WEIGHT CHANGES RELATIVE TO DIET SODA INTAKE OF PARTICIPANTS IN A NUTRITION ORIENTED WEIGHT LOSS PROGRAM

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ABSTRACT

Introduction: Over the past two decades, obesity rates in the U.S. have risen dramatically by approximately 30.4%. Overwhelming evidence associates co-morbid conditions to the presence of obesity. The purpose of this research project is to determine the role of diet soda consumption in weight management.

Methods: Program records were analyzed from 40 participants in a 12-week nutrition and healthy weight program that included education about the possible risks of drinking at least one can of diet soda daily. Participants were divided into three groups based on their self-select behavior: Group 1) drank diet soda and maintained or increased soda intake throughout the program; Group 2) drank diet soda and decreased intake throughout the program; and Group 3) did not drink diet soda prior to or throughout the program. Paired t-test analyses were used to determine program effectiveness in reducing weight, BMI, and waist circumference (WC) of individual groups. Independent t-test analyses were used to compare these outcome measures between groups.

Results: For all participants combined, weight, BMI, and WC were significantly reduced ($p \leq .0001$) at the end of the study when compared to baseline, indicating overall program effectiveness. Group 1 weight ($p \leq .0383$) and BMI ($p \leq .0413$) were significantly reduced, but WC was not ($p \leq .0806$). Group 2 weight ($p \leq .001$), BMI ($p \leq .0027$), and WC ($p \leq .0016$) were significantly reduced. Group 3 weight ($p \leq .0033$), BMI ($p \leq .0027$), and WC ($p \leq .0016$) were also significantly reduced. When the post-test data were compared by groups, there were no significant differences in any of the variables between the groups ($p > .05$).

Conclusion: Participating in a nutrition and healthy weight program has been shown to be an effective intervention for weight loss for diet soda drinkers, those who reduce diet soda
consumption, and non-diet soda drinkers alike. It is not clear whether diet soda intake is actually a factor in their success toward weight loss. This research provides excellent groundwork for further refining the dietary interventions to determine any correlation between diet soda intake and weight. Further research with larger sample sizes is needed to better understand the role of diet soda in relation to weight.
Dedication

This project is dedicated to those who have helped me to develop my career thus far: to the dietitians who were willing to teach me how things work outside the classroom and textbook, to the doctors who believe in the difference we can make, and to the professors who guide my efforts to specialize in my passion.
Acknowledgements

I would like to acknowledge the developers and supervisors of Intermountain Health Care Weigh to Health Program for their cooperation and allowing me to teach, observe, and collect data throughout their programs. I also want to acknowledge the participants who are willing to allow me to use their information to further my research.

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CHAPTER I
INTRODUCTION

From 1986 to 2006, the rate of obesity in the U.S. has risen dramatically, estimated at 30.4%. (1) In addition to the rise in obesity rates, risk trends for and development of co-morbid conditions have increased significantly as well. (2) Scientists and medical professionals have found overwhelming evidence concerning the association of these co-morbid conditions to the presence of obesity. (3) Currently, one of the most prevalent questions is: how can we combat the development of obesity in our population?

Significance of Problem

Evidence suggests that hypocaloric and nutrient dense diets, increased physical activity, and improved nutrition are incredibly beneficial in preventing and even reversing obesity. (2) As a result, a new market has emerged, with product after product being developed to replace sugar and fat filled delicacies in an effort to battle obesity. The sugar-free and fat-free logos appear everywhere – with general acceptance by consumers as a “safer” and “healthier dietary alternative.”

However, is this really the case? Are these sugar-free and fat-free products the dietary answer for obesity? This research study is directed toward one facet of this question. Diet soda has been one of the most popular products seized by the weight loss oriented population. These products have zero calories and zero fat. (4) They taste sweet, quench thirst, and may help keep people from eating snacks, thereby aiding in the hypocaloric diet. Observation and research indicate that diet soda consumption is more prevalent among people with a BMI of 25 or higher. (5, 4) This observation leads to the question; does diet soda actually assist in weight loss? If so, it
would be logical to assume that those who consume the most diet soda would have a healthier BMI and a lower body weight. Do people who are approaching obesity flock to diet soda to improve their body weight; or, are people who are already obese hoping that diet soda will help them to lose weight, while not seeing weight loss results?

**Problem Statement**

The purpose of this current research project was to determine the role of diet soda with overall nutrition and activity in an effort for women to lose weight. This researcher wanted to determine if those who voluntarily give up diet soda have better success in losing weight than their counterparts. In addition, the researchers also pursued whether focusing on a hypocaloric diet also increased the personal efforts of the volunteers toward ensuring that the foods consumed were nutrient dense and beneficial in their weight loss goals.

Diet soda has been marketed and praised by consumers for its ability to provide sweet lasting flavor to the diet, without adding the excess non-nutritive calories the body does not need. However, several facts and myths have also been touted through media and internet resources concerning possible risks and dangers associated with drinking diet soda, particularly in excess of more than one can per day. (6, 7, 8, 9, 10) Nutrition and health facts, supported by peer-reviewed research studies, will be used to educate volunteer participants about the possible benefits and risks that are associated with drinking at least one can of diet soda regularly. (11, 3)

The findings of this research may be a step toward understanding the ongoing problem of obesity- and therefore, guide researchers toward finding obesity control mechanisms, rather than temporary theories that may or may not be helpful.
Hypotheses

Those volunteers who participated in a 12-week nutrition and healthy weight program were hypothesized to see significant reductions in weight, BMI, and waist circumference, overall. Based on the nutrition intervention, and the inclusion of education regarding possible risks for developing chronic diseases and co-morbidities associated with drinking at least one diet soda per day, it was also hypothesized that those who significantly reduce their intake of diet soda at the end of the program will see significantly higher reductions in weight, BMI, and waist circumference, than those who do not reduce their diet soda intake. Further, it is hypothesized that those who did not drink diet soda prior or during the program will experience the highest reductions in weight, BMI, and waist circumferences, when compared to those who do drink at least one can of diet soda per day.
CHAPTER II

REVIEW OF THE LITERATURE

Thorough research has been conducted on the impact of drinking sugary carbonated drinks on a regular basis. Evidence indicates that this behavior is associated with weight gain (12), metabolic syndrome (3, 13, 14, 15), inflammation (16, 17), cardiovascular problems (3, 15, 18), renal dysfunction (19), electrolyte imbalances (20, 21), and dental erosion. (22) The 2007 analysis of U.S. beverage trends indicated that beverages consumed in the United States are the source of nearly one fourth of average daily calories. (23)

According to the 2006-2011 *World Outlook for Regular and Diet Bottled Carbonated Soft Drinks in Refillable Glass Bottles* (24), the amount of money spent across the globe on carbonated drinks is just shy of $2.2 billion U.S. Dollars, with $561 million (25.7%) being spent in the U.S. Between the years of 2001-2011, this was an increase of $154 million, or a 63% rise in U.S. consumption of carbonated beverages.

In an effort to reduce risk of weight gain, many individuals turn to diet beverages as their drink of choice. They are usually calorie free, sugar free, and full of flavor. Many people use diet soda as a flavorful method for avoiding munching on food throughout the day, and therefore as a tool for weight loss. (5) Many studies have been conducted comparing conversion to diet soft drinks from sugary soft drinks, and whether such a change will result in weight loss or less weight gain. These studies provide evidence to support this positive weight change. (4, 25, 26, 27, 28)

However, very few studies have been conducted assessing if cutting diet soft drinks completely from the diet would result in even more weight loss than if the dieter were to continue diet beverage drinking. A meta-analysis indicated that all studies reviewed, comparing
the intake of aspartame containing drinks to other beverages (i.e. sucrose containing drinks),
were associated with weight loss, except when compared to water intake. (27)

A review of the current research supported the consumption of diet soda as a replacement
for sugary soft drinks to improve fluid intake and result in weight loss. However, arguments also
exist for removing diet soda as well as other diet non-carbonated beverages completely. Four key
elements have surfaced as the primary threats to human health stemming from diet beverages:
artificial sweeteners (primarily aspartame and sucralose), caffeine intake, electrolyte imbalances,
and excess acid levels in the body. (29)

Soda Consumption

The consumption of soda and sugary beverages has been a health concern since 1942,
when the American Medical Association sent out a strong recommendation regarding the intake
of added sugar. (20) At this time, the average consumption of soda (diet and regular) per person
annually was about 90 8-oz drinks (20), but by 2000, rose to about 600 8-oz drinks per person
annually [Figure 1]. (30)

Researchers have estimated that
between 1970 and 1997, the average
consumption of regular sugar sweetened
carbonated beverages had risen from 22.2 to
41.4 gallons per year, which reflects nearly
double intake. (25) This illustrates an
increase from 355 8-oz servings to 662 8-oz
servings per year, which is an approximate
increase of 187 calories daily, assuming that each 8-oz serving is approximately 100 calories. Another estimate reflected that from 1960 to 1990 the increase of soft drink consumption increased by more than three times. (31)

Energy Intake

Sugary beverages represent 69% of all soft drinks sold. Each fluid ounce provides 11 calories on average. (32) Consequently, a typical 12-ounce can of soda provides approximately 132 calories, and a simple increase in size from a 20 oz. drink to a 32 oz. drink at the fast food chain or convenience store would result in over 120 additional calories to the diet.

According to a 2007 government analysis of U.S. beverage trends, beverages are the source of nearly one fourth of the daily caloric intake. (23) These types of beverages are thought to be the largest source of dietary caloric intake, particularly for the adolescent age group. (25, 23)

Children and adolescents tend to be a primary target of advertisements. In fact, consumption analyses have estimated that teens drink the most calorie filled beverages. Dr. David Ludwig reported that with each can of sugary drinks a child consumes per day, that child’s risk of obesity increased by 60%. (23, 33) These findings suggest that the consumption of sugar sweetened beverages may be a significant contributory factor in the observed rise in obesity in America today. (33)

Risk of Co-morbidities

As indicated previously, several studies have implicated that the rise in consumption of sugary soft drinks is related to increased risk of inflammation (17, 34), weight gain due to
increased energy consumption (1, 23), metabolic syndrome (3, 13, 14, 15), cardiovascular dysfunction (3, 15, 18), osteoporosis (20, 31), kidney stones (35), and dental erosion. (22, 36)

There are several possible explanations for increases in risk for chronic disease. First, increased weight gain is associated with most of the co-morbidities of chronic diseases. (1, 3, 13, 23) Also, with the caloric intake from sweetened beverages, and the increase of individuals’ consumption of soft drinks with associated weight gain, consumption of these beverages promotes an increased risk level of weight gain. Another reason for the increased risk of these co-morbidities may be attributed to the replacement of dairy products with sodas in the diet. Dairy products tend to have a protective effect against metabolic syndrome, diabetes, hypertension, and atherosclerosis. (37, 38, 39) Research data analyses of beverage consumption patterns reflect that persons who consume more soda are less likely to get sufficient amounts of vitamin A, calcium, or magnesium, all of which are associated with reduced risk of these co-morbidities. People who drink more soda have been noted to have a lower intake of dairy products, as well as other nutrient rich foods containing essential vitamins and minerals. (25, 31, 37, 40)

Other reasons for increased co-morbidity of chronic disease risk are possible electrolyte or acid/base imbalances related to soda intake. Cola intake as low as three cans per day has been associated with an increased risk of potassium depletion (29), resulting in hypokalemia, myopathy, and even the possibility of paralysis. Phosphorus intake is also thought to be a culprit for bone resorption in order to maintain blood calcium homeostasis. (20) According to one major study, phosphate based drinks are also associated with kidney stone development. This study isolated 1009 males, ages 18-75, who reported a consumption of at least 160 ml of soda consumption per day. Half of the participants refrained from continuing this consumption and
experienced a 6.4% improvement in freedom from recurrence for kidney stone development (p = .023). Additionally, when compared to phosphate-based drinks in particular, the improvement was 15% (p = .0002). (35) In studying the relationship between soda and urinary calcium excretion, Heaney and Rafferty found that there was an increase in short term urinary calcium excretion in 20-40 year old women [n=32] in caffeine containing beverages only. Non-caffeinated beverages did not produce this effect. While there is evidence indicating this relationship, more research must be conducted to confirm the exact mechanism where cola is associated with low bone mineral density in older women. (31)

Caffeine intake has also been associated with electrolyte imbalances. Caffeine has been associated with increased beta adrenergic stimulation, increase Na/K+ ATPase, production of metabolic alkalosis, increased rennin levels, and a diuretic effect in the body. (29) Common side effects of caffeine intake include: “diarrhea, dizziness, fast heartbeat, hyperglycemia, blurred vision, drowsiness, dry mouth, flushed dry skin, fruit like breath odor, increased urination, loss of appetite, nausea, stomachache, tiredness, troubled breathing, unusual thirst, or hypoglycemia.” (20, p. 20) Along with these caffeine consumption associations, Keeling also noted that caffeine has also been linked with bone loss in older women.

In relation to the imbalance of physiological homeostasis, research has been conducted regarding whether the pH of soft drinks may interfere with calcium absorption, storage, and retention in the body. The pH of a soft drink can range from 2.38 to 4.03. For comparison, the pH of water is 7.67. Experiments have indicated that it would take 32 glasses of water to neutralize a 12 ounce soda’s effect on blood pH. (20) However, the research did not indicate whether this experiment has been conducted in vivo or in vitro. Researchers have theorized that such a change in blood pH acidity may have an effect on bone resorption as well. (20, 40)
In summary, the human consumption of sugary soda has been a prime focus for the medical and health industry for countless reasons. As a result, companies have been searching for ways to provide that same great flavorful drink without increasing the risk of all of the associated co-morbidities. Diet soda was created and promoted as having zero calories with the same great taste as regular sugar sweetened sodas. But, did providing this beverage option to the public accomplish the goal of less weight and better health when consuming diet colas?

**Diet Soda**

Diet soda has been created as an alternative to the increased caloric intake of regular, sugary soft drinks. They are flavored with a class of “intense sweeteners,” which reduce the caloric intake from 0.44 kcal/g to zero. (4) Artificially sweetened beverages are the largest source of intense sweeteners by weight and volume. In 330 ml of beverage, there is about 150 to 250 mg of artificial sweeteners. (5, 40) The population consumption of diet drinks has increased significantly, with a rise of over five times consumption from 2.1 gallons to 11.6 gallons per capita between 1970 and 1997. (25)

**Concern for Body Weight**

One of the primary reasons people tend to drink diet soda is concern for their weight. Reports indicate a positive association [p<.001] between BMI and the heavy use of intense sweeteners. (5, 41) In one study, those who drank > 825 ml (defined as “heavy users”) of artificially sweetened beverages in one day had a mean BMI of 25.7, which was significantly higher [p<.05] than the “non-heavy users” mean BMI of 22.4. (5) However, these data do not indicate a causal effect of diet soda consumption and an increase in BMI or excessive weight gain. Further research needs to be conducted to determine if people with high BMIs drink diet
soda in an effort to lose weight, or whether diet soda has the potential to increase weight. Appleton also reported that high body weights were significantly related to increased concern \[ p<.001 \] regarding body weight and weight related issues. (5)

Other Weight Related Issues

Research has indicated that some of the weight related issues associated with diet soda consumption include the desire to restrict eating (5), increased purchase of lower calorie food and drink items (25), and as a way to lower overall caloric intake in an effort to lose weight. (27) Several studies have been conducted as to determine whether these approaches lead to any change in weight, as identified in the following paragraphs.

Weight Loss

Several studies have recorded the association of caloric intake and weight with diet soda intake. (1, 4, 25, 27) For example, a 10-week randomized, double-blind intervention of 41 men and women 20-50 years old, resulted in not only a decrease in body weight, but also fat mass and blood pressure, as compared to those drinking sugary soft drinks. (1, 42) According to BJ Rolls, “Preliminary clinical trials suggest that aspartame may be a useful aid in a complete diet and exercise program or in weight maintenance. Intense sweeteners have never been found to cause weight gain in humans.” (28, p. 872)

Weight Gain

There are many studies that have indicated that diet soda can result in weight loss, or at least the stopping of weight gain, and thereby reduce risk of developing the weight related co-
morbidities previously mentioned. (1, 4, 25, 27, 28) It is important to note that most of these studies compare diet soda to sugary soda and not to other alternative beverages, such as water. Despite the comment by Dr. Rolls (28), there are many other studies which do produce evidence to the contrary regarding weight and weight associated risk of co-morbidities, one of which dates back to 1986. (4, 11, 25, 37) For example, in a major study researching diabetes in the Multi-Ethnic Study of Atherosclerosis (MESA), daily diet soda consumption “was associated with a 36% greater relative risk of incident metabolic syndrome and a 67% greater relative risk of incident type 2 diabetes compared with non-consumption.” (3, p. 688) This same study found that those who consumed at least one daily serving of diet soda were at a significantly greater risk level for high fasting glucose levels, and for developing a high waist circumference. Studies conducted with rats have also revealed similar results. (3, 12) Rats, when exposed to intense sweeteners, gained significantly more weight than those animals consuming a regular diet.(43) Fowler and colleagues collected and analyzed over seven years of data on 1,550 Mexican American and non-Hispanic Americans between the ages of 25 to 64. Of these participants, 622 were of a normal weight at the beginning of the study. Approximately 1/3 of these participants became overweight or obese, according to follow-up data collected after 7-8 years. The data from these participants were further analyzed to determine the risk of becoming overweight or obese based on their intake of regular soft-drinks or diet soft drinks. (11) Those drinking diet soda appear to be at a higher risk for becoming overweight or obese than their counterparts drinking regular soda. It is important to note that these results indicate a strong association of diet soda consumption and weight gain, but do not necessarily imply causation of obesity as noted in the discussion section of this thesis.
Table 1: Risk of becoming overweight based on soft drink intake

<table>
<thead>
<tr>
<th>Regular Soft-drink Drinkers</th>
<th>Diet Soft-drink Drinkers</th>
</tr>
</thead>
<tbody>
<tr>
<td>26% for up to ½ can each day</td>
<td>36.5% for up to ½ can each day</td>
</tr>
<tr>
<td>30.4% for ½ to 1 can each day</td>
<td>37.5% for ½ to 1 can each day</td>
</tr>
<tr>
<td>32.8% for 1 to 2 cans each day</td>
<td>54.5% for 1 to 2 cans each day</td>
</tr>
<tr>
<td>47.2% for more than 2 cans each day</td>
<td>57.1% for more than 2 cans each day</td>
</tr>
</tbody>
</table>

1Adapted from Fowler, SP, 2005. 65th Scientific Sessions- American Diabetes Association

There are several factors that may contribute to this weight gain, including physiological compensation (12), purchasing habits (25), the effects of intense sweeteners on hunger (28), or even the same possible electrolyte or acid/base chemical effects that are unrelated to sweetener and present in both regular and diet soda. For example, soda in general, sugary or diet, would have similar pH levels, caffeine content, and phosphoric acid content regardless of the sweetener used. (20) Therefore, the risks of co-morbidities noted in the previous sections would be equally applicable for diet soda.

**Purchasing Habits**

Binkley and Golub analyzed data from the ACNielsonHomescan Consumer Panel to compare purchasing patterns of diet soda buyers as compared to regular soda buyers. (25) These researchers found that those who bought more diet soda tended to spend more money on nutritious foods and restrain from purchasing foods with higher calories and less nutrient density. Diet soda purchasers also tended to purchase more soda products in general than those who purchased regular soda. However, as the quantity of diet sodas purchased increased, so did snack
purchases. Conversely, dairy purchases also decreased as the quantity of diet beverages increased. (25)

Aspartame

Aspartame is “used in over 6000 consumer foods and beverages, including diet sodas, instant breakfasts, breath mints, gum, cereals, cocoa mixes, frozen desserts, juices, yogurts, milk drinks, and diet related products.” (20, p 20) Aspartame is the primary ingredient of most diet beverages. A typical 12 ounce can of diet soda contains approximately 180 mg of aspartame, which equals about 4.5 packets of NutraSweet. (40) Aspartame intake may be associated with several side effects published by the FDA, including: headaches, mental confusion, tremors, seizures, weight gain, irritability, anxiety, and slurred speech. (20, 40, 44, 45) Studies have found that rats who consume aspartame in appropriate amounts (similar in ratio to what a human would consume with regular diet soda intake) had a higher rate of carcinogenic cellular activity, including: lymphoma, leukemia, tumors, and neurological defects. (46, 47) Dr. Adrian Gross, toxicology representative to the FDA stated, “Without a shadow of a doubt, aspartame can cause brain tumors and brain cancer.” (20, p. 20)

Another concern of aspartame intake is the associated phenylalanine intake. Wurtman indicated that the regular intake of four to five diet soft drinks per day provides enough phenylalanine to cross the blood brain barrier and disrupt the functioning of neurotransmitters. This type of dysfunction can result in “depression, anxiety, sleep difficulties, headaches, high blood pressure, increased appetite, and possibly seizures.” (40, p.6)

As reflected by the analysis of grocery store purchases, diet soda is more frequently bought in large quantities, with households spending nearly $200 more annually on diet soda
than those buying regular soda. (25) As a result, individuals need to understand the risks of storing diet sodas. Some evidence has emerged regarding the degeneration of aspartame in elevated storage temperatures. The denaturing of aspartame produces methanol, a poisonous methyl alcohol, and may produce formic acid and diketopiperazine, a brain tumor agent. (40, 48)

Sucralose

Sucralose (Splenda) has emerged with wide acceptance into the world of diet and artificially sweetened foods. While it is not primarily used in soft drinks, it is important to recognize that this may soon become a well-known ingredient in these drinks or related low calorie foods. According to biochemist Bowen, “Splenda/Sucralose is simply chlorinated sugar; a chlorocarbon. Common chlorocarbons include carbon tetrachloride, trichlorethelene, and methylene chloride, all deadly. In test animals, Splenda produced swollen livers, as do all chlorocarbon poisons, and also calcified the kidneys of test animals in toxicity studies. Chlorocarbon poisoning can cause cancer, birth defects, and immune system destruction.” (40, p. 7-8) However, critics of this study report that the amount of Splenda provided to these rats was astronomical compared to the amount that a human would ingest - comparing the 3,000 mg/kg of body weight provided to the rats to the human equivalent of 240 g per day: 20,000 individual packets of Splenda per day, for 28 days for a 176-pound person.(49) Currently, the FDA acceptable daily intake of Splenda for humans is 5 mg/kg/day.(50)

Effects of Artificial Sweeteners on Hunger

In 1986, a major study was published by researchers Stellman & Garfinkle, who reported that the heavy use of artificial sweeteners was associated with higher body weights, BMIs, and
weight gain. (5) That same year, researchers Blundell & Hill published a report revealing evidence that aspartame flavored fluids resulted in increased appetite ratings. (28) Rolls reported that this study specifically focused on a comparison of the effects of glucose, aspartame solutions, and water on appetite ratings of subjects throughout one hour post consumption. The subjects were male and female students [n=95] with no prior screening as to initial body weight or diet status. The students self rated their motivation to eat as well as their stomach fullness. The glucose solution was related to a decrease in motivation to eat and an increase in stomach fullness, while aspartame reflected the exact opposite. (28) In this initial study, food was not provided at the end of the observational hour, and so was not actually correlated with increased intake. According to Rolls, Blundell’s group has since reported further information and results regarding this study, suggesting “the intense sweeteners aspartame, saccharin, and acesulfame-K can all increase hunger ratings compared with water, but they have not found that solutions of these sweeteners lead to an increase in food intake at 1 hour later.” (28, p. 872)

The Relationship of Diet Soda Intake to Overall Energy Intake

Hunger is difficult to define, and therefore difficult to measure. In addition, as revealed previously, it is presumptuous to assume that just because hunger ratings are increased (28), people consume more calories. As a result, research has been conducted to determine if energy intakes have a positive relationship with aspartame and diet soft drink consumption. According to Binkley, “Individuals who purchased the most diet soda also purchased the largest amount of snack foods, far more than any of the other groups, including those buying smaller amounts of diet soda. This is important because by our estimates, snack foods were a leading source of calories for all the soft drink buying groups. For the high diet group, we estimate that they
accounted for over 10% of the calories from the foods we considered, and as compared to the buyers of regular soft drinks approximately 50 additional calories per day. In addition, we estimated that the total daily calories of the two groups to be essentially the same.” (25, p. 570). Binkley also found that those who purchased diet sodas and regular sodas averaged the same caloric intake. Those who avoided soft drinks all together had an average consumption that was approximately 120 calories less than those purchasing soda. (25)

One reason for the equalization of caloric intake between diet and regular soda drinkers has been theorized as a physiological change in the body, related to aspartame intake, which disrupts the ability for the body to count calories. The idea is that based on food characteristics, such as texture or sweetness, the body can gauge the amount of calories that it is about to receive. Studies have been conducted in rats which produced evidence to this effect. (51, 52) This is thought to be a physiological reaction related to the Pavlovian theory, the famous “experiment in training dogs to associate food with the ringing of a bell. After being conditioned to the bell, the dogs salivated when they heard it- even when they did not see or smell food.” (52p. 2) It is proposed that rats and possibly even humans develop a similar relationship between flavors and/or textures of food and the associated caloric content. When the body does not receive that intake, it generates the urge to compensate with increased food intake. (51)

On the other hand, it is also theorized that the human body can compensate for such energy deficits more readily than to energy excess. (4) Bellisle & Drenowski were able to conclude in their research that aspartame sweetened drinks were not associated with increased food intake, nor were there differences in hunger ratings among any of the conditions. Another recent study showed no effect of aspartame in drinks on subsequent food intake. (4)
It is clear that there are varying theories as to the effect of artificial sweeteners on hunger, and the existing evidence to this effect is conflicting. (4,25,51,52) More research needs to be conducted on this particular topic to determine if hunger is actually affected by artificial sweeteners, and if so, the exact mechanism by which this effect would present itself.

**Caffeine**

Relative to the risks associated with caffeine as stated above (p. 4), it is important to note that many diet drinks contain the same amount of caffeine as their sugary counterparts. Therefore, the inherent risk of increased caffeine intake is not reduced by switching to diet sodas. In fact, if anything, based on Binkley’s (25) assessment of significantly increased purchases of diet vs. regular sodas, it could be hypothesized that caffeine consumption is also significantly increased, thereby increasing the risk of electrolyte imbalances, dehydration, and other previously noted risks associated with caffeine intake.

To summarize, there is clear evidence relating increased consumption of sugary soft drinks to increased weight, weight associated health risks, and co-morbidities including, but not necessarily limited to metabolic syndrome (3, 13, 14, 15), cardiovascular dysfunction (3, 18, 15), and inflammation. (16, 17) Evidence is also emerging regarding a possible relationship between these types of co-morbidities and the increasing consumption of diet soda. However, it is not clear as to the exact relationship that increasing consumption of diet soda has on weight or weight associated health risks. Theories and conflicting studies have been published to this effect, and more research is needed in an effort to develop evidence based practices regarding this issue. The objective of this pilot study is to determine if reduction of diet soda intake among
participants in a nutrition/weight management class has greater success with weight loss than those who maintain or even increase diet soda consumption.

The American Dietetic Association and the American Medical Association have both conducted research regarding the effectiveness of commercial and self-help weight loss programs. While many of these programs focus on hypocaloric, nutrient dense diets in conjunction with physical activity, few of them report any findings as to the effectiveness of diet soda consumption in an effort to lose weight or maintain a healthy body weight. This current research study will focus on the effects of diet soda consumption on body weight (53, 54).
CHAPTER III METHODS

Experimental Design

This study is a pre-test, post-test, and follow-up test research design involving subjects participating in the Weigh to Health Program that was conducted by Intermountain Health Care. This program was approved by the Intermountain Healthcare Institutional Review Board (IRB) approval committee for the complete study, and was exempted from review by the Bowling Green State University Human Subjects Review Board. Written informed consent was obtained from participants at the beginning of the study. Participants were verbally informed by the researcher of the nature of the study, the information that would be gathered, possible risks of participation, and that participation was voluntary and were asked to sign a study participation consent document (Appendix A), which was then collected and stored in a secure office. Data files used for this study had identifiers removed, and were stored on an electronic spreadsheet on a password protected computer. The data on the spreadsheet were used for the present study.

The Weigh to Health program was a six-month nutrition education course, provided by the local non-profit hospital organization, Intermountain Healthcare. This course was taught by registered dietitians, with an emphasis on evidence based effective practices associated with improved diet and lifestyle habits with weight loss as one of the measurable side effects. The course began with 12 weekly sessions of nutrition, followed by optional monthly follow up classes offered for one year.

The initial phase of the Weigh to Health program directly addressed regular soda and diet soda intake, which are discouraged, whereas water was emphasized as an improved method for quenching thirst, subduing hunger, and maintaining hydration status as related to the aforementioned studies. In these classes, pre-tests, post-tests, and follow-up tests were given to
the participants. The participants were also asked to provide information on: their current weight, current intake in servings per day (fruits, vegetables, dairy, whole grains), current exercise in minutes per day, and current soda intake.

Subjects

Using Statistical Analysis Software (SAS) 9.2 (2008, SAS Institute Inc., Cary, NC), a power test was conducted to determine the appropriate subject number for this study. Based on the power analysis, it was determined that a minimum of 34 subjects would be needed to determine significance at the $p=.01$ level, and 24 subjects at the $p=.05$ level. This study compared the data collected from 40 participants. These subjects were selected because they had a complete set of data collected, they participated in classes which included education materials regarding diet soda consumption, and they included data inquiry as to pre and post diet soda consumption.

The Weigh to Health program was open to participants over the age of 18 with a body mass index (BMI) of 35 or over. (55) Each group class incorporated approximately 16-24 people. Groups tended to have more women than men, and participation in this program was voluntary. Recruitment of subjects was through marketing advertisements (Appendix B), and by word of mouth. The local hospital cooperates with two primary insurance companies, which agreed to provide incentives for their constituents to participate in the class. For example, the cost of the class is $225 per person, paid up front. These insurance companies reimbursed $200 upon completing the course and making significant changes in habit, or meeting certain weight loss goals. This provided financial incentive for people to not only participate in the program, but to complete it in its entirety, and follow the principles taught in order to have this class effectively
paid for through insurance. As a result, most of the participants were also constituents of these cooperating insurance providers, but the program was not limited to this type of participant. Participants could also choose to pay out of pocket or join via family or physician referrals.

**Educational Intervention**

Participants attended a 12-week course of weekly 1.5 hour diet and nutrition classes, in which regular soda *and* diet soda intake were discouraged, and water was emphasized as an improved method for quenching thirst, subdued hunger, and maintaining hydration status. In these classes, registered dietitians taught and discussed the risks, benefits, practical application tips, and nutrition education covering the following topics: nutrition, exercise, meal planning, emotional eating, label reading, positive self-talk, intuitive eating, behavior modification, stress management, shopping on a budget, healthy cooking, eating out, physical activities (Weigh to Health, Appendix A). The intake of diet soda and regular soda were discussed in detail during the nutrition lecture and referred to as appropriate throughout the course.

Upon completion of the 12-week phase, participants no longer participated in the weekly class, but were encouraged to take the lessons they learned and apply them independently. They were then encouraged to participate in monthly follow-up classes, which were optional. These classes focused on relaying nutritional information on current health events, such as food safety, organic versus inorganic foods, and other nutrition research studies. The specific topics were subject to the teaching registered dietitian’s discretion. At six months from the initial week of class, the participants were required (in order to certify completion of the program) to participate in a six month follow-up class, in which they participated in the follow-up questionnaires and body measurements.
Data Collection Instruments

Pre-tests, post-tests, and follow-up tests, developed by program staff, were given to the participants to assess weight, food intake (fruits, vegetables, dairy, whole grains), exercise levels, and soda intake. Participants received paper copies of the following forms “Demographic and Anthropometric Measurements,” “Weight Management Questionnaire (Pre),” “Weight Management Questionnaire (Post),” (Appendices C, D, and E). The instructor, a registered dietitian, was available to answer any participant questions or concerns during this time. Fruits, vegetables, and dairy were measured in cups per day. Grains and liquids were measured in ounces per day. Moderate physical activity, defined by examples on the questionnaire, was measured in minutes per day.

The participants also monitored their weight throughout the program with assistance of the program staff using equipment at the health care center. Height was measured on a vertical, wall-mounted ruler, and documented in inches. Weight was measured on a Tanita TBF-310GS scale (Tanita Corporation of America, Inc., Arlington Heights, Illinois), which also calculates BMI. Weight was recorded in pounds. Waist circumference, recorded in inches, was taken by the registered dietitian, measuring horizontally around the waist with a flexible measuring tape, one inch above the hip bone. Each of these anthropometric measurements was recorded on a standardized form (Appendix C). Only the initial and final weights of the program were utilized in this study.

Data Analysis

A statistical analysis was conducted utilizing StatCrunch Software (version 5.0, 2007, Integrated Analytics LLC, Mc Lean, VA), available through Pearson Education at www.statcrunch.com
(56). Descriptive statistics were computed for collected demographic information, including gender, ethnicity, education level, and income. Paired t-test analyses were conducted to determine overall effectiveness of the nutrition and healthy weight intervention program, as well as to break down the effectiveness of the treatment program in individual groups based on participant’s weight, BMI, and waist circumference. Independent t-test analyses were conducted to determine any significant changes in weight, BMI, and waist circumference between the groups. An ANOVA test was also conducted to determine any existing differences in the means between the groups.
CHAPTER IV RESULTS

Demographic Information

The subjects were primarily female (80%), white (97%), college educated (77%), with relatively high incomes (>-$55,000/year) (Table 2).

Table 2: Demographic information for subjects completing the Weigh to Health program.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>Number</th>
<th>Percent of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>8</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>32</td>
<td>80.0</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>White</td>
<td>39</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Education</td>
<td>&lt;12th grade</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>High School grad</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>College grad</td>
<td>20</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Advanced degree</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>Income</td>
<td>&lt;$25,000</td>
<td>2</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>$25,001-40,000</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>$40,001-55,000</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>$55,001-70,000</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>$70,001-85,000</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>&gt;$85,000</td>
<td>10</td>
<td>25.0</td>
</tr>
</tbody>
</table>
Program Effectiveness

A paired t-test analysis of all participants (n=40) was used to determine if the overall program was effective in weight, BMI, and waist circumference reduction. Statistical analysis of the data from all participants indicated that overall, the program was effective in achieving participants weight loss goals based on the following outcome measurements: weight (pounds), BMI, and waist circumference (inches). For all participants combined, all three of these outcome measurements were significantly reduced, $p<0.0001$. These outcome measurements suggest that the intervention program was effective in helping the participants meet these reduction goals (Table 3).

Table 3: Anthropometric changes for participants in the Weigh to Health program at least 12 weeks

<table>
<thead>
<tr>
<th>Weight (pounds)</th>
<th>BMI</th>
<th>Weight Change (pounds)</th>
<th>Waist Circumference (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td>t-test</td>
<td>Pre</td>
</tr>
<tr>
<td>Mean</td>
<td>240.82</td>
<td>233.35</td>
<td>p=0.0001</td>
</tr>
<tr>
<td>Std Error</td>
<td>1.405</td>
<td>0.225</td>
<td>0.553</td>
</tr>
<tr>
<td>DF</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>T-Stat</td>
<td>5.315</td>
<td>5.292</td>
<td>5.509</td>
</tr>
</tbody>
</table>
**Diet Soda Intake**

Based on the participants’ responses of daily diet soda consumption, participants appeared to decrease their overall consumption of diet soda, but the results fell short of the standards for statistical significance of $p=0.05$, with a calculated level of $p=0.0543$. Therefore, it was determined that the overall program was not effective in influencing the diet soda intake of the group overall (Table 4).

The group assignments were made on self-selected soda consumption and were assigned the following designations:

- **Group 1:** Did not decrease diet soda intake throughout the course of the program. Intake remained the same or increased.
- **Group 2:** Decreased diet soda intake throughout the course of the program.
- **Group 3:** Did not drink diet soda prior to the program, and continued not to drink diet soda, throughout the course of the program.

Group 1 did not significantly increase their diet soda intake throughout the course of the program ($p=0.0919$). Group 2 did significantly decrease their diet soda intake throughout the course of the program ($p=0.0374$). Group 3 was identified as those participants who did not drink diet soda prior to the program, and continued to not drink diet soda throughout the course of the program. As such, no statistical analysis was needed to determine change in diet soda intake of these participants. It was important to separate out group 3 because it was not possible to determine if the education in the program influenced their decision to not drink diet soda, as they had not been drinking diet soda in the beginning of the study (Table 4).
Table 4: Overall paired T-Test pre/post diet soda intake of Weigh to Health participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Soda intake (ounces)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1 (n=9)</td>
<td>16.22±15.95</td>
<td>21.44±14.69</td>
</tr>
<tr>
<td>2 (n=16)</td>
<td>97.75±184.79</td>
<td>63.91±171.64</td>
</tr>
<tr>
<td>3 (n=15)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total sample</td>
<td>42.75±123.35</td>
<td>31.17±17.91</td>
</tr>
</tbody>
</table>

1 Groups were formed based on self-report of soda consumption.
2 Group 1: Did not decrease diet soda intake throughout the course of the program. Intake remained the same or increased. Group 2: Decreased diet soda intake throughout the course of the program. Group 3: Did not drink diet soda prior to the program and continued to not drink diet soda throughout the course of the program.

**Anthropometric Outcomes**

Analysis of the anthropometric outcome measures, weight, BMI, and waist circumference, was reflective of the results found in the overall program. Even when divided into groups, all three subsets of participants experienced a reduction in weight, BMI, and waist circumference. For group 1, weight ($p<0.0383$) and BMI ($p<0.0413$) were significantly reduced. However, the waist circumference was not decreased ($p<0.0806$). Group 2 participants, who decreased their diet soda consumption throughout the course of the program, experienced significant reduction in weight loss ($p<0.001$), BMI ($p<0.0027$) and waist circumference ($p<0.0016$). Group 3 participants, who did not drink diet soda throughout the course of the program, also experienced significant reduction with all three outcome measures (weight $p<0.033$; BMI $p<0.0027$; waist circumference $p<0.0016$), (Table 5).
Table 5: Mean anthropometric changes of subjects in the Weigh to Health program by group

<table>
<thead>
<tr>
<th>Group</th>
<th>Weight (pounds)</th>
<th>BMI</th>
<th>Weight Change</th>
<th>Waist (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1</td>
<td>238.29 ± 54.8</td>
<td>232.14 ± 49.7</td>
<td>38.79 ± 9.8</td>
<td>37.76 ± 8.8</td>
</tr>
<tr>
<td>(n=9)</td>
<td>±54.8</td>
<td>±49.7</td>
<td>±9.8</td>
<td>±8.8</td>
</tr>
<tr>
<td>2</td>
<td>248.64 ± 56.1</td>
<td>241.43 ± 57.9</td>
<td>39.39 ± 8.2</td>
<td>38.25 ± 8.3</td>
</tr>
<tr>
<td>(n=16)</td>
<td>±56.1</td>
<td>±56.9</td>
<td>±8.2</td>
<td>±8.3</td>
</tr>
<tr>
<td>3</td>
<td>234.00 ± 50.6</td>
<td>225.46 ± 46.4</td>
<td>37.93 ± 7.4</td>
<td>36.59 ± 7.1</td>
</tr>
<tr>
<td>(n=15)</td>
<td>±50.6</td>
<td>±46.4</td>
<td>±7.4</td>
<td>±7.1</td>
</tr>
</tbody>
</table>

1 Group 1: Did not decrease diet soda intake throughout the course of the program. Intake remained the same or increased. Group 2: Decreased diet soda intake throughout the course of the program. Group 3: Did not drink diet soda prior to the program and continued to not drink diet soda throughout the course of the program.

Comparison of Groups

While analysis of the groups suggests a trend of reduction for all three health related outcome measures overall, comparison between the groups does not significantly favor one group over another in weight, BMI, and waist reduction based on diet soda consumption. This analysis was conducted at post-test only, not at pre-test. Comparison of these three outcome measures between group 3 (no intake of diet soda and remained as such) and group 2 (maintained or increased diet soda consumption) resulted in no significant relationships, \( p=0.3443, p=0.3542, p=0.3423 \) respectively. Group 3 compared to group 1 (did not decrease diet soda consumption) resulted in no significant relationships, \( p=0.2862, p=0.3188, p=0.1794, \) respectively.
respectively. Comparison of group 2, which decreased diet soda during the program, to group 1 also did not reflect statistical significance for these same three measures, \( p=0.3780, p=0.4172, p=0.2231 \), respectively. Despite the existing trend of the raw data, analysis does not show statistical significance at the \( p=0.05 \) level (Table 6). One-way ANOVA analysis of the means resulted in \( p=0.8146 \), which also did not show statistical significance.

Table 6: Sample differences for weight, BMI, waist circumference reductions between groups at post-test.

<table>
<thead>
<tr>
<th>Comparisons</th>
<th>Weight</th>
<th>( p )</th>
<th>BMI</th>
<th>( p )</th>
<th>Waist Circumference</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 v. 2</td>
<td>-1.0743055</td>
<td>0.378</td>
<td>0.121178485</td>
<td>0.4172</td>
<td>1.0559722</td>
<td>0.2231</td>
</tr>
<tr>
<td>Group 2 v. 3</td>
<td>-1.32125</td>
<td>0.3443</td>
<td>0.19377024</td>
<td>0.3542</td>
<td>0.5029167</td>
<td>0.3423</td>
</tr>
<tr>
<td>Group 3 v. 1</td>
<td>2.3955555</td>
<td>0.2862</td>
<td>0.31494874</td>
<td>0.3188</td>
<td>1.5588889</td>
<td>0.1794</td>
</tr>
</tbody>
</table>

\(^1\) Group 1: Did not decrease diet soda intake throughout the course of the program. Intake remained the same or increased. Group 2: Decreased diet soda intake throughout the course of the program. Group 3: Did not drink diet soda prior to the program and continued to not drink diet soda throughout the course of the program.
CHAPTER V DISCUSSION

It is well known that the consumption of carbonated soft drinks, both sugar-sweetened and diet alike has increased dramatically over the past two decades, particularly from 1986-2006. (1) Similarly, the rates of obesity, diabetes, heart disease, and other chronic diseases have increased since the 1970’s. (25) Researchers acknowledged these trends and were able to provide evidence linking the consumption of sugary beverages to these chronic diseases (5, 11,13-16, 25), but research data has yielded mixed results as to the role of diet soda in these trends. (3-5,10,11,25) One of the main motivations for this study is an observed dependency of diet soda intake in people looking to lose weight. Several reasons may exist for this. First, people may look to diet soda as a way to fill their stomachs and stave off hunger throughout the day. However, Binkley referred to a theory that diet soda may be detrimental to overall health via, “disruption of the sensory mechanisms associating sweetness with calories, or … consumer rationalization.” (25, p. 569) Sharon Fowler refers to this type of phenomena as the Mad Hatter Theory. She recalls the scene in which Alice is offered a cup of tea, but is never served. Offended, she helps herself to the tea and also some bread and butter. She states, “If you offer your body something that tastes like a lot of calories, but it isn't there, your body is alerted to the possibility that there is something there and it will search for the calories promised but not delivered.” (57) Additionally, people may utilize the diet soda as a tool for justifying other purchases- for example, they may elect to order a hamburger, and justify the addition of French fries because they elected not to have those calories administered through regular soda. This type of reasoning may also answer as to the implied association of weight gain and diet soda consumption present in the results of Fowler’s research.
Based on the investigator’s assessment of the audience, nutrition educations was provided to the participants who, based on their demographics, displayed a sense of intelligence from being highly educated, were motivated because they enrolled in the intervention voluntarily, and had the financial ability to change their habits in order to improve their nutrition and/or achieve a healthy weight. This program was selected due to its focus on behavior based changes as opposed to programs offering supplementation or marketed foods as a primary weight loss method. As such, it was determined by the Weigh to Health program director that providing direct education regarding diet soda consumption and possible risks of chronic disease would affect the participants’ perceptions and decisions regarding diet soda intake. After all, the effectiveness of the program education substantiated this reduction of diet soda consumption theory by our findings that illustrated participants were willing to make overall changes suggested in the intervention, which resulted in significant weight loss as well as corresponding reductions in BMI and waist circumference. If the same theory applied to a single point of education, such as diet soda, data analysis should have been able to determine the role of diet soda in weight loss, if any existed.

One of the main foci of this study was to determine if reducing diet soda would significantly improve weight reduction rates. According to the American Dietetic Association, “Health can be improved with relatively minor weight losses. A weight loss of 10% may ameliorate health risks associated with excessive body weight.” (58, p. 331) In relation, BMI and waist circumference measurements can be a reflection of the distribution of excess weight, which can be directly related to increased health risks associated with increased body weight. According to the American Heart Association, both include values related to an increased risk of type 2 diabetes, hypertension, and cardiovascular disease. (Table 7, 59) On average, these
participants experienced a weight loss of 3%. In addition, overall participation in the Weigh to Health Program also resulted in significant reduction of BMI and waist circumference, a great start toward improved health and reduced risks of co-morbidities associated with excess body weight. (58)

With a focus on diet soda consumption in particular, like previous studies (1, 4, 11, 25), the results were mixed. Based on this evidence, it was determined in this study that the reduction of diet soda consumption in the diet is not an effective tool for greater weight loss for these participants. However, outcomes of this pilot study suggest that further development of the experiment and research is needed to determine the exact role that diet soda consumption plays in the battle against weight.

Table 7: Classification of overweight and obesity by BMI, waist circumference, and associated disease risks

<table>
<thead>
<tr>
<th>Disease Risk 1 Relative to Normal Weight and Waist Circumference</th>
<th>BMI (kg/m²)</th>
<th>Obesity Class</th>
<th>Men 102 cm (40 in) or less</th>
<th>Women 88 cm (35 in) or less</th>
<th>Men &gt; 102 cm (40 in)</th>
<th>Women &gt; 88 cm (35 in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5–24.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0–29.9</td>
<td>Increased</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>30.0–34.9</td>
<td>I</td>
<td>High</td>
<td>Very High</td>
<td>Very High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35.0–39.9</td>
<td>II</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
<td></td>
</tr>
<tr>
<td>Extreme Obesity</td>
<td>40.0 + 2</td>
<td>III</td>
<td>Extremely High</td>
<td>Extremely High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Disease risk for type 2 diabetes, hypertension, and CVD.
2 Increased waist circumference also can be a marker for increased risk, even in persons of normal weight.
3 National Heart Lung and Blood Institute: Classification of overweight and BMI, waist circumference, and associated disease risks (59).
This pilot study provided enough information for refining methods to conduct further research. For example, to use this same model of program, it would be necessary to incorporate a much larger sample size to determine the scope of diet soda effects in relation to other nutritional habits and lifestyles. Otherwise, it is necessary to isolate the topics and interventions to be more directly focused on the consumption of diet soda. Another modification may include setting up a class specific to the education of diet soda intake alone as the intervention, which would help to isolate diet soda as the primary driving factor or change in the participants’ diet (based on pre-test/post-test analysis), and could therefore be analyzed with more validity concerning its relationship to weight-related outcome measures. The study could be further refined by incorporating diet soda consumption logs in which participants keep and report more frequent and consistent records of diet soda intake, rather than estimating pre- and post- intervention consumption amounts. A weekly report should be used with the addition of more consistent measurements in weight, BMI, and waist circumference throughout the intervention.

Additionally, future studies may further increase in reliability and validity with participants being randomly assigned to treatment groups (increased consumption of diet soda v. decreased consumption of diet soda) rather than self-select groups. In summary, this pilot study provides sufficient groundwork with which to develop and conduct a more formal and precise intervention based experiment using diet soda consumption as a primary factor of weight loss.

Limitations

This study was primarily a pilot study. Because the program evaluated was mostly a type of nutrition and weight management program, the education was not focused on diet soda alone, but also included several other topics like: breakfast intake, activity, food pyramid recommendations, meal planning, weight tracking, and recording of solid and liquid intake.
While diet soda was emphasized throughout the program, any one or a combination of these changes in lifestyle may have also influenced weight, BMI, and waist circumference. In addition, it is important to note that those participants who were willing to positively or negatively decrease diet soda intake may have also been more willing to change other lifestyle factors, which could confound the results. For, those who did not consume diet soda to begin with, it is possible that the education may have supported and strengthened their decision to not consume diet soda. The sample size was not large enough to account for all of these variables, and to determine their exact role in weight reduction. In the future, it would be beneficial to have a much larger sample size, in which the data could be analyzed with a multi-variable regression analysis to determine the driving factors associated with weight loss more accurately.

**Conclusion**

The results of this study elucidated little as to the positive or negative effect of diet soda consumption in relation to personal weight loss. While participating in a nutrition and weight management program has been shown to be an effective weight loss intervention for diet soda drinkers, those who reduce diet soda consumption, and non-diet soda drinkers alike, it is not clear whether the intake of diet soda is actually a factor in their success toward weight loss. However, this research does provide excellent groundwork for further refining the interventions and increasing the sample size to better understand the role of diet soda in relation to weight. It could be that, indeed, there is no relationship between diet soda and weight loss; but, the limitations of this study still require for multiple facets to be refined and the data analyzed before such a conclusion can be reached definitively.
REFERENCES


APPENDIX A – Intermountain Healthcare Consent Form

CONSENT and AUTHORIZATION DOCUMENT
INTERMOUNTAIN INSTITUTIONAL REVIEW BOARD


PRINCIPAL INVESTIGATOR: Kathleen Nielsen, RD

CO-INVESTIGATOR(S): Christie Benton, RD; Heather Fillipowicz, MS, RD; Dana Gunderson, RD; Natalie Hawes, RD; Jalaine Kantor, RD; Peggy McClellan, MPA, RD; Catherine McDonald, PhD, RD; Ann Romero, RD; Charlotte Scott, RD; Cynthia White, RD; Holly Wilkens, MS, RD; Pauline Williams, MPA, RD.

SPONSOR: Intermountain Healthcare Food and Nutrition Service Departments.

LOCATION: Bear River Valley Hospital, Cassia Regional Medical Center, Delta Community Medical Center, Fillmore Community Medical Center, Heber Valley Medical Center, Logan Regional Hospital, Logan Budge Clinic, Sanpete Valley Hospital, Sevier Valley Hospital, Urban Central Region, Urban North Region, Urban South Region, and South West Region facilities.

BACKGROUND: Almost 65% of adults in the United States are overweight or obese. Excess weight raises the risk of: high blood pressure, high cholesterol, diabetes, heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, and some cancers. Even small decreases in weight may improve health and reduce risk of disease. This research project will evaluate the program's success in changing weight, knowledge, and behavior.

You are invited to participate in this study because you have enrolled in Intermountain’s “Weigh to Health” nutrition program and have a body mass index (BMI or weight to height ratio) greater than 30 or a body mass index of 27 with at least one of the following: high blood pressure, high cholesterol, heart disease, Type 2 (or adult onset) diabetes or sleep apnea.

Before you decide to volunteer for this study, please read the following information carefully. Discuss the information with family and friends, if you wish.

STUDY PROCEDURE: This is an observational study over time. Each person will receive standard treatment according to the “Weigh to Health” program guidelines. The “Weigh to Health” program is taught by Registered Dietitians trained in weight management.

You will be asked to give information about your gender, race, education, income, and health. You will complete a survey twice about your weight management knowledge and behaviors. Your weight, height and waist circumference will be measured twice. Physical activity is required. There are several options to choose from.

The expected time in the study is 6 months. You may select from two weight program options:

- **Individual sessions.** Five private sessions with a dietitian. Each session lasts about one hour.

  OR

- **Group Course.** Twelve classes with 15-20 other people. Each class lasts 90-minutes. Classes taught by a dietitian.

In both options you will set goals, track intake, and learn about nutrition, activity, and behavior.

Patient Initials
IRB Template Revised 03/22/2006

Intermountain Healthcare Institutional Review Board
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APPROVED

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RISKS: There is a potential risk for loss of privacy of personal health information. The study is designed to decrease this risk. Personal information is assigned a code number. The code key is kept in a secure file.

BENEFITS: We cannot promise any benefits to study volunteers. The study data may help us design effective weight programs.

ALTERNATIVE PROCEDURES: You may choose not to participate in the study. You may participate in the "Weigh to Health" nutrition program whether or not you participate in the research study.

PERSON TO CONTACT: For answers to research questions, please contact:
Kathleen Nielsen 801-387-7632
Peggy McClellan 801-357-7714
Heather Filipowicz 801-408-6046

INSTITUTIONAL REVIEW BOARD: If you have questions regarding your rights as a research subject, or if problems arise which you do not feel you can discuss with the investigator, please contact the Intermountain Office of Research at 1-800-321-2107.

INJURY NON-COMPENSATION STATEMENT: "In the event you sustain injury resulting from your participation in the research project, the Intermountain Healthcare facility where you participate can provide to you, emergency and temporary medical treatment and will bill your insurance company. Since this is a research study, payment for any injury resulting from your participation in this research study may not be covered by some health insurance plans. If you believe that you have sustained an injury as a result of your participation in this research program, please contact the investigator as soon as possible. You may also contact the Intermountain Office of Research at 1-800-321-2107.

VOLUNTARY PARTICIPATION: Your participation is voluntary. If you volunteer you will be asked to sign a consent form. You are free to withdraw at any time and without giving a reason. This will not affect your relationship with the investigator or staff nor standard of care you receive.

UNFORESEEABLE RISKS: The study may involve risks to the participant that are currently not identified.

RIGHT OF INVESTIGATOR TO WITHDRAW: You may withdraw from the study at anytime without penalty.

COSTS TO SUBJECTS AND COMPENSATION: There are no additional costs to persons in this study. There is no compensation for persons in this study.

NEW INFORMATION: New findings found during the research, which may relate to the subject's willingness to continue participation will be provided to the subject.

NUMBER OF SUBJECTS: We expect about 500 participants from 14 Intermountain sites to be involved in the study.

CONFIDENTIALITY/ AUTHORIZATION FOR USE OF YOUR PROTECTED HEALTH INFORMATION: Intermountain Healthcare has a commitment to protect your confidentiality. Federal regulations require that you understand how your protected health information (PHI) is used for this study. Information gathered during the study include:
- Name
- Address
- Telephone number
- Anthropometric measures (height, weight, BMI, waist circumference)
- Medical history
- Demographic information (gender, ethnicity, education, and income)
DISCLOSURE: We may share your information with Utah State University, Department of Nutrition and Food Science. You will not be identified by name, social security number, address, telephone number, or any other information that would directly identify you, unless required by law. Your data will be assigned a code number. The code key is kept in a secure file.

Others who will have access to your protected health information for this research project include Intermountain's Institutional Review Board (the committee that oversees research studying people) and authorized members of the Intermountain workforce who need the information to perform their duties (for example: provide treatment, to ensure integrity of the research, and for accounting or billing matters), the Food and Drug Administration, and others as required by law.

Signing this document means you allow us, the researchers in this study, and others working with us to use protected health information about your health for this research study. You can choose whether or not you will participate in this research study. However, in order to participate you have to sign this consent form.

You may change your mind later and ask us to stop using or disclosing your protected health information. This must be done in writing. You must either give this notice, call a revocation, or in person to the Principal Investigator, the Principal Investigator’s staff, or mail it to Kathleen Nielsen, Director Nutrition and Food Services; McKay-Dee Hospital Center; 4401 Harrison Blvd.; Ogden, UT 84403. If you revoke this authorization, we will not be able to collect new information about you, and you will not be able to participate in the study. However, we can continue to use information we have already started to use in our research, as needed to maintain the integrity of the research.

Just so you know, if we send protected health information about you outside Intermountain, based on this or any other authorization you sign, we cannot guarantee that the recipient will not redisclose your protected health information to a third party. The recipient of the information may not be required to abide by this Authorization or applicable federal and state law governing the use and disclosure of your protected health information.

This authorization lasts until this study is finished.

For more information about my rights to my protected health information, how to revoke this authorization, and how Intermountain uses my health information, I may ask to see or obtain a copy of the Intermountain Notice of Privacy Practices.

I hereby acknowledge that I have received or been offered a copy of Intermountain’s Notice of Privacy Practices.

CONSENT: I confirm that I have read and understand this consent and authorization document and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

I agree to participate in this research study and authorize you to use and disclose health information about me for this study, as you have explained in this document.

Participant’s Name (Print) ____________________________

Participant’s Signature ____________________________ Date ______________

Name of Person Obtaining Authorization and Consent ____________________________

Signature of Person Obtaining Authorization and Consent ____________________________ Date ______________

Intermountain Healthcare
Institutional Review Board
MAY 15 2009 APPROVED MAY 15 2010 EXPIRES

Patient Initials ________________

IRB Template Revised 03/22/2006
APPENDIX B – Weigh to Health Program Marketing Brochure

**The Weigh to Health Nutrition Program**

**About the Program:**
The Weigh to Health Nutrition Program is for overweight adults who desire to lose weight and improve health. The program is:

- Evidence-based. The program is based on current research and uses the most effective methods for losing weight and keeping it off.
- Standardized. The same curriculum is used at all participating Intermountain Healthcare facilities.
- Credentialed. The program is provided by Registered Dietitians with training and experience in weight management.

**Two Options:**
- Individual counseling
- Group course

**Payment and Registration:**
Total payment is required in advance for either the individual counseling or group course options. Pre-registration is highly encouraged as class enrollment is limited and classes fill quickly. To pre-register, please contact your local facility listed on the back of this brochure.

**INDIVIDUAL COUNSELING**

**Program Components:**
The individual program consists of the following 5 personalized sessions with a Registered Dietitian trained in weight management:

- An initial in-depth session to evaluate your diet, lifestyle history, nutrition status, knowledge and habits.
- 4 follow-up sessions to help you create and follow a personal plan for nutrition, activity, and behavior changes.

**Program Features:**
- Encourages goal setting and tracking to achieve overall weight loss goals.
- Provides a support system and regular reporting structure to encourage success.
- Allows you to schedule appointments at your pace to reinforce the skills and knowledge needed to implement your personal plan.
- Offers language translation assistance at most facilities.
- Available at all Intermountain facilities (see contact numbers on back panel).

**Cost:** $225
Includes the 5 personalized sessions described above. Additional follow-up sessions may be recommended but would be billed separately.

**Group Course**

**Program Components:**
The group course consists of 12 weekly 90-minute classes taught by a Registered Dietitian, with guest instructors such as an exercise specialist, behavior specialist, and chef. During classes, participants will:

- Develop personal goals using eating style and exercise assessment tools
- Learn to manage nutrition, activity, and behavior
- Track intake and exercise

**Topics Include:**
- Nutrition
- Exercise
- Meal planning
- Emotional eating
- Label reading
- Positive self-talk
- Intuitive eating
- Behavior modification
- Stress management
- Shopping on a budget
- Healthy cooking
- Eating out
- Physical activity ideas with each class

**Cost:** $225
Includes the 12 weekly sessions described above, plus 12 monthly follow-up sessions at no extra charge. See the back panel for a list of locations.
DID YOU KNOW:

- Over 65% of adults in the United States are overweight or obese.

Excess weight increases the risk of:
- High blood pressure
- High cholesterol levels
- Diabetes
- Heart disease
- Stroke
- Gallbladder disease
- Osteoarthritis
- Sleep apnea and other breathing problems
- Cancers of the endometrium, breast, prostate, and colon

- Research shows that even small decreases in weight help to improve health and reduce risk of disease.
- Weight loss helps improve:
  - Blood pressure
  - Glucose and insulin levels
  - Triglyceride levels
  - LDL and HDL cholesterol levels
  - Quality of life

INDIVIDUAL COUNSELING CONTACTS:

- Alta View Hospital 801.507.2253
- American Fork Hospital 801.855.3461
- Bear River Valley Hospital 435.716.5329
- Caesars Regional Medical Center 208.677.6288
- Delta Community Medical Center 435.864.5581
- Dixie Regional Medical Center 435.251.3789
- Fillmore Community Medical Center 435.743.5591
- Heber Valley Medical Center (Est. 1371) 435.654.2500
- Intermountain Medical Center 801.507.3253
- LDS Hospital 801.507.3253
- Logan Regional Medical Center 435.716.5329
- McKay Dee Hospital Center 801.387.7854
- Park City Medical Center 435.658.7119
- Riverton Hospital 801.507.3253
- Saratoga Valley Hospital 435.462.4620
- Sevier Valley Hospital 435.893.0569
- Utah Valley Regional Medical Center 801.357.8143
- Valley View Medical Center 435.868.5335

GROUP COURSE CONTACTS:

- Dixie Regional Medical Center 435.251.3789
- Intermountain Medical Center 801.507.3253
- LDS Hospital 801.507.3253
- Logan Regional Medical Center 435.716.5329
- McKay Dee Hospital Center 801.387.7854
- Park City Medical Center 435.658.7119
- Riverton Hospital 801.507.3253
- Utah Valley Regional Medical Center 801.357.8143
- Valley View Medical Center 435.868.5335
### Demographic and Anthropometric Measurements

**Name** (last, first) ___________________________________________  ID# ____________

- Individual  Group

**Date of birth** (mm/dd/yyyy) ____/_____/______

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<td>Estimated energy needs</td>
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**Gender:**  Male  Female

**Ethnicity**
- White
- Black
- Hispanic
- American Indian
- Alaska Native
- Asian
- Pacific Island

**Household Income**
- Less than $25,000
- $25,001-$40,000
- $40,001-$55,000
- $55,001-$70,000
- $70,001-$85,000
- More than $85,000

**Education Level**
- Less than the 8th Grade
- 8-12th Grade
- High School Graduate
- College Graduate
- Advanced Degree

Please mark if you have any of the following
- Diabetes Type I or Type 2
- Hypertension (high blood pressure)
- Dyslipidemia (high cholesterol)
- Coronary artery disease
- Sleep Apnea
APPENDIX D – Nutrition and Activity Information Pre-Questionnaire

Weight Management Questionnaire (Pre )

Your name_________________________  ID#__________________09

1. How many days a week do you eat breakfast?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7

2. How many days a week do you participate in moderate (walking, household chores) to vigorous (running, swimming, dancing, sports) physical activity?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7

3. On days you participate in moderate to vigorous activities, how many minutes do you spend each day?
   ____________ Minutes moderate to vigorous activity each day

4. How often do you weigh yourself?
   a. More than once a day
   b. Daily
   c. A few times a week
   d. Weekly
   e. A few times a month
   f. Monthly
   g. A few times a year
   h. Never
5. How often do you record or monitor your food intake?
   a. Daily
   b. A few times a week
   c. Weekly
   d. A few times a month
   e. Monthly
   f. A few times a year
   g. Never

5a. If you do not record your food intake, do you practice intuitive eating?
   Circle one: Yes  No  I don’t know

6. On average, how many cups of vegetables do you eat daily?
   ___________ Average cups of vegetables daily

7. On average, how many cups of fruits do you eat daily (excluding fruit juice)?
   ___________ Average cups of fruit daily

8. On average, how many cups of fruit juice do you drink daily?
   ___________ Average cups of fruit juice daily

9. On average, how many cups of milk, yogurt, or cheese do you consume daily? (1-2 ounces of cheese is equivalent to one cup of milk or yogurt)
   ___________ Average, cups of milk, yogurt of cheese daily

10. On average, how many ounce equivalents of whole grains do you consume daily? (an ounce equivalent is 1 slice whole grain bread, 1/4 whole grain bagel, 6-inch whole grain or corn tortilla, 1/2 cup cooked whole grain cereal, pasta, or brown rice). Please record whole grains, not refined grains.
    ___________ Average ounce equivalents of whole grains daily

11. On average, how many ounces of soda, punch, lemonade, or sports drink do you consume daily?
    ___________ Average ounces of regular soda, punch, lemonade, or sports drink daily
    ___________ Average ounces of diet soda, punch, lemonade, or sports drink daily
APPENDIX E – Nutrition and Activity Information Post-Questionnaire

Weight Management Questionnaire (Post)

Your name_________________________  ID#__________________09

1. How many days a week do you eat breakfast?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7

2. How many days a week do you participate in moderate (walking, household chores) to vigorous (running, swimming, dancing, sports) physical activity?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7

3. On days you participate in moderate to vigorous activities, how many minutes do you spend each day?
   ____________ Minutes moderate to vigorous activity each day

4. How often do you weigh yourself?
   a. More than once a day
   b. Daily
   c. A few times a week
   d. Weekly
   e. A few times a month
   f. Monthly
   g. A few times a year
   h. Never
5. How often do you record or monitor your food intake?
   a. Daily
   b. A few times a week
   c. Weekly
   d. A few times a month
   e. Monthly
   f. A few times a year
   g. Never

5a. If you do not record your food intake, do you practice intuitive eating?
   Circle one: Yes No I don’t know

6. On average, how many cups of vegetables do you eat daily?
   ____________ Average cups of vegetables daily

7. On average, how many cups of fruits do you eat daily (excluding fruit juice)?
   ____________ Average cups of fruit daily

8. On average, how many cups of fruit juice do you drink daily?
   ____________ Average cups of fruit juice daily

9. On average, how many cups of milk, yogurt, or cheese do you consume daily? (1-2 ounces of cheese is equivalent to one cup of milk or yogurt)
   ____________ Average, cups of milk, yogurt or cheese daily

10. On average, how many ounce equivalents of whole grains do you consume daily? (an ounce equivalent is 1 slice whole grain bread, 1/4 whole grain bagel, 6-inch whole grain or corn tortilla, 1/2 cup cooked whole grain cereal, pasta, or brown rice). Please record whole grains, not refined grains.
    ____________ Average ounce equivalents of whole grains daily

11. On average, how many ounces of soda, punch, lemonade, or sports drink do you consume daily?
    ____________ Average ounces of regular soda, punch, lemonade, or sports drink daily
    ____________ Average ounces of diet soda, punch, lemonade, or sports drink daily