BASELINE TRAITS AS PREDICTORS OF SUCCESS IN MEDICAL WEIGHT MANAGEMENT

MASTER'S THESIS
SUBMITTED TO THE FACULTY OF
UNIVERSITY OF MINNESOTA COLLEGE OF FOOD, AGRICULTURE, AND NATURAL RESOURCE SCIENCES
BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

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May 2015

Acknowledgements

I would like to thank everyone who was involved in the process of this project. Jonathan Puchalla, thank you for your hard work on the database and the help that you provided me throughout my research. To my committee members, Dr. Carrie Earthman and Dr. William Thomas, thank you for helping guide my research and helping me better understand the research process.

My sincerest gratitude goes to Dr. Shalamar Sibley for continually pushing me to get the most out of this research experience. I thank her for deepening my understanding of the process as well as the outcomes. You have helped me in so many ways throughout the two years in the program, both personally and academically. Your commitment to my experience has allowed me to gain an immeasurable amount of information about the field and beyond.

Lastly, I would like to especially thank my family for their continued support and encouragement throughout my graduate school experience. They have been there for me every step of the way and have been very understanding of the dedication that I have put into the program. They have always supported my dreams and have done everything they can to help in that pursuit.

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Introduction

Obesity is vastly becoming of great concern in many areas around the world. In the United States alone 35.5% of adult men and 35.8% of adult women are classified as obese.[1] Various physical, environmental, and behavioral factors can contribute to the onset of obesity in an individual's life. In turn obesity can contribute to consequences including financial burdens, increased health risks such as diabetes, coronary heart disease, degenerative joint disease, certain types of cancer, as well as psychological issues.[2] Obesity treatment can include lifestyle modification, pharmacological intervention, or surgery; however, better understanding of factors related to weight loss success and strategies for individualized effective treatment plans are needed. By identifying baseline factors that are associated with weight loss success there is potential for individuals to be better placed into the most appropriate individualized weight loss treatment plans, which may result in greater weight loss success.

Part 1: Cause of Obesity

Obesity is defined as having a body mass index (BMI) of greater than or equal to 30 kg/m^2.[3, 4] This is caused by an imbalance of energy intake and energy expenditure leading to net energy storage.[5] Information from the National Health and Nutrition Examination Survey (NHANES) suggests that there was an average daily intake increase from 1972 to 2000 with 168 kcal a day for men and 335 kcal a day for women.[6] This energy intake increase along with an estimated decrease in physical activity found by Church et al. of 142 kcal per day decrease since 1960. This explains the increase in energy imbalance leading to weight gain over this period.[6, 7] An increase in per capita energy intake over the past 40 years of a 20% increase reported by the USDA has changed the collective diet (*figure* 1).[8, 9]

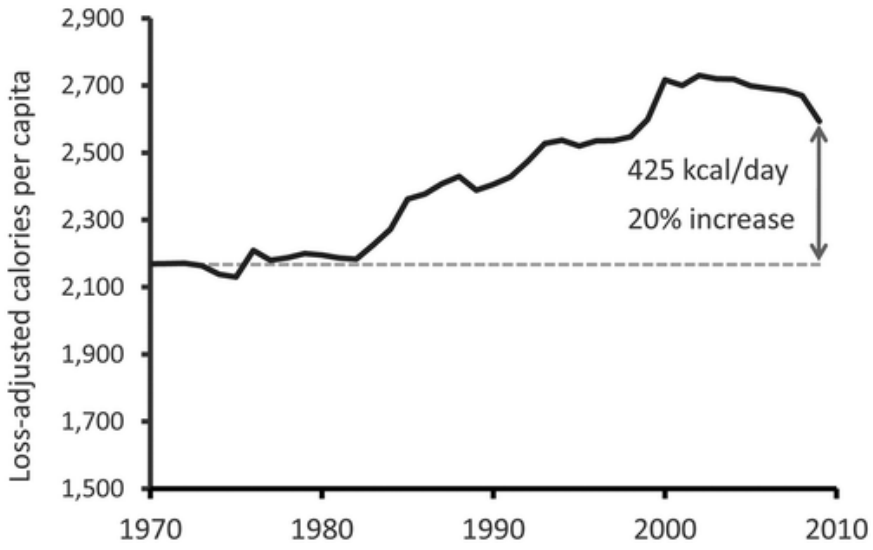

Figure 1*: Per capita energy intake according to the U.S. Department of Agriculture food disappearance data (corrected for waste). Daily energy intake has increase 20% from 1970-2009.*[8, 9]

Energy expenditure occurs through resting metabolic rate, thermic effect of food, and physical activity.[10] Resting metabolic rate is the amount of energy that is necessary to fuel the body at rest and is proportional to fat-free body mass. The thermic effect of food is the amount of energy the body uses to absorb and metabolize the food that is consumed. Physical activity accounts for the biggest portion of energy expenditure in an individual.[10] Increased physical activity levels and frequency are associated with decreased risk of obesity.[11] The body is also more prone to preserving existing body weight causing issues with weight loss in individuals who have already gained weight.[10] In situations of negative energy balance the body is more likely to defend against it, thus preserving current weight than it is for the body to defend against positive energy balance. Because so much of the population is already in a positive energy situation this can cause issues with correcting the positive energy state that would lead to successful weight loss.

A number of factors contribute to energy imbalance and need to be addressed in an individualized fashion including genetic, physiologic, environmental, psychological, social, and economic situation.[12] Genetic predisposition of weight loss response may contribute to weight gain. This can be seen by the fact that there is large variability among individuals who are completing similar programs, suggesting that genetics plays a role in the response to the treatment and the amount of weight loss.[13] Despite good adherence to a program, individuals may experience less than desirable results due to variations in the genes, both monogenic and polygenic. Monogenic obesity can be caused by variations in leptin and leptin receptor genes for example, however; these mutations are rare.[14, 15] Polygenic obesity in due to gene-gene interactions, which causes a wide range of obesity characteristics that influence body fat accumulation and fat distribution.[15] With variations in genotype obesity there is the need for different approaches utilized for weight loss, specifically addressing the mutations that are being expressed.[15]

A patient's physical abilities can greatly impact an individual's ability to increase the physical activity portion of weight loss plans, thus potentially leading to greater weight gain and little to no weight maintenance. Behavioral factors, including eating patters, attitude towards food, willingness to make a change, and confidence in that ability to make a change can all contribute to overall weight loss success among individuals. If an individual is unwilling to make changes in their current behaviors there will be little likelihood of successful weight loss.

Environmental factors can contribute to overall energy imbalance; this includes the "built" environment as well as medications that a patient may be taking. The built environment includes food availability, such as fast food options and healthy food availability in grocery stores and an environment structured so that individuals expend less energy in their daily activities of living. Regarding increased intake, factors that affect food choices, such as education level, income, and related socioeconomic variables need to be considered when addressing why there is an overall increased consumption of

calories.[16] Another area that needs to be considered part of an individual's environment includes the use of medications that cause weight gain. These drugs include psychotropic medications, some diabetic medications, anti-hypertensives, steroid hormones, and contraceptives.[17]

Part 2: Implications of Obesity

With an increase in the amount of individuals classified as obese there is an increase in the number of individuals who face the complications that are associated with obesity. Individuals with obesity have an increased risk of type 2 diabetes, coronary heart disease, some forms of cancer, osteoarthritis, nonalcoholic fatty liver disease, and high blood pressure.[18] With an increase in the various diseases associated with obesity there is an overall decrease in the quality of life including depression, disability, physical discomfort, and possibly social isolation.[18] Obesity is the second leading cause of preventable, premature death in the United States, second only to smoking with a 2 to 3 times higher risk of death than those of normal weight.[19, 20, 21] Of these deaths an average 100,00 to 200,000 deaths are caused by the comorbidities that are associated with obesity.[22 - 25] Individuals who are classified as obese are estimated to have a decreased life expectancy of 0.8 to 7 years.[25, 26, 27]

Obesity contributes to the risk of serious health consequences. Obese women have a 10 to 17-fold increase in risk for developing type 2 diabetes and obese men have an 11 to 23-fold increase.[28] Among these individuals a decrease in weight can significantly improve complications that are associated with type 2 diabetes including glycemic control, cardiovascular risk, and risk of some cancers.[29 - 32] Along with diabetes, the presence of dyslipidemia is high among obese individuals. This includes elevated low-density lipoprotein cholesterol, decreased high-density lipoprotein cholesterol, and elevated triglycerides.[32] This lipid profile is associated with increased risk of heart disease and stroke.[18] Excess weight is also associated with nonalcoholic fatty liver disease, a chronic disease that may progress to end-stage liver disease.[34] Obesity is also associated with increased risk of progression to end-stage renal disease.[34, 35]

In terms of mood disorders and obesity, it is unclear whether psychopathology is a cause or consequence of extreme obesity.[36] Nonetheless, these issues can cause major problems in regards to successful weight loss and weight maintenance. Mood disorders are commonly seen among obese individuals. Depressive disorder, dysthymia, and anxiety disorders have been diagnosed in up to 48% of candidates of bariatric surgery.[37 - 43] Also, among these bariatric patients, around 25% report treatment from a mental health professional with 12% to 38% using psychiatric medication(s). Many of these medications are associated with excess weight gain and difficulty with weight loss.[38, 40 - 44]

Obesity, especially extreme obesity, is associated with reduced health-related quality of life.[45] Investigators have found a positive relationship between BMI and physical limitations, bodily pain, and fatigue.[46 - 51] Decreases in quality of life are associated with increases in anxiety, depression, feelings that food controls their life, and impaired social abilities.[52] Many people feel that with an increase in weight there is an overall loss in the ability to control their lives, thus potentially leading to a further increase in weight due to the thoughts of them being out of control. Physical inabilities also contribute to overall decrease in quality of life, these issues can either be the cause of the increased weight gain or can be an effect of an overall increase of weight over time. Physical inability can lead to issues with everyday activities causing patients to be unable to complete daily tasks and physical activity.

Part 3: Financial Impact of Obesity

The financial impact of obesity is considered a huge burden to the United States health care system. Not only is there an increased cost associated with obesity itself, obesity related comorbidities need to be considered when calculating costs. The Center for Disease Control estimated that annual cost of obesity in the United States reached $147 billion in 2008, with obese individuals having medical costs $1,429 higher than those of normal weight annually.[19] Some studies have shown that with a decrease in obesity related comorbidities there will be an overall decrease in obesity related care and the

costs associated.[53] In a matched cohort study carried out by Mason et al. looking at the same medical procedures between obese and non-obese individuals from 2005 to 2009 there was over a $160 million difference in cost.[53] This gap in costs was due to differences in utilization of hospital resources, differences in length of stay, and intensity of services. There is an increased association between obesity and an increased number of secondary and additional procedures needed by the patient including intubation, medical ventilation, physical therapy, and rehabilitation. It was concluded that because the patients were medically matched otherwise, that all differences in cost perioperatively were deemed due to excess body mass or its impact on postoperative demands.[53]

Along with increased medical costs there are also costs associated with decreased productivity. This decrease in productivity is caused by higher rates of disease, disability, and death. Of the previously stated causes of decreased productivity, including disease and decreased quality of life, there is an estimated cost of $270 billion annually in the United States.[54] Even a modest amount of weight loss can contribute to an increase in productivity and a decrease in general medical costs, thus leading to an overall decrease in the financial impact of obesity and its related comorbidities.

Part 4: Understanding of Weight Loss

4.1 Weight Loss and Weight Loss Success – Definitions

When considering weight loss among obese individuals, the overall goal is to have a meaningful weight loss with prolonged maintenance of the decreased weight including a reduction in overall fat mass leading to a reduction of mortality and morbidity. A successful amount of weight loss is considered to be between 5% and 10% of baseline weight to see clinically significant improvements. With a weight loss of 5% to 10% there is a decreased risk of type 2 diabetes among high-risk individuals as well as a significant improvement in glycemic control among those with type 2 diabetes.[21]

Typically, initial weight loss has a strong association with late and overall success of weight loss treatment.[55] Individuals who had a weight loss of greater than or equal to

10% weight loss at the end of year one had a 10.4 times greater chance of sustaining greater than 10% weight loss at year four.[56] However, successful weight loss and weight maintenance requires significant amounts of lifestyle modifications.[57] Maintenance of the lost weight is associated with the initial weight loss, achievement of set goals, an active lifestyle, self-monitoring weight related behavior, a regular food intake pattern, and control over eating behaviors such as stress eating.[58, 59] Overall, long-term success depends on the patient's ability to incorporate large lifestyle and behavior changes.[52] Adherence of weight loss programs seems to be one of the most difficult aspects of successful weight loss.[60] Increased frequency of face-to-face contact with patients over a long period of time helps direct adherence to changes, which later improves the outcome of the treatment.[61] Web based interactions have not shown to be as beneficial as actual face-to-face encounters between a patient and a physician.[30] However, different treatment approaches have varied definitions of weight loss success and varied amounts of patients reaching that successful benchmark complicating overall understanding of optimal approaches for weight management success.

4.2 Health Benefits of Obesity Treatments

Treatment of obesity is associated with many improvements in comorbidities and quality of life. In overweight and obese adults that are at high risk for type 2 diabetes weight loss of 2.5 kg to 5.5 kg can reduce the risk by 30% to 60%. In individuals with type 2 diabetes, weight loss of 2% to 5% can result in modest reductions in fasting plasma glucose concentration and lower HbA1c by 0.2% to 0.3%. Weight loss of 5% to 10% can lower HbA1c levels by 0.6% to 1.0% and reduce the need for diabetes medications.[62]

Individuals with elevated CVD risk that achieve 5% weight loss have an approximate reduction in 3 mm Hg systolic blood pressure and 2 mm Hg diastolic blood pressure. At a weight loss of greater than 5% there is an even greater reduction in blood pressure and a decrease in use of antihypertensive medications.[62]

Weight loss has a dose-response relationship with improvements in lipid profile. A 3 kg weight loss has been shown to have a mean reduction in triglycerides of at least 15 mg/dL. A 5 kg to 8 kg weight loss was shown to have a reduction of LDL of 5 mg/dL and an increase in HDL of 2 to 3 mg/dL. Modest improvements in triglycerides, HDL, and LDL are observed with a weight loss of at least 3 kg.[62]

Part 5: Introduction to Treatments

Treatment for obesity can be carried out in a variety of different ways including pharmacology, surgery, lifestyle intervention, or any combination these.[63] A comprehensive approach to weight management including diet, physical activity, and behavior therapy has been shown to be more successful than one intervention strategy alone.[29] Treatment approaches should be selected based on the individual's age, gender, degree of obesity, health risks, behavioral characteristics, as well as success of previous weight loss attempts.[21]

Even a modest amount of weight loss of 5% to 10% of initial weight for an obese individual can create a great reduction in total cholesterol, low-density lipoproteins, cholesterol, and serum triglyceride levels and thus improving complications associated with obesity.[21] These improvements lead to decreases in blood pressure and instances of insulin resistance, type 2 diabetes, and cardiovascular disease.[21] Regardless of the type of treatment that is used on the patient, an overall decrease in weight creates an improvement of health status and quality of life.

5.1 Pharmacotherapy

In comparison to other diseases in which drugs are used for treatment, fewer options are available and approved for obesity.[21] In order for a weight loss drug to be considered effective there needs to be a significant amount of absolute weight loss, percent of weight loss, and percent of patients achieving greater than or equal to 5% - 10% weight loss. There also needs to be a significant change in clinical measurements including blood pressure, glycemic control, and cholesterol compared to the placebo group.[64] The FDA

must see meaningful weight loss if the drug meets at least one of the two guidance criteria. The first guidance criteria considers a drug effective if the mean weight loss between actual product and a placebo group must be at least 5% and the difference is statistically significant. The second considers a drug successful if the portion of subjects who lose ≥5% of baseline body weight in the treatment group is at least 35%, is approximately double the placebo group, and is statistically significant.[65] As long as one of these criteria is met the FDA considers the drug to produce meaningful weight loss and will be approved for weight loss.

For the most effective outcome while using medications, treatment should be paired with a lifestyle modification program as a drug treatment can only be maintained for a limited time.[66] The benefits of pharmacotherapy cause it to a good resource for weight loss with significant decreases in blood pressure, lipid levels, and blood glucose levels with overall increases in insulin sensitivity.[67] Current exploration of targeted pathways include medications that act centrally to suppress appetite and increase energy expenditure and medications that inhibit energy intake through the blocking of orexigenic signaling in the feeding center.[21, 57] However, it remains unclear as to which type of medications pathway that is targeted is associated with the most significant and long-term weight loss.[57]

There are risks that are associated with the use of weight loss medications and should be considered before putting a patient on these potent weight loss stimulators. This includes risk for development of a tolerance or the potential for addition, later leading to a change in medication therapy or potentially leading to a change in weight loss therapy all together.

5.1.1 Currently Used Medications

Monotherapy

There are two main categories of weight loss medications that are approved in the United States. These include fat absorption inhibitors and anorexiants. Fat absorption inhibitors, such as lipase inhibitor medications, act peripherally to reduce absorption of dietary fat in

the gut.[21, 63] Anorexins work to promote satiation, reducing the desire to eat. This is done through interfering with neurological pathways in the hypothalamus, by inhibiting orexigenic pathways (appetite stimulators) and promoting anorexigenic pathways.[57]

Orlistat works peripherally as a lipase inhibitor, decreasing the amount of fat that is absorbed in the stomach and intestines from food by up to 30%.[57, 68, 69] It is currently approved by the FDA for long-term weight loss.[2, 65, 70] Orlistat can be found as an over the counter medication under the trade name of Alli or as a prescription under the trade name Xenical. The overall decrease in fat absorption contributes to the side effects of stearrhea and bowl incontinence with high fat meals.[71] Orlistat contributes to weight loss leading to improvements in cardiovascular risk factors, type 2 diabetes, hypertension, and dyslipidemia. Orlistat therapy has been shown to increase the odds of ≥5% weight loss compared to diet only therapy after a 1-year follow-up.[72]

Lorcaserin (Belviq) is a serotonin agonist causing anorectic effects leading to increased satiety and decreasing food intake causing to weight loss.[73] The FDA approved it in June of 2012 to be used as a long-term weight loss drug for obese patients.[74] Common side effects include headache, upper respiratory tract infection, nausea, and dizziness.[75, 76] Lorcaserin creates significant reductions in waist circumference and BMI as well as total cholesterol, LDL cholesterol, and triglycerides.[76] Weight loss seen among lorcaserin users at one year showed a 4.5% to 5.8% decrease in baseline weight compared to the placebo group achieving 1.5% – 2.8% decrease in body weight.[75, 77]

Phentermine, trade names Adipex-P and Suprenza, is a sympathomimemetic amine that acts as an appetite suppressant and energy expenditure promoter that is an approved short-term weight loss monotherapy by the FDA. Phentermine blocks the dopamine and norepinephrine transporters leading to an increase in dopamine and norepinephrine in the hypothalamus. This leads to reduced appetite and subsequent weight loss.[68, 73] Studies have shown a 3.6 kg greater weight loss than those taking a placebo.[69] It can lead to headaches, an increase in pulse rate and anxiety, an increase in blood pressure, and can

cause cardiovascular complications, especially in those that already have pre-existing cardiovascular conditions.[73, 78]

Diethylpropion is an appetite suppressant, decreasing overall hunger sensation leading to weight loss, and energy expenditure promoter.[63, 79] The appetite suppressant effect is cause by central nervous system stimulation, with mechanisms that are still uncertain.[63] Diethylprpropion, trade name Tenuate, is approved for short-term weight loss, but is currently being studied to see if it can be used for long-term weight loss. In a study carried out by Cercato et al. patients were placed on either diethylpropion or a placebo to see the effects of weight loss.[80] Of the patients that were on the diethylpropion, 51.3% of them achieved 10% or more weight loss compared to 3.13% in the placebo group. When looking at the potential for using dietylpropion for long-term weight loss, at 6 months patients taking the drug lost an average of 9.8% of initial body weight, where the placebo group only lost 3.2%.[80] Side effects that can be seen among individuals who are taking diethylpropion include tachycardia, elevated blood pressure, palpitations, and restlessness and anxiety.[80]

Topiramate was originally used as an anticonvulsant and migraine prophylactic, but after significant weight loss was seen in epileptic patients it started to be used as a weight loss medication in obese individuals. Although, not approved specifically for weight loss by the FDA, it is used for short-term weight loss.[4, 81] The mechanism by which topiramate works for weight loss is still unknown. It is speculated that it inhibits GABA actions and reduces excitatory glutamate actions.[73] Side effects that can be seen with topiramate include paresthesia, fatigue, and difficulty with concentration.[82, 83, 84] It is sometimes used as an adjunct to mood stabilizing drugs that have a tendency to cause patients to gain weight.[73] Individuals on topiramate achieved greater amounts of 5% and 10% weight loss from baseline body weight than those on a placebo. Topiramate users exhibited 5.9% - 6.5% weight loss compared to 1.9% weight loss shown in those on a placebo.[83]

Naltrexone and bupropion are also used as monotherapies for weight loss. Naltrexone is an opioid receptor antagonist used in the treatment of alcohol and opioid dependence, which also leads to suppressed food intake.[85] Although not approved by the FDA for weight loss, naltrexone is being used off label for weight loss with varying success for significant weight loss.[86, 87] Bupropion was originally used for depression and smoking cessation with mild weight loss seen as a side effect.[88] Buproprion works by inhibiting norepinephrine and dopamine reuptake leading to suppressed appetite.[73] However, cardiovascular concerns are still being assessed.[89]

Combination Drugs

Drugs are being used in combination when monothreapies do not seem to be effective for a patient. By creating combination therapies smaller doses of each medication can be used with synergistic effects allowing for multiple mechanisms to be utilized creating an overall greater amount weight loss. This includes the phentermine and topiramate combination called Qsymia, approved in 2012. Qsymia is thought to produce longer-lasting weight loss results due to the synergistic effects.[73] This combination can partially lead to a decrease in the side effects compared to either agent alone.[90 - 93]

Another combination therapy, not yet approved by the FDA, is the mixture of naltrexone and bupropion known as Contrave. Contrave can lead to appetite suppression and subsequent weight loss.[73, 94] The naltrexone that is added can remove the negative opioid feedback and enhance the effect of the bupropion.[73]

5.1.2 Removed Drugs

Although there are drugs that are available both in monotherapy and combination therapy there are many drugs that have been removed from the market for varying reasons. Fen-Phen, a combination of fenfluramin and phentermine, is a serotoninergic combination that increases serotonin levels in the brain. Fen-Phen was removed from the market due to possible side effects of pulmonary hypertension and heart valve issues caused by fenfluramin.[95]

Recently, sibutramine, an FDA approved drug for long-term weight loss was voluntarily removed from the market. Sibutramine inhibited the reuptake of serotonin and norepinephrine in the central nervous system, thus increasing satiety, reducing hunger, and decreasing the drop in metabolic rate when weight was lost.[95] Sibutramine stimulates the sympathetic nervous system, potentially causing issues with cardiovascular function including increased risk of heart attack and stroke.[73]

5.2 Surgery

Bariatric surgery has now become a viable option for weight loss in morbidly obese that have not responded to pharmaceutical and lifestyle modification options. Two major approaches are being utilized, these approaches include intestinal malabsorption and gastric restriction.[96, 97, 98] However, due to surgical risks and complications, surgery is used selectively among individuals. Indications for consideration of surgery for obesity management include a BMI of greater than or equal to 40 kg/m^2 or a BMI of 35 kg/m^2 to 39.9 kg/m^2 with the presence of comorbidities, including type 2 diabetes, high blood pressure, and severe sleep apnea.[18, 66] Although bariatric surgery is associated with an increase in success in terms of weight loss and improvements in comorbidities there are side effects that need to be addressed when discussing this option with patients.[30, 99] Early complications occur in 5% to 10% of patients including pulmonary embolism, respiratory failure, stomal obstruction, bleeding, and gastrointestinal leaks.[36] Many patients also experience later complications of nutrition and metabolic changes. Occurrences of these complications vary between patients and are associated with the patient's age, BMI, the type of surgery performed, and presence of other comorbidities.[66, 100]

Bariatric surgery is associated with macronutrient and micronutrient deficiencies.[101, 102, 103] These complications are due to the surgical induced anatomical changes to the individual's gastrointestinal tract and have been reported in at least 25% of patients.[104, 105] Macronutrient deficiencies include protein-calorie malnutrition and fat malabsorption.[102] Micronutrient deficiencies often include zinc, vitamin D_3, folic acid, iron, and vitamin B_{12}. These deficiencies can be attributed to the change in the absorptive areas of the GI

tract, changes in co-factors (such as intrinsic factor) needed for absorption of certain micronutrients, as well as overall changes in dietary choices and decreased food intake.[101] For example, vitamin B_{12} is often deficient due to a loss of intrinsic factor, reducing the bioavailability, and also due to a decreased consumption of B_{12} containing foods like meat.[106, 107] A vitamin D deficiency can potentially cause hyperparathyroidism leading to bone disease, muscle weakness, and cardiovascular issues in high-risk individuals.[108] Patients that receive weight loss surgery should be taught potential issues with macro and micronutrient deficiencies and also be monitored to avoid potential side effects that accompany the deficiencies. Supplementation based on the patient's history and type of surgery performed can be prescribed and often times can prevent a patient from getting a deficiency.[102] Macronutrient and micronutrient deficiencies can also be do to a large number of individuals experiencing vomiting and gastric dumping. This has been reported in one-third to two-thirds of all gastric bypass patients.[46, 110, 109] Often times this is the result of overeating or consuming foods that are not recommended post surgery, such as foods high in sugar.[45]

Along with micronutrient and micronutrient deficiencies, there can be difficulty with compliance pre- and post bariatric surgery. Issues including missed appointments, binge eating, and depression, which are associated with poorer weight loss. This supports the current clinical practice of having regular contact between the physician and the patient as well as having aggressive treatment plans to address psychological symptoms and maladaptive eating patterns both before and after surgery.[61] By addressing issues prior to bariatric surgery there is the possibility of decreasing the likelihood of poorer weight loss. Strong associations between binge eating and poor weight loss in bariatric patients have been shown by multiple studies.[46, 61, 111] Issues with disordered eating may continue post surgery if not addressed and corrected.[36, 46, 111] With greater understanding by the patient of what it means to have weight loss surgery and what the expectations are as a patient there can be a more successful outcome.[61]

5.2.1 Restrictive

Laparoscopic adjustable gastric banding (LAP-BAND) is a laparoscopic technique used to separate the stomach into two pouches. This is done by placing an adjustable band around the stomach, just below the gastroesophageal junction, that can be inflated to allow for a varying sized channel between the two pouches.[112] This procedure is associated with slow/steady weight loss and results in approximately 25% excess weight loss at 5 years in two-thirds of the patient population.[113] Adjustments to the band may be necessary to increase or decrease the passage size between the two sections of the stomach, with an increase in inflation leading to a decrease in oral intake.[112] LAP-BAND has the lowest risk of complications compared to gastric bypass, sleeve gastrectomy, and duodenal switch.[114] However, re-operations vary enormously within patients from 2% to 80%.[115] Some patients may experience prolapse, usually of the anterior stomach, with urgency of reparative surgery dependent on the patient's symptoms.[112] Patient's complications and symptoms are not exhibited the same by everyone; therefore, patients are recommended to undergo an annual esophagram to check for complications.[112]

Sleeve gastrectomy (SG) is an irreversible procedure reducing the size of the stomach to a narrow gastric tube. The sleeve gastrectomy procedure has gained in popularity and is no longer just used in high-risk or super-obese patients as the first step of a two-part approach.[116 - 120] SG procedures have shown both short and intermediate positive results and do not seem to have as many nutritional deficiencies as gastric bypass.[121 - 125] As with gastric bypass, SG is associated with safe and effective reduction in comorbidities, but without the high need of supplementations that are needed with gastric bypass.[122] Weight loss at 5 year follow up has been reported at 55% loss of excess body weight with greater than 50% excess weight loss sustained after 5 years.[126, 127] However, major complications of the gastric sleeve procedure include leakages in the lines (1.2%) as well as internal bleeding (3.6%); however, risk outcomes still differ between studies.[121 – 123, 127 - 129]

5.2.2 Malabsorptive

Biliopancreatic diversion with duodenal switch consists of removing a large portion of the stomach and attaching the duodenum to end of the intestine, closing off the middle portion. This leads to a decreased stomach and intestine size limiting the time that digestive enzymes can interact with food, decreasing in the absorptive area for calories and nutrients.[18] Originally just the biliopancreative diversion, the addition of the duodenal switch eliminated negative side effects. Biliopancreatic diversion with duodenal switch has been shown to provide the greatest sustained weight loss among all bariatric procedures.[130] Depending on the amount of the intestine that is left connecting the stomach and the colon, it has been reported that excess weight loss was between 70% and 80%.[130] With a smaller portion of the intestine available for the digestion and absorption of nutrients, the biliopancreatic diversion with duodenal switch has the greatest number of nutritional deficiencies leading to the requirement of long-term follow-up care.[130]

5.2.3 Restrictive and Malabsorptive

Roux-en-Y gastric bypass surgery was the most commonly used weight loss surgery as of 2011.[114, 131, 132] Massive weight loss is seen in patients who receive this procedure. Reductions in obesity-related comorbidities and mortality occur with randomized prospective trials reporting 50% to 80% loss of excess body weight over 5 years.[57, 130, 133 - 136] In gastric bypass a small pouch is created at the top of the stomach, the small intestine is then connected to the pouch to bypass most of the stomach and creating a distal remnant.[57, 137] This creates a large shift in the volume of food that is consumed, thus leading to decreased weight through decreased food intake.[137] The newly formed pouch is reduced to roughly 5% of the original capacity of the stomach.[57] However, with a decrease in the stomach size and intestinal absorptive surface there are issues with nutrient absorption such as iron, calcium, thiamine, and vitamin B_{12}.[57, 122, 137] Postoperative complications like deep vein thrombosis, anastomotic leaks, internal hernias, gastrointestinal bleeding, wound complications, and staple-line disruption have been seen in 10% of cases.[138, 139, 140] Although gastric bypass is associated malabsorption, it has shown to have good long-term results with successful weight loss, some important

improvements in health outcomes, and improved quality of life.[109, 141 - 143] Most patients exhibit sustained weight loss and resolution of comorbidities within the first 2 years after surgery with long-term studies showing weight regain after 10 to 15 years of surgery.[114, 144 - 147] Studies have reported that most weight regain beginning after 2 years postoperatively and is estimated at around 15% of the maximum weight loss seen.[104, 140, 148]

Although there are complications with bariatric surgery, this treatment has become more common with the use of laparoscopic techniques.[132] Surgical treatment is associated with substantial weight loss leading to improvements in obesity related diseases like diabetes, hypertension, dyslipidemia, obstructive sleep apnea, and quality of life.[29, 143, 149, 150] Bariatric surgery is considered the most effective treatment for morbidly obese individuals, but it like all other therapies is only part of the tools needed.[146] Important underlying issues still need to be addressed when trying to achieve weight loss success.

5.3 Lifestyle Intervention

Lifestyle intervention can include behavioral strategies, diet modification, and exercise modifications. By addressing issues within an individual's lifestyle long-term changes can be made leading to initial weight loss success and sustained weight maintenance. Successful lifestyle interventions are associated with an individual's higher self-efficacy, higher self-esteem and motivation, and realistic goals for weight loss and weight expectations at baseline.[55, 151, 152] Lifestyle intervention includes a moderately reduced calorie diet, increased physical activity, and behavior intervention to facilitate adherence.[29]

Caloric restriction is commonly the foundation of most weight loss programs.[57] A general guideline of caloric deficit of 500 to 1,000 kcal of estimated energy requirements should result in a weight loss of 1 to 2 pounds per week.[29] Behavior intervention includes the incorporation of nutrition education, such as reading nutrition labels, recipe modifications, and cooking classes. By increasing an individual's knowledge there is a

chance at changing the patient's food choices.[29] Behavioral modification has been shown to be effective in decreasing body weight; however, there is a need for this type of intervention to be intensive and sustained.[36, 153 - 155] In a study carried out by Kong et al. intensive lifestyle intervention were assigned to individuals with varied level of confidence in their ability to make a change.[156] Participants with an increased level of confidence regarding capability to increase level of physical activity demonstrated a significant percentage of weight loss at one year. With the significant weight loss there was better prevention of the development of obesity related health issues including type 2 diabetes and cardiovascular events during follow-up of these study participants.[156]

Studies continue to show that physical activity should be combined with caloric restriction in order to maximize weight loss among individuals. Not only can exercise contribute to an increase in the amount of energy that is expended by an individual, it also improves metabolic fitness, even if there is little weight loss achieved.[157, 158, 159] Recommendations for physical activity include 30 minutes of moderate to vigorous physical activity 5 to 7 days per week.[57] An increase in physical activity contributes to weight loss, may decrease highly concerning abdominal fat, and may help with maintenance of weight after initial weight loss is successful.[29] Aerobic activity significantly increases energy expenditure, improves cardiovascular function, and increases metabolic fitness.[160] Strength training promotes lean muscle mass, maintains resting metabolic rate as well as improving muscle strength and endurance, thus supporting further increases in physical activity.[161, 162]

Typically, intensive interventions only addressing lifestyle changes have a high drop out and non-responder rate.[156] This suggests that not all patients are suitable for lifestyle changes alone. Therapy escalates to include pharmacotherapy and surgery where appropriate, with specific choices made after individualized, detailed assessment. Other studies have suggested that patients tend to struggle to adhere to low-calorie diets and thus over time the caloric intake increases significantly, especially in individuals who receive bariatric treatments.[36, 114, 148, 163]

5.4 Combination Treatments

By combining various treatment approaches a greater weight loss and longer weight maintenance can be obtained leading to an overall improvement in life. Comprehensive weight management programs are more successful than using any one intervention alone.[29] Addressing multiple areas of concern may allow for the patient to achieve weight maintenance over a longer period of time, contributing to a greater improvement of health. Treatments should last at least 6 months with increase in length depending on the weight loss that is achieved with follow–ups to provide successful weight management approaches.[29]

Comprehensive weight management programs can lead to increased weight loss by incorporating multiple areas. This could include various aspects of behavior therapy such as self-monitoring, stress management, stimulus control, problem solving, and social support. When combining this with diet and physical activity higher weight loss can be seen.[29] By combining different approaches there are multiple synergistic ways in which energy intake can be decreased and energy output increased.

For individuals who have failed with other approaches, surgical procedures could promote significant weight loss and improve comorbidities; however, behavior interventions should be used in combination to prevent lapses in corrected eating patterns.[57] Along with increased weight loss, behavior modification strategies need to be implemented to decrease the chance of unwanted side effects, such as dumping syndrome, when eating the wrong diet after bariatric surgery.[36]

Part 6: Barriers to Weight Loss Success

Although many treatment types are available, there are many factors that contribute to the issues that are seen by many patients trying to reach a successful weight loss goal. One major barrier to weight loss includes the generalized weight loss plans that are administered to patients seeking help. This generalized approach does not address an

individual's gender, age, or socioeconomic status for example, causing treatments to be unsuccessful potentially leading to a decrease in compliance. This also correlates with the number of visits that an individual will attend, which is also associated with success in weight loss. A greater number of visits predicted more successful maintenance of weight loss, with 10% weight loss maintainers having significantly more treatment contacts than patients who maintained a loss of 0 – 4.9% or who gained back above baseline weight.[56] By not addressing these factors there may be unrealistic goals set by the physician and patient and a decrease in the amount of visits later contributing to overall decreased likelihood of success.[29]

Another barrier to weight loss success is individual variability in readiness to change, confidence in ability to make a chance, and sustained adherence. Exhibiting low readiness to change can potentially affect the change of success, creating more drastic need for various treatment types.[58] In bariatric patients, it has been noted that preoperative behavioral complications may impair postoperative weight loss and long-term weight maintenance.[36] A decrease in adherence of changes that are prescribed contributes to an overall lack of ability to achieve weight loss goals. If an individual is unable to change their behavior and effectively implement change in areas including dietary barriers, like eating away from home too often, eating high caloric foods, and not paying attention to diet, there is an overall decrease odds of being successful in weight loss by 48% to 64%.[58] This suggests that there may need to be more focus on behavior changes that are done in order to achieve moderate weight loss and maintain that body weight even in surgical patients.

Other contributing barriers include medical factors preventing weight loss. This includes medications, physical abilities, and other health issues that may be present that prevent lifestyle change or increase in physical activity. With a wide range of medications that cause weight gain among individuals, it is hard to determine what factors of the medication are causing the weight gain. However, there is evidence that some of the most prescribed drug classes do cause significant weight gain.[164] Decreased energy

expenditure, due to decreased physical ability can cause issues with weight gain and overall decrease in quality of life.[164]

Another barrier to consider in terms of weight loss success is the issue of perceived barriers, which can include time to exercise, cost of healthy foods, and social support.[58] According to Elfhag and Rossner, both pressure and lack of social support are important in weight loss with ability to handle life stress and having better coping strategies being associated with successful weight maintenance.[55] If these perceived barriers are not addressed when prescribing a weight management plan, there is a greater chance of unsuccessful weight loss and decreased compliance.

Part 7: Determining the Best Treatment

Determining the best treatment for an individual undergoing treatment for obesity can be complicated. History of weight cycling, disinhibited eating, binge eating, hunger or eating in response to negative emotions and stress are factors that can contribute to development of obesity and difficulty with achievement and maintenance of weight loss. Without proper treatment and follow-up the instance of weight regain is highly prevalent. Obese individuals typically regain about 1/3 of the lost weight within the first year.[56] By identifying key areas in which an individual may struggle, there is the potential to prevent the individual from weight regain and aid in success of weight loss. Barriers including medical history, previous weight loss attempts, motivation and willingness to change, and ability to set goals for one's self are associated with weight loss success.[55, 156, 165, 166]

The prevention and treatment of obesity will be better achieved by targeting existing effective interventions specific to each patient.[156] By addressing factors associated with barriers of weight loss success there can be an overall understanding of what needs to be changed, what it will take to make those changes, and establishing successful goals. By addressing these areas there can be greater success not only in the weight loss that is seen, but also the chance of return visits and completion of weight loss programs. With the wide variety of patients that are being seen at weight management clinics, there needs

to be some understanding of the differences between patients and application of this understanding to the individual needs of each patient.

Part 8: Baseline Predictors of Success

Identifying an individual's characteristics that might predict how well they are able to respond to treatments could lead to improved success and reduce weight regain.[55] These factors can also contribute to the type of treatment that an individual is placed on, decreasing the chance of an individual spending time on a treatment that doesn't end up benefiting them. By placing a patient on the correct treatment right away there is a greater chance for immediate success, which later leads to an overall higher success in long term weight loss.[55] Weight loss within the first year has been shown to increase the odds of achieving a >10% weight loss after 4 years by 10.4 times more than those who lost <5% in the first year.[56] It is important to identify factors that could potentially cause issues with weight loss due to the already difficult nature of weight loss and weight maintenance.[58] There is potential for factors related to medical reasons (controlling blood sugar or acid reflux), disordered eating patterns, socioeconomic status and food insecurity, changes in hunger perception, emotional eating, binge eating, and potentially issues with craving driven eating to cause issues with weight loss. Slight increases in consumption due to any type of factor can lead to an overall increase in weight and difficulties with weight loss.

8.1 Preventative Medical Eating

Medical reasons that can contribute to subsequent weight gain include eating to correct or prevent low blood sugar or eating to reduce stomach acid or pain. Many patients experience weight gain and increased fat mass while undergoing diabetes treatment with insulin.[167] An increased intake of food during the day can lead to an overall increase in calorie intake. Hypoglycemic episodes are treated with varying amounts of glucose or glucose containing foods.[168] Depending on the amount of occurrences of hypoglycemia an individual has, there is the potential for large amounts of calories to be consumed over time, contributing to excess weight. Addressing these issues with behavioral and diet

modification can lead to an overall better control of blood glucose and gastrointestinal reflux disease symptoms leading to a decreased need to snack to control these issues.

8.2 Disordered Eating Patterns

Changes in what is considered normal eating patterns can be classified as having disordered eating patterns. Disordered eating patterns includes frequency of eating, preparation of foods, and conditions of where the meals are consumed. All of these aspects can contribute to a potential positive caloric consumption leading to greater weight gain as well as issues with sustained weight loss.

Increasing the frequency of meals consumed can contribute a significant increase in caloric intake if calories are not cut throughout other parts of the day.[169] This includes increases in snack consumption, especially if the snack that is consumed in a non-hungry state due to the nature of snacks being high-energy and low satiety.[170]

Along with increased frequency of eating, issues with increased portion sizes are contributing to higher caloric consumption.[16, 170] An increase in portion sizes as well as a decrease in food quality has led to increased energy density and increased energy intake throughout the day.[171, 172]

Preparation of meals as well as conditions in which meals are consumed is contributing to increases in consumption as well as increases in energy density of the foods that are being consumed. An increase in the amount of people that are eating away from home at fast-food restaurants and sit-down establishments has shown an increase in overall weight gain among individuals. Fast food consumption has increased from 2% to 28% of total food spending over the past 50 years.[173] The quick nature of the meals that are provided, the palatability, as well as the cheap cost has caused individuals to feel that these options are best for their current lifestyle. The prevalence of food that has very little prep time have also shown to be increasing, causing an increased consumption of salt, fat, and calories.[173]

A change in eating environments has also contributed to a higher amount of calories that are consumed. Eating in front of the TV or computer can cause an individual to not realize how much food they are consuming. This causes them to over consume when normally they would have hunger cues to get them to stop eating.[8] Also, a shift in the meal patterns, including skipping meals such as breakfast has been associated with increased weight gain.[170] The prevalence of skipping breakfast has increased over past decades, contributing to the increased weight gain and other adverse health outcomes.[174]

8.3 Food Insecurity

Socioeconomic factors that contribute to potential weight gain encompasses concerns about not having enough food to eat, not having enough money to consume a healthy diet, and frequency of visiting a food pantry. Obesity is disproportionately associated with individuals of low economic status with the prevalence of obesity rising among those of low socioeconomic status. Two potential mechanisms may be contributing to this occurrence.[175] First, the idea that individuals who are food insecure are overweight because they can only afford cheaper food, which tends to be more calorie dense leading to excessive energy intake.[176, 177] Second, those individuals who are food insecure go through periods without sufficient food leading to the tendency to overeat when sufficient food is available, contributing to overall increased energy intake.[178, 179] Current evidence suggests that mildly food-insecure individuals are most likely to be overweight and obese in both men and women, with stronger associations seen in women.[180, 181, 182]

8.4 Decreased Hunger Perception

Changes in hunger perception can increase an individual's feeling of hunger when normally they would have decreased hunger cues after eating. Hunger perception involves multiple factors that influence the hunger cues that are present within brain including cues from the central nervous system (CNS) and body fat mass.[16]

Satiation and satiety are used to describe perception of fullness and reduced interest in food after a meal, respectively.[16] A change in the body's understanding of satiation and

satiety can cause an issue with excess eating during a meal from not being able to interpret the signals for satiation. Normally these responses allow for termination of eating before reaching the gastric capacity so an appropriate amount of time is available for the body to be able to digest and distribute nutrients throughout the body.[183] This effect is caused by a combination of gastric distention and the release of peptide signals from the gastrointestinal tract.[184] Normally gastric distention is sensed by mechanoreceptors in the stomach, which then relays a signal through the vagal afferent and spinal sensory nerves to the hindbrain.[185] Some peptides released from the gastrointestinal tract that cause satiation and satiety include cholecystokinin (CCK), glucagon-like peptide-1 (GLP-1), oxyntomodulin, peptide YY, apolipoprotein A-IV, and enterostatin.[185] The pancreas also releases peptides to induce satiety, these include pancreatic polypeptide, glucagon, and amyline.[16, 186, 187, 188]

Leptin, a hormone released by adipocytes, plays an important role in energy homeostasis by signaling to the brain changes in energy balance and fuel storage.[16, 189, 190] Leptin is present in the body in relation to the amount of fat mass present in the body and acts on the brain as a negative feedback regulator by restraining energy intake.[190] A decrease in leptin signaling causes an increase in food intake, positive energy balance, and fat accumulation.[16, 189, 190] Leptin acts on and promotes neurons that express proopiomelanocortin (POMC) synthesis and releases melanocortin peptides potentially causing anorexigenic effects on the body.[190]

8.5 Emotional Eating

Emotional eating can include excess consumption when in a depressed, stressed, or bored state, as well as using food as a reward. Emotional eating is associated with higher consumption of snacks, potentially adding a significant amount of calories during the day.[191] Emotional eating is involved with weight gain as it is often linked with poor diet, including greater intake of energy-dense foods such as high-fat snacks.[192] When patients are able to restrain their eating patterns and decrease their levels of uncontrolled emotional and binge eating there is a greater chance of weight loss and maintenance.[193]

Although no exact estimates for emotional eating prevalence have been measured, there is evidence that it is more common among obese individuals than normal weight individuals.[194] This difference could be due to the fact that obese individuals show greater responses in brain reward regions to high fat and high sugar foods.[195, 196, 197] Adults with greater reward center activation show poorer response to weight loss treatments.[198]

8.6 Binge Eating

The prevalence of binge eating disorder occurs in 3.5% of women and 2% of men totaling 3% of the population.[199, 200] Of the individuals who have binge eating disorder, 60% of them are obese and have ongoing weight gain.[201] Binge eating includes hiding food consumption, having issues with stopping eating, and a feeling of being out of control when eating with the potential for eating until becoming uncomfortably full. Binge eating is associated with higher weight, more weight regain and issues with weight cycling after weight loss.[202, 203] It is also considered to be a barrier to weight loss success with eating behavior being an important role in the prevention of obesity.[203, 204, 205] Binge eating can also be associated with the feeling of guilt, shame, and disgust after eating.[199] By identifying binge eating in the beginning stages of weight loss and subsequent weight maintenance there is the possibility for prevention of failure in weight loss.[193] In particular, individuals who exhibit binge eating disorder that have received Roux-en-Y gastric bypass showed significantly lower excess weight loss than those that do not exhibit binge eating at two year follow up (*figure* 2) .[206] Although this significance was not seen right away (6 months follow-up), the occurrence of binge eating during longer follow up shows significant issues within the ability of an individual with untreated binge eating disorder to sustain the weight loss.[206]

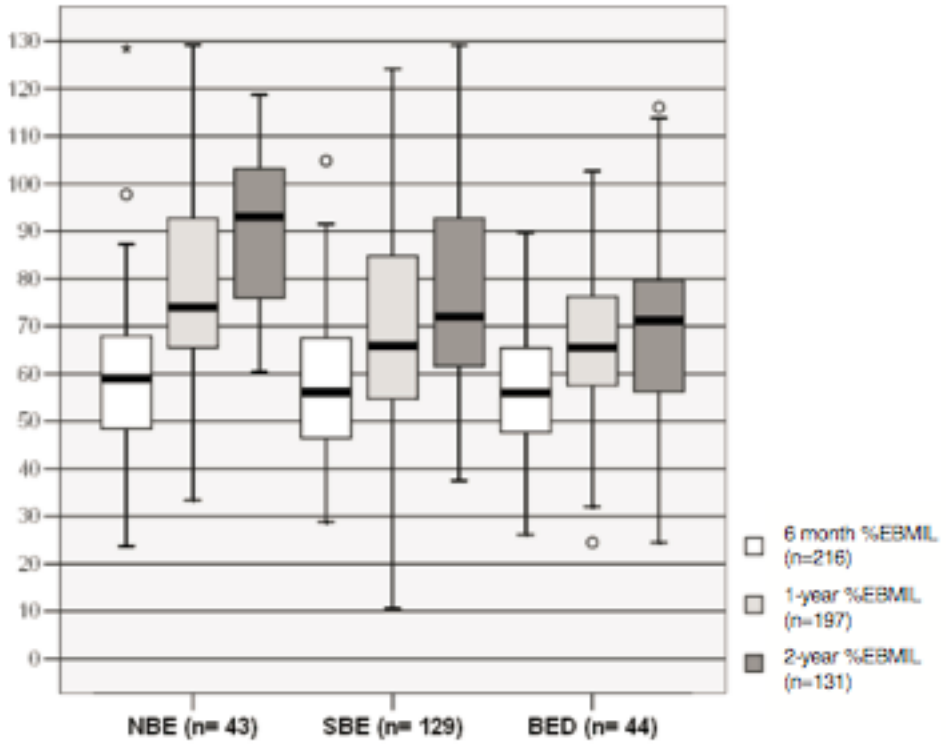

Figure 2: Significantly higher percent excess BMI loss at year 2 in non-binge eating individuals than binge eating individuals post Roux-en-Y gastric bypass.[206]

The presence of disinhibited eating, or the tendency to overeat in the presence of food, and lack of dietary restraint seem to impact individual's weight significantly and are associated with weight gain and higher body weight.[204, 207] In a study carried out on women aged 55 – 65, disinhibited eating was a significant independent predictor of weight change. Similarly, women with a high level of disinhibited eating as well as high levels of restraint had lower weight than women with high levels of disinhibited eating with low levels of restraint.[204] By addressing issues with disinhibited eating when restrained eating is not present there will be a positive association with weight loss.[204] This data contributes to previous research that eating behavior is an important factor in determining excess weight gain in adulthood.

8.7 Craving Driven Eating

Food cravings issues include always thinking about food and eating, giving into thoughts about food and eating, and as with emotional eating, eating can occur when not hungry. The association between food cravings and the occurrence of obesity has become more important due to the dramatic growth of obesity and the occurrence of food cravings.[208, 209] Cravings, which arise with hedonic or pleasure and driven habit pattern formation, have been shown to lead to obsessive thoughts about food and impulsive consumption of craved foods in some individuals increasing the risk for weight gain.[210] Thus, food cravings have the potential to be used as a predictive factor of future high caloric food intake and subsequent weight gain among individuals.[211]

There is, however, variability in the occurrence and strength of the food cravings among individuals. Women who reported having either binge eating disorder or nighttime eating syndrome were more likely to have higher levels of food cravings than those who did not.[212] Patients seeking bariatric treatment also have greater occurrence of food cravings, especially related preoccupations with food.[213] By better understanding the nature of the food cravings for bariatric patients, there is potential to improve outcomes following surgery post-operatively as well as earlier intervention pre-operatively.[213]

Along with initial weight loss, individuals who have regained weight have less of an ability to cope with food cravings.[214] Overall food cravings have been related to high BMI, dropout from weight loss treatments, and an increased number of lifetime weight loss attempts.[209, 215] Therefore, potentially leading to an overall decrease in successful long-term weight loss, weight maintenance, and lifestyle changes.

With the high prevalence of obesity and obesity related comorbidities, individualized treatment approaches that will allow for the greatest amount of successful weight loss for each patient need to be designed. Treatment approaches that are currently in place include pharmacotherapy, weight loss surgery, and lifestyle modification. Although there are multiple treatment choices for someone looking to lose a significant amount of weight,

the practice of generalized treatment strategies contribute to lower weight loss success and greater weight regain recidivism. The barriers that are currently exhibited by patients need to be addressed in order to achieve successful and meaningful weight loss.

Chapter 2: Baseline Traits as Predictors of Success in Medical Weight Management

Study Review

Background: Although there are current treatment plans for individuals who are seeking to lose a significant amount of weight, success rate are highly variable. Barriers to success include lack of attention to development of individualized weight loss plans, issues with lack of readiness to change or confidence to make a change, and pre-existing medical conditions and medications that inhibit weight loss. By understanding and addressing an individual's baseline characteristics there is the potential to create a more successful individualized weight loss program.

Aim: To determine the relationship between baseline characteristics and subsequent weight loss in individuals at the University of Minnesota Adult Medical Weight Management clinic (MWM clinic).

Materials/Subjects and Methods: Three-hundred fifty intake assessment forms from the MWM clinic were collected over a one and a half year time frame. Assessments were checked for completion based on answers of the Eating Habit (Table 1) and Eating Habit Frequency sections (Table 2), excluding any patient from further analysis if either section was not completed. The questions were split into 6 trait categories including preventive medical eating, disordered eating patterns, food insecurity, hunger disorder, emotional eating, and craving and binging. Later, craving and binging were split into binge eating and craving driven eating to determine the relationship between binging and craving. Data from a total of 219 patients were used for statistical analysis using SAS (version 9.3, SAS Institute Inc., Cary, NC).

Results: Mean months of follow-up time for individuals with at least two visits (n = 84) was 4.05 ± 2.93 with significant difference seen between men (3.66 ± 1.95) and women (4.24 ± 3.29) (P = 0.040). Mean weight change per 30 days was -2.62 ± 4.05 (female: -2.13 ± 3.47; male: -3.65 ± 4.99) and the mean percent weight change per 30 days was -0.96 ± 1.46 (female: -0.82 ± 1.40; male: -1.26 ± 1.56). Success of 5% baseline body weight was seen in 42 (50%) and 10% in 23 (27%) of the population. Significant

difference was seen between individuals who reported food insecurity compared to those who did not with change in weight per 30 days with individuals reporting food insecurity having a change in weight of -1.2 ± 0.8 pounds and those not reporting food insecurity having a change in weight of -3.5 ± 0.5 (P = 0.017). Percent change in weight per 30 days was seen to be significant between individuals with food insecurity (-0.36 ± 0.3) and those who did not report food insecurity (-1.3 ± 0.2) (P = 0.008). Highest odds ratios were seen in individual reporting food insecurity versus not and those reporting craving and binging versus not. Individuals who did not report food insecurity were 4.1 times more likely to reach 5% success (P = 0.010) and 5.6 times more likely to reach 10% success (P = 0.955). Patients that did not report craving and binging were 2.2 times more likely to reach 5% success (P = 0.306), and 3.7 times more likely to reach 10% success (P = 0.072).

Conclusions: Individuals who self-reported food insecurity had significantly less weight loss per 30 days and percent weight change per 30 days compared to those who did not report food insecurity. Disordered eating (87%), craving driven eating (71%), and binge eating (82%) were the most common baseline traits seen in our patients. Women reported emotional eating more frequently than men (women: n = 42 (74%); men: n =14 (52%); P = 0.047). Hunger disorder was only reported in 59% (36 women and 14 men) of our study patients and was not statistically different between men and women. Presence of craving and binging was seen in 77% of females (n = 40) and 61% of males (n = 14) (P = 0.153).

In conclusion, hunger driven eating was not as strongly reported in our obese population as some non-hunger related baseline traits including emotional eating and binging and craving driven eating. Food insecurity was negatively related to weight loss success, suggesting that low socioeconomic status remains a major barrier to successful weight loss.

Introduction

Obesity and its related comorbidities are a significant public health issue within the United States and around the world.[1] Contributing to the onset of obesity are physical, environmental, and behavioral factors that lead to increased energy input and decreased energy output. These factors interact to create an imbalance between energy intake and energy output leading to overall excess weight. With excess weight gain and decreased quality of life there is an increased risk of type 2 diabetes, coronary heart disease, some forms of cancer, and high blood pressure.[18]

Prior weight loss treatments have yielded highly variable amounts of success among individuals. Although weight loss success is defined in a number of ways, most people consider a loss of 5% to 10% of baseline weight to be beneficial for individuals.[29] Treatment approaches that are being used include pharmacotherapy, weight loss surgery, and lifestyle modification. However, there are many barriers that should be addressed in order to obtain the greatest amount of weight loss.

Identifying key information within a patient's history including attitude, eating habits, comorbidities, and medications can potentially lead to more successful outcomes. These baseline predictors could be utilized to design individualized treatment plans that would be more successful and lead to less variability of success among obese individuals. Baseline predictors include preventive medical eating, disordered eating patterns, socioeconomic status and food insecurity, changes in hunger perception, emotional eating, binge eating, and craving driven eating. By addressing these issues specific to the patient who is being treated, there is a greater chance of successful and sustained weight loss.

Part 1: Project Objectives

Based on the ever-increasing need for successful treatments for obese individuals, the research objectives were designed to better understand the patient population at the University of Minnesota Adult Medical Weight Management clinic (MWM clinic).

Along with demographic information, intake assessments were used to determine if there are any predictors of success based on baseline traits. Based on the self-reported answers on the intake assessment categories, describing individuals' eating habits and frequencies, provides information that not only would be helpful in creating an individualized weight loss plan, but might also predict how successful they would be.

Based on the descriptive categories that were created and then used to group questions, the research hypothesis was that individuals who have higher occurrence of preventive medical eating, disordered eating, food insecurity, hunger disorder, emotional eating, craving and/or binging driven eating would exhibit less weight loss than those who did not identify those baseline traits. Namely, individuals who only lacked nutritional knowledge needed for successful weight loss. Further, we sought to characterize which of these additional factor(s) were the most significant hindrances to successful weight loss in our patients.

We additionally sought to further examine data from subjects who exhibited binge and craving driven eating patterns. It was hypothesized that the individuals who identified as bingers were a subset of individuals who identified as cravers. Groupings of questions were used to identify baseline traits that potentially predict successful outcome of weight loss.

Part 2: Materials and Methods

2.1 University of Minnesota Medical Weight Management

The University of Minnesota Adult Medical Weight Management clinic (MWM clinic) uses an intake assessment for their patient population to deliver individualized treatment plans for the management of excess body weight. By identifying demographic information, previous weight loss attempts, medical history, eating habits, and behavior and attitude toward change the physicians at the MWM clinic develop plans that are tailored to the individual and their situation. Each new patient to the clinic completes the intake assessment prior to or during the initial appointment. The answers to the

assessment are reviewed and discussed by the physician and patient who work together to design a weight loss plan.

2.2 Data Extraction

Data covering a two and a half year time period from 3/1/2010 to 9/10/2012 were extracted from Allscripts and EpicCare to create the Access (2013, Microsoft Corporation) database utilized for this analysis. Information that was extracted included patient's demographic information, clinic encounters, anthropometrics, medications, medical problem history, laboratory orders, and any prior bariatric surgical procedures. The total population included 1,174 patients that would be later used in conjunction with the baseline intake assessment forms to determine eligibility for the current analysis. Patient baseline intake assessment forms were matched based on first and last name and date of birth against the overall population to pull in all previous medical history from the overall clinical database for subjects in this analysis.

2.3 Intake Assessment

2.3.1 Selection Criteria

Intake assessments were gathered over a one and a half year time line with a total of 350 patients. Of the obtained intake questionnaires, not all surveys were fully completed, thus excluding some individuals from further analysis process. The two main sections in the baseline intake assessment questionnaire for this analysis that were the focus for were the Eating Habits (18 questions) (Table 1) and Eating Habits Frequency (6 questions) (Table 2) sections of the assessment. The Eating Habits section instructions are for subjects to check to indicate a positive response. Similarly, the Eating Habit Frequency section instructions were to check to indicate a full positive response, a partial positive response, or a lack of positive response. Lack of positive response was treated as a negative response.

After excluding individuals who did not have the Eating Habits and the Eating Habits Frequency sections filled out the total of cases available for analysis was 222 patients

whom we also had extracted clinical database information. After identifying 3 patients who did not have complete information regarding visits, a final total of data for 219 patients was used for the current analysis. Subject data were then split into two groups; records from subjects with two visits that could be used to look at baseline predictors and weight loss and records from those who did not have two consecutive measurements for assessing weight loss. Individuals who had two visits who also had bariatric surgery within 4 years of the extraction were excluded from the weight loss analysis. The total population that was excluded was 135 patients, with data from 84 patients available to be used for the change in weight analysis (*figure 3*).

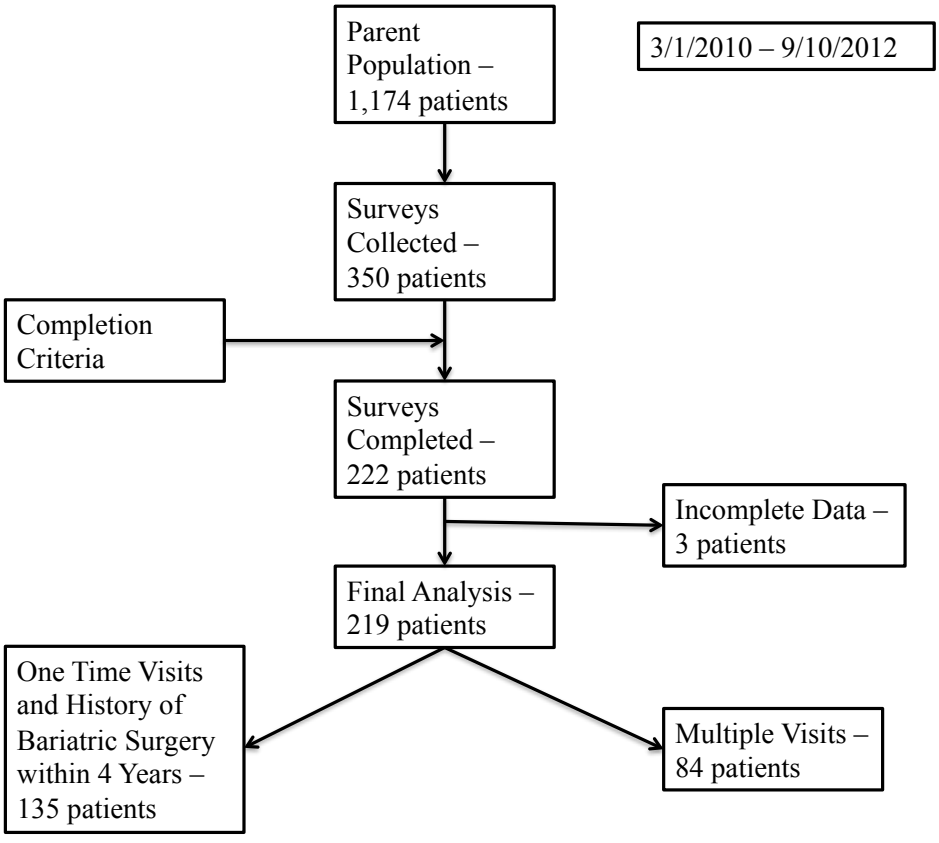

Figure 3: *Analysis eligibility flow chart.*

2.3.2 Question Grouping

Questions from both the Eating Habits and Eating Habit Frequency sections were then combined (24 total questions) and split into 6 trait categories (Table 3). These categories include preventive medical eating, disordered eating patterns, food insecurity, hunger disorder, emotional eating, and craving and binging. Later the craving and binging category was separated further into binge eating and craving driven eating to address if there was a distinct difference between the individuals who identified as bingers and those that identified as cravers or if there was significant overlap between those reporting binging and craving. Two questions were discarded due to the fact that they did not fit appropriately in the specific categories that were established. These included the "I make myself vomit food that I have eaten or take laxatives to get rid of food I have eaten" and "I try not to let myself ever get hungry" leaving 22 questions for final analysis.

2.3.3 Answer Coding

Answers to the questions were coded as 0 for no/never, 1 for sometimes, and 2 for yes/often. They were then standardized again to achieve a 0 for no/never, 0.5 for sometimes, and 1 for yes/often. One question, "I eat at regular times in the day", was negatively coded with 0 for yes, 1 for sometimes, and 2 for no. The answer coding in each category was added together to get a total answer out of the number of questions that were in each category. The category totals were as follows (Table 3):

- Preventive medical eating: 2 questions
- Disordered eating patterns: 5 questions
- Food insecurity: 3 questions
- Hunger disorder: 3 questions
- Emotional eating: 1 question
- Craving and binge eating: 8 questions total
    - Binge eating was later split into two categories: binge eating (6 questions) and craving driven eating (2 questions)

The answer total of each category was then divided by the number of questions that were in the category to have each category's rating on a scale of one for equal weight between categories (e.g. medical reason totals answer total/2) then multiplied by 100. Thus, a larger number within each category suggests a greater response within that category.

2.4 Statistical Analysis

Data were analyzed using SAS (version 9.3, SAS Institute Inc., Cary, NC). Descriptive statistics and correlations were run to gain an understanding of the patient population that is seen at the MWM clinic and used to assess confounding factors related to weight loss. Analysis included calculating the mean, frequency, and the P-value to compare groups and find significant difference at the 0.05 significance level (Appendix 1). Regression analysis was performed to determine the correlation and odds ratio between category intensity and weight loss, percent weight loss, number of follow-up months, and 5% and 10% weight loss success adjusted for gender. Linear regression was used to assess the strength of category responses with the decrease in weight per 30 days, percent decrease in weight per 30 days, and follow-up months.

Part 3: Results

3.1 Demographics

Baseline demographic information is presented for our subjects in Table 4 (information regarding total population and excluded population can be seen in Table 1 and Table 2, respectively, in Appendix 2). A total of 84 patients were included in our subject analysis with 57 females (68%) and 27 males (32%). Baseline weight for our subject population was 263 ± 74 pounds with females having a mean of 248 ± 67 pounds and males having a mean of 296 ± 87 pounds. Baseline BMI averaged 41 ± 9 kg/m^2 for females and 42 ± 10 kg/m^2 for males, with a population mean of 41 ± 9 kg/m^2. There was no significant correlation between baseline age or BMI. Statistical significance was seen between gender and baseline weight with a P-value of 0.005 (0.05 significance level). Mean age for the group was 47 ± 13 years (mean age for women: 46 ± 14 years; mean age for men: 49 ±11 years). Additionally, more individuals who were not included in the weight

change analysis reported food insecurity (n = 51; 38%) than those who were included in the weight change analysis (n = 23; 27%). This suggests that individuals may not have returned for additional visits due to low socioeconomic status.

Comorbidities that were seen frequently among females include Cardiovascular Disease (n = 26; 42%), chronic pain (n = 24; 42%), and hypertension (n = 22; 38%). Among males type 2 diabetes (n = 16; 59%), Cardiovascular Disease (n = 13; 48%), and hypertension (n = 13; 48%)were also seen at relatively high rates. There was a significant difference between males and females in the occurrence of type 2 diabetes (male: n = 16 (59%); female: n = 10 (18%); P = <0.001) perhaps related to differences in gender-related body fat distribution (Table 5). Comorbidities for the total population and for the excluded group can be seen in Appendix 2, Table 3 and Table 4.

3.2 Medication Usage

Type 2 diabetes was seen in 26 of the 84 individuals (31%). Of these individuals with diabetes, 50% (n = 13) were reported to be on GLP-1 agonists, 50% (n = 13) were on insulin, and 38% (n = 10) were on both GLP-1 agonists and insulin (Table 6).

Other medications that were of interest to the study included topiramate, naltrexone, and phentermine, along with the GLP-1 agonists and insulin that were prescribed at any time during the extraction. Topiramate was reported in 40% (n = 34; female: n = 22 (39%); male: n = 12 (44%)), naltrexone in 27% (n = 23; female: n = 18 (32%); male: n = 5 (19%)), and phentermine in 27% (n = 23; female: n = 16 (28%); male: n = 7 (26%)). Seventeen individuals reported using GLP-1 agonists (20%; female: n = 9 (16%); male: n = 8 (30%)) and insulin was prescribed to 15 (18%; female: n = 6 (11%); male: n = 9 (33%)) (Table 7). Total population medication usage can be seen in Appendix 2 Table 5.

Of the 75 individuals who identified as having a presence of craving and binge eating, 44 (59%) were taking naltrexone, topiramate, or both. Naltrexone had been taken to 13 people (17%), 21 had been on topiramate (48%), and 10 had taken both (13%). Of the

individuals who only identified as cravers (n = 6), 2 were taking naltrexone only (33%), 2 were on topiramate only (33%), and 2 used both (33%). Individuals who identified as only binger eaters (n = 15), 3 were taking naltrexone only (20%), 5 were on topiramate only (33%), 2 were using both (13%), and 5 were not taking either (33%).

3.3 Weight Loss Barrier Scores

Mean strength of baseline trait scores for each weight loss barrier category was obtained for the total population (Appendix 2: Table 5; by gender Appendix 2: Table 6), our subject population (Table 8; by gender Table 9), and the excluded population (Appendix 2: Table 7; by gender Appendix 2: Table 8). Though none of the difference in mean scores reached significance in our 84 subjects, highest mean scores were seen in the emotional eating (65.48 ± 47.20), craving driven eating (46.69 ± 36.95), disordered eating (36.90 ± 23.28), and craving combined with binging (34.29 ± 23.28) categories. Hunger disorder had a lower mean strength of trait score of 30.92 ± 26.98. Strength of trait scores among our subjects was lowest for preventive medical eating (12.80 ± 22.79) and food insecurity (10.28 ± 28.30).

Mean scores of each category analyzed by gender showed significant difference in the emotional eating weight loss barrier category (72.81 ± 44.38 vs. 50.0 ± 50.0 for women vs. men respectively; P = 0.038) (Table 9). Among females the strongest score was emotional eating (72.81 ± 44.39), followed by craving driven eating (50.82 ± 36.25), disordered eating (39.65 ± 24.05), and craving and binging (37.26 ± 22.27) categories. Males presented strongest associations with the emotional eating (50.0 ± 50.0), craving driven eating (37.96 ± 37.58), hunger disorder (31.41 ± 22.40), and disordered eating (31.11 ± 20.82) categories. Mean score of binge eating only among females was 32.54 ± 23.11 and males 24.70 ± 22.54 (P = 0.147). Craving driven eating only scores for females was 50.82 ± 36.25 and 37.96 ± 37.58 for males (P = 0.137).

3.4 Months of Follow-up and Weight Loss

Mean months of follow-up, change in weight, and percent change in weight are presented in Table 10 for our subject population, as well as separated by gender with the P-values reported. Mean months of follow-up for our subjects (n = 84) was 4.05 ± 2.93 (women: 4.239 ± 3.293; men: 3.664 ± 1.948). Significant difference was seen for the follow-up months with a P-value of 0.041. Change in weight per 30 day increments had a mean decrease of 2.62 ± 4.05 pounds. The mean percent change in weight per 30 days showed a decrease of 0.96 ± 1.46 percent for all of our subjects. Females exhibited a mean decrease of 2.13 ± 3.47 pounds and a mean percent decrease of 0.82 ± 1.40 per 30 days. For males a mean decrease in weight over 30 days was 3.65 ± 4.99 pounds and a mean percent decrease per 30 days of 1.26 ± 1.56. Neither change in weight per 30 days or percent change in weight per 30 days was significantly different between males and females.

Weight loss success was measured in two categories: 5% and 10% of baseline weight (Table 11). Among the 42 (50%) individuals of our total subject population who reached 5% success, 29 (49%) were female and 14 (52%) were male (P = 0.815). The highest success rate of 10% baseline weight was seen in 23 (27%). Thirteen females (23%) and 10 males (37%) were able to reach this weight loss benchmark (P = 0.172) in our subject population. No significance difference was seen when comparing the percentage of females and males who are able to achieve the 5% and 10% weight loss success levels.

3.5 Presence of Categories

The presence of a category, defined as a subject reporting any level of positive response to a given baseline trait question group category, was analyzed by gender and tested for significance. A single positive response within each category formed the reference population. Significance was seen with the presence of emotional eating (74% vs. 52% for females vs. males respectively; P = 0.047) (Table 12). Trend level significance was seen with the presence of craving driven eating by gender (77% vs. 59% for females vs. males respectively; P = 0.089). The category with the highest presence in females was the

craving and binging combined category (n = 52; 91%), followed by disordered eating (n = 5; 88%), the binge eating only (n = 48; 84%), and the craving driven eating only (n = 44; 77%) categories. Males showed highest presence of disordered eating (n = 23; 85%), craving and binging combined (n = 23; 85%), hunger disorder (n = 21; 78%), and binge eating alone (n = 21; 78%).

Of the 75 patients who were identified as having craving and binging traits there were 52 females and 23 males. Fifteen of these individuals (20%) answered yes to having a binge eating presence without a craving driven eating presence (male: 7; female: 8). Six of the 75 individuals (8%) answered yes to having craving driven eating without the presence of binge eating (male: 2; female: 4). Of the 75 individuals, 54 people (72%) identified as having both binge eating and craving driven eating (male: 14; female: 40) (Table 13). No significance was seen between males and females who identified as binge eaters, craving driven eaters, or both.

3.6 Regression Analysis

3.6.1 Linear Regression

Linear regression was performed to determine the relationship between the presence of a weight loss barrier category and the change in weight per 30 days, the percent change in weight per 30 days, and the follow-up months (Table 14). Significant difference was seen between individuals who did not have presence of food insecurity in change in weight per 30 days and percent change in weight per 30 days (P = 0.017 and 0.008 respectively) compared to those who did have the presence of food insecurity. The presence of any other weight loss barrier category did not show significance or trend level significance in change in weight per 30 days, percent change in weight per 30 days, or follow-up months compared to those who did not have presence of the category.

Similarly, linear regression was used to analyze the relationships between the strength of weight loss barrier category score and change in weight per 30 days, the percentage change in weight per 30 days, and follow-up months (Table 15). Response to the craving

and binging category was significant in predicting the increase in weight per 30 days (P = 0.027; beta coefficient: 4.21 ± 1.9). With an increase in the response to the craving and binging category there is less weight loss per 30 days and percent weight loss per 30 days than those who do not identify as having presence in this category. No other category had significant findings between strength of category response and the decrease in weight, percent decrease in weight, or months of follow-up. Trend level significance was seen between presence of craving and binging and percent weight change per 30 days (4.21 ± 1.9; P = 0.058), binge eating presence and the change in weight and percent change in weight per 30 days (3.76 ± 1.9 and 1.20 ± 0.68 respectively; P = 0.050 and 0.084 respectively), and craving driven eating and the change in weight per 30 days (2.18 ± 1.2; P = 0.07).

3.6.2 Logistic Regression

Logistic regression was performed to analyze the odds ratios, after adjusting for gender, comparing the odds of each level of weight loss success (5% and 10% of baseline) between those that had reported the condition (reference level) and those who did not (Table 16). Highest odds were seen in the individuals not reporting food insecurity. The odds of 5% success in those who did not report food insecurity were 4.1 times the odds of 5% success for those who did report food insecurity (P = 0.01). Trend level significance showed differences among those that reported craving and binging and binge eating in 10% success. Individuals who did not have presence of craving and binging were 3.7 times more likely to achieve 10% weight loss compared to those who did report craving and binging. Those who did not report binge eating were 2.8 times more likely to achieve 10% weight loss compared to those who did report binge eating (P = 0.087). No significance was reached for individuals who did not report preventive medical eating, disordered eating, hunger disorder, emotional eating, and craving driven eating at both the 5% and 10% weight loss success levels.

Part 4: Discussion

The objective of this study was to analyze the baseline traits in individuals at the University of Minnesota Adult Medical Weight Management Clinic in relation to weight loss outcomes. Mean months of follow-up, weight loss in pounds, percent weight loss, and success rates of 5% and 10% of baseline weight were analyzed. Intake assessments were utilized to determine which baseline traits were present and the strength and later used to determine if these baseline factors could predict how well an individual might do with weight loss. We found that individuals who reported food insecurity had significantly less weight loss per 30 days and percent weight change per 30 days compared to those who did not report food insecurity. Individuals who reported food insecurity were more likely to not return to the Medical Weight Management clinic, potentially contributing as a major barrier to successful weight loss. Overall, non-hunger related baseline traits were more common among our subjects with few baseline traits predicting how well an individual will achieve weight loss success.

There have been studies looking at baseline traits and weight loss outcomes.[216 - 222] In these other reports the relationships between baseline traits in relation to weight change varied significantly. In some cases there were interactions between predictors, behaviors, treatment types, and the overall difference between the patient populations, which likely contributed to variability in the relationships between baseline traits and subsequent weight loss.[218, 219, 221] There have been patient-matching treatment algorithms created based on degree of overweight, waist circumference, cardiovascular disease risk factors, however, future interactions should include psychological factors such as attitude, emotional distress, depression, and body image.[219, 223, 224]

Several retrospective studies have identified behavior and psychological factors that are correlated to unsuccessful long-term weight loss.[225, 226, 227] There is still however quite a bit of variability with these predicting factors with only 20-25% of weight loss predicted by baseline variables.[219, 222, 228] Some investigators have reported little or no association between weight changes during treatment and baseline presence of binge eating while

others have found binge eating to be an important predictor in lack of weight loss success.[219, 229, 230] In our own study, change in weight per 30 days was related to strength of baseline self-reported craving and binging behavior (P = 0.027).

The difference between men and women has been studied for many different factors including weight change, success in maintaining weight loss, and presence of baseline traits. In females the overall decrease in weight and likelihood of maintaining the weight loss is lower than with males.[231] These results are consistent with findings that women are more likely to diet than men are, suggesting that women have more occurrence of weight cycling.[231] Although not statistically significant, our study showed that women had less weight loss than men in both pounds lost per 30 days and percent body weight loss per 30 days. We did find a self-reported difference in the presence of baseline traits, which could have contributed to the overall decreased success of weight loss of women. Other studies have found the occurrence of binge eating disorder to be higher among females compared to males 3.5% vs. 2% respectively in one study.[199] In our study relatively high amounts of binge eating were reported in both males (85%) and females (97%), following the trend of an increasing number of obese individuals around the United States exhibiting symptoms of binge eating disorder.[199]

Low socioeconomic status has been linked to obesity, with current obesity rates rising among individuals of low socioeconomic status.[19] Current evidence suggests that individuals, both men and women, who are mildly food-insecure are more likely to be overweight and obese. However, women have been shown to have a higher association between low socioeconomic status with overweight and obesity compared to men.[180, 181, 182] Our findings showed that those who reported food insecurity lost less weight than those who did not (1.2 ± 0.8 pounds vs. 3.5 ± 0.5 pounds respectively, expressed as weight change per 30 days; P = 0.017; and 0.36 ± 0.3 percent vs. 1.3 ± 0.2 percent respectively, expressed as percent weight change per 30 days; P = 0.008). The odds of 5% and 10% weight loss success in individuals who presented food insecurity were significantly lower, P = 0.010 and P = 0.030 respectively.

Our study was limited by having completed questionnaires in only a small percentage of the overall database population and limited time frame in which data was collected. Our final sample size was relatively small compared to the overall population. With self-reported responses there is the possibility that an individual may respond inaccurately based on providing what the provider may want to hear. There may be issues with recall and thus the accuracy of answers and misunderstanding of the questions being asked. Another limitation to the study was the questionnaire itself. Although it was adapted from and utilized similar wording as validated questionnaires, this specific questionnaire has not been validated. Issues with patient retention can be seen by the number of patients with at least two visits available for weight change analysis (n = 84) after starting with 219 in the total population. This lack of retention and resulting small sample size may limit the generalizability of our results. However, we found no difference in demographic and presence of baseline traits among the individuals. Adjustments for medication usage were not carried out in this analysis, which could have affected the ability to see the relationship between reported traits at baseline and subsequent weight loss success.

In conclusion, we examined a number of self-reported baseline traits within our clinic population and found that there was a significant difference in weight loss comparing those who identified as being food insecure and those who did not. Regarding strength of baseline trait for the other examined categories, including preventive medical eating, disordered eating, hunger disorder, emotional eating, craving and binging, we did not find significant differences in weight loss. In regards to presence of the baseline trait categories and subsequent weight loss success, we found individuals who reported food insecurity were less likely to achieve 5% success. Regarding any level of presence of the baseline trait categories and subsequent weight loss success, we found that presence of baseline traits did not predict weight loss success for the preventive medical eating, disordered eating, hunger disorder, emotional eating, and craving and/or binging categories. Presence of low socioeconomic status within our population exhibited less weight loss per 30 days, percent weight loss per 30 days, and reaching the 5% and 10% success level.

Table 1: Eating Habit Section

Eating Habit Questions
1. I eat at regular times in the day, that is breakfast, lunch, dinner
2. I eat most of my food at the end of the day
3. Most of the food I eat requires very little cooking or preparation
4. I find myself hiding food or food wrappers
5. I eat most of my meals in front of the TV or computer
6. I eat when I'm depressed, stressed, bored, or to reward myself
7. I feel hungry all the time, even if I have just eaten
8. I feel like I am always thinking about eating
9. When I have a craving I try not to give in but usually end up giving in
10. Once I start eating I have a hard time stopping
11. I try not to let myself ever get hungry
12. Feeling full after a meal is important to me
13. I have stomach acid or pain and eating makes it feel better
14. I eat extra snacks to prevent or correct low blood sugars
15. I wake up at night to eat
16. I worry about not having enough food to eat
17. I have been to the food shelf at least a few times this year
18. A lack of money keeps me from eating a healthy diet

Table 2: Eating Habit Frequency Section

Eating Habit Frequency Questions
1. I tend to over eat. For example I can eat almost a whole box of cereal, a large bag of chips, or a loaf of bread in one sitting
2. I feel out of control when I eat
3. I make myself vomit foods that I have eaten or take laxatives to get rid of food I've eaten
4. I eat large amounts when I am not hungry
5. I eat until I am uncomfortably full
6. I feel bad about myself or guilty after I over eat

Table 3: Category and Questions

Category	Number of Questions	Questions
Preventive Medical Eating	2	- I have stomach acid or pain and eating makes it feel better - I eat extra snacks to prevent or correct low blood sugars
Disordered Eating Patterns	5	- I wake up at night to eat - I eat at regular times in the day, that is breakfast, lunch, dinner - I eat most of my food at the end of the day - Most of the food I eat requires very little cooking or preparation - I eat most of my meals in front of the TV or computer
Food Insecurity	3	- I worry about not having enough food to eat - I have been to the food shelf at least a few times this year - A lack of money keeps me from eating a healthy diet
Hunger Disorder	3	- I feel hungry all the time, even if I have just eaten - Feeling full after a meal is important to me - I try not to let myself ever get hungry
Emotional Eating	1	- I eat when I'm depressed, stressed, bored, or to reward myself
*Binge Eating	6	- I find myself hiding food or food wrappers - Once I start eating I have a hard time stopping - I tend to over eat. For example I can eat almost a whole box of cereal, a large bag of chips, or a loaf of bread in one sitting - I feel out of control when I eat - I eat until I am uncomfortably full - I feel bad about myself or guilty after I over eat
*Craving Driven Eating	2	- I feel like I am always thinking about food - When I have a craving I try not to give in but usually end up giving in

* Binge eating and craving driven eating is a subset of craving and binging

Table 4: Baseline Data for Our Patients: Male vs. Female: Values are mean ± SD

	Female	Male	P Value
N	57	27	
Age (years)	46 ± 14	49 ±11	0.244
Baseline Weight (lbs)	248 ± 67	296 ± 87	0.005
Height (in)	65 ± 3	70 ± 3	<0.001
BMI	41 ± 9	42 ± 10	0.904
Race			
Caucasian	43 (75%)	19 (70%)	0.185
African	0 (0%)	1 (4%)	
African-American	0 (0%)	1 (4%)	
Other	7 (12%)	1 (4%)	
Unknown	7 (12%)	5 (19%)	
Bariatric Surgery History			
Yes	4 (7%)	1 (4%)	0.549
BP			
Diastolic	74 ± 11	76 ± 10	0.475
Systolic	128 ± 15	131 ± 15	0.482
Relationship Status			
Single	32 (56%)	11 (41%)	0.396
Partnered	24 (42%)	15 (56%)	
Unknown	1 (2%)	1 (4%)	
Socioeconomic Status			
Disabled	15 (26%)	7 (26%)	0.927
No	3 (5%)	2 (7%)	
Disabled	39 (64%)	18 (67%)	
Unknown			
Employed	8 (14%)	6 (22%)	0.195
Employed	3 (5%)	2 (7%)	
On Disability	8 (14%)	0 (0%)	
Unemployed	38 (67%)	19 (70%)	
Unknown			
Smoking			
Former	5 (9%)	4 (15%)	0.448
Current	4 (7%)	1 (4%)	
Alcohol			
Current Drinker	4 (7%)	2 (7%)	0.297

Table 5: Comorbidities for Our Subjects by Gender: Male (n = 27) Female (n = 57)

	Female	Male	P-value
SA *Yes*	10 (18%)	8 (30%)	0.207
GERD *Yes*	7 (12%)	2 (7%)	0.500
OA *Yes*	8 (14%)	2 (7%)	0.381
CP *Yes*	24 (42%)	9 (33%)	0.442
CVHD *Yes*	26 (46%)	13 (48%)	0.828
HTN *Yes*	22 (38%)	13 (48%)	0.407
HLIP *Yes*	15 (26%)	11 (41%)	0.182
BP *Yes*	4 (7%)	1 (4%)	0.549
DEP Yes	19 (33%)	6 (22%)	0.298
DM2 *Yes*	10 (18%)	16 (59%)	<0.001
DM1 *Yes*	0 (0%)	1 (4%)	0.144
HYPOT4 *Yes*	8 (14%)	1 (4%)	0.153
HPTH *Yes*	2 (4%)	0 (0%)	0.325
PCOS *Yes*	3 (5%)	0 (0%)	0.225
SD *Yes*	14 (25%)	11 (41%)	0.130

SA: Sleep Apnea: GERD: Gastrointestinal Reflux Disease; OA: Osteoarthritis; CP: Chronic Pain; CVHD: Cardiovascular Heart Disease; HTN: Hypertension; HLIP: Hyperlipidemia; BP: Bipolar Disorder; DEP: Depression; DM2: Type 2 Diabetes; DM1: Type 1 Diabetes; HYPOT4: Hyperperothyroidism; HPTH: Hypothyroidism; PCOS: Polycystic Ovarian Syndrome; SD: Sleeping Disorders

Table 6: Medications of Diabetics:

	Total Population (n = 219)	Our Subjects (n = 84)
Reported Diabetes	53	26
GLP-1 Agonists	25 (47%)	13 (50%)
Insulin	21 (40%)	13 (50%)
Both	15 (28%)	10 (38%)

Table 7: Medication Usage for Our Subjects:

	Our Subjects (n = 84)	Female (n = 57)	Male (n = 27)	P-value
GLP-1 Agonists	17 (20%)	9 (16%)	8 (30%)	0.140
Insulin	15 (18%)	6 (11%)	9 (33%)	0.011
Topiramate	34 (40%)	22 (39%)	12 (44%)	0.610
Naltrexone	23 (27%)	18 (32%)	5 (19%)	0.210
Phentermine	23 (27%)	16 (28%)	7 (26%)	0.837

Table 8: Mean Weight Loss Barrier Scores: n = 84

Category	Mean	SD
Preventive Medical Eating	12.80	22.79
Disordered Eating	36.90	23.28
Food Insecurity	10.28	20.30
Hunger Disorder	30.92	26.98
Emotional Eating	65.48	47.20
Craving and Binging	34.29	23.28
*Binge Eating**	30.02	23.08
*Craving Driven Eating**	46.69	36.95

* Included in Craving and Binging score

Table 9: Mean Weight Loss Barrier Scores Compared Between Males (n = 27) and Females (n = 57) for Our Subjects.

Category	Females Mean ± SD	Males Mean ± SD	P Value
Preventive Medical Eating	14.04 ± 22.17	10.19 ± 24.28	0.473
Disordered Eating	39.65 ± 24.05	31.11 ± 20.82	0.117
Food Insecurity	9.92 ± 19.34	11.04 ± 22.57	0.816
Hunger Disorder	30.68 ± 29.08	31.41 ± 22.40	0.910
Emotional Eating	72.81 ± 44.39	50.00 ± 50.00	0.038
Craving and Binging	37.26 ± 22.27	28.00 ± 24.53	0.089
*Binge Eating**	32.54 ± 23.11	24.70 ± 22.54	0.147
*Craving Driven Eating**	50.82 ± 36.25	37.96 ± 37.58	0.137

* Included in Craving and Binging score

Table 10: Mean Months of Follow-up, Change in Weight (Pounds) and Percent Change in Weight per 30 Days

	Our Population	Female	Male	P-value
N	84	57	27	
Months of follow up	4.05 ± 2.93	4.24 ± 3.29	3.66 ± 1.95	0.405
Change in weight per 30 days (Pounds)	-2.62 ± 4.05	-2.13 ± 3.47	-3.65 ± 4.99	0.109
Percent change in weight per 30 days	-0.96 ± 1.46	-0.82 ± 1.40	-1.26 ± 1.56	0.204

*Negative value is equal to weight loss (pounds) and percent weight loss

Table 11: Weight Loss Success Levels

	Total Population (n = 84)	Female (n = 57)	Male (n = 27)	P-value
5% Success *Yes*	42 (50%)	28 (49%)	14 (52%)	0.815
10% Success *Yes*	23 (27%)	13 (23%)	10 (37%)	0.172

*Percent of individuals achieving weight loss success levels

Table 12: Presence of Weight Loss Barriers: values reported are percent reporting the condition

	Female (n = 57)	Male (n = 27)	P-value
Preventive Medical Eating	17 (30%)	5 (19%)	0.271
Disordered Eating	50 (88%)	23 (85%)	0.748
Food Insecurity	16 (28%)	7 (26%)	0.837
Hunger Disorder	36 (63%)	14 (52%)	0.180
Emotional Eating	42 (74%)	14 (52%)	0.047
Craving and Binging *Binge Eating** *Craving Driven Eating**	55 (97%) 48 (84%) 44 (77%)	23 (85%) 21 (78%) 16 (59%)	0.403 0.472 0.089

*Presence was defined as having at least 1 positive response to the weight loss barrier category

Table 13: Binge Eaters and Craving Driven Eaters

	Total Identifiers (n = 75)	Female (n = 52)	Male (n = 23)	P-value
Binge Presence Only	15 (20%)	8 (15%)	7 (30%)	0.133
Craving Presence Only	6 (8%)	4 (8%)	2 (9%)	0.883
Presence of Both	54 (72%)	40 (77%)	14 (61%)	0.153

*Identifiers are individuals with at least 1 positive response in the weight loss barrier category

Table 14: Linear Regression Analysis: mean weight changes ± SE, adjusted for gender, negative values represent weight loss

	Change in Weight per 30 days (Pounds)	% Change in Weight per 30 days	Follow Up Time (Months)
Preventive Medical Eating			
Yes	-1.7 ± 0.9	-0.73 ± 0.3	4.2 ± 0.7
No	-3.3 ± 0.5	-1.1 ± 0.2	3.9 ± 0.4
P-value	0.120	0.268	0.709
Disordered Eating			
Yes	-2.8 ± 0.5	-1.0 ± 0.2	3.8 ± 0.4
No	-3.7 ± 1	-1.3 ± 0.4	4.7 ± 0.9
P-value	0.474	0.474	0.359
Food Insecurity			
Yes	-1.2 ± 0.8	-0.36 ± 0.3	4.7 ± 0.6
No	-3.5 ± 0.5	-1.3 ± 0.2	3.7 ± 0.4
P-value	0.017	0.008	0.146
Hunger Disorder			
Yes	-2.9 ± 0.5	-1.1 ± 0.2	4.2 ± 0.4
No	-2.8 ± 0.8	-0.97 ± 0.3	3.4 ± 0.6
P-value	0.946	0.787	0.233
Emotional Eating			
Yes	-2.6 ± 0.6	-0.95 ± 0.2	4.3 ± 0.4
No	-3.4 ± 0.8	-1.2 ± 0.3	3.4 ± 0.6
P-value	0.413	0.500	0.201
Craving and Binging			
Yes	-2.7 ± 0.5	-0.98 ± 0.2	4.1 ± 0.4
No	-3.9 ± 1	-1.4 ± 0.5	3.1 ± 1
P-value	0.412	0.374	0.340
Binge Eating*			
Yes	-2.8 ± 0.5	-0.99 ± 0.2	4.11 ± 0.4
No	-3.4 ± 1	-1.3 ± 0.4	3.3 ± 0.8
P-value	0.569	0.502	0.311
Craving Driven Eating*			
Yes	-2.4 ± 0.6	-0.9 ± 0.2	3.6 ± 0.4
No	-3.8 ± 0.8	-1.3 ± 0.3	4.7 ± 0.6
P-value	0.155	0.349	0.127

* Included in Craving and Binging score

** Negative values are weight loss (pounds) and percent weight loss

*** Presence was defined as having at least 1 positive response in the weight loss barrier category

Table 15: Simple Linear Regression: values are ± SD

	Change in Weight per 30 Days	% Change in Weight per 30 Days	Follow-up Time (Months)
Preventive Medical Eating			
Parameter Estimate	1.73 ± 2.0	0.24 ± 0.71	1.08 ± 1.4
P-value	0.379	0.736	0.44
Disordered Eating			
Parameter Estimate	0.47 ± 1.9	0.42 ± 0.69	-2.54 ± 1.4
P-value	0.807	0.543	0.065
Food Insecurity			
Parameter Estimate	2.69 ± 2.2	1.15 ± 0.78	1.64 ± 1.6
P-value	0.221	0.146	0.302
Hunger Disorder			
Parameter Estimate	-0.64 ± 1.7	-0.36 ± 0.60	-0.12 ± 1.2
P-value	0.699	0.547	0.918
Emotional Eating			
Parameter Estimate	0.86 ± 0.94	0.20 ± 0.34	0.98 ± 0.68
P-value	0.365	0.551	0.151
Craving and Binging			
Parameter Estimate	4.21 ± 1.9	1.30 ± 0.68	-0.81 ± 1.4
P-value	0.027	0.058	0.559
Binge Eating*			
Parameter Estimate	3.76 ± 1.9	1.20 ± 0.68	-0.18 ± 1.4
P-value	0.050	0.084	0.898
Craving Driven Eating*			
Parameter Estimate	2.18 ± 1.2	0.64 ± 0.43	-0.99 ± 0.87
P-value	0.070	0.142	0.260

*Presence was defined as having at least 1 positive response

**A positive value represents weight gain and increase in months of follow-up

Table 16: Logistic Regression Analysis: Odds ratio (95% CI), adjusted for gender, comparing odds of each level of weight-loss success between those not reporting the condition and those who did report the condition (reference level).

	5% Success	10% Success
No Preventive Medical Eating vs Preventive Medical Eating	1.63 (0.61, 4.4)	1.85 (0.54, 6.3)
P-value	0.333	0.327
No Disordered Eating vs. Disordered Eating	0.81 (0.23, 2.9)	1.59 (0.41, 6.1)
P-value	0.740	0.503
No Food Insecurity vs. Food Insecurity	4.07 (1.4, 11.8)	5.59 (1.2, 26.5)
P-value	0.010	0.030
No Hunger Disorder vs. Hunger Disorder	0.91 (0.36, 2.3)	0.997 (0.35, 2.9)
P-value	0.840	0.955
No Emotional Eating vs. Emotional Eating	0.98 (0.39, 2.5)	0.94 (0.33, 2.7)
P-value	0.959	0.900
No Craving and Binging vs. Craving and Binging	2.15 (0.50, 9.3)	3.73 (0.89, 15.7)
P-value	0.306	0.072
No Binge Eating* vs. Binge Eating*	1.62 (0.52, 5.1)	2.78 (0.86, 9.0)
P-value	0.404	0.087
No Craving Driven Eating* vs. Craving Driven Eating	1.25 (0.48, 3.3)	1.77 (0.62, 5.0)
P-value	0.655	0.282

* Included in Craving and Binging score

Chapter 3: Summary and Conclusions

Summary and Conclusions

An increasing amount of individuals being classified as obese and an increased need for treatment of obesity and its comorbidities are important public health issues around the world. By assessing a patient carefully prior to or during the initial visit, there is the possibility of designing more individualized weight loss plans. This can lead to better treatment options and overall greater weight loss success within the clinic.

With the increasing number of treatment approaches that are available to individuals, it seems that individuals should be exhibiting high levels of success. However, this is not the case. There are highly variable amounts of weight loss success among individuals who are able to lose weight. Many factors contribute to the overall success, or lack there of, including age, physical ability, genetics, and environment. It is difficult to fully explain the reasons for the high amount of variability in weight loss results and why some individuals are better able to adopt attitude and behavior change and others are not.[155] However, baseline predictor trait assessment followed by better designed targeted treatment approach has the potential to provide patients with the most viable options for successful weight loss and long term weight maintenance.

The focus of our study was to take a clinical intake assessment and use the answers to find a relationship between presence of weight loss barrier traits and subsequent weight loss outcomes. In our study the presence of the different categories including: preventive medical eating, disordered eating, food insecurity, decreased hunger perception, emotional eating, binge eating, and craving driven eating were analyzed for frequency between men and women. There were some difference in presence of disordered eating, binge eating, and craving driven eating frequency with women tending to have a higher prevalence of these issues compared to men.

Additionally, in our study various measures of weight loss and success were utilized including the change in weight per 30 days, the percent change in weight per 30 days, and success of 5% and 10% loss of baseline weight. There were significant difference in

weight loss per 30 days and percent weight loss per 30 days for individuals who had presence of food insecurity, those who exhibited binge eating, and those who exhibited craving driven eating compared to those that did not. Significance was also seen for decreased weight per 30 days (less weight loss) for those who had identified emotional eating compared to those who did not (all factors were adjusted for gender). Simple linear regression showed significant difference ($P = 0.027$) between higher scores in the craving and binging category and the low amount of weight less per 30 days.

These results provide insight into using baseline clinical intake assessments help target weight loss barriers and guide successful treatment. By addressing the key characteristics with which an identifies there can be a better understanding of what the issues are, what how well that individual will do, and the prospect of assessing better therapeutic plans. Only one baseline trait, food insecurity, had significant difference in change in weight per 30 days and percent change in weight per 30 days. Logistic regression showed that the odds ratio for 5% success was higher in individuals who did not have food insecurity compared to those who did.

Although limitations were present in this study, the information that was gained can improve our understanding of the obese patient population. Predicting baseline traits can help identify areas in which an individual will have the greatest issues with weight loss and maintenance.

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Appendix 1: SAS (9.3) Coding

Demo input

```
data demo;
infile 'C:\Users\bayer051\Desktop\patientvisitsbaseline-2(5-29-14)-1.csv' dlm = ","
firstobs = 2;
input pid include $ age sex $ sbp dbp ht avg_ht wt bmi std_bmi relationship $ race $
employed $
disabled $ smoking $ alcohol $ history_bs $ med disord socio hungdis emotional binge
craving;
run;
proc print data = demo;
run;
proc means data = demo;
class include;
var age avg_ht wt std_bmi dbp sbp;
run;
proc ttest data = demo;
class include;
var age avg_ht wt std_bmi dbp sbp;
run;
proc freq data = demo;
tables include* (sex relationship race employed disabled smoking alcohol
history_bs)/chisq;
run;
data include;
set demo;
if include = "no" then delete;
run;
proc print data = include;
run;
proc means data = include;
class sex;
var age avg_ht wt std_bmi dbp sbp;
run;
proc ttest data = include;
class sex;
var age avg_ht wt std_bmi dbp sbp;
run;
proc freq data = include;
tables sex* (relationship race employed disabled smoking alcohol history_bs)/chisq;
```

```
run;
proc means data = demo;
class sex;
var med disord socio hungdis emotional binge craving;
run;
proc ttest data = demo;
class sex;
var med disord socio hungdis emotional binge craving;
run;
proc means data = include;
class sex;
var med disord socio hungdis emotional binge craving;
run;
proc ttest data = include;
class sex;
var med disord socio hungdis emotional binge craving;
run;
data exclude;
set demo;
if include = "yes" then delete;
run;
proc print data = exclude;
run;
proc means data = exclude;
var med disord socio hungdis emotional binge craving;
run;
proc means data = exclude;
class sex;
var med disord socio hungdis emotional binge craving;
run;
proc ttest data = exclude;
class sex;
var med disord socio hungdis emotional binge craving;
run;
```

Comorbidities input

```
data comorbids;
infile 'C:\Users\bayer051\Desktop\ICD9-2-5-29-14.csv' dlm = "," firstobs = 2;
input pid include $ sex $ sa $ gerd $ oa $ cp $ cvhd $ htn $ hlip $
bp $ dep $ dm2 $ dm1 $ hypot4 $ hpth $ pcos $ sd $ int $ md $;
run;
proc print data = comorbids;
run;
```

```
proc freq data = comorbids;
tables sa gerd oa cp cvhd htn hlip bp dep dm2 dm1 hypot4 hpth pcos sd int md;
run;
proc freq data = comorbids;
tables include*(sa gerd oa cp cvhd htn hlip bp dep dm2 dm1 hypot4 hpth pcos sd int
md)/chisq;
run;
data include;
set comorbids;
if include = "no" then delete;
run;
proc print data = include;
run;
proc freq data = include;
tables sex * (sa gerd oa cp cvhd htn hlip bp dep dm2 dm1 hypot4 hpth pcos sd int
md)/CHISQ;
run;
```

Medication Input

```
data medications;
infile ‘C:\User\bayer051\Desktop\meds.csv’ dlm=’,’ firstobs=2;
input pid include $ sex $ glp1 insulin top naltrex phen;
run;
proc print data = medications;
run;
proc freq data = meds;
tables glp1 insulin top naltrex phen;
run;
proc freq data = meds;
tables sex*(glp1 insulin top naltrex phen)/chisq;
run;
```

Binge Crave Frequency Input

```
data bingecrave;
infile 'C:\Users\bayer051\Desktop\bingerscravers.csv' dlm = ',' firstobs=2;
input pid include $ sex $ crav_bing binge crave GLP1 insulin top naltrex phen both
bineonly craveonly;
run;
proc print data = bingecrave;
run;
proc freq data = bingecrave;
table sex*bineonly/chisq;
```

```
run;
proc freq data = bingecrave;
table sex*craveonly/chisq;
run;
proc freq data = bingecrave;
table sex*both/chisq;
run;
```

Mean Answers Input

```
data answers;
infile 'C:\Users\bayer051\Desktop\patientvisitsbaseline-2(5-29-14)-1.csv' dlm = ","
firstobs=2;
input pid include $ age sex $ sbp dbp ht avg_ht wt bmi std_bmi relationship $ race $
employment $ disabled $
smoking $ alcohol $ history_bs $ med disord socio hungdis emotional crav_bing binge
crave;
run;
proc print data = answers;
run;
proc means data = answers;
var med disord socio hungdis emotional crav_bing binge crave;
run;
proc means data = answers;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
proc ttest data = answers;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
data include;
set answers;
if include = 'no' then delete;
run;
proc print data = include;
run;
proc means data = include;
var med disord socio hungdis emotional crav_bing binge crave;
run;
proc means data = include;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
```

```
proc ttest data = include;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
data exclude;
set answers;
if include = 'yes' then delete;
run;
proc print data = exclude;
run;
proc means data = exclude;
var med disord socio hungdis emotional crav_bing binge crave;
run;
proc means data = exclude;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
proc ttest data = exclude;
class sex;
var med disord socio hungdis emotional crav_bing binge crave;
run;
```

Regression input

```
data regression;
infile 'C:\Users\bayer051\Desktop\changewtanswers5-28-14.csv' missover dlm="," 
firstobs=2;
input pid include $ sex $ wt bmi std_bmi med disord socio hungdis emotional crav_bing 
binge crave
d_wt_per30d pcd_wt_per30d success3 success5 success10 follow_up_months;
med = (med > 0.00);
disord = (disord >0.00);
socio = (socio >0.00);
hungdis = (hungdis >0.00);
emotional = (emotional >0.00);
crav_bing = (crav_bing > 0.00);
binge = (binge >0.00);
crave = (crave >0.00);
run;
proc print data = regression;
run;
proc means data = regression;
class sex;
var d_wt_per_pcd_wt_per30d follow_up_months;
```

```
run;
proc ttest data = regression;
class sex;
var d_wt_per30d pcd_wt_per30d follow_up_months;
run;
proc freq data = regression;
tables sex * (success3 success5 success10)/chisq;
run;
%macro reg_sex_adjusted (pred= );
  proc glm data = regression;
  class sex &pred;
  model d_wt_per30d pcd_wt_per30d follow_up_months = sex &pred;
  lsmeans &pred / stderr pdiff;
%mend ;

%reg_sex_adjusted (pred= med);
%reg_sex_adjusted (pred= disord);
%reg_sex_adjusted (pred= socio);
%reg_sex_adjusted (pred= hungdis);
%reg_sex_adjusted (pred= emotional);
%reg_sex_adjusted (pred= crav_bing);
%reg_sex_adjusted (pred= binge);
%reg_sex_adjusted (pred= crave);

%macro log_reg_sex_adjusted (pred= );
  proc logistic descending data = regression;
  class sex &pred;
  model success3 = sex &pred;
  run;
  proc logistic descending data = regression;
  class sex &pred;
  model success5 = sex &pred;
  run;
  proc logistic descending data = regression;
  class sex &pred;
  model success10 = sex &pred;
%mend;

%log_reg_sex_adjusted (pred= med);
%log_reg_sex_adjusted (pred= disord);
%log_reg_sex_adjusted (pred= socio);
%log_reg_sex_adjusted (pred= hungdis);
%log_reg_sex_adjusted (pred= emotional);
%log_reg_sex_adjusted (pred= crav_bing);
```

```
%log_reg_sex_adjusted (pred= binge);
%log_reg_sex_adjusted (pred= crave);


proc freq data = regression;
tables sex * (med disord socio hungdis emotional crav_bing binge crave) / chisq;
run; quit;
```

SLR Input

```
data linear;
infile 'C:\Users\bayer051\Desktop\changewtanswers5-28-14(1).csv' dlm = ',' firstobs=2;
input PID include $ sex $ wt bmi std_bmi med disord socio hungdis emotional crav_bing
binge crave
d_wt_per30d pcd_wt_per30d success3 success5 success10 follow_up_months;
run;

proc reg data = linear;
model d_wt_per30d = {med disord socio hungdis emotional crav_bing binge crave};
plot d_wt_per30d*{med disord socio hungdis emotional crav_bing binge crave};
run;
quit;
proc reg data = linear;
model d_wt_per30d = med;
plot d_wt_per30d * med;
run;
quit;
proc reg data = linear;
model pcd_wt_per30d = med;
plot pcd_wt_per30d*med;
run;
quit:
proc reg data = linear;
model follow_up_months = med;
plot follow_up_months*med;
run;
quit;
proc reg data = linear;
model d_wt_per30d = disord;
plot d_wt_per30d * disord;
run;
quit;
proc reg data = linear;
model pcd_wt_per30d = disord;
```

```
plot pcd_wt_per30d*disord;
run;
quit;
proc reg data = linear;
model follow_up_months = disord;
plot follow_up_months*disord;
run;
quit;
proc reg data = linear;
model d_wt_per30d = socio;
plot d_wt_per30d * socio;
run;
quit;
proc reg data = linear;
model pcd_wt_per30d = socio;
plot pcd_wt_per30d*socio;
run;
quit:
proc reg data = linear;
model follow_up_months = socio;
plot follow_up_months*socio;
run;
quit;
proc reg data = linear;
model d_wt_per30d = hungdis;
plot d_wt_per30d * hungdis;
run;
quit;
proc reg data = linear;
model pcd_wt_per30d = hungdis;
plot pcd_wt_per30d*hungdis;
run;
quit:
proc reg data = linear;
model follow_up_months = hungdis;
plot follow_up_months*hungdis;
run;
quit;
proc reg data = linear;
model d_wt_per30d = emotional;
```

Appendix 2: Supplementary Tables

Table 1: Baseline Data: Values are mean ± SD

	Total Population	Female	Male	P values
N	219	156	63	
Age	46 ± 13	45 ± 13	48 ± 13	0.106
Baseline Weight (lbs)	262 ± 69	248.63 ± 59.46	294.60 ± 79.93	<0.001
Height (in)	66.31 ± 4.22	64.63 ± 3.35	70.35 ± 3.2	<0.001
BMI	41.8 ± 10	41.7 ± 9	41.7 ± 11	0.967
Race				
Caucasian	65%	65%	67%	0.615
African	1%	0%	2%	
African-American	2%	2%	2%	
Other	7%	7%	6%	
Unknown	26%	26%	23%	
Bariatric Surgery History				
Yes	17%	22%	3%	<0.001
BP				
Diastolic	77.18 ± 10.96	76.94 ± 11.08	77.76 ± 10.72	0.648
Systolic	129.87 ± 13.89	129.53 ± 13.67	130.75 ± 14.52	0.595
Relationship Status				
Single	51%	53%	46%	0.407
Partnered	41%	40%	43%	
Unknown	8%	7%	11%	
Socioeconomic Status				
Disabled				
No	12%	13%	11%	0.917
Disabled	3%	3%	3%	
Unknown	85%	84%	86%	
Employed				
Employed	10%	10%	10%	0.192
On Disability	3%	3%	3%	
Unemployed	5%	7%	0%	
Unknown	82%	80%	87%	
Smoking				
Former	6%	6%	6%	0.998
Current	6%	6%	6%	
Alcohol				
Current Drinker	5%	5%	6%	0.446
More Than One Visit				
Yes	45%	46%	43%	0.721
No	55%	54%	57%	

Table 2: Baseline Data: Our Population vs. Excluded. Values are mean ± SD

	Our Population	Excluded	P Value
N	84	135	
Sex			
Female	57 (68%)	99 (73%)	0.384
Male	27 (32%)	36 (27%)	
Age (years)	47 ± 13	46 ± 13	0.473
Baseline Weight (lbs)	263 ± 74	261 ± 65	0.816
Height (in)	67 ± 4	66 ± 4	0.342
BMI	41 ± 9	42 ± 10	0.698
Race			
Caucasian	62 (74%)	81 (60%)	0.020
African	1 (1%)	0 (0%)	
African-American	1 (1%)	3 (2%)	
Other	8 (10%)	7 (5%)	
Unknown	12 (14%)	44 (33%)	
Bariatric Surgery History			
Yes	5 (6%)	32 (24%)	<0.001
BP			
Diastolic	76 ± 10	79 ± 11	0.005
Systolic	129 ± 15	131 ± 13	0.377
Relationship Status			
Single	43 (51%)	69 (51%)	0.049
Partnered	39 (46%)	51 (38%)	
Unknown	2 (3%)	15 (11%)	
Socioeconomic Status			
Disabled			
No	22 (26%)	5 (4%)	<0.001
Disabled	5 (6%)	1 (1%)	
Unknown	67 (68%)	129 (95%)	
Employed			
Employed	14 (17%)	7 (5%)	<0.001
On Disability	5 (6%)	1 (1%)	
Unemployed	8 (9%)	3 (2%)	
Unknown	57 (68%)	124 (92%)	
Smoking			
Former	9 (11%)	5 (4%)	0.233
Current	5 (6%)	8 (6%)	
Alcohol			
Current Drinker	6 (7%)	6 (4%)	0.492

Table 3: Comorbidities all: 219

	Frequency	Percent
SA		
Yes	44	20%
GERD		
Yes	28	13%
OA		
Yes	32	15%
CP		
Yes	88	40%
CVHD		
Yes	93	43%
HTN		
Yes	88	40%
HLIP		
Yes	65	29%
BP		
Yes	13	6%
DEP		
Yes	69	32%
DM2		
Yes	53	24%
DM1		
Yes	5	2%
HYPOT4		
Yes	19	9%
HPTH		
Yes	2	1%
PCOS		
Yes	4	2%
SD		
Yes	61	28%

SA: Sleep Apnea: GERD: Gastrointestinal Reflux Disease; OA: Osteoarthritis; CP: Chronic Pain; CVHD: Cardiovascular Heart Disease; HTN: Hypertension; HLIP: Hyperlipidemia; BP: Bipolar Disorder; DEP: Depression; DM2: Type 2 Diabetes; DM1: Type 1 Diabetes;
HYPOT4: Hyperperothyroidism; HPTH: Hypothyroidism; PCOS: Polycystic Ovarian Syndrome; SD: Sleeping Disorders

Table 4: Comorbidities Our Subjects (n = 84) vs. excluded (n = 135)

	Our Subjects	Excluded	P-value
SA *Yes*	18 (21%)	26 (19%)	0.697
GERD *Yes*	9 (11%)	19 (14%)	0.469
OA *Yes*	10 (12%)	22 (16%)	0.371
CP *Yes*	33 (39%)	55 (41%)	0.831
CVHD *Yes*	39 (46%)	54 (40%)	0.349
HTN *Yes*	35 (42%)	53 (39%)	0.724
HLIP *Yes*	26 (31%)	38 (28%)	0.657
BP *Yes*	5 (6%)	8 (6%)	0.994
DEP Yes	25 (30%)	44 (33%)	0.661
DM2 *Yes*	26 (31%)	27 (20%)	0.066
DM1 *Yes*	1 (1%)	4 (3%)	0.393
HYPOT4 *Yes*	9 (11%)	10 (7%)	0.398
HPTH *Yes*	2 (2%)	0 (0%)	0.072
PCOS *Yes*	3 (4%)	1 (1%)	0.128
SD *Yes*	25 (30%)	36 (27%)	0.619

SA: Sleep Apnea: GERD: Gastrointestinal Reflux Disease; OA: Osteoarthritis; CP: Chronic Pain; CVHD: Cardiovascular Heart Disease; HTN: Hypertension; HLIP: Hyperlipidemia; BP: Bipolar Disorder; DEP: Depression; DM2: Type 2 Diabetes; DM1: Type 1 Diabetes; HYPOT4: Hyperperothyroidism; HPTH: Hypothyroidism; PCOS: Polycystic Ovarian Syndrome; SD: Sleeping Disorders

Table 5: Medication Usage – All Patients (n = 219)

	Total Population (n = 219)	Female (n = 156)	Male (n = 63)
GLP-1 Agonists	31 (14%)	19 (12%)	12 (19%)
Insulin	24 (11%)	11 (7%)	13 (21%)
Topiramate	63 (29%)	47 (30%)	16 (25%)
Naltrexone	44 (20%)	34 (22%)	10 (16%)
Phentermine	40 (18%)	30 (19%)	10 (16%)

Table 6: Mean Weight Loss Barrier Scores – All Patients (n = 219)

Category	Mean	SD
Preventive Medical Eating	13.58	24.44
Disordered Eating	40.59	24.91
Food Insecurity	15.48	25.41
Hunger Disorder	30.32	28.13
Emotional Eating	65.98	46.39
Craving and Binging	33.77	24.85
*Binge Eating**	29.50	24.77
*Craving Driven Eating**	46.56	37.62

* Included in Craving and Binging score

Table 7: Mean Weight Loss Barrier Scores Compared Between Males (n = 63) and Females (n = 156)

Category	Females Mean ± SD	Males Mean ± SD	P Value
Preventive Medical Eating	14.26 ± 25.26	11.90 ± 22.39	0.519
Disordered Eating	43.01 ± 25.39	34.60 ± 22.78	0.023
Food Insecurity	16.12 ± 25.73	13.90 ± 24.71	0.560
Hunger Disorder	29.54 ± 28.62	32.24 ± 26.99	0.521
Emotional Eating	72.44 ± 43.73	50.00 ± 49.19	0.001
Craving and Binging	36.60 ± 24.78	26.76 ± 23.79	0.008
*Binge Eating**	31.60 ± 25.41	24.30 ± 22.45	0.048
*Craving Driven Eating**	51.58 ± 36.87	34.13 ± 36.84	0.002

* Included in Craving and Binging score

Table 8: Mean Weight Loss Barrier Scores – Excluded (n = 135)

Category	Mean	SD
Preventive Medical Eating	14.07	25.48
Disordered Eating	42.89	25.68
Food Insecurity	18.72	27.70
Hunger Disorder	29.95	28.91
Emotional Eating	66.30	46.05
Craving and Binging	33.44	25.86
*Binge Eating**	29.17	25.84
*Craving Driven Eating**	46.48	38.17

* Included in Craving and Binging score

Table 9: Mean Weight Loss Barrier Scores Compared Between Males (n = 36) and Females (n = 99) – Excluded.

Category	Females Mean ± SD	Males Mean ± SD	P Value
Preventive Medical Eating	14.39 ± 26.99	13.19 ± 21.12	0.810
Disordered Eating	44.95 ± 26.04	37.22 ± 24.10	0.123
Food Insecurity	19.69 ± 28.26	16.06 ± 26.31	0.503
Hunger Disorder	28.89 ± 28.48	32.86 ± 30.28	0.482
Emotional Eating	72.22 ± 43.58	50.00 ± 49.28	0.013
Craving and Binging	36.21 ± 26.22	25.83 ± 23.53	0.039
*Binge Eating**	31.05 ± 26.75	24.00 ± 22.71	0.162
*Craving Driven Eating**	52.02 ± 37.40	31.25 ± 36.54	0.005

* Included in Craving and Binging score