The Effect of Sugar Sweetened Beverage Consumption on Body Mass Index

by

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Abstract

Previous research indicates a discrepancy surrounding the linkage between sugar sweetened beverage consumption and obesity, as determined by body mass index (BMI). The present study examined the relationship between BMI and sugar sweetened beverage consumption among college students. Ninety-two subjects (68 females and 24 males) aged 19-24 years old completed a food frequency questionnaire to determine the frequency and amount of sugar sweetened beverages (soda, fruit drinks, sports drinks, and tea or coffee drinks) that were consumed. Height and weight measurements were used to calculate BMI and determine BMI-for-age percentiles. Results indicated no significant differences between frequency of beverage intakes and BMI. The average ounces of sugar sweetened beverages consumed and body mass index were also unrelated. Males consumed sugar sweetened beverages significantly ($p < .05$) more frequently than females. Significant differences ($p < .05$) were also observed between types

of sugar sweetened beverages consumed by the sample. Although this study was unable to establish a relationship between sugar sweetened beverage consumption and body weight, findings suggest a further need to generate a larger body of research to understand the connections of sugar sweetened beverages and body weight.

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Table of Contents

List of Tables

Chapter I: Introduction

Obesity is an epidemic that has spread throughout the United States. According to the 2005-2006 National Health and Nutrition Examination Survey (NHANES), 32.7% of adults 20 years of age and older are classified as overweight with a body mass index (BMI) $\geq$25, and 34.3% of adults 20 years of age and older are classified as obese with a BMI $\geq$ 30 (Centers for Disease Control [CDC], 2009a). Flegal, Carroll, Ogden, and Curtin (2010) conducted research using the latest data provided by the NHANES 2007-2008. The study examined 5,555 men and women 20 years and older to determine the prevalence of overweight and obesity in 2007-2008. The study found the prevalence of obesity in 2007-2008 among men and women was 32.2% and 35%, respectively. The study found the obesity prevalence among non-hispanic white males was 31.9%, 37.3% among non-hispanic black males, 33.0% among non-hispanic white females, and 49.6% among non-hispanic black females. Obesity increases the risk for chronic diseases such as type II diabetes, cancer, dyslipidemia, hypertension, coronary heart disease, liver and gallbladder disease, sleep apnea, and stroke (CDC, 2009b). Maintaining a healthy body weight, a BMI between 18.5 and 25, is important to living a long and healthy life.

Many positive and negative eating patterns or habits are formed as a child and often continue into adulthood. Positive patterns include an adequate intake of fruits, vegetables, dairy, grains, and meat, while limiting the intake of processed foods, fat, and sugar. In contrast, negative dietary patterns include excessive intakes of processed food, added sugar, and fat. An emerging negative pattern has been the increased rate in which sugar sweetened beverages have been consumed. The increased consumption of sugar sweetened beverages provides no positive effect on diet quality, health, or body weight. This trend often develops in childhood and

continues into adulthood. Further, this trend has spread throughout the United States, negatively impacting obesity rates (California Center for Public Health Advocacy [CCPHA], 2010).

Gortmaker, Long, & Wang (2009) defined sugar sweetened beverages to include soda, fruit drinks, sport drinks, low calorie drinks, sweetened tea, and any beverage that contains added caloric sweeteners, also called added sugars. High fructose corn syrup and sucrose (table sugar) are the two added sugars primarily used to sweeten beverages. Like sucrose, high fructose corn syrup is a combination of glucose and fructose. However, high fructose corn syrup is produced by converting cornstarch to corn syrup, which is mostly glucose; fructose is added to the mixture during processing (Jones, 2010). High fructose corn syrup has become a commonly used sweetener in beverages because of its low cost and ability to extend and maintain shelf life.

As obesity rates have dramatically increased in the past 30 years, the typical portion size of sugar sweetened beverages consumed in the United States (U.S.) has also risen. The high rates in which soda has been consumed may be due to the increase in portion sizes. In the 1960's, a typical portion of soda was a 6.5 ounce bottle; by 2002 this size has more than tripled to a 20 ounce bottle (Valentine, 2002). The increase in portion size also contributes to increased energy intake, which plays a role in weight gain and obesity.

As the obesity rate and sugar sweetened beverage consumption continues to swell, research surrounding the impact of sugar sweetened beverages on obesity continues. A study conducted by the California Center for Public Health Advocacy found that 24% of adults consumed at least one soda or sugar sweetened beverage per day, which increased the risk for becoming overweight or obese by 27% (CCPHA, 2010).

Research conducted by Schulze et al. (2004) found women who increase their sugar sweetened beverage consumption from one or fewer drinks per week to one drink per day gained

the most weight over a four-year period. The increased consumption of sugar sweetened beverages caused an increased weight gain due to excess calorie intake. Sugar sweetened beverages provide discretionary calories in the form of added sugars. Discretionary calories are supplied by added sugars, solid fat, and alcohol. These dietary components are not necessary to maintain a healthy diet and often lead to weight gain. Beverages provide calories but few, if any, essential nutrients. Drinking one 12 ounce can of soda every day for a year provides 55,000 calories, which is equal to 15 pounds (University of California San Francisco, 2011). The greater consumption of food with large amounts of added sugars the more difficult it is to consume enough nutrients without gaining weight.

Marshall et al. (2005) found the increased consumption of sugar sweetened beverages to displace milk and have a negative effect on overall diet quality. Milk intake was inversely associated with intakes of soda, juice drinks, and added sugar beverages. According to Ludwig, Peterson, & Gortmaker (2001), milk supplies the body with vitamins A, D, and B12, calcium, magnesium, and protein. These nutrients supply the foundation for the development of bone mass and teeth maintenance. The displacement of milk in the diet increases the risk for osteoporosis and weakened bones. Further, the shift from milk consumption to sugar sweetened beverage consumption over the years is a significant factor in the displacement of milk as well as the increased caloric intake leading to weight gain and obesity.

There are numerous economic implications when considering the increased risk for health consequences due to individuals being overweight and obese. The U.S. spends $147 billion per year on direct medical costs due to obesity; obese individuals spend 41% more money in healthcare each year than the person of ideal body weight (Reinberg, 2010). Preventing these

health consequences incurred by overweight and obese individuals would subsequently decrease medical cost each year.

Given the negative impact added sugar intakes may have on diet quality and health, recommended intakes for added sugars are expressed as upper limits or maximum amounts to consume. The Dietary Reference Intakes for macronutrients (Institute of Medicine, 2002) suggest that added sugars should comprise no more than 25 percent of the total calorie intake. A more recent consensus report of the American Heart Association (2011) recommends that added sugars should comprise no more than one-half of the discretionary calorie allowance specified in the United States Department of Agriculture (USDA) food guide for healthy eating. In general, this amount is limited to no more than 100 calories per day from added sugars for most women and no more than 150 calories per day for most men in the U.S. Similarly, the newly released 2010 dietary guidelines for Americans calls for reducing the intake of discretionary calories, including added sugars in the American diet (U.S. Department of Health and Human Services, 2010a). Lowered intakes of added sugars could prevent excessive use of sugar sweetened beverages, which in turn, may prevent the excess calorie intake leading to weight gain.

Statement of the Problem

Half of all Americans consume sugar sweetened beverages including soda, juice, and sports drinks (Gortmaker, Long, & Wang, 2009). Added sugars supply a significant amount of calories to the American diet. The intake of added sugars contributed by the increased consumption of sugar sweetened beverages may play a role in the increased energy intake in the American diet leading to weight gain. Numerous studies have examined the association between sugar sweetened beverage consumption and weight gain. In a recent examination of previous research findings, Johnson et al. (2009) concluded that the role of sugar sweetened beverage

intakes on the etiology of overweight and obesity remains controversial and inconclusive. Chen et al. (2009) examined 810 adults to determine the affect of sugar sweetened beverage consumption on weight gain in an 18 month randomized control trial. This study found a significant association between sugar sweetened beverage intake and weight change.

Due to the growing problem of obesity and high consumption of sugar sweetened beverages, it is important to understand the effect of sugar sweetened beverage consumption on weight gain. Studies have examined factors contributing to weight gain and obesity in the college age population, but little research has proven a relationship between sugar sweetened beverage consumption and weight gain. Few studies have examined the effect of sugar sweetened beverage consumption on BMI in the college student population, which increases the importance of this research study.

Purpose of the Study

The purpose of the present study was to determine if sugar sweetened beverage consumption, has an effect on the body mass index of college students, aged 19-24 years, at the University of Wisconsin-Stout (UW-Stout). A food frequency questionnaire was administered to determine sugar sweetened beverage consumption; and BMI was collected using the Tanita Body Composition Analyzer, Model TBF-215 (Tanita).

The research activities were conducted in October of 2010. The Human Performance Laboratory (Heritage Hall 423) was used to administer the food frequency questionnaire and to determine BMI and BMI-for-age percentile of the participants.

Research Objectives

The present research has been performed to address the following:

1. Determine the relationship between sugar sweetened beverage consumption, gender, and age.
2. Determine the relationship between sugar sweetened beverage consumption and body mass index.
3. Compare the consumption of various sugar sweetened beverages and evaluate the relationship to body mass index.

Assumptions and Limitations of the Study

Researching human participants involves various assumptions. In this study it is assumed that the participants completed the food frequency questionnaire honestly and understood the questions on the questionnaire with the assistance from the researcher.

Limitations of the study include the following: obtaining participants was difficult due to the requirement of obtaining BMI in the human performance lab; participants may not answer all the survey questions completely and/or honestly; and the sample selection was not randomized, rather a convenience sample was utilized which limits the ability to generalize the results of the study. A further limitation was that no pilot test of the food frequency questionnaire was administered and analyzed.

Definition of Terms

There are several terms commonly used in this study that need to be defined for a more complete understanding of the study.

Added sugars. Sugars, syrups, and other caloric sweeteners that are added to foods during processing, preparation, or consumed separately. Added sugars do not include naturally occurring sugars such as those that occur in milk and fruit (U.S. Department of Health and Human Services, 2010b).

Body mass index (BMI). A measure of weight in kilograms (kg) divided by height in meters (m) squared. BMI is considered a reasonably reliable indicator of total body composition, which is related to the risk of disease and death. BMI status categories include underweight, healthy weight, overweight, and obese (U.S. Department of Health and Human Services, 2010b).

Discretionary calorie allowance. The balance of calories remaining in a person's energy allowance after accounting for the number of calories needed to meet recommended nutrient intakes through consumption of foods low in fat or no-added-sugars. The discretionary calorie allowance may be used for forms of foods that are not the most nutrient-dense (e.g., whole milk rather than fat-free milk), for additions to foods (e.g., salad dressing, sugar, butter), for alcoholic beverages, or for intake from any food group or oils over the amount recommended. In MyPyramid, added sugars and discretionary solid fats are always counted as discretionary calories (U.S. Department of Health and Human Services, 2010b).

Metabolic syndrome. Characterized by a group of metabolic risk factors that increase the risk for coronary heart disease and other diseases related to plaque buildup in artery walls and type II diabetes (American Heart Association, 2011).

Overweight. A BMI between 25.0 to 29.9 kg/m^2 for adults 20 years and older (CDC, 2011a); a BMI equal to or above the 85^{th} percentile but less than the 95^{th} percentile on the Centers for Disease Control BMI-for-age growth for boys and girls 2 through 19 years old (CDC, 2011b).

Obese. A BMI equal to or above 30.0 kg/m^2 for adults 20 years and older (CDC, 2011a); a BMI equal to or greater than the 95^{th} percentile on the Centers for Disease Control BMI-for-age growth for boys and girls 2 through 19 years old (CDC, 2011b).

Healthy body weight (BMI). A BMI of 18.5 to 24.9 kg/m^2 for adults 20 years and older (CDC, 2011a); a BMI equal to or greater than the 5th percentile but less than the 85th percentile on the Centers for Disease Control BMI-for-age growth for boys and girls 2 through 19 years old (CDC, 2011b).

Sugar sweetened beverages. Sweetened beverages are those that contain caloric sweeteners and include:

Soft drinks, soda, pop, and soda pop. Is defined by CDC (2010) as "nonalcoholic, flavored, carbonated or non-carbonated beverages usually commercially prepared and sold in bottles or cans" (p. 4).

Fruit drinks, punches, or ades. Is defined by CDC (2010) as "sweetened beverages of diluted fruit juice" (p. 4).

Sports drinks. Is defined by CDC (2010) as "beverages designed to help athletes rehydrate, as well as replenish electrolytes, sugar, and other nutrients," (p. 4).

Energy drinks. Is defined by CDC (2010) as "most energy drinks are carbonated drinks that contain large amounts of caffeine, sugar and other ingredients, such as vitamins, amino acids, and herbal stimulants" (p. 4).

Methodology

Data was collected at the UW-Stout Human Performance Lab. Prior to data collection, an original food frequency questionnaire was developed by the researcher based on similar food frequency questionnaires, as well as, some questions unique to this study. The food frequency questionnaire and research proposal were submitted to the UW-Stout's Human Subjects approval board. Upon approval, data collection began in October of 2010. The survey data collected included frequency and amount (ounces) of sugar sweetened beverage consumption, gender, and

age. Participants' height and weight were measured by the researcher using the Tanita machine which automatically calculated the BMI for the subjects 20-24 years old. Height and weight of the subjects that were 19 years old was collected using the Tanita machine and entered into the Children's BMI calculator (CDC, 2011c). The data was compiled in an excel file and the results were analyzed by the researcher. An associate from the Budget and Analysis office at UW-Stout assisted the researcher with the statistical analysis. The statistical program for Social Sciences version 18.0 was used to analyze data.

Chapter II: Review of Literature

Introduction

This chapter will discuss BMI, BMI-for-age percentiles, obesity trends in the United States, recommended added sugar intakes, and sugar sweetened beverage consumption trends. This chapter will conclude by discussing obesity in relation to sugar sweetened beverage consumption.

BMI and BMI-for-Age Percentile

BMI is an indicator of body fatness in most people and is used to assess weight categories that may lead to health problems. BMI is not a measure of direct body fat, but research has shown that it correlates to direct measures of body fat such as underwater weighing and dual x-ray absorptiometry (Centers for Disease Control [CDC], 2011a).

For adults, aged 20 years and older, BMI calculation requires height and weight measurements to complete the formula: BMI (kg/m^2) equals weight in kilograms divided by height in meters squared. According to the CDC (2011a), classifications of body weight categories based on BMI measurements are as follows: BMI of 18.5-24.9 indicates normal weight; BMI of 25-29.9 indicates overweight; BMI of 30-34.9 indicates class I obese; BMI of 35-39.9 indicates class II obese; and BMI of 40 or higher indicates class III obese.

BMI interpretation in children and teenagers is different than adult interpretation. Children and teenagers are continually growing and their body fat differs between sex and age. Therefore, the CDC BMI-for-age growth charts are used to interpret BMI in children and teenagers based on gender. These growth charts classify children and teens into a percentile and allow for the differences in sex and age. The percentile ranking is used to classify the body weight status of boys and girls 2 through 19 years old as follows: less than the 5^{th} percentile

indicates underweight; 5th percentile to less than the 85th percentile indicates healthy weight; 85th percentile to less than the 95th percentile indicates overweight, 95th percentile to less than 97th percentile indicates obese, and 97th percentile and above indicates extreme obesity (CDC, 2011b).

BMI is used as a tool to evaluate body fat and possible weight problems because of its low cost and the ability to easily calculate. In cases of extreme athletes, or people with increased muscle mass, BMI may indicate overweight or obesity when the condition does not exist because of their heavy muscle mass. Calculating BMI does not distinguish between the muscle and fat for the weight factor; therefore a high muscle mass may increase the weight factor, which may increase the BMI number (CDC, 2011a).

Obesity Trends

The obesity epidemic throughout the United States continues to be a major health concern. The National Health and Nutrition Examination Survey (NHANES) (2007-2008) found 34.2% of adults aged 20 years and older are overweight and 33.8% of adults aged 20 years and older are obese. This data suggests an increase in the prevalence of obesity among adults since the NHANES III (1998-1994) reported a prevalence of 23% (Ogden & Carroll, 2010a).

Obesity rates have not only increased in adults, but also have begun increasing in children and adolescents. According to Ludwig, Peterson, & Gortmaker (2001), the prevalence of obesity among children throughout the United States has increased by 100% between 1980 and 1994. Several environmental and social factors contribute to obesity, but one factor that needs more attention is sugar sweetened beverage consumption.

NHANES (2003-2004) reported 17% of U.S. children and adolescents ages 2-19 years are overweight; an increase among 12-19 year olds from 11% to 17% from 1988-1994 (CDC,

2009a). The latest NHANES (2007-2008) reported 18.1% of U.S. children and adolescents between the ages of 12-19 years old were obese, an increase from 5% reported for this age group in the 1976-1980 survey (Ogden & Carroll, 2010b).

As the prevalence for obesity increases in children and adolescents, the probability of it progressing into adulthood is increased. Vanhala, Vanhala, Kampusalo, Halonen, and Takala, (1998) followed 439 subjects from age seven to adulthood. The study found half of the obese children in the study had become obese adults. The study also found that obese children who became obese adults were at a much higher risk for developing metabolic syndrome and cardiovascular consequences.

The National College Health Risk Behavior Survey evaluated 4,609 undergraduate college students' 18-24 years old to determine prevalence of health risk behaviors. The survey found 15.5% of students were overweight (National Center for Chronic Disease Prevention and Health Promotion, 1997). Lowry et al. (2000) conducted a study on 4,609 U.S. college students to examine the associations of physical activity and food choice with weight management practices. The study found that 35% of the students were overweight or obese.

Further research conducted by Huang et al. (2004) examined the relationship between weight status and components of metabolic syndrome in college students. The study collected anthropometric data including weight, height, BMI, and waist and hip circumferences from 163 students ages 18-24 years old. The study found 27% of the college students were overweight.

Sira and Pawlak (2010) conducted a cross-sectional survey to investigate the rate of overweight and obesity, and eating attitudes among college students 18-25 years old. The study used self-reported data to collect height and weight and calculate BMI. The study concluded 21.8% of the participants were overweight and 10.8% were obese.

Obesity increases the risk for further health complications such as type II diabetes mellitus, cancer, dyslipidemia, hypertension, coronary heart disease, liver and gallbladder disease, sleep apnea, and stroke (CDC, 2009b). Conditions such as type II diabetes are more commonly found in overweight and obese individuals. According to the World Health Organization [WHO] (2003), approximately 85 percent of people with diabetes mellitus are type II, and of those, 90 percent are overweight or obese.

Recommended Added Sugar Intake

Major sources of added sugars in the American diet include regular sodas, sports drinks, energy drinks, and fruit drinks (U.S. Department of Health and Human Services, 2010a). National guidelines and recommendations for healthy eating have suggested a limit on added sugar intake. The United States Department of Agriculture (USDA) and United States Department of Health and Human Services released the Dietary Guidelines for Americans (DGA) which have given recommendations for healthy diets for Americans two years of age and older. First released in 1980, the DGA have published new recommendations every five years advising Americans to limit or avoid excessive sugar intake (U.S. Department of Health and Human Services, 2011a).

The 2005 DGA (2005) recommended limits for added sugar intake in healthy diets. These Dietary Guidelines suggest a discretionary calorie allowance for healthy food plans based on calorie levels. This allowance limits the intake of added sugars which contribute to discretionary calorie intake in the American diet. Added sugar limits range from 20 grams to 34 grams for a 1,000 to 3,200 calorie food plan, respectively (U.S. Department of Health and Human Services, 2005).

The latest Dietary Guidelines for Americans (U.S. Department of Health and Human Services, 2010b) recommends decreasing foods and beverages with added sugars or caloric sweeteners. These guidelines recommend no more than 5-15% of total calories be obtained from added sugars.

Similarly, other authorities on diet and health have recommended limiting intakes of added sugar. The Institute of Medicine (2002) recommends no more than 25% of total calories from added sugars. A recent study by Johnson et al. (2009) found that added sugar intake greatly exceeds discretionary calorie allowance. In light of these findings the American Heart Association recommends no more than one-half of the discretionary calorie allowance from added sugar intake, which limits Americans to no more than 150 calories per day for most men and no more than 100 calories for women.

Sugar Sweetened Beverage Consumption Trends

Sugar sweetened beverage consumption has increased dramatically over the past several decades and is being examined as a factor in being overweight or obese. As sugar sweetened beverage consumption has increased over the years, overweight and obesity rates have increased as well. Over the past 50 years, intakes of regular soda, juice, and sport drink consumption have increased almost 500%. Half of all Americans consume soft drinks every day, most of which are sugar sweetened (School Nutrition on Action Committee [SNAC], 2002).

Portion sizes are another factor contributing to the increased consumption of sugar sweetened beverages. Over the past several decades, portion sizes throughout America have increased and continue to increase. The serving size of a soft drink in the 1950's was 6.5 ounces; today soft drinks are sold in 20 ounce, 24 ounce, and 64 ounce bottles (SNAC, 2002). The

increase in sugar sweetened beverages increases the intake of calories, which may lead to weight gain.

Sugar sweetened beverage consumption patterns have developed in children and progressed throughout childhood into adulthood. According to SNAC (2002) sugar sweetened beverages provided 11% of calories for adolescents, and 1/3 of teenage boys consume at least three cans of soda daily.

Several studies have examined the consumption of sugar sweetened beverages among adolescents and college-age students. West et al. (2006) examined sugar sweetened beverage intake of 265 undergraduate college students over the course of a month. The study found that 95% of the students reported sugar sweetened beverage intake within the previous month, 65% reported consuming sugar sweetened beverages daily, and younger undergraduates reported a significantly higher sugar sweetened beverage intake than the older undergraduate students.

Shields, Corrales, and Metallinos-Katsaras (2004) evaluated the frequency of consumption of gourmet coffee beverages. The study collected a beverage questionnaire and 3-day food diary of 165 undergraduate and graduate women. A comparison of gourmet coffee consumers versus non-consumers indicated that gourmet coffee consumers consumed an additional 206 calories and 32 grams of sugar per day more than the non-consumers. The study concluded a significant percentage of college women consume gourmet coffee beverages, which contributes to additional fat and energy intake to overall dietary intake.

Barquera et al. (2008) measured the volume and energy contributed by beverages consumed by 416 Mexican adolescents 14 to 18 years old and 2,180 Mexican adults 19 years of age and older. The study determined that in 2006, Mexican adolescents obtained 20.1% of their

energy intake from energy containing beverages and adults obtained 22.3% of their energy from energy containing beverages.

Further research has examined the consumption of sugar sweetened beverages among the adult population. Bleich, Wang, Wang, & Gortmaker, (2008) examined the trend in sugar sweetened beverage consumption in adults throughout the U.S. The study evaluated 24-hour dietary recalls of adults 20 years of age and older from the NHANES III, 1988-1994 and 1999-2004. The study determined that sugar sweetened beverage consumption increased over the past ten years and sugar sweetened beverages contributed a large portion of the total daily caloric intake. The study also found sugar sweetened beverage consumption to be the highest among the groups at greatest risk for obesity and type II diabetes mellitus.

Obesity and Sugar Sweetened Beverage Consumption

The increase in sugar sweetened beverage consumption increases the energy intake of individuals, which may lead to weight gain. A study conducted by Ludwig, Peterson, and Gortmaker (2011) of 548 school aged children found that for each additional serving of sugar sweetened drink consumed, BMI increased as well as the frequency of obesity.

The effect of sugar sweetened beverage intake on weight gain and obesity in children, adolescents, and adults is continually being researched. Morrill and Chinn (2004) examined factors contributing to the obesity epidemic in the U.S. in both children and adults. The research concluded two of the factors contributing to the obesity epidemic are changes in physical activity and food consumption, particularly the increase in carbohydrate intake from soda and foods containing high fructose corn syrup.

Several studies have examined the consumption of sugar sweetened beverages among adolescents and college-age students, and the effect of their consumption on overweight and

obesity. Ebbeling et al. (2006) examined the effect of decreasing sugar sweetened beverage consumption on body weight. This pilot study examined 103 subjects ages 13 to 18 years who consumed sugar sweetened beverages on a daily basis. A control group and an intervention group were randomly selected to receive non-caloric (sugar-free) beverages. The research found that decreasing sugar sweetened beverage consumption had a positive effect on body weight and a strong link to BMI.

Berkey et al. (2004) evaluated the relationship between BMI changes and intakes of sugar sweetened beverages, milk, fruit juice, and diet soda among 9-14 year old boys and girls. Change in BMI and beverage intakes was monitored over two one-year periods. The study concluded that sugar sweetened beverage intake was associated with minor BMI increases.

Further research has examined the consumption of sugar sweetened beverages among the adult population and the effect of their consumption on overweight and obesity. Bermudez and Gao (2011) examined the association between sugar sweetened beverage consumption and abdominal obesity in 947 American adults, using the 1999-2000 NHANES data. Participants with the highest sugar sweetened beverage consumption had significantly higher BMI, waist circumference, and body weight in relation to the participants with a low intake. Participants with the highest sugar sweetened beverage consumption had significantly higher BMI, waist circumference, and body weight in relation to the participants with a low intake. Research done by Liebman et al. (2003) examined the relationship between body mass index and lifestyle variables such as physical activity and eating patterns among 928 male and 889 female adults. The study used BMI to define overweight and obesity and participants completed a questionnaire providing their height, weight, eating behaviors, physical activity, and diet intake. The study

concluded that a greater frequency of drinking sugar sweetened beverages was associated with increased risk for overweight or obesity.

Cunha et al. (2010) conducted a population-based cross-sectional study on 1,009 subjects between the ages of 20 and 65 years old. The subjects completed a food frequency questionnaire to identify dietary patterns; BMI and waist circumference were also collected. The study determined a positive association between a Western food intake pattern, which consisted of fast food, soft drinks, juices, cakes, cookies, dairy, sweets, and snacks, and waist circumference in female participants.

Previous studies on children, adolescents, and adults have showed an increasing trend in the rates of overweight and obesity. Consequently, previous studies have also showed an increase in sugar sweetened beverage consumption throughout the United States. Limited research has been conducted on the role sugar sweetened beverage consumption may have on overweight and obesity. Further research may be beneficial to determine the effect of sugar sweetened beverage consumption on the risk of overweight and obesity.

Chapter III: Methodology

Introduction

The purpose of this study was to determine if sugar sweetened beverage consumption had an effect on the BMI of college students aged 19-24 years old. This chapter will discuss sample selection procedures, instrumentation, data collection methods, data analysis procedures, and limitations of the study. Prior to beginning the study, all methods were approved by the University of Wisconsin-Stout Institutional Review Board for Protection of Human Subjects.

Subject Selection and Description

Subjects were selected on a volunteer basis from students aged 19-24 years old enrolled at the University of Wisconsin-Stout (UW-Stout) in the fall semester of 2010. Requirements to participate in the study were: being at least 19 years old and less than 25 years old. A list of courses with an enrollment of 100 or more students was obtained from the UW-Stout Registrar's Office and used for sampling of participants in the study. To improve statistical power and increase chances of obtaining statistically significant results, classes of 100 or more students were selected for participation. The researcher contacted the professor of each course via email to set up a meeting to discuss the purpose of the study and obtain the professor's approval to ask for volunteers from the class to participate in the research study.

The classes with an enrollment of 100 or more students were: Introduction to Art (ARTH-222-001), Nutrition for Healthy Living (FN-102-001), Nutrition for Healthy Living (FN-102-002), Nutrition for Healthy Living (FN-102-004), Introduction to Retail Merchandising and Management (BURTL-105-001), Food Technology (FN-222-001), and Introduction to Business Administration (BUMGT-100-001). The sample was selected from all classes, except for Introduction to Business Administration, due to the inability to obtain approval from the

professor. Nutrition for Healthy Living (FN-102-002 and FN-102-004), and Food Technology (FN-222-001) offered extra credit points to the students who participated in this study. An equivalent extra credit opportunity was made available in the course to those students who declined to participate in this study.

The researcher met with each class having the instructor's approval to request student participation. In a brief oral presentation, the researcher informed the classes of the purpose, risks, procedures, and requirements of the study. The researcher also distributed consent forms (Appendix A) for students who volunteered to read and sign, which validated they understood the purpose, risks, procedures, and requirements for participating in the study. Participants were able to withdraw at any time from the study without consequences. All students who signed the consent form were contacted via e-mail by the researcher to meet for an appointment in the Human Performance Lab (Heritage Hall 423) to complete the food frequency questionnaire (Appendix B) and have their BMI determined using a calibrated Tanita Body Composition Analyzer, Model TBF-215 (Tanita). The researcher sent an e-mail to the volunteers at the beginning of October notifying them the Human Performance Lab would be open for their participation every Tuesday and Thursday throughout the month of October from 3:00 p.m. to 6:00 p.m. All students who participated in the study established an individual appointment with the researcher and reported to the Human Performance Lab and completed the data collection requirements.

Instrumentation

The instrument used to collect data for this research was an original food frequency questionnaire developed by the researcher based on similar food frequency questionnaires (Splett and Owen, 1999), as well as questions unique to this study. The researcher developed this

instrument to be used for this study only. The purpose of the instrument was to determine the frequency of sugar sweetened beverage intakes and the quantity typically consumed at one occasion by participants. The instrument asked participants to record how often (rarely or never, 1 time per month, 2-3 times per month, 1-2 times per week, 3-4 times per week, 5-6 times per week, 2-3 times per day, and more than 3 times per day) they consumed the four types of sweetened beverages: soda, fruit drinks, sports drinks, and sugar-sweetened tea or coffee drinks. Also, participants recorded how much they usually consumed at one occasion: 8 ounces, 12 ounces, 16 ounces, or 20 ounces. Illustrations were provided of an 8 ounce, 12 ounce, 16 ounce, and 20 ounce glass as a reference for participants to use to estimate these quantities. A copy of the instrument is provided in Appendix B.

Data Collection Procedures

Data were collected for this study during October 2010 in the Human Performance Laboratory at UW-Stout. Once participants reported to the laboratory, the researcher provided instructions to each participant individually for completing the food frequency questionnaire. Participants were informed that the pictures of glasses displayed in the instrument were to be used as a guide for estimating portion sizes consumed. Subjects were handed the instrument and given as much time as they needed to complete it.

Upon completion of the food frequency questionnaire, the participant's height and weight were collected using the Tanita machine in a semi-private room. The participants were asked to remove all outer clothing (hats, shoes, socks, sweatshirts, and jackets). Also, participants were asked to provide his/her age in years and gender for the researcher to enter this information into the Tanita machine. For height and weight measurements, participants were asked to step on the Tanita machine and stand erect with their weight evenly distributed. The

participant's head was adjusted to the Frankfurt plane by the researcher and the horizontal bar of the Tanita machine was lowered to crown of the participant's head. The participant's height was measured to the nearest half inch and weight measured to the nearest 0.2 pounds by the Tanita. BMI in kilograms per meter squared (kg/m^2) was computed automatically for the 20 to 24 year old participants. A printout of this data was generated by the Tanita machine and attached to the respective participants' instrument. The following BMI ranges (kg/m^2) from the Center for Disease Control and Prevention (CDC) were used to classify participants according to standard body weight categories: underweight indicated by a BMI of less than 18.5, normal weight indicated by a BMI of 18.5-24.9, overweight indicated by a BMI between 25.0-29.9, and obese indicated by a BMI of equal to or above 30.0 (CDC, 2011a).

Heights and weights of 19 year old participants were collected using the same procedures as described above for older participants. The height, weight, sex, and age of 19 year old participants were entered into a Children's BMI Group Calculator (CDC, 2011c) to determine BMI-for-age percentile. The following BMI-for-age percentile ranges were used to classify these participants into standard categories for body weight status: underweight indicated by a BMI below the 5^{th} percentile, normal weight indicated by a BMI equal to or greater than the 5^{th} percentile but less than the 85^{th} percentile, overweight indicated by a BMI equal to or above the 85^{th} percentile but less than the 95^{th} percentile, and obese indicated a BMI equal to or greater than the 95^{th} percentile.

The completed instruments along with attached Tanita records were kept in a locked file for the duration of the research study. The participants receiving extra credit points for participation in the study signed their name to the sign-in sheet for their according class. The data collection process took approximately 5-10 minutes per subject.

Data Analysis

A number of statistical tests were used in this study to examine consumption and the relationship to BMI of the four types of sugar sweetened beverages: soda, fruit drinks, sports drinks, and tea or coffee drinks. The program used for analyzing this data was the Statistical Program for Social Sciences (SPSS 18.0).

Frequencies were determined and reported for demographic variables (age and gender); anthropometric measures (height, weight, BMI, and BMI-for-age-percentiles); the number of times sugar sweetened beverages were usually consumed (rare/never, 1 per month, 2-3 times per month, 1-2 times per week, 3-4 times per week or more); and the amount in ounces usually consumed each time (8 ounce, 12 ounce, 16 ounce, and 20 ounce).

To obtain sufficient observations for statistical analyses, the frequency of beverage consumption was collapsed into three categories: rare/never or one time per month, 2-3 times per month, and one or more times per week. Similarly, to obtain an adequate number of observations for statistical tests, BMI measurements were collapsed into the two body weight categories: underweight/normal weight, and overweight/obese.

To determine if a relationship occurred between the demographic variables and the number of times sugar sweetened beverages were consumed across all four beverage types, Spearman Rho correlation was used. Additionally, this test was conducted to evaluate the relationship between BMI and the number of times sugar sweetened beverage consumption occurred.

To determine if there was a difference in the frequency of sugar sweetened beverage consumption across all four of the beverage types, a Friedman test was conducted. A post hoc comparison was used to determine where differences in frequency of sugar sweetened beverage consumption occurred.

Mean values were computed to determine the average amount in ounces of each beverage type typically consumed per occasion (portion size), and a repeated measures analysis of variance (ANOVA) was conducted to determine if there was a difference among the consumption of the four beverage types. Pairwise comparisons were used to determine where differences in the mean intakes occurred between the beverage types. Finally, Spearman Rho correlation was used to evaluate the relationship between the average amounts of sugar sweetened beverage consumption and demographic variables (age and gender).

Cross tabulation and Chi-square tests were used to determine differences in the frequency of beverage consumption across two body weight categories: underweight/normal and overweight/obese. A Spearman Rho correlation was used to evaluate the relationship between average amounts of sugar sweetened beverage consumption and BMI. Further, an independent samples t-test was conducted to compare the means between each of the four beverage types and the two body weight categories.

Limitations

A limitation of the study was collecting the body mass index through the use of the Human Performance Laboratory. Time constraints and other factors associated with reporting to the laboratory during hours available for data collection may have deterred students from participating in the study. In addition, self-reporting of sugar sweetened beverage consumption was a limitation due to the reliability and accuracy of the participants' documentation and the researcher's inability to corroborate this information.

An added limitation would be in the researcher's instrument. The question asking participants to document their 'age in years' allowed them to circle a range (19-20 years, 21-22 years, or 23-24 years); instead documentation of the participant's specific age was necessary and

would have allowed for collection of numerical ratio data. To correct this limitation in the current data, the specific age of subjects was obtained from his/her Tanita record and utilized as the documentation for age in this study. Interval measurements from the instrument were not used.

A further limitation is the lack of a pilot experiment. An administered pilot experiment may have improved the research design as well as the statistical significance of results. The use of a convenience sample for this research was another limitation. Therefore, the sample fails to represent all UW-Stout college students or 19-20 year old college students, making it difficult to generalize findings to the entire population.

Chapter IV: Results

This chapter will present the results of the research study designed evaluate consumption of sugar sweetened beverages and determine their effects on BMI in 19-24 year old college students. The characteristics of the sample will be presented. Findings on the frequency of sugar sweetened beverage intakes, usual intakes, and the relationship of sugar sweetened beverage consumption to BMI will be discussed. Because analysis showed gender was an important variable in sugar sweetened beverage consumption, the findings are presented for all participants (both sexes) females and males.

Characteristics of the Sample

Ninety-two males and females participated in the study. The majority (73.9%) were female (n = 68) and 26.1% were male (n = 24). The age of participants ranged from 19 years to 24 years. The participants who were 19 years old represented 64% (n = 59) of the sample; those who were 20-22 years represented 34% (n = 31) of the sample. The two remaining participants were in the 23-24 year-old category, representing 3.2% of the total sample.

Table 1 illustrates the means and standard deviations for anthropometric measurements: height, weight, BMI, and BMI-for-age percentile for participants. The average participant in this study was 66 inches tall and weighed 151 pounds. Participants 20 years and older had an average BMI of 23.9, while the average 19 year-old fell at the 66th percentile on the CDC BMI-for-age growth chart.

Table 1

Means and Standard Deviations of Height, Weight, BMI, and BMI-for-age-percentiles of Participants (N =92)

Characteristic	Mean	Standard Deviations
Height (inches)	66.0	±3.39
Weight (pounds)	151.0	±29.83
BMI (kg/m^2)	23.9	±2.65
BMI-for-age percentile	66.4	±21.94

Body mass index and BMI-for-age percentiles classified participants into body weight categories: underweight, normal weight, overweight, obese. When the sample was distributed by BMI (Table 2), the majority of men and women were normal weight. Of the total sample (both sexes), 25% were overweight, 3 participants (3.3%) were obese, and 1 participant was underweight (1.1%).

Table 2

BMI Distribution of the Sample by Gender (N = 92)

BMI Category	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
<18.5 or < 5th Percentile (Underweight)	1	1.1	1	1.5	0	0
18.5 to 24.9 or > 5th to 85th Percentile (Normal Weight)	65	70.7	50	73.5	15	62.5
25 to 29.9 or >85th to 95th Percentile (Overweight)	23	25.0	15	22.1	8	33.3
≥30 or ≥95th Percentile (Obese)	3	3.3	2	2.9	1	4.2

Frequency of Sugar Sweetened Beverage Consumption

Participants were asked the number of times they usually consume sugar sweetened beverages using a scale ranging from rarely or never to three or more times a day. Table 3 presents the frequency of soda consumption. The largest number of all participants (both sexes) reported rarely or never drinking soda; while two to three times per month was the second most frequently recorded response for all of the participants, and the most frequently recorded response for males. Most participants reported consuming soda on a weekly basis, compared to monthly or daily. Interestingly, only one participant reported drinking soda two to three times per day, which was the highest frequency reported.

Table 3

Number of Times Participants Usually Consumed Soda by Gender (N = 92)

Soda	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
Rare/Never	22	23.9	18	26.5	4	16.7
1 time per month	9	9.8	7	10.3	2	8.3
2-3 times per month	19	20.7	12	17.6	7	29.2
1-2 times per week	16	17.4	12	17.6	4	16.7
3-4 times per week	11	12.0	10	14.7	1	4.2
5-6 times per week	11	12.0	7	10.3	4	16.7
1 time per day	3	3.3	1	1.5	2	8.3
2-3 times per day	1	1.1	1	1.5	0	0

With respect to the frequency of fruit drinks consumed (Table 4), the highest number of all participants (both sexes) identified consuming this beverage one to two times per week. Rarely or never drinking fruit drinks was the second most frequently reported response for all participants, followed by consuming fruit drinks two to three times per month. Findings show that the largest proportion of females reported rarely or never consuming fruit drinks, whereas the largest proportion of males reported drinking these beverages 2-3 times a month. Only two participants, both female, reported consuming fruit drinks daily.

Table 4

Number of Times Participants Usually Consumed Fruit Drinks by Gender (N = 92)

Fruit Drinks	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
Rare/Never	19	20.7	15	22.1	4	16.7
1 time per month	12	13.0	10	14.7	2	8.3
2-3 times per month	15	16.3	14	20.6	1	4.2
1-2 times per week	25	27.2	15	22.1	10	41.7
3-4 times per week	11	12.0	6	8.8	5	20.8
5-6 times per week	7	7.6	5	7.4	2	8.3
1 time per day	1	1.1	1	1.5	0	0
2-3 times per day	1	1.1	1	1.5	0	0

Regarding the consumption of sports drinks (Table 5), findings show that the largest proportion of females (45.6%) reported rarely or never consuming these beverages, while only 16.7% of males reported this same frequency of consumption. For males, the largest proportion (25%) reported using sports drinks two to three times per month and the second largest proportion (20.8%) reported consuming sports drinks once or twice a week. In this study, no participant reported using sports drinks on a daily frequency.

Table 5

Number of Times Participants Usually Consumed Sports Drinks

Sports Drinks	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
Rare/Never	35	38.0	31	45.6	4	16.7
1 time per month	9	9.8	6	8.8	3	12.5
2-3 times per month	19	20.7	13	19.1	6	25.0
1-2 times per week	13	14.1	8	11.8	5	20.8
3-4 times per week	10	10.9	7	10.3	3	12.5
5-6 times per week	6	6.5	3	4.4	3	12.5

Results for the frequency of tea or coffee drinks (Table 6) show that most women (41.2%) and men (45.8%) rarely or never consume these beverages. A few participants ($n = 5$) reported consuming these beverages 5-6 times per week.

Table 6

Number of Times Participants Usually Consumed Tea or Coffee Drinks

Tea or Coffee Drinks	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
Rare/Never	39	42.4	28	41.2	11	45.8
1 time per month	14	15.2	12	17.6	2	8.3
2-3 times per month	12	13.0	9	13.2	3	12.5
1-2 times per week	11	12.0	9	13.2	2	8.3
3-4 times per week	6	6.5	4	5.9	2	8.3
5-6 times per week	5	5.4	3	4.4	2	8.3
1 time per day	3	3.3	1	1.5	2	8.3
2-3 times per day	2	2.2	2	2.9	0	0

Spearman correlation analysis showed a significant negative relationship ($r_s = -.21, p < .05$) between the frequency of sugar sweetened beverage intakes and gender. The relationship suggested that males consumed sugar sweetened beverages more frequently than females. No significant correlation was found between age and frequency of sugar sweetened beverages consumed ($r_s = -.14, p > .05$).

Significant differences appeared in the number of times each of the sugar sweetened beverages was consumed ($x^2 = 20.70, p < .05$). Further, Friedman analysis confirmed significant differences ($p < .05$) in the frequency of consumption among the types of sugar sweetened beverages. Post hoc comparisons of beverage types showed that soda was consumed significantly ($p < .05$) more frequently than coffee or tea beverages. Similarly, the frequency of

fruit drink consumption was significantly (p <.05) higher than tea or coffee consumption. Fruit drink consumption was also significantly (p <.05) higher than sports drink consumption. No significant differences were observed in frequency for the remaining comparisons of beverage types: sports drink and tea or coffee consumption, sports drink and soda consumption, and soda and fruit drink consumption.

Usual Intakes of Sugar Sweetened Beverage Consumption Per Occasion

Participants were asked to identify the amount (ounces) of sugar sweetened beverages they usually drank at one time (portion size). The results for soda consumption (Table 7) show 50% of all participants reported consuming soda in 12 ounce portion sizes. This portion size was most commonly consumed by both male and female participants. Fifteen participants, including males and females reported usually consuming 8 ounce portion sizes (the smallest size evaluated). Eight participants, all females, reported consuming soda in 20 ounce portion sizes (the largest portion size evaluated).

Table 7

Frequency of Usual Soda Intakes by Gender

Usual Intake	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
8 ounces	15	16.3	11	16.2	4	16.7
12 ounces	46	50.0	31	45.6	15	62.5
16 ounces	4	4.3	3	4.4	1	4.2
20 ounces	8	8.7	8	11.8	0	0

Regarding the amount of fruit drinks usually consumed (Table 8) the most commonly reported portion size by all participants (40.2%) was eight ounces. Females reported consuming fruit drinks most frequently in 8 ounce portions sizes (44.1%), whereas males reported consuming the same beverage most frequently in 12 ounce portion sizes (41.7%).

Table 8

Frequency of Usual Fruit Drinks Intakes by Gender

Usual Intake	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
8 ounces	37	40.2	30	44.1	7	29.2
12 ounces	30	32.6	20	29.4	10	41.7
16 ounces	8	8.7	7	10.3	1	4.2
20 ounces	8	8.7	5	7.4	3	12.5

Results for the amount of sports drink consumption (Table 9) show 30.9% of females consume sports drink most frequently in a 12 ounce portion size. Conversely, males reported consuming the same beverage most frequently in a 16 ounce portion size. Interestingly, no males reported consuming sports drinks in an 8 ounce portion size.

Table 9

Frequency of Usual Sports Drinks Intakes by Gender

Usual Intake	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
8 ounces	9	9.8	9	13.2	0	0
12 ounces	25	27.2	21	30.9	4	16.7
16 ounces	26	28.3	15	22.1	11	45.8
20 ounces	20	21.7	13	19.1	7	29.2

Regarding the amount of tea or coffee drink consumption (Table 10), 30.4% of all participants recorded the 8 ounce portion as the most commonly consumed size. A limited number of participants ($n = 6$) reported consuming tea or coffee drinks in 20 ounce portion sizes.

Table 10

Frequency of Usual Tea or Coffee Drinks Intakes by Gender

Usual Intake	Both Sexes		Female		Male	
	(*n*)	%	(*n*)	%	(*n*)	%
8 ounces	28	30.4	19	27.9	9	37.5
12 ounces	19	20.7	15	22.1	4	16.7
16 ounces	17	18.5	14	20.6	3	12.5
20 ounces	6	6.5	5	7.4	1	4.2

Average Intakes of Sugar Sweetened Beverages

When the average amounts of beverage intakes were determined (Table 11), a significant difference was observed among the four beverage types. Pairwise comparisons revealed the amount of sports drinks consumed was significantly higher ($p < .05$) than the three other beverage types (soda, fruit drinks, and tea or coffee drinks). Generally, when participants consumed sugar sweetened beverages, sports drinks incurred the largest volume per consumption.

Table 11

Mean Intakes (Ounces) and Standard Deviations for Sugar Sweetened Beverages by Gender (n = 68 females, n = 24 males)

Beverage	Both Sexes $M \pm SD$	Female $M \pm SD$	Male $M \pm SD$
Soda pop	9.71 ± 5.82	9.82 ±6.20	9.50 ±4.70
Fruit drinks	10.37 ±4.88	10.33 ±4.68	10.50 ±5.51
Sports drinks	12.92 ±6.19	12.12 ±6.30	15.17 ±5.40
Tea or Coffee drinks	9.17 ±6.24	9.65 ±6.30	7.83 ±6.07

Correlation analysis for demographic variables showed a negative relationship ($r_s = -.05$, $p < .05$) between the total consumption of all four sugar sweetened beverage types and gender. On average males drank a significantly larger total volume of sugar sweetened beverages than females. No association was found between the average amount of sugar sweetened beverage consumption and age ($r_s = .03$, $p > .05$).

Relation of Sugar Sweetened Beverage Intake and BMI

The frequency of sugar sweetened beverage intakes by BMI categories is presented in Table 12. To obtain sufficient observations for statistical analyses, BMI categories were collapsed into two body weight categories (underweight/normal weight, and overweight/obese). Similarly, to acquire adequate observations in the frequency of beverage consumption, the categories were collapsed to rare/never or one time per month, two or three times per month, and one or more times per week. No significant differences were observed between frequency of intakes and BMI as evaluated by Chi-square and Cross tabulation analyses. Correspondingly, Spearman Rho correlation analysis showed no association between the number of times sugar sweetened beverages were consumed and BMI, ($r_s = .13, p > .05$). The average ounces of sugar sweetened beverages consumed and BMI were also not related ($r_s = .18, p > .05$).

Table 12

Frequency of Sugar Sweetened Beverage Intakes by Body Weight Status (N =92)

Number of Times	Underweight/Normal Weight BMI<25 or BMI Percentile <85th	Overweight/Obese BMI≥25 or BMI Percentile ≥85th
Soda Pop		
Rare/never/ or 1 per month	26 (39.4)	5 (19.2)
2-3 times per month	12 (18.2)	7 (26.9)
1 or more times per week	28 (42.4)	14 (53.8)
Fruit Drinks		
Rare/never/ or 1 per month	22 (33.8)	9 (34.6)
2-3 times per month	12 (18.5)	3 (11.5)
1 or more times per week	31 (47.7)	14 (53.8)
Sports Drinks		
Rare/never/ or 1 per month	31 (47.0)	13 (50.0)
2-3 times per month	13 (19.7)	6 (23.1)
1 or more times per week	22 (33.3)	7 (26.9)
Tea or Coffee Drinks		
Rare/never/ or 1 per month	40 (60.6)	13 (50.0)
2-3 times per month	9 (13.6)	3 (11.5)
1 or more times per week	17 (25.8)	10 (38.5)

Note: Percents are values in parenthesis.

Table 13 illustrates the means and standard deviations for amounts in ounces of sugar sweetened beverage consumed based on the two specified BMI categories. An independent samples t-test was conducted to compare means between each of the four beverage types and the two body weight categories. The analysis was inconclusive, as there were no statistically significant results. Further, the null hypothesis could not be rejected because the average amount consumed for each beverage type was not statistically different across the two body weight categories. A trend emerged within the data for the average amounts of sugar sweetened beverages consumption and BMI categories. As shown in Table 13, the underweight/normal weight participants tended to consume lower average amounts of each sugar sweetened beverages studied (soda, fruit drinks, sports drinks, and tea or coffee drinks) than did the overweight/obese participants.

Table 13

Average Number of Ounces Consumed for each Beverage Type and Body Weight Category (N=92)

Beverage Type-Body Weight Category	(*n*)	Mean	Standard Deviation
Soda			
Underweight/Normal	66	9.45	±6.06
Overweight/Obese	26	10.46	±5.19
Fruit drinks			
Underweight/Normal	65	10.03	±4.70
Overweight/Obese	26	11.23	±5.31
Sports drinks			
Underweight/Normal	66	12.55	±6.15
Overweight/Obese	26	13.85	±6.32
Tea or Coffee drinks			
Underweight/Normal	66	8.73	±6.03
Overweight/Obese	26	10.31	±6.71

Chapter V: Discussion

This chapter will discuss the limitations throughout the research process, particularly as related to the findings and conclusions of the study. This chapter will emphasize findings and conclusions of the present study in relation to previous research on sugar sweetened beverage intakes and BMI of 19-24 year olds, to the extent possible. Lastly, recommendations will be made pertaining to the logistics of the present study, and future research on this topic.

Limitations

The limitations of this study have been described in detail in chapter III. Several methodological challenges have particular relevance to the interpretations and conclusions that may be made in this study. The convenience sampling technique and the small sample size of this study are shortcomings, which make it difficult to generalize findings to 19-24 year-old college students or even the UW-Stout population.

This study utilized a food frequency questionnaire for respondents to report their usual frequency and quantity of sugar sweetened beverage consumption. This methodology is susceptible to imprecision and measurement errors inherent to semi-quantitative food frequency assessments of this type. Although this study provided pictures of cup sizes in ounces for participants to use as a guide for more precise estimates of quantities consumed, data are still subject to over estimation and under estimation in the frequency and amount of consumption, due to the participant's perceived notions, inaccuracy, or other limitations associated with self-reports. Further, the pictures provided in the food frequency questionnaire may have caused confusion due the different proportions. Also, the food frequency instrument was developed for this study and lacked validation against a more objective method that may have eliminated reporting bias.

The lack of a pilot experiment is a shortcoming of the present study, which may have impacted the findings. An administered pilot experiment may have improved the research design as well as the statistical significance of results.

An additional limitation was the inability to determine the contribution of the caloric intake from sugar sweetened beverages to the participants total daily calorie intake. Determining the sugar sweetened beverage calorie contribution may have been a better indicator of the role of sugar sweetened beverage intake in weight gain.

Finally, limited data appear available on sugar sweetened beverage consumption and BMI/body weight status of 19-24 year old college students. Some studies group 19 year olds with children and adolescents for analyses; while other studies include this age with adults. This inconsistency in methodology has limited direct comparisons of findings in the present study.

Conclusions

The results of the present research established a relationship between the four types of sugar sweetened beverages and gender. Specifically, males consumed sugar sweetened beverages more frequently than females. Evidence in relevant research suggests a congruency among these findings. School Nutrition on Action Committee (SNAC) (2002) examined soft drink, fruit juice, and milk consumption among adolescents (12-19 years) and confirmed a similar outcome, with adolescent males consuming more soft drinks than adolescent females. Similarly, in a study using a semi-quantitative food frequency questionnaire to evaluate sugar sweetened beverage consumption of 265 undergraduates at the University of Arkansas-Little Rock, an urban university, West et al. (2006) found that men were more likely than women to report daily use of sugar sweetened beverages. In the present study, only 26.1 percent of the

sample was male. The effect of gender differences in sugar sweetened beverage consumption may be even more pronounced, given a sample that better represented the male population.

No relationship was established between sugar sweetened beverage consumption and age. Conversely, research (West et al., 2006) has established a relationship between sugar sweetened beverage consumption and age. More specifically, the research examined 265 undergraduate students and determined younger undergraduates consumed greater quantities of sugar sweetened beverages than the older undergraduate population. Similarly, national data based on the NHANES surveys (Bleich, Wang, Wang, & Gortmaker, 2008) showed that the per capita consumption of sugar sweetened beverage intakes were higher among younger adults (20-44 years) compared to older adults. A relationship between sugar sweetened beverage consumption and age may not have been established in the present study due to a sample where age was not stratified equally. The participants who were 19 years old represented 64% ($n = 59$) of the sample; those who were 20-22 years represented 34 percent ($n = 31$) of the sample, and those who were 22-24 years old represented 3.2 percent ($n = 2$) of the sample. Additionally, NHANES findings are based on a large-scale 24 hour food recall, which may further explain differences in results when compared to the present study.

Based on findings in the present study, it may be concluded that differences exist in the consumption pattern of the four beverage types studied. The present research determined that soda and fruit drinks were consumed more frequently than tea or coffee drinks. Shields, Corrales, and Metallinos-Katsaras (2004) determined a significant proportion of female college students consumed gourmet coffee beverages, contributing to additional fat and energy intake. Participants in the present research were generally female (74% of the sample) with a normal body weight (73.5% of the sample), and consumed tea or coffee drinks less than two to three

times per month (72% of the sample). Therefore, the findings reported by Shields, Corrales, and Metallinos-Katsaras support the trend in the present findings that females who consume coffee or tea less frequently may be more likely to be normal weight. The low frequency of coffee consumption compared to soda and fruit drinks may have been due to the general demographics of the sample (normal weight, females). Fruit drinks were also consumed more frequently than sports drinks. No differences were established in the present research between the frequency of consumption of sports drinks and tea or coffee drinks, sports drinks and soda, and soda and fruit drinks.

The present research established a difference in the portion size of sugar sweetened beverage consumption. Sports drinks were consumed in larger portions than the other three beverage types: soda, fruit drinks, and tea or coffee drinks. Generally, when participants consumed sugar sweetened beverages, sports drinks incurred the largest volume per consumption. Conversely, SNAC (2002) examined soft drinks, fruit juice, and milk consumption among adolescents and determined soda was the consumed in the largest portion size. The present research did not find this difference; however, SNAC did not account for sports drink consumption. Further examination of the findings regarding the amount of sports drinks consumed may be misleading due to the portion size in which sports drinks are marketed compared to the three other beverage types. Generally, sports drinks are marketed in larger volume containers which may influence the amount of beverage consumption.

With respect to the relationship between BMI/body weight status and sugar sweetened beverage consumption, findings of this study are inconclusive as no significant differences were found between BMI categories and sugar sweetened beverage consumption. BMI data were collapsed into two categories to obtain sufficient observations (underweight/normal weight and

overweight/obese). Also, to obtain adequate observations of frequencies of beverages consumed, categories were collapsed to three groups (rare/never or one time per month, 2-3 times per month, and one or more times per week). No significant relationship was demonstrated between BMI categories and either the frequency of consumption or the usual portion size of sugar sweetened beverage consumed. However, a trend emerged between the consumption of sugar sweetened beverages and the BMI categories. The underweight/normal weight participants tended to consume less sugar sweetened beverages than the overweight/obese participants. Similarly, NHANES findings (Bleich, Wang, Wang, & Gortmaker, 2008) observed trends in sugar sweetened beverage consumption by body weight status among adults. The 1988-1994 survey concluded daily consumption of sugar sweetened beverages was highest among the obese participants.

Morrill and Chinn (2004) examined factors contributing to obesity among children and adults and established that food consumption patterns, particularly carbohydrate intake from soda and foods high in fructose corn syrup, contributed to the obesity epidemic. Decreasing sugar sweetened beverage consumption among adolescents was found to positively affect body weight and was strongly linked to BMI (Ebbeling et al., 2006). Berkey, Rockett, Field, Gillman, and Colditz (2004) determined a positive association between sugar sweetened beverage intakes and increased BMIs among adolescents. In studies with adults (20 years and older), Liebman et al., (2003) determined a greater frequency of sugar sweetened beverage consumption was associated with the risk for overweight or obesity. More recently, Bermudez and Goa (2011) examined the relationship between sugar sweetened beverage consumption and BMI and concluded that participants with the highest sugar sweetened beverage consumption had a significantly higher BMI compared to the participants with a low sugar sweetened beverage consumption. In a

review of research on adults, including 19 year olds, the 2010 Dietary Guidelines Advisory Committee (DGAC) concluded that a moderate body of evidence suggests that increased body weight is associated with increased intakes of sugar sweetened beverages. The present research revealed a congruent trend between sugar sweetened beverage consumption and increased BMI; however, findings may not have reached significance, possibly due to the low number of participants in the underweight (n = 1), overweight (n = 23), and obese (n = 3) categories. The 2010 DGAC acknowledged the controversy in research findings on sugar sweetened beverage intakes and obesity, and noted that recent systematic reviews of research on this topic have reached conflicting conclusions. The DGAC observed that controversial results may be explained by inconsistent methodologies in measuring sugar sweetened beverage consumption, and in conducting systematic reviews of the literature on this topic.

Finally, the present study focused only on the intakes of sugar sweetened beverages in relation to BMI/body weight status. An increase in BMI or overweight/obesity is fundamentally due to a positive energy balance, which is affected by numerous factors in addition to the kinds, quantities, and portion sizes of foods consumed. Total energy intake, physical activity, genetics, and a myriad of environmental factors are known to influence food intakes, energy balance, and consequently BMI/body weight status. Limited evidence shows that intake of sugar sweetened beverages is linked to higher energy intake in adults (DGAC, 2010). Also, sugar sweetened beverages are not different than other extra calories in their impact on energy intake and body weight (DGAC, 2010). Therefore, the multifaceted determinants of BMI and body weight status may partly explain the controversy that remains regarding the role of sugar sweetened beverages in overweight/obesity.

Recommendations

Results of the current research indicate that further studies on sugar sweetened beverage consumption and BMI/body weight status among college age students are warranted. There is limited research surrounding sugar sweetened beverage consumption and the role it may play in weight gain in the college age population. This age group (19-24 years old) encompasses the transitional period between adolescence and adulthood, and studies on this population may be beneficial in understanding shifts in body weight status that may occur during the life stages. Further research should be conducted to validate the findings of this study.

Although this study was unable to establish a relationship between sugar sweetened beverage consumption and BMI/body weight status, sugar sweetened beverage consumption should be monitored in the occurrence of weight change. A recommended approach for a semi-quantitative assessment may be a longitudinal examination of sugar sweetened beverage consumption and weight gain using repeated measures of body weight, and the frequency and amount of sugar sweetened beverage consumption. Repeated observations over a period of time would enhance the reliability of food frequency measurements. Further, a longitudinal design would allow for the analysis of long-term patterns in beverage consumption and weight change to be determined.

A beneficial approach for future investigations would be to examine the total daily quantity of sugar sweetened beverages consumed along with daily food intake and energy output. This approach would allow for an examination of sugar sweetened beverage intakes in relation to total calorie consumption, and may indicate the role of sugar sweetened beverages in excessive calorie intake.

More specifically, based on the present research methodology, several recommendations can be made regarding further research examining the effect of sugar sweetened beverages on

BMI/body weight. The first recommendation would be to determine a more accurate measure of the participant's beverage consumption to increase specificity. A food frequency questionnaire was used in the present study; however, some participants may have had difficulty estimating portion sizes. To obtain a more accurate measurement of beverage intake, participants could log their daily consumption of sugar sweetened beverages. A second recommendation would be to continue the use of an objective measure assessing BMI and body weight status in future research. The present research used a Tanita machine to collect height and weight measurements which increased the validity of measurements when compared to self-report body weight data.

The survey used for data collection should be revised for future use in research. The question, 'Age in years' should allow the participant to document their specific age. This change would allow for the collection of numerical ratio data which would limit the use of non-parametric tests, and allow for consistency between the questionnaire and Tanita measurements as used in this study. A further recommendation would be to evaluate the college age population separately; conducting studies to evaluate BMI-percentiles (<20 years) for weight evaluation separately from studies evaluating BMI (≥20 years). The present study examined participants using BMI-percentiles (19 years) and BMI (≥20 years) requiring two different standards of measurement. Future research may benefit from focusing on one standard of measurement.

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Appendix A: Consent Form

Consent to Participate in UW-Stout Approved Research

Title: The Effect of sweetened beverage consumption on body mass index

Investigator:
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507-459-3477

Research Sponsor:
Dr. Esther Fahm
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Home Economics 342

Description:
This study attempts to quantify the use of sweetened beverages among UW-Stout students older than the age 18 years up to 24 years. The purpose is to discover if sweetened beverage intake has an effect on body mass index.

Risks and Benefits:
There are no risks involved in participation of this study. Questions in this study do not deal with sensitive issues. The study does require you to provide personal information including age, gender, and the use of sweetened beverages. Weight will be obtained in a private room with only the researchers present. Benefits of this study include learning if sweetened beverage consumption has an effect on body mass index.

Minors:
If you are under the age of 18 years you are not eligible to participate in the study.

Time Commitment:
The time commitment is minimal for this study. It will require approximately 10 minutes for you to complete a short questionnaire, and 5 minutes for the researcher to measure your height and weight. The only other tasks required are for participants to carefully read and sign this form, and report to the Human Performance Lab (Home Economics Building-Room 423) to complete the questionnaire and have the researcher measure your height and weight.

Confidentiality:
Your name will not be available on any survey documents, and your survey/data information will be unidentifiable to the researcher. This form will be kept in a locked file, separate from any other documents completed with this project. All data will be kept separately in a locked file and accessible to only the researcher and researcher's advisor. All data will be compiled and not reported/published in any way to identify you.

Right to Withdraw:
Participation in this study is on a volunteer basis. There are no consequences for not participating in the study. You have the right to withdraw from the study at any time.

IRB Approval:

This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

For any other questions or comments please contact:

Investigator: Andrea Griffin
507-459-3477
griffina@my.uwstout.edu

Research Advisor: Dr. Esther Fahm
715-232-2550
fahme@my.uwstout.edu

IRB Administrator:
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Statement of Consent:
By signing this consent form you agree to participate in the Study entitled, The Effect of sweetened beverage consumption on body mass index.

Signature:_____Date_____

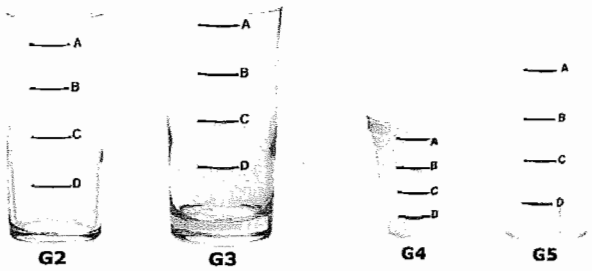
Appendix B: Food Frequency Questionnaire

The Effect of sweetened beverage consumption on body mass index Survey/Instrument

You may choose to not answer any question at anytime.

DIRECTIONS: Below is a definition of sugar sweetened beverages. Also listed are equivalencies to help determine the amount of sugar sweetened beverages. After reading page 1, continue to page 2 to complete the food frequency questionnaire.

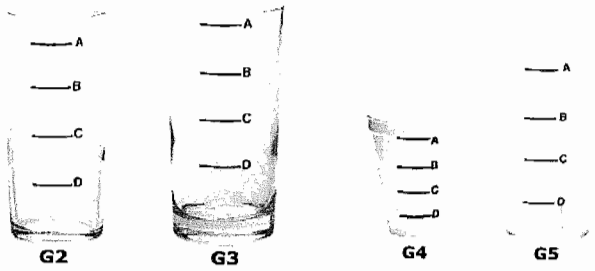
Sweetened beverages are those that contain caloric sweeteners and include:
Soft drinks: Nonalcoholic, flavored, carbonated or non-carbonated beverages usually commercially prepared and sold in bottles or cans
Soda, pop, soda pop: Same as soft drink
Fruit drinks, punches, or ades: Sweetened beverages of diluted fruit juice
Sports drinks: Beverages designed to help athletes rehydrate, as well as replenish electrolytes, sugar, and other nutrients
Tea and coffee drinks: Teas and coffees to which caloric sweeteners have been added
Energy drinks: Most energy drinks are carbonated drinks that contain large amounts of caffeine, sugar and other ingredients, such as vitamins, amino acids, and herbal stimulants
(CDC, 2010).



G2-12 oz. G3-16 oz. G4-8 oz. G5-20 oz.

Soda is usually sold in 12 ounce cans or 20 ounce bottles
Fruit Juices are often sold in 20 ounce bottles
Sports drinks-ades are often sold in 20 ounce bottles
Energy drinks like Monster and Rockstar are sold in 16 ounce cans and Redbull is sold in an 8.4 ounce can
Sweetened coffee beverages are often sold as 16 ounces

DIRECTIONS: For the following Food Frequency Questionnaire, put an X in the column that signifies the **number of times** you usually consume each of the sweetened beverages listed in the left column. Also, please circle the letter (G2, G3, G4, or G5) that best describes your usual serving size.



G2-12 oz. G3-16 oz. G4-8 oz. G5-20 oz.

Consumption of Sweetened Beverage									**Usual Serving Size**
Sweetened Beverages	**Rare or Never**	**1 per month**	**2-3 per month**	**1-2 per week**	**3-4 per week**	**5-6 per week**	**2-3 per day**	**More than 3 per day**	**Circle One G2 G3 G4 G5**
Soda/Pop/Soda Pop									Circle One G2 G3 G4 G5
Fruit drinks or punches (Not 100% juice)									Circle One G2 G3 G4 G5
Sports Drink/Energy Drinks (Gatorade, Powerade, Monster, Red Bull, Etc.)									Circle One G2 G3 G4 G5
Sweetened Tea or Coffee beverages									Circle One G2 G3 G4 G5

Please answer questions 1 and 2 below by circling the answer that describes you.

1. Gender: Male Female

2. Age in years: 19-20 21-22 23-24

Thank you for your participation!