International Study of Macro-/Micronutrients and Blood Pressure</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>NACHRI</td>
<td>The National Association of Children's Hospitals and Related Institutions</td>
</tr>
<tr>
<td>NASPGHAN</td>
<td>North American Society for Pediatric Gastroenterology, Hepatology and Nutrition</td>
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<td>NWCR</td>
<td>National Weight Control Registry</td>
</tr>
<tr>
<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>RYGB</td>
<td>Roux-en Y</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<td>VSG</td>
<td>Vertical Sleeve Gastrectomy</td>
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<td>Wk</td>
<td>Week</td>
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CHAPTER I

THE RELATIONSHIP BETWEEN FRUIT AND VEGETABLE INTAKE OF ADOLESCENTS BEFORE SLEEVE GASTRECTOMY AND SUCCESS WITH WEIGHT LOSS SIX MONTHS POST-SURGERY

INTRODUCTION

Topic and Problem

An analysis of representative national hospital administrative data in the United States revealed that the annual number of surgical weight loss procedures in adolescents remained stable between 1996 and 2000.\(^1\) This analysis also found that between 2000 and 2003, the rate of surgical weight loss procedures in adolescents tripled to an estimated 771 procedures nationwide. In a survey of bariatric surgeons in the United States in 2005, 75 percent reported that they were planning to perform an adolescent procedure in the upcoming year, while 42 percent reported they were in the process of developing a multidisciplinary adolescent weight loss surgery program at their center.\(^1\)

Childhood and adolescent overweight and obesity has more than tripled over the past two decades.\(^2\) Overweight is defined in children and adolescents by the Center for Disease Control and Prevention (CDC) as having a BMI at or above the 85th percentile and lower than the 95th percentile for children of the same age and sex.\(^3\) Obesity in adolescents is defined as a BMI at or above the 95th percentile for children of the same age and sex.\(^3\) Children and adolescents who are overweight are likely to remain overweight or become obese in adulthood.\(^4\)
Some pediatric studies report that bariatric surgery is a more effective weight loss method than diet supervision and counseling for obese young patients who have co-morbidities.\(^5\) Although bariatric surgery is becoming more common for adolescents, evidence-based postoperative nutritional guidelines have yet to be published.\(^6\) While bariatric surgery in adolescents has not been extensively studied, studies that examine adult bariatric populations identify weight re-gain as one of the greatest challenges for these individuals.\(^5,7\)

Currently, there are few studies that describe outcomes after bariatric surgery in adolescents or nutrition behaviors that predict sustained weight loss post-surgery. The few studies that have analyzed predictors of success in adolescents undergoing bariatric surgery have identified increased physical activity and more frequent nutritional counseling as variables that aid in successful weight loss.\(^7,8\) Widhalm et al. (2011) reported that patients with a mean age of 17.7 ± 2.6 years who underwent the gastric banding procedure regained much of their weight at a 48 month follow-up. According to dietary records, despite the limited ability to consume large amounts of food, patients had re-adopted habits of drinking greater amounts of high calorie beverages and more calorie dense foods leading to weight re-gain despite the bariatric surgery.\(^8\) This observation is not surprising given that it has been found that adolescents who consume more sugar-sweetened beverages have higher body weight compared to those who drink less.\(^9\) These findings are just one example of why more emphasis needs to be placed on dietary habits before and after a bariatric procedure.
Significance

In a longitudinal study of 2,617 participants, Freedman et al. (2001) found that 77% of obese children would remain obese into adulthood ($\geq 30$ kg/m$^2$).\textsuperscript{4} Participants were initially screened at ages 2 to 17 years old and were reexamined at 18 to 37 years. Mean follow up time was 17 years. The correlation between childhood BMI and adult BMI was $r = 0.58$. This association did not vary significantly by race, age, or gender.

There is strong evidence to suggest that childhood obesity is associated with elevated blood pressure, dyslipidemia, inflammatory markers, and insulin resistance which are all factors that may produce increased risk of atherosclerosis.\textsuperscript{10} These factors have been shown to improve with weight loss. Insulin resistances, along with blood pressure, triglycerides, and HDL cholesterol have also been shown to improve after losing weight. Additionally, postmortem studies have found that obesity in adolescents is associated with strong evidence of atherosclerosis at autopsy.\textsuperscript{11} Baker et al. (2007) found that with each single unit increase in Z score for BMI for boys aged 7-13 and girls aged 10-13, there was a significant increased risk for a coronary event in adulthood.\textsuperscript{12} This study used information from the Danish National Cause of Death Register.\textsuperscript{13}

Impaired glucose tolerance is also highly associated with obesity in adolescents.\textsuperscript{14} This can lead to insulin resistance, which can eventually lead to type II diabetes.\textsuperscript{14} Wing et al. (2011) concluded from an observational analysis of adult participants in the Look AHEAD (Action for Health in Diabetes) study that modest weight losses of just 5% to 10% were associated with significant decreases in CVD risk factors and that greater weight losses had greater benefits.\textsuperscript{15}
While the use of bariatric surgery for adolescents has become more common (Roux-en Y, gastric band, sleeve gastrectomy), sleeve gastrectomy has become a more widely used method for adolescents in recent years, increasing in prevalence from 6.7% in 2008 to 24% in 2011 (p < 0.01). With the rate of severe obesity (BMI ≥40 kg/m²) rising in children in the United States to an estimated 4% to 6%, it is imperative to find solutions that will encourage sustained weight loss in this population.

**Purpose and Research Questions**

The objectives of this study are 1) to describe fruit and vegetable intake in adolescents who undergo a sleeve gastrectomy between 2011 and 2013 at a pediatric healthy weight clinic in Atlanta Georgia and 2) to determine whether there is a correlation between fruit and vegetable intake before surgery and weight loss post-surgery. We hypothesize that adolescents who consume more servings of fruit and vegetables before surgery will achieve greater weight loss six months after surgery. If we fail to reject the research hypothesis, then increased fruit and vegetable intake after surgery in this population may assist adolescents with achieving their weight loss goals.
Bariatric Surgery and Weight Loss Maintenance

Bariatric surgery does not guarantee sustained weight loss. It is possible to gain the weight back.\textsuperscript{5,7} These procedures require the patient to adhere to a strict diet and supplement regimen for the rest of his or her life. When patients are unable to maintain such changes, it is likely that the individual will regain the weight lost. Studies that have examined the long term effects of bariatric surgery on body weight in adults have identified post-surgery weight re-gain as a significant concern.\textsuperscript{5,18,19} While specific dietary patterns that may cause this weight re-gain have not been clearly defined through research, it has been shown in adults that eating small meals throughout the day including three servings of vegetables and one serving of fruit, drinking less sweetened beverages, sleeping at least 7 hours, and exercising have all be linked to successful weight loss maintenance after surgery.\textsuperscript{20}

In a longitudinal assessment of 61 adolescents who underwent laparoscopic Roux-en-Y gastric bypass at a single pediatric center from between 2002 and 2007, Inge et al. (2010) explored the relationship between baseline BMI and BMI 1 year after surgery. Patients were categorized into 1 of 3 preoperative BMI groups: group 1, BMI = 40.0 to 54.9 kg/m\textsuperscript{2} (n = 23); group 2, BMI = 55.0 to 64.9 kg/m\textsuperscript{2} (n = 21); and group 3, BMI = 65.0 to 95.0 kg/m\textsuperscript{2} (n = 17). Mixed linear modeling was used to show changes in BMI and cardiovascular risk factors between baseline and year 1. The mean baseline BMI of
the study cohort was 60.2 ± 11 kg/m². The mean decrease in BMI was 37.4% of starting BMI at 1 year after surgery (p < .001). Percent BMI change varied little by preoperative BMI groups (-37.2%, -36.8%, and -37.7% for groups 1, 2, and 3 respectively; p = .8762). One year after surgery, only 17% of patients achieved a non-obese BMI (<30 kg/m²).

Significant improvements in systolic and diastolic blood pressure (P < .0001), fasting insulin (P < .0001), total cholesterol (P = .0007), and triglyceride levels (P < .0001) were observed post-surgery irrespective of baseline BMI class. Inge and colleagues concluded from this study that preoperative BMI served as an indicator of BMI at 1 year after surgery. This study also suggests that one does not have to lose a significant amount of weight in the first year post surgery in order to see significant improvements in other markers of health.21

In a prospective controlled study, Sjostrom et al (2004) compared obese subjects who had undergone gastric banding, vertical banded gastroplasty, or gastric bypass with matched subjects who had been treated for obesity using conventional methods ranging from lifestyle intervention and behavioral modification to no intervention at all. Treatments in the control group were not standardized. Subjects in the bariatric group were matched with a control subject based on 18 matching variables; sex, age, weight, height, waist and hip circumferences, systolic blood pressure, serum cholesterol and triglyceride levels, smoking status, diabetes, menopausal status, four psychosocial variables with documented associations with risk of death, and two personality traits related to treatment preferences. At two years, weight had increased in the control group by 0.1% from baseline and increased by 1.6% from baseline at 10 years (P < 0.001). In the surgery group, weight had decreased 23.4% from baseline at two years, but at 10
years the decrease was only 16.1% decreased from baseline (P < 0.001). This study revealed that while bariatric patients experienced weight gain between two and ten years, their net weight loss was still significantly more than subjects who did not undergo surgery. In a retrospective study, Christou et al. (2006) examined the percent of weight lost or gained in 228 patients after undergoing gastric bypass surgery. Researchers found that the failure rate for adult gastric bypass patients (mean age of 42 ± 3.4 years) who were followed for at least 10 years (mean 11.4 ± 2.8 years) was 20% for severely obese patients (BMI < 50 kg/m²) and 58% for super obese patients (BMI > 50 kg/m²). Failure was defined as having a BMI ≥ 35 in morbidly obese and a BMI ≥ 40 for super obese at 10 years post-surgery. Super obese patients lost weight more rapidly from baseline to 2 years at which time they reached their lowest weight. There was a significant weight re-gain in patients from the lowest BMI that was reached at approximately 2 years compared with 5 years after surgery as well as 5 years to 10 years after surgery (P > 0.0001). It should also be noted that there was also a significant difference (P < 0.0001) between super obese and severely obese patients. Super obese patients lost weight more rapidly from baseline to lowest weight reached, but then re-gained weight more rapidly when compared with severely obese patients.

Population Specific Nutrition Guidelines

While evidence based guidelines have yet to be published for adolescents who undergo bariatric surgery, the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and The National Association of Children’s Hospitals and Related Institution (NACHRI) published nutritional recommendations in
2011. It is recommended that a preoperative nutritional assessment be given for all patients planning to have bariatric surgery. During this assessment, patients should undergo a nutritional evaluation which includes selective micronutrient needs as well as identifying nutritional and educational needs. It is also suggested that a food frequency/eating behavior questionnaire be completed by the patient to provide more insight on current personal nutritional practices. During the pre-operative phase, a healthy balanced diet consisting of adequate protein, fruits, vegetables, and whole grains is recommended in order to encourage weight stabilization or weight loss. In the post-operative phase, the NASPGHAN/NACHRI recommends a diet progression for gastric sleeve patients occurring in 5 stages (Table 1).

**Table 1. Diet Progression after the Gastric Sleeve Procedure**

<table>
<thead>
<tr>
<th>Sleeve Gastrectomy Stages of Progression</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 oz/hour of Ice Chips, Water, sugar-free clear liquids</td>
<td>Full Liquids, high protein</td>
<td>Smooth consistency foods and liquids</td>
<td>Soft Foods</td>
<td>All textures, healthy foods</td>
<td></td>
</tr>
<tr>
<td>First 24-48 Hours, then 3-7 days ad lib</td>
<td>Weeks 1-5</td>
<td>Weeks 5-8</td>
<td>Weeks 9-12</td>
<td>Begins at 13 weeks for life</td>
<td></td>
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</table>

Daily recommendations for Stage 5 which begins at 9 weeks and should be followed for life include; a total of 800-900 calories, 60 grams of protein, and 80-90 oz. (or based on estimated requirements) of fluids. At this time new foods should be
introduced including all healthy food choices with a meal pattern of 3-6 meals per day and a volume up to ¾ to 1 ½ cup per meal.

Dietary Behaviors of Adult Bariatric Patients

In a longitudinal clinical study, Johnson et al (2013) examined dietary changes in obese patients ranging in age from 31 to 47 years of age undergoing gastric bypass (n=72, mean age=42.6) or lifestyle intervention (n=54, mean age=46.8) and assessed their dietary intake using a Food Frequency Questionnaire (FFQ) at baseline and at one year follow up\textsuperscript{19}. They found that dietary intake did not significantly differ between treatment groups at baseline. Mean weight loss at 1 year follow up for the surgery group was 30% while the lifestyle intervention lost an average of 8% of their original weight. At a one year follow up, the lifestyle group had a significantly higher daily intake of fruits and vegetables (P = 0.002), whole grains (P < 0.001) and fiber (P < 0.001) than the surgery group. The surgery group also had a higher percentage of total energy consumption from saturated fat than the lifestyle group at a one year follow up (P < 0.001). In this study, the surgery group reported a significantly lower energy intake overall when compared to the lifestyle intervention group at one year follow-up (P < 0.001). Some of these differences in food group consumption can be explained by the proportional decreased energy intake in the surgery group compared with the lifestyle intervention group.\textsuperscript{22}

According to the NASPGH/NACHRI guidelines, for the first 4 months after surgery, bariatric patients are advised to limit fiber containing foods such as fruits and vegetable skins, and whole grains. However, after the first 12 weeks, patients are allowed to introduce all foods back into the diet.\textsuperscript{6} This may be an indication that once the fruits and vegetables are temporarily removed from the diet, they are not being
successfully reintroduced. Thus, it is important to study dietary interventions for patients undergoing bariatric surgery separately from patients who undergo a lifestyle intervention.

Bond et al. (2009) studied a direct comparison of weight-loss maintenance in adult individuals who achieved significant weight loss through bariatric surgery vs. non-surgical approaches. Data was extracted from the National Weight Control Registry (NWCR), which is an ongoing longitudinal study of individuals who have successfully maintained weight loss. The registry includes participants who have lost weight through both surgical and non-surgical means. The researchers identified participants who underwent bariatric surgery (n=105, mean age=45.8) and matched each individual these participant with 2 matching registry members who lost weight through non-surgical means (n=210, mean age= 44.6). Inclusion criteria for the study included having lost at least 13.6 kg and maintaining that weight loss for at least one year and being at least 18 years of age. The two groups were matched on sex, weight, weight loss, and weight maintenance duration at the time of study entry within 2 years. The study found that both groups gained small amounts of weight from time of registry entry to 1 year, but the magnitude of weight re-gain did not differ significantly across groups (P = 0.034). There were significant differences in dietary behaviors between surgical and non-surgical groups. Participants who underwent bariatric surgery reported a higher percentage of calories from fat than non-surgical participants (P = 0.001). Additionally, the surgical group reported a higher amount of fast food consumption and a lower consumption of breakfast during the week (P = 0.002). These differences identify a need to focus on dietary strategy for these patients. While initial weight loss from bariatric surgery is to be
expected due to the stomach being resized to allow a fraction of the amount of food previously allowed, it may also be a false sense of achievement, allowing the impression that fast food consumption, skipping breakfast, and high fat meals can still yield weight loss results. It begs the question of whether replacing these calories with more nutrient dense foods such as fruits and vegetables might yield more long term, sustaining results.

Freiere et al. (2012) examined food quality, physical activity, and nutritional follow-up as a determinant of weight regain after Roux-en-Y gastric bypass. Using a food frequency questionnaire, Freire examined 100 patients who had underwent bariatric surgery and divided them into three groups (1-2 years post-surgery, mean age = 45.0; 2-5 years post-surgery, mean age=41.5; and over 5 years post-surgery, mean age=48.7). Most of the participants were women (84%). Rates of weight regain and the percentages of excess weight loss (EWL) were calculated. Patients also indicated how often they attended nutritional follow-up visits after the operation and the type and frequency of physical activities. The study concluded that while fruit and vegetable intake did not necessarily have an inverse effect on weight re-gain, patients who did re-gain weight were found to have poor diet quality that included an increased intake of sweets as well as oils and fatty foods. Patients who re-gained weight also reported less physical exercise pre-surgery (P < 0.05) and had less nutritional counseling (P < 0.01) at follow-up. Mean EWL among all participants was 59.1 ± 20.3%. Weight regain was seen in 56% of the patients with 29% of the patients having regained over 10.1% of the minimum weight reached after surgery. Weight regain significantly increased as time increased after surgery (up to 2 y: 14.7%; from 2 to 5 y: 69.7%; over 5 y: 84.8%). Poor diet quality was characterized by excessive intake of calories from snacks and sweets (P < 0.05), and fatty
foods (P = 0.01) and was found to be statistically higher among those who regained weight.\textsuperscript{7}

In a longitudinal study, Laurenius et al. specifically examined the relationship between decreased energy density in diet and changes in food selection following Roux-en-Y. Food intake was calculated for 43 patients (31 women and 12 men) with a mean age of 43 ± 10 undergoing Roux-en-Y and followed for 2 years post operatively. Mean pre-operative BMI for participants was 44.3 kg/m\textsuperscript{2}. A validated dietary questionnaire was used to assess dietary intake. Mean pre-surgical dietary intake was found to be 1.07 kcal/g (0.99-1.16 kcal/g) before surgery and 0.78 kcal/g (0.74-0.83 kcal/g) at 6 weeks (P < 0.001) post-surgery. At 1 and 2 years post-surgery, values were found to be 0.90 kcal/g (0.84-0.97 kcal/kg; P < 0.001) and 0.96 kcal/g (0.86-1.05; P < 0.01 kcal/kg), respectively. The conclusion of this study revealed no significant correlation between weight change and decreased energy density of diet at one year (P = 0.183) or two years (P = 0.775). This study was done in an adult population and weaknesses of this study included a small sample size and that it lacked information on physical activity.\textsuperscript{25}

Dietary intake for adolescents undergoing bariatric surgery is an essential component for their success in weight loss. While dietary recommendations have been set forth by the NASPGHAN/NACHRI (2011) for the adolescent bariatric population, more research needs to be conducted to create more population specific and evidence based guidelines that will mediate successful weight loss.

**Fruit and Vegetable Intake in Adolescents**

Today in the United States, less than 20% of youth consume fruits and vegetables to meet national dietary guidelines.\textsuperscript{26,27} Adolescents today consume the majority of fruit
from fruit juices rather than whole fruits, while the majority of vegetable intake for adolescence seems to be coming more from white potatoes than from green, yellow, and orange vegetables. Adolescents who consume high amounts of energy from fast food have been found to be less likely to meet recommended intake for fruits ($P < 0.01$).\(^{28}\)

Lorson et al. (2009) examined correlates of fruit and vegetable intake in children and adolescence in the United States between 1999-2002 using NHANES data. A final sample of 6,513 children and adolescents between the ages of 2-18 were analyzed. Using the fruits and vegetables as the dependent variables, intakes from 24-hour recalls were measured using the US Department of Agriculture MyPyramid Equivalents Database. To further break down the fruit and vegetable food groups, vegetables consumed as French fries and fruit intakes from 100% fruit juice were generated for each analysis. Weight status categories were created using the following body mass index percentile ranges for children: 5th to 85th percentile, 85th to 95th percentile, and 95th percentile and above.

Findings revealed that approximately 28\% of reported vegetable intake by adolescents came from French fries, while 38\% of total fruit intake came from fruit juice.\(^{27}\) Furthermore, the study found that overweight children and adolescents consumed less total fruit and more French fries than those who were normal weight or at risk overweight.\(^{27}\) It is not only important to pay attention to the amount of fruits and vegetables consumed, but also the source of these fruits and vegetables. The Dietary Guidelines for Americans 2010 recommend that people choose whole or cut-up fruits which are not as calorie dense, more often than fruit juice which contains more calories per gram. There is strong evidence to suggest that adolescents who consume more sugar-
sweetened beverages have higher body weight compared to those who drink less (USDA, 2011). 

Dietary Approaches to Weight Loss

There are many variables that contribute to the diet and weight status of children and adolescents. According to recent studies, some of the most important variables include social support, socio-economic status, and availability of healthy food in the household. Many dietary interventions used in the treatment of obesity employ the concept of energy density (ED) of foods. This intervention is also sometimes referred to as the stoplight method; developed by Epstein and colleagues in 1987. In practice, ≤1.5 kcal/g is considered low ED or “green light”, medium ED or “yellow” is 1.6-2.4 kcal/g, and ≥2.5 kcal/g would be considered high ED or “red light”. Many studies have found that weight loss success can be attained through consuming more low ED foods and less high ED foods. Fruits and vegetables usually fall into the low ED category. Fruits and vegetables also tend to have a more satiating effect due to their high water and fiber content. The purpose of the stop light approach is to encourage foods that are higher in fiber and more satiating, thus decreasing total energy consumption and increasing micronutrient intake.

Schusdziarra et al. (2011) evaluated a weight loss program that encouraged adult overweight patients to replace high ED foods with low ED foods. The mean length of intervention was 10.5 weeks and took place between 2003 and 2006. Dietary counseling was based on a dietary recall recorded before the intervention. Counseling was provided by a dietitian and two physicians. The first counseling session focused on encouraging the replacement of high ED foods for low ED foods. Participants were provided with a
booklet that contained 1,500 food items divided into 37 groups. Within each group, foods were listed in order by their ED. 189 patients were analyzed for follow up in 2008 for pre and post intervention eating habits. This intervention resulted in an average monthly BMI decrease of 0.195 points over 16.8 months. At follow-up, food intake was reduced by 10% from 1024±286.5 to 927±340.7g/day (p value < 0.0001). Total energy intake was reduced by a mean of 568 (1,736 ± 571.5 to 1,168 ± 433.3) kcal per day. At baseline, participants consumed 25% of food quantity from high ED foods, but contributed to nearly 50% of energy intake. After the intervention, low ED foods such as fruits and vegetables contributed the majority of energy intake (50%) while medium ED and high ED food consumption was reduced.32

Using a similar approach to the aforementioned study, Ello-Martin et al (2007) identified a correlation between dietary energy density and fruit and vegetable intake with weight loss in obese women.28 This year-long study focused on reducing fat intake, based on the principle that fat is more energy dense (9 kcal/g) than carbohydrates and proteins (4 kcal/g). Ninety-seven, 20-60 year old women with a BMI of 30-40 kg/m² were divided into two separate intervention groups. The reduced fat (RF) group was advised to reduce fat intake, whereas the reduced fat plus increased fruits and vegetable (RF+FV) group was advised to decrease fat intake while increasing intake of fruits and vegetables. During the first six months of the study, all participants met with a dietitian once a week for 30 minutes. During this phase, participants received written materials and individual instruction from dietitians. Information included literature on cooking and recipe modification, grocery shopping, dining out, meal, and snacking ideas. During the second 6 month phase, participants met in small groups within their intervention group
for one group session and one individual session per month. These group sessions were also led by a dietitian and consisted of 6 topics for review: holiday eating, cooking and recipe modification, appropriate portion sizes, label reading, dining out, and grocery shopping. After one year, participants from both groups had lost significant amounts of weight. At months 6, 9, and 12, fruit and vegetable intake was found to be the most predictive factor of weight loss from baseline ($R^2 = 0.26, 0.16, \text{ and } 0.20$, respectively; all $P < 0.0006$). Through dietary analysis, the study also revealed that participants from the RF+FV group reduced their dietary energy density to a greater extent than the participants in the RF group. Through the duration of the trial, however, participants in the RF+FV group had a significantly different pattern of weight loss than the RF group ($P = 0.002$ for group × time interaction). During the first 6 months, participants in the RF+FV group lost more body weight ($19.6 \pm 1.8 \text{ lbs}$) than did those in the RF group ($14.7 \pm 1.5 \text{ lbs}; P = 0.034$), which resulted in a difference of $33\%$ weight loss. During the second 6 months of the trial, the pattern of weight change did not differ significantly between the groups ($P = 0.056$). At the end of the trial, the RF+FV group lost significantly more weight than the RF group ($P = 0.021$). Over the course of both phases, participants in the RF+FV group also reported significantly lower hunger ratings ($P = 0.030$).\textsuperscript{33}

Raynor et al. (2011) specifically examined the relationship between energy density (kcal/g) of foods in the diet and weight loss management.\textsuperscript{34} The participants were divided into 3 groups; the overweight group (OW group), weight loss management group (WLM group), and the normal weight group (NW). The OW group consisted of individual’s with BMI’s of 27-45 kg/m$^2$, ages 18-65 years old who could walk at least 2
blocks and who were entering an 18 month weight loss program. The WLM group consisted of individuals who had to have been overweight (BMI > 25 kg/m²) at some point in their life, normal weight (BMI= 19-24.9 kg/m²) at entry into the trial, and have lost 10% of their maximum body weight and maintained that weight loss for at least 5 years. The NW group were normal weight (BMI= 19-24.9 kg/m²) at entry into the trial and had never been overweight or obese. In order to assess dietary intake, self-reported intake was analyzed for all 3 groups using identical methods during the same time period. Trained interviewers conducted three 24 hour dietary recalls at random on non-consecutive days. After adjusting for baseline group differences in age, sex, and self-reported weekly energy expenditure from physical activity, self-reported caloric intake was significantly lower in WLM compared to the OW group (P < 0.05). The analysis also revealed that the WLM group consumed more fiber than the OW group. While the WLM group consumed more grams of food and beverage per day, the WLM group reported the lowest ED (energy density) out of all the groups followed by NW, and then OW. The WLM group reported eating more fruits and vegetables per day (P < 0.005) as well as more whole grains (P < 0.005), compared to the OW and NW groups. Furthermore, the OW group reported consuming significantly more servings per day of fried potatoes than the NW or WLM group (P < 0.005). This investigation suggests that eating a diet that is higher in fruits and vegetables leads to consuming a diet with a lower ED encouraging sustained weight loss as illustrated by the WLM self-reported dietary intake correlating with their successful weight loss maintenance.
Factors Affecting Weight Loss and Weight Loss Maintenance

There are many non-dietary factors that contribute to potential weight loss, weight gain, or weight maintenance. Phelan et al. (2009) distinguished environmental, behavioral, and psychological variables that contributed to weight loss in weight loss maintainers versus treatment seeking obese. This study was designed to identify behavioral variables that distinguished weight loss maintainers (WLM, n=167) from treatments seeking obese (TSO, n=306). The WLM group had lost at least 10% of their maximum body weight and had kept it off for at least 5 five years and were of normal body weight at the time of the study. The TSO group had a history of dieting and had a BMI of $\geq$ 25 at the time of the study. The TSO group was further broken down into TSO-1 (predominately Caucasian; n= 153) and TSO-2 (predominately African American; n=153). Using the Block Food Frequency Questionnaire in TSO-1 and a 24-h dietary recall in WLM and TSO-2, researchers analyzed daily caloric intake and percentage of calories from fat, protein, and carbohydrates. Amongst the dietary findings of the study, WLM had more frequent breakfast consumption than TSO I and TSO II (OR = 0.86). The study also revealed that the WLM group had more low-fat foods in the home than TSO I and TSO II (OR= 1.01) and less high-fat foods and snacks in the house than TSO I (OR= 1.67) and TSO II (OR=1.00). WLM also participated in more physical activity than the TSO group (OR=1.08).35

Using a mailed survey of U.S. adults aged 18 years or older, Kruger et al. (2008) examined behaviors associated with weight loss maintenance among people who reported trying to lose weight. Data was analyzed on the number of daily fruit and vegetable servings, minutes per week of physical activity, dining out behavior, and confidence in
one's ability to engage in behavioral strategies. The study revealed that adults who consumed fewer than five fruit and vegetable servings per day and accrued 420 minutes or more per week of physical activity or consumed five or more fruit and vegetable servings and accrued 150 minutes of physical activity per week were more successful at weight loss maintenance.\textsuperscript{36}

Other studies have looked at dietary changes over time in relation to weight loss using multiple dietary recalls. The International Study of Macro-/Micronutrients and Blood Pressure (INTERMAP) study (Shay et. al, 2012) examined associations of usual energy, food, and nutrient intakes with BMI among US participants. The INTERMAP was an international cross-sectional study of dietary factors and blood pressure in men and women (ages 40–59 y). Data from 1,794 Americans who were not consuming a special diet provided 24-h dietary recalls and 2 timed 24-h urine collections. Data was collected over four office visits. The 24 hour recall was collected via an in depth multi-pass 24 hour recall conducted by trained interviewers. They found that not only was lower energy intake associated with lower BMI in both sexes, but higher intakes of fresh fruit, pasta, and rice and lower intakes of meat were associated with lower BMI. These associations were attenuated in multivariable analyses. Lower urinary sodium and intakes of total and animal protein, dietary cholesterol, saturated fats, and heme-iron and higher urinary potassium and intakes of carbohydrates, dietary fiber, and magnesium were associated with lower BMI in all participants. They concluded from this study that diets higher in nutrient-dense carbohydrate and lower in animal protein and saturated fat were associated with lower total energy intakes, more favorable micronutrient intakes, and
lower BMI. This study illustrates the importance of studying dietary composition as it relates to weight and BMI using multiple dietary recalls and a larger study population.

Fruits and vegetables have a lower energy density, leading to lower overall caloric intake. As a result, studies that have examined the dietary behaviors of children, adolescents, and adults have identified consumption of fruits and vegetables as a mediator of weight loss success and healthy weight maintenance. Further research will need to be conducted in the bariatric population in order to determine similar benefits in this population. Recommending fruits and vegetables as a part of a healthful and balanced diet may be more effective for weight loss and maintenance for the adolescent bariatric population than strict calorie counting and restriction. Current guidelines provided by the NASPGHAN/NACHRI for adolescents undergoing bariatric surgery only provide recommendations for caloric (800-900 kcal) and protein intake (60 grams), meals size (¾ – 1 ½ cups per meal), and meal frequency (3-6 meals per day). There are currently no recommendations on fruit and vegetable intake or fiber intake. With such a small volume of food being recommended per meal, it may prove beneficial and improve overall satiety to focus on fiber containing foods with lower caloric density such as fruits and vegetables in order to maximize lifelong adherence to the recommended diet for this population.

Bariatric Surgery Procedures

There are three types of operations that are commonly offered in the United States: adjustable gastric banding (AGB), Roux-en-Y gastric bypass (RYGB), and vertical sleeve gastrectomy (VSG). The primary mechanism for AGB is in decreasing food intake by placing a small bracelet-like band around the top of the stomach. This
restricts the size of the opening into the stomach. The surgeon can then control the size of this opening using a circular balloon inside the band. This balloon is inflated or deflated with saline solution to meet the needs of the patient.

RYGB restricts food intake by creating a small pouch that is similar in size to the one created with the AGB procedure. Food absorption is also reduced by sending food directly from the pouch into the small intestine. The food is absorbed differently because the stomach, duodenum, and upper intestine no longer have contact with food. Bile and other digestive juices then join up with the food lower in the small intestine.\(^{38}\)

During a sleeve gastrectomy, the stomach is reduced to about 25% of its original size. This is done by removing a large portion of the stomach and leaving a narrow stomach tube. The open edges are then stapled to form a sleeve or tube. The sleeve gastrectomy permanently reduces the size of the stomach to 60-100 mL, permitting smaller amounts of food and encouraging early satiety.\(^{39}\) Ghrelin is a hunger regulating hormone released from the fundus and has recently been linked to the cause of weight loss success in patients undergoing this procedure. When the fundus is resected, the majority of ghrelin secreting cells are removed, thus reducing circulating ghrelin.\(^{40}\) This technique is unlike the laparoscopic adjustable gastric band, commonly referred to as an “a band”, which is a purely restrictive procedure commonly used in obese patients that does not affect the production of gastric hormones. The advantage to the sleeve gastrectomy procedure over the adjustable lap band is that the missing portions of the stomach no longer produce ghrelin, possibly leading to less hunger stimulation. As sleeve gastrectomy and other bariatric procedures become more common in the treatment for obesity in adolescents, it is imperative to find dietary predictors of success in these
patients. More research needs to be conducted to create more population specific and
evidence based nutritional guidelines for pre-surgery as well as post-surgery in order to
optimize weight loss potential and weight loss maintenance. The objectives of this study
are to describe fruit and vegetable intake in adolescents who undergo a sleeve
gastrectomy between 2011 and 2013 at a pediatric outpatient clinic and to determine
whether there is a correlation between fruit and vegetable intake before surgery and
weight loss post-surgery.
CHAPTER III

METHODS

Participants

The participants in this study received the sleeve gastrectomy procedure. Inclusion criteria for the study included that patients were over 13 years old and had an initial BMI over 35 kg/m$^2$ with a comorbidity or 40 kg/m$^2$ with no comorbidity. All patients had undergone extensive counseling and assessment by a team of medical professionals (pediatrician, psychologist, exercise physiologist, nurse, and dietitian) for at least 6 months to qualify for the surgery in order to optimize results after sleeve gastrectomy.

Protocol: Pediatric Healthy Weight Clinic

Before scheduling an initial appointment with the clinic, parents are required to send in a “Background and Medical Information Form” about their child that includes general health history information, allergies, previous dieting attempts, time spent doing physical activity, and total screen time, including televisions, tablets, phones, and computers. After this form is received by the clinic, they are able to schedule an initial appointment. It is then determined if the patient will be more appropriate for general weight loss counseling or for bariatric surgery. In order to be eligible for bariatric surgery, the patient must have a BMI of 40 kg/m$^2$, or a BMI of 35 kg/m$^2$ with comorbidity, and between the ages of 13 and 20. If it is determined that the patient is eligible for surgery, they are then counseled by the medical team which is made up of a dietitian, pediatrician, psychologist, nurse, and exercise physiologist. The patient must be
signed off by all team members as being ready for surgery in order to receive the bariatric surgery. Important considerations that are monitored include: the ability to comply with post-surgery diet, psychological readiness, and physical ability to undergo surgery. In order to have surgery, patients must be seen and evaluated by the entire team for a minimum of six months.

Research Design

This study was a retrospective chart review in collaboration with an outpatient pediatric weight clinic in metro Atlanta, GA. The medical records of patients who underwent bariatric surgery between 2011 and 2013 and were under the supervision of the clinic for at least one year were reviewed and analyzed. Institutional Review Board (IRB) approval was obtained from both the clinic and Georgia State University.

Variables collected included demographic information; (date of birth, age, gender, and race) baseline and six months post-surgery measures for height (cm), weight (kg), and calculated BMI (kg/m²). Weight and height were collected during visits to the clinic by the same nurse each time. Weekly number of cups of fruits and vegetables, cups of sweetened beverages (separated as fruit juice or soda), and cups of fried foods eaten, and meals eaten from or at restaurants as reported at the initial consultation were analyzed. Because this study aimed to explore the relationship between dietary behaviors before bariatric surgery and weight loss after surgery, dietary recall data from after surgery were not analyzed. Dietary recalls were conducted by a registered dietitian (RD) using a dietary recall and FFQ (see appendix 1) along with food and portion size models to determine exact servings of foods and beverages consumed.
Statistical Analysis:

All statistical analyses were conducted using SPSS (version 21.0, SPSS, Inc., Chicago, IL). Descriptive statistics were used to describe mean weight, BMI and BMI z-score, as well as fruit, vegetable and sweetened beverage consumption. Gender and race were described using frequency tables. All variables were checked for normality. If variables were not normally distributed, log transformations were conducted and normality was reassessed. If the variables were still found to not be normally distributed, non-parametric tests were used. Kruskal-Wallis tests were used to determine if there was a difference in initial weight or weight lost by race as well as differences in fruit and vegetable intake by race. Kendall’s tau rank correlation was used to analyze relationships between initial weight and changes in weight with baseline fruit and vegetable intake. Relationships between initial weight and changes in weight and baseline sweetened beverage consumption were explored also using Kendall’s tau rank correlation. A p-value of < 0.05 was considered significant.
CHAPTER IV
RESULTS

Data from 13 patients were collected. Two patients were subsequently excluded from the results analysis due to follow up time being less than six months. Thus, the sample size included a total of 11 patients. The demographic and anthropometric characteristics of the population are shown in Table 2. The mean age of participants was 17.1 ± 1.51 years. The final study population consisted of 6 African-Americans and 5 Caucasians; 2 males and 9 females. Initial mean weight of participants was 141.54 ± 29.34 kg; mean initial BMI was 50.78 ± 9.12 kg/m². Patients were divided according to BMI into severely obese (BMI < 50 kg/m², n= 6); and super obese (BMI > 50 kg/m², n = 5). Average follow up time was 7.45 ± 1.21 months. Mean follow up weight was 116.2 ± 20.89 kg; mean follow up BMI was 41.25 ± 6.5 kg/m². Mean change in BMI was -9.54 ± 3.9 kg/m² and mean change in BMI percentage was -18.45 ± 4.46%. Mean BMI Z-score at baseline for all patients was 2.73 ± 0.28 and 2.38 ± 0.37 at follow up. Mean change in BMI Z score was -0.35 ± 0.12. The correlation between change in BMI Z score with both fruit and vegetable and sweetened beverage consumption was found not be significant.

Anthropometric characteristics and fruit and vegetable intake by race is shown in Table 3. Kruskal-Wallis tests revealed that there were no significant differences between initial weight by race (p = 0.33) or weight lost by race (p = 0.30). There was also no significant difference in fruit and vegetable or sweetened beverage consumption by race. Although not statistically different, it is interesting to note that the mean combined fruit and
vegetable consumption was slightly higher in Caucasian patients vs. African American patients (14.1 ± 8.1 cups’ vs. 12.8 ± 8.2 cups, respectively). Mean vegetable consumed weekly in all patients at baseline was 7.32 ± 4.38 cups and mean weekly consumption of fruits was 6.0 ± 4.16 cups. None of the participants met the US dietary guidelines for fruit or vegetable intake during their initial assessment. The US Dietary Guidelines recommend 2.5 cups of vegetables per day and 1.5 cups of fruit per day for adolescent females and 3 cups per day of vegetables and 2 cups per day of fruit for adolescent males.  

Servings of sweetened beverages were divided into fruit juice and sweetened beverage other than fruit juice. Data were available for sweetened beverages other than fruits juice for 8 participants and mean consumption was 5.44 ± 9.79 servings per day (1 serving = 8 oz). Data were available for fruit juice intake for 7 participants and mean consumption was 7.93 ± 15.15 servings per day.

**Table 2: Demographic and anthropometric characteristics of the total study population**

<table>
<thead>
<tr>
<th>Gender</th>
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<td>Female</td>
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<table>
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<td>African-American</td>
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<td>Caucasian</td>
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<table>
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<tr>
<th>BMI Classification</th>
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<tr>
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<td>54.5</td>
</tr>
<tr>
<td>Super Obese (BMI &gt; 50 kg/m²)</td>
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<td>45.5</td>
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</table>
Table 3: Anthropometric characteristics and fruit and vegetable consumption by race

<table>
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<tr>
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<th>Caucasian (n = 5)</th>
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</thead>
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<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Age (years)</td>
<td>17.1 ± 1.5</td>
<td>13-19</td>
<td>16.7 ± 1.9</td>
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<tr>
<td>Weight (kg)</td>
<td>141.5 ± 29.3</td>
<td>115.8-222.2</td>
<td>144.1 ± 38.9</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>50.8 ± 9.1</td>
<td>43.1-74.3</td>
<td>51.9 ± 11.5</td>
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<td>BMI z-Score</td>
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<td>2.43-3.43</td>
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<tr>
<td>Cups of Vegetables/Wk</td>
<td>7.3 ± 4.4</td>
<td>2-14</td>
<td>7.0 ± 4.5</td>
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<tr>
<td>Cups of Fruits/Wk</td>
<td>6.1 ± 4.5</td>
<td>1-14</td>
<td>5.8 ± 4.8</td>
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<tr>
<td>Combined Cups of Fruits and Vegetables</td>
<td>13.4 ± 7.8</td>
<td>3-24.5</td>
<td>12.83 ± 8.2</td>
</tr>
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</table>

**Fruits and Vegetables**

There was a weak and non-significant negative correlation between combined fruit and vegetable consumption with initial weight ($r = -0.34, p= 0.56$) as well as with weight lost ($r = -0.25, p = 0.23$) (Figures 1 and 2). There was also a weak and non-significant negative correlation between servings of vegetables consumed at baseline with weight lost ($r = -0.22, P = 0.44$) servings of fruit consumed at baseline and weight lost ($r = -0.22, P = 0.50$) (Figures 3 and 4). When BMI was stratified by weight class into severely obese and super obese; super obese patients consumed fewer cups of fruits and vegetables combined than severely obese at baseline (15.8 ± 8.3 vs. 10.5 ± 6.5).
Figure 1: Cups of Vegetables with Initial Weight in Kilograms

Figure 2: Cups of Fruits with Initial Weight in Kilograms
Figure 3: Cups of Vegetables with Weight Lost in Kilograms

Figure 4: Cups of Fruits with Initial Weight in Kilograms
Sweetened Beverages

There was a positive correlation between sweetened beverage intake and initial weight ($r = 0.91$, $p = 0.50$) (Figure 5). There was also a positive correlation between baseline sweetened beverage intake with weight lost ($r = 0.96$), however these relationships did not meet statistical significance ($p = 0.06$) (Figure 6). Furthermore, super obese patients at baseline consumed less daily sweetened beverage other than fruit juice than severely obese patients ($0.75 \pm 1.5$ vs. $10.13 \pm 12.76$). There was no significant relationship found between initial weight and weight loss with other dietary behaviors including dining out frequency, dairy consumption, fried food consumption, or breakfast consumption due to missing data from our sample size.

Figure 5: Juice and Sweetened Beverage with Initial Weight in Kilograms
Figure 6: Servings of Juice and Sweetened Beverage with Weight Lost in Kilograms
CHAPTER V
DISCUSSION AND CONCLUSIONS

We found a weak negative correlation between fruit and vegetable consumption before surgery and weight loss six months post-surgery in adolescents’ bariatric patients. While these findings fail to reject the null hypothesis, it is important to note studies have shown that the greatest degree of relative weight loss occurs within the first 6 months after surgery.\textsuperscript{41,42} Thus, differences in dietary consumption may play a greater role in weight lost after a longer period of time post-surgery. Because weight loss was measured just six months after surgery, it may be important to consider that a longer time frame would reveal a stronger relationship between weight loss with dietary patterns before surgery.

Another study that examined dietary intake and weight loss 7 years after surgery did find a relationship between dietary behaviors and weight lost. Cook et al. (1999) examined habits that led to successful weight loss maintenance in 100 patients who underwent gastric bypass surgery. Surveys were conducted in person, over the phone, or in writing. Successful weight loss was defined as maintaining at least 74\% of initial weight loss. Results of the survey revealed that successful patients reported eating 3 servings of vegetables per day and 1 serving of fruit per day. Fifty-eight percent of successful patients also reported not drinking carbonated beverages of any kind and 55\% reported not drinking any fruit juice or sweetened beverages. Seventy-seven percent of successful patients reported exercising an average of four times per week for at least 40 minutes.\textsuperscript{20} This study identified habits that led to successful weight loss maintenance in
gastric bypass patients an average of 7 years after surgery. This longer follow up time allowed for a more realistic look at how dietary factors effected weight loss maintenance over time. One weakness of this study was the use of self-reported dietary recall which can overestimate adherence to dietary guidelines. To date, there have been no studies that examine dietary behaviors that may lead to successful weight loss maintenance in adolescents who undergo bariatric surgery. Conclusive data in this area will assist in creating evidence based nutritional guidelines for this population.

Our study analyzed dietary intake from an initial clinic visit. Examining multiple dietary recalls in order to identify changes dietary habits over time may have been valuable for this study. It is unknown what dietary changes these patients made leading up to surgery and after surgery. It would be expected that some nutritional changes were made before surgery as these patients visited with a registered dietitian multiple times before having surgery. Additionally, patients are required to demonstrate that they can maintain weight or lose weight before surgery, suggesting that nutritional changes were implemented. Future studies that analyze initial dietary recalls along with subsequent dietary recalls would provide more conclusive evidence about how initial dietary habits affect ability to make dietary changes, successfully lose weight, and maintain weight loss.

While no significant differences in weight loss or dietary intake were found by race, it is important to point out that the mean consumption of fruits and vegetables for African-Americans was lower than that of Caucasians while mean sweetened beverage intake for African-Americans was higher than that of Caucasians. Studies have shown that Caucasians consume more fruits and vegetables on average than African-Americans. An analysis of NHANES III data revealed that specifically, Caucasians averaged 4.90 ±
3.53 servings fruit and vegetables per day, compared with 3.99 ± 3.38 servings per day for African-Americans. Some studies have also shown that Caucasians have better weight loss success over time compared with African-Americans. In contrast, during a 20 year study, Phelan et al. (2010) found that amongst 1,869 African-American and Caucasian men and women between the ages of 18-30 years old, African Americans were more likely to maintain weight loss than Caucasians while gender did not seem to play a substantial role in weight loss maintenance after four years.

It is important to not only study dietary intake in obese adolescents who undergo bariatric surgery, but to evaluate psychological factors involved in a patient’s initial dietary habits as well as the patient’s ability to make dietary changes. Backman et al. (2002) studied the predictors of healthful dietary practices in adolescents using the Theory of Planned Behavior to determine how gender and ethnicity influence the relationship among the theoretical constructs. The Theory of Planned Behavior states that attitude toward behavior, subjective norms, and perceived behavioral control, together shape an individual's behavioral intentions and behaviors. The study sample consisted of 780 adolescents recruited from four public high schools in California between 14-18 years old. Researchers used an initial and one month follow up questionnaire that measured intention, attitude, subjective norm, perceived behavioral control, behavioral beliefs and outcome evaluations, normative beliefs and motivation to comply, and control beliefs and perceived facilitation toward healthful dietary behavior. A 67 item follow-up FFQ was used to assess the usual dietary intake and healthful eating behaviors of adolescents during a 1-month period (3 weekdays, 1 weekend day). Intention to eat a healthy diet was found to be a direct determinant of healthful dietary
behavior as measured by total calories, percent calories from fat, and servings of fruits and vegetables reported. Perceived behavioral control did directly predict healthful dietary behavior. This suggests that dietary practices in teenagers are controlled more by personal motivation than by external control factors. Participants also reported feeling that eating more fruits and vegetables and limiting caloric intake had a stronger association with their intention to eat a healthful diet than consuming fewer calories from fat. Female participants reported more positive attitudes towards healthful eating and greater intentions to eat a healthy diet, and consumed significantly less calories than their male counterparts. Females also perceived more social pressure to eat fruit and less social pressure to consume chocolate, chips, and sweets than males. These findings suggest that a dietitian and psychologist working in a healthy weight clinic such as the one used in the current study, may need to approach dietary changes for patients differently according to gender. Backman et al. (2002) also found that African-American adolescents reported significantly more caloric intake and percent calories from fat than Caucasians or Hispanics. Furthermore, adolescents with positive attitudes towards healthful eating believed that they would like the taste of healthy foods, feel good about themselves, tolerate giving up foods that they like to eat, and lose weight or maintain a healthy weight. This should be taken into consideration when looking at a patient’s initial psychological evaluation along with their initial dietary recall, recognizing that consuming fruits and vegetables would be considered “adopting a healthy food” while decreasing sweetened beverage intake would be considered “giving up a food they like”. The study also revealed that adolescents felt that the mother was the most influential individual on their own dietary behavior. The ability of the family, particularly the
mother, to adopt healthy eating behaviors may be important for the overall success of the patient. Availability of healthy foods and access to enough money were also found to be related to healthful dietary behaviors, revealing that monetary costs associated with healthful foods were a concern for the participants. For this reason, it may also important for the dietitian working with such patients to offer dietary suggestions that are not cost-prohibitive.

Our results also suggested that patients, who consumed more sweetened beverages at baseline, had lost more weight 6 months after surgery. However, patients who consumed more sweetened beverages at baseline also had a higher initial weight and BMI. The relationship between increased baseline sweetened beverage consumption with increased weight loss could be due to a more extreme caloric reduction from initial intake. These patients are encouraged to discontinue consumption of sweetened beverages prior to and after surgery in order to avoid dumping syndrome and are also advised to avoid caffeine which is often a component of soft-drinks. A longer study may reveal if baseline beverage consumption presents itself later on after surgery and thus affects potential long term weight loss.

It is not fully understood which dietary habits are easier to adopt for obese adolescents. For example, it may be easier to decrease consumption of calorie dense foods if the adolescent also enjoys less calorie dense foods such as fruits and vegetables. It may be more difficult to avoid foods that contribute to weight gain if the adolescent is not able to replace these foods with healthier options they already consume. Eliminating foods they enjoy while introducing foods they do not enjoy may pose an additional obstacle for long term dietary changes and thus may lead to a decreased opportunity for
long term weight loss maintenance. While there are currently no studies to our knowledge that explore this possibility, this may be an area of interest that will help to understand dietary predictors of success in adolescents who undergo bariatric surgery. For this reason, this study focused on baseline dietary behaviors.

**Limitations**

This study has several limitations. A longer study is needed to determine the effects of dietary behaviors on weight loss, maintenance, and re-gain after bariatric surgery among adolescents. Research has shown that there is an increased risk for weight re-gain in bariatric patients at two to five years post-surgery. Thus, following up with our patient population longer than six months post-surgery may more realistically reflect how dietary behaviors affect their long term weight loss outcomes. Dietary recalls were only considered from an initial assessment and there were no data on changes in dietary behavior leading up to surgery or post-surgery. While it has been shown that an overall reduction in energy consumption favors an ideal body weight, few studies have been able to identify individual components of dietary composition that determine success in weight loss or favor an ideal body weight for bariatric patients, particularly in adolescents. Furthermore, a larger sample size would possibly reveal more statistically significant results.

**Future Directions**

It has been shown that patients who receive more dietary counseling after surgery, also have a more significant decrease in BMI after surgery. Post-operative studies often rely on dietary recall in form of surveys and FFQs rather than encounters with a dietitian. One way to improve the information available for research in this area may
be to train dietetic interns to administer a dietary recall over the phone on a regular basis. This may also allow patients to ask basic nutrition related questions after their surgery. Research has shown that simply tracking dietary intake can help in the maintenance of weight loss. Additionally, the research has suggested that patients who undergo bariatric surgery and have more follow up with a dietitian are less likely to regain weight after surgery. Because bariatric surgery in adolescents is still a relatively new concept, it will be important to try to find ways to track adherence to nutrition recommendations weight loss, weight loss maintenance, and complications in these patients far into adulthood. More research may also provide a rationale for more insurance coverage for nutritional follow up with a dietitian. Keeping patients engaged with health professionals after their surgery through a solid network of convenient community programs such as sports programs, camps, and support groups may help keep patients focused motivated long term after surgery.

Conclusions

A clear relationship between dietary intake of fruits and vegetables before surgery and weight loss after surgery has yet to be determined. The current study provides direction for future research on this topic. The decision to pursue bariatric surgery for the treatment of obesity is a challenging decision for adolescents and their families. Finding nutritional strategies to promote weight loss maintenance after bariatric surgery is imperative to ensure optimal outcomes for adolescents.
REFERENCES


APPENDIX A

Nutrition Assessment Form “Health4 Life”

Name:

Date:

DOB:

Family Member present:

Medical Dx: ___________________________ Fam. History: ___________________________

ABW: _______ ( )%tile HI: _______ ( ) %tile BMI: _______ ( )%tile Wt Change _______ R BW:

Surgery date: _______ (Wt): _______ EBW: _______ Pre surgery comorbidities:

Surgery: ☐ SGA ☐ LGB

Est Kcal needs: _______ Est Kcal intake: _______ Current diet: _______ Motivation:

24 hour recall

Meals/day: ____________ Snacks/day: ____________

Breakfast AM Snack Lunch PM Snack Dinner HS Snack

Cups Veg/fruit: _______ Cups fruit: _______ Fixed food: _______ Restaurant food: _______

Cups H2O/day: _______ Cups milk/d: _______ Cups juice/d: _______ Cups swt bevg/day: _______

Fam Meals/wk: _______ PA: _______ min/d weekday: _______ days/wk: _______ min/day weekend:

Screen time: _______ hr/day weekday: _______ hr/day weekend:

Vitamin/Protein supplements: _______ Food allergies/intolerance: _______

Previous diet attempts:

NUTRITION DIAGNOSIS:

__________________________________________ related to ___________________________________

__________________________________________ as evidenced by ___________________________________

Factors affecting outcome:

☐ No/inappropriate support system ☐ Knowledge deficit ☐ Difficulty obtaining healthy foods/food stamps

☐ Resistant to change ☐ Shopping meals ☐ Carotic beverages

☐ Frequent snacking ☐ Lack of exercise ☐ Binging

☐ Family dynamics

INTERVENTION: (Educational Material Provided/Topics Covered):

☐ Serving Sizes/Plate Method ☐ Meal Planning ☐ Healthy Eating

☐ Liquid calories/sugar demo ☐ Fiber/Water/Veggies ☐ Physical activity/screen time

☐ Breakfast Essentials ☐ Dyslipidemia ☐ Support Systems/Behavior change

☐ Fast foods/Eating out ☐ Food Labels ☐ Healthy Inexpensive foods

☐ Label reading ☐ Snacks ☐ Mindful eating

Goals: (1) ____________________________________________ (2) ____________________________________________ (3) ____________________________________________

MONITORING & EVALUATION:

☐ F/U in: _______ with: ____________________________

Health for Life Registered Dietitian

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45
2 to 20 years: Girls
Body mass index for age percentiles

<table>
<thead>
<tr>
<th>Date</th>
<th>Age</th>
<th>Weight</th>
<th>Stature</th>
<th>BMI*</th>
<th>Comments</th>
</tr>
</thead>
</table>

*To Calculate BMI: Weight (kg) - Stature (cm) + Stature (cm) x 10,000
or Weight (lb) - Stature (in) - Stature (in) x 703

BMI

Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with
the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts