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Sugar-Sweetened Beverage Consumption Frequency vs. BMI: National Health and Nutrition Examination Survey 2003-2004

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ABSTRACT

Tol Chan
Sugar-Sweetened Beverage Consumption Frequency vs. BMI
National Health and Nutrition Examination Survey 2003-2004
(Under the direction of Institute of Public Health at GSU)

Objective: Over the past several decades, increase in SSB consumption has coincided with increasing rates of obesity. This study evaluated the association between SSB consumption and BMI.
Methods: FFQ data from NHANES 2003-2004 was used to examine 100% orange juice, sugar-sweetened fruit drinks, soft drinks, and other beverage consumption frequency vs. mean BMI. ANOVA, relative risk, and linear regression analyses were done.
Results: ANOVA found significant differences in mean BMI across consumption frequencies for orange juice (p=.001), sugar-sweetened fruit drinks (p<.001), and soft drinks (p<.001). Increased risk of being obese was associated with increasing consumption frequency for orange juice (RR=1.282), sugar-sweetened fruit drinks (RR=1.417), and soft drinks (RR=1.749). Multiple linear regression found significant positive associations between mean BMI and sugar-sweetened fruit drinks (b=.056, p=.004) and soft drinks (b=.134, p=.001).
Conclusion: This study found that mean BMI was positively associated with certain beverage consumption frequency (sugar-sweetened fruit drinks, soft drinks consumed during summer, soft drinks consumed during rest of year), but not others (100% orange juice). Fewer significant results were found when confounding variables were controlled. Drinking soft drinks or sugar-sweetened fruit drinks increased the risk of obesity more than drinking natural fruit juices.

INDEX WORDS: calorically-sweetened beverage, artificially-sweetened beverage, energy-sweetened beverage, fruit juice, fruit drink, soft drink, soda, pop, physical activity, overweight, obesity, adiposity
LEGEND: SSB = sugar-sweetened beverage, BMI = body mass index, FFQ = Food Frequency Questionnaire, NHANES = National Health and Nutrition Examination Survey, p = p-value, RR = relative risk, b = beta value

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by

TOL CHAN

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APPROVAL PAGE

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NATIONAL HEALTH AND NUTRITIONAL EXAMINATION SURVEY 2003-2004

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DEDICATION PAGE

I would like to dedicate this thesis to all those who have helped and supported me in my academic endeavors.

ACKNOWLEDGEMENT PAGE

I would like to acknowledge all the faculty and administrators at the Institute of Public Health at Georgia State University for helping me achieve my Master of Public Health. I would like to thank all the professors for sharing their knowledge during classes and advisement. I would also like to thank DeKalb County Board of Health for providing me a practicum location. I would like to thank all the managers and supervisors there who have guided me in my work.

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CHAPTER I - INTRODUCTION

Purpose of Study

Over the last several decades, soft drinks and other sugar-sweetened beverage consumption has increased significantly in the United States and other westernized countries (Popkin and Nielsen, 2003). Coinciding with this is the increase in the number of obese people in the United States, which has the highest obesity rates in the developed world (Anon, 2005). The prevalence of obesity has been relatively stable since the 1960's, but has started increasing in the mid 1970's. From 1980 to 2002 the rate has doubled, reaching the current rate of 32% of the adult population (Ogden et al., 2006).

Many studies have investigated the relationship between sugar-sweetened beverage consumption and obesity or body mass index (BMI) in children and adolescent populations. Fewer studies have been done looking at the adult population, even though it has been shown that consumption was highest among young adults (Bleich et al. 2009). To study the relationship between sugar-sweetened beverage consumption and obesity, several studies have utilized data from the National Health and Nutrition Examination Survey (NHANES), but not the Food Frequency Questionnaire (FFQ) part. The purpose of this study was to evaluate the association between sugar-sweetened beverage consumption frequency and BMI of the U.S. adult population using the FFQ part of NHANES 2003-2004.

BMI of Obesity and Overweight

The World Health Organization (WHO) defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health (WHO, 2009).

Overweight and obesity are major risk factors for a number of chronic diseases, including diabetes, cardiovascular diseases and cancer. Once considered problems only in developed countries with high income, overweight and obesity are now increasing in countries with low and middle-income, especially in urban settings. (WHO, 2009)

Body mass index (BMI), expressed as weight/height^2 (kg/m^2), is commonly used to classify body types. The categories are: underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), class I obesity (30.0-34.9), class II obesity (35.0-39.09), and class III obesity or extreme obesity (≥40). (WHO 2009)

To monitor health measures such as BMI, the Centers for Disease Control and Prevention (CDC) conduct a National Health and Nutrition Examination Survey (NHANES) each year. NHANES uses a stratified, multistage, probability sample of the civilian, U.S. non-institutionalized population. A household interview and a physical examination are conducted for each survey participant by trained health technicians using standardized measuring procedures and equipment. During the physical examination, conducted in mobile examination centers, height and weight are measured as part of a more comprehensive set of body measurements. From these measures BMI is calculated. (CDC, 2011)

Mortality of Obesity

Obesity is a leading preventable cause of death worldwide. As of 2001 overweight and obesity have been ranked number seven as preventable causes of death worldwide (Lopez et al., 2006). They have been ranked number two as preventable causes of death in the United States, only behind smoking (Mokdad et al., 2004). In the

United States it is estimated that 111,909 – 365,000 deaths or 4.6 – 15.2% of the total annual deaths are caused by overweight and obesity (Haslam and James, 2005).

One study found that for both sexes mortality was lowest at about 22.5-25 kg/m^2 BMI (Whitlock et al., 2009). Each 5 kg/m^2 higher BMI was on average associated with about 30% higher overall mortality, 60-120% for diabetic, renal, and hepatic mortality, 10% for neoplastic mortality, and 20% for respiratory and all other mortality. It is estimated that obesity (BMI 30-35) reduces life expectancy by 2-4 years, and severe obesity (BMI > 45) reduces life expectancy by 8-10 years. (Whitlock et al., 2009)

Morbidity of Obesity

Although obesity is considered a disease, it is also a risk factor for other medical disorders, including diabetes mellitus type 2, high blood pressure, high blood cholesterol, high triglyceride levels, and metabolic syndrome (Grundy, 2004). These conditions are either caused directly by obesity or indirectly through other risk factors such as poor diet and sedentary lifestyles. The link between obesity and other conditions varies in strength, the strongest being the link with type 2 diabetes. Excess body fat accounts for 64% of diabetes cases in men and 77% of cases in women (Seidell, 2005).

Obesity is associated with excess body fat and enlarged fat cells, and increased secretions from enlarged fat cells can lead to metabolic changes resulting in diabetes. Excess fatty acids released by the enlarged fat cells are stored in the liver or muscle, causing insulin resistance. Diabetes develops when the secretory capacity of the pancreas is overwhelmed in battling insulin resistance. Other secretions from the enlarged fat cells could change endothelial function, leading to cardiovascular disease and hypertension. Chemicals released from enlarged fat cells are also associated with cancer. Increased production of estrogen by the enlarged fat cells may play a role in increasing the risk for breast cancer and other forms of abnormal growth. The combined effects of increased fat cells and the products they release can lead to a reduction of life expectancy. (Bray, 2004)

Obesity can also increase the incidence of other medical conditions by having the person physically carry more mass of adipose tissue. The increased mass of adipose tissue could lead to sleep apnea from increased parapharyngeal fat deposits. It could lead to osteoarthritis resulting from the wear and tear on joints from carrying more mass of fat. Some people may experience social disabilities from stigma or discrimination for being obese. (Bray, 2004)

Obesity Epidemiology

Obesity was considered rare for much of human history until the 20th century. In 1997 the WHO formally recognized obesity as a global epidemic (Caballero, 2007). As of 2005 the WHO estimates that at least 400 million adults (9.8%) are obese worldwide, with higher rates among women than men. Today most industrialized countries are facing increasing obesity rates due to the effects of over-nutrition, urbanization, and modernization. (WHO, 2009) It is estimated that sub-Saharan Africa may be the only region where obesity is not common (Haslam & James, 2005).

Obesity in the United States

American society has become ‘obesogenic,’ characterized by environments that promote increased food intake, non-healthy foods, and physical inactivity (CDC, 2009). Results from NHANES show that the age-adjusted prevalence of obesity among U.S. adults (age 20 years and over) went from 14.5% in NHANES I 1971-74, to 23.2% in

NHANES III 1988-94, to 30.9% in NHANES 1999-2000, to 35.1% in NHANES 2005-06. The prevalence of overweight, however, has remained relatively stable over the same time period. (CDC, 2008)

Causes of Obesity

The cause of obesity is complex and multifactorial. It is common knowledge that people gain weight if their energy intake exceeds their energy expenditure. At the individual level, the combined effects of excessive caloric intake and a lack of physical activity are thought to explain most cases of obesity (Lau et al., 2007). At the population level, the increasing rates of obesity could be caused by more easily accessible and palatable diet, increased reliance on cars, and mechanized manufacturing. (Bleich et al., 2008; Drewnowski and Specter, 2004)

The obesity epidemic is a normal population response to the dramatic reduction in the demand for physical activity and the major changes in the food supply of countries over the last 40 years (James, 2008). The dietary energy supply, expressed in kilocalories per person per day, is the food available for human consumption. It reflects both foods consumed and foods wasted to give an overestimate of the total amount of calories consumed. The per capital dietary energy supply has increased significantly over time in all parts of the world except Eastern Europe and parts of Africa. (FAO, 2009)

In the United States, the dietary energy supply went up from 3180 kcal/day during 1979-1981, to 3460 kcal/day during 1989-1991, to 3770 kcal/day during 2001-2003. For the entire world population, the dietary energy supply went up from 2358 kcal/day during 1964-1966, to 2435 kcal/day during 1974-1976, to 2655 kcal/day during 1984-1986, to 2830 kcal/day during 1997-1999. (FAO, 2009)

Studies conducted at the CDC also showed the average energy intake has increased over the past several decades. In the United States during the period 1971-2004, the average number of calories consumed by men increased by 168 calories per day (2450 calories in 1971 to 2618 calories in 2004), and for women increased by 335 calories per day (1542 calories in 1971 to 1877 calories in 2004). These estimates are based on each person's recall and may underestimate the amount of calories actually consumed. (Wright et al., 2004) According to a follow-up study by CDC, increases in calories consumed seemed to have leveled off recently. In the 10-year period from 1999-2008, energy intake appeared relatively stable. No statistically significant linear increases or decreases in total energy intake were found (Wright & Wang, 2010).

Several reasons have been suggested to explain the increase in average calorie consumed by Americans in the previous couple decades. They include the increasing consumption of energy-dense fast food and sugar-sweetened beverages, the increase in portion size of restaurant foods, the increase in eating outside of home, and the lowering of prices of certain foods through the U.S. farm bill.

Fast Food

In the United States, fast food outlets have increased from about 30,000 in 1970 to more than 233,000 in 2004. It is considered to be the most rapidly expanding sector of the food distribution industry (NRA, 2005; Jeffery et. al, 2005). Consumption of fast food meal has tripled and calorie intake from fast food has quadrupled between 1977 and 1995 (Lin et al., 1999). Money spent on out-of-home food represented 25% of total food spending in 1970. It has increased to 47.5% of total food spending in 1999 and is projected to increase to 53% by 2010 (Clauson, 2000).

Although convenient and tasty, fast foods tend to be high in energy densities and glycemic loads, excessive in portion size, but low in micronutrients and fiber (Pereira et al., 2005; Isganaitis and Lustig, 2005). People consuming fast food may easily exceed daily energy requirements, leading to weight gain and obesity in the long run (Rosenheck, 2008). Moreover, fast food is often consumed with calorie-dense sugar-sweetened drinks such as carbonated soft drinks, fruit juices, milkshakes, sweetened tea and coffee.

Studies have found that large portions of energy-dense foods can lead to excess energy intakes (Ledikwe et al., 2005). The energy density and the portion size of a food or meal can both affect energy intake, but what about the combined effects? One study found that increases in portion size and energy density led to independent and additive increases in energy intake. Consuming large portions of high energy-dense meals did not lead to compensation for the additional intake by eating less at the subsequent meal, nor were there any differences in hunger and fullness ratings. Eating large portions of foods with a high energy density may facilitate the overconsumption of energy. (Kral et al., 2004)

Portion distortion and value for money explain why people buy and consume larger portion sizes than they actually need. Larger portions are made attractive by offering more value for money (i.e. having a lower price for each increasing unit). At fast food restaurants, for example, super-sized value meals are offered with more fries and a larger cup of beverage. Continuous exposure to larger food portions contributes to portion distortion among consumers. People assume larger portion sizes as an appropriate amount to consume at a single meal, when in fact the portion size exceeds the serving size. (Steenhuis and Vermeer, 2009) Market place portions are often three to four times larger than the recommended portion size, while consumers incorrectly perceive them as standard portions (Hogbin and Hess, 1999).

U.S. Farm Bill

In the United States, subsidization of corn, soy, wheat, and rice through the U.S. farm bill has made the main sources of processed food cheap compared to fruits and vegetables (Pollan, 2007). These crops along with cotton received 92 percent of the $21 billion in federal farm payments in 2006. Because the biggest payments go to the biggest farms, small family farms growing other crops like fresh produce are driven out of business. Crop subsidies have fueled the industrialization and concentration of agriculture into giant agribusinesses, increasing the production and utilization of corn sweeteners and vegetable oils in processed foods (Lochhead, 2007).

Processed foods in general are more energy dense than fresh foods. They contain less water and fiber but more added fat and sugar, which makes them less filling but contain more calories. Because processed foods use cheap ingredients like oil, sugar, and high fructose corn syrup, they are usually cheaper than fresh foods. Supposedly a dollar could buy 1,200 calories of cookies or potato chips but only 250 calories of carrots. A dollar could buy 875 calories of soda but only 170 calories of orange juice. (Pollan, 2007) There might be an inverse relationship between food energy density and energy cost, such that energy-dense foods (made from refined grains, sugars, fats) represent the lowest-cost option to the consumer (Drewnowski and Specter, 2004).

For most of history, the poor have typically suffered from a shortage of calories, not a surfeit. Yet in the past few decades, obesity rates have been increasing among people at all wealth levels, including those in poverty. There is some evidence that consumers with the least amount of money to spend on food are the ones most likely to be overweight (Drewnowski and Specter, 2004). One reason could be that consumers with lower socioeconomic status buy cheaper but more energy-dense processed foods, and end up consuming more calories but fewer nutrients. Instead of buying milk and 100% fruit juices, these consumers may opt to buy cheaper soda and fruit drinks. These drinks are cheaper per unit volume but actually contain more calories from added sugars. Drinking sugar-sweetened beverages could be a contributor to the nation’s obesity epidemic at the poverty level. (Drewnowski, 2009)

CHAPTER II – REVIEW OF LITERATURE

SSB Definitions

In the literature, sugar-sweetened beverages (SSB) refer to any soft drinks, colas, sodas, and other sweetened carbonated beverages (Pereira, 2006). They include fruit drinks with added sugar and 25% or less juice. They also include sweetened teas, sports drinks, and other types of sweetened beverages. Most of these are sweetened with high-fructose corn syrup (HFCS), which was first introduced as HFCS-42 (42% fructose) and HFCS-55 (55% fructose) in 1967 and 1977 (Bray et al., 2004). Some other terms used for sugar-sweetened beverages are calorically-sweetened beverages, artificially-sweetened beverages, and energy-sweetened beverages. Sugar-sweetened beverages are usually categorized separately from 100% fruit juices or natural juices.

Sugars and Calories

Sugar-sweetened beverages contain various amounts of sugars, total calories, and calories from sugar. A 12 fl oz. (355 ml) can of regular Coca-Cola has 39g of sugars, 140 total calories, and 140 calories from sugar. A 20 oz. (590 ml) bottle of Coca-Cola has 65g of sugars, 240 total calories, and 240 calories from sugar. A 20 oz. (590 ml) bottle of Mountain Dew has 77g of sugars, 290 total calories, and 290 calories from sugar. (Beverages, 2011)

An 8 oz. (240 ml) glass of Minute Maid orange juice has 24g of sugars, 100 total calories, and 96 total calories from sugar. An 8 oz. (240 ml) glass of apple juice has 26g of sugars, 120 total calories, and 104 calories from sugar. An 8 oz. glass of lemonade has

27g of sugars, 140 total calories, and 140 calories from sugar. (Beverages, 2011) In comparison, one cup (240g) of plain whole milk has 12g of sugar and 150 calories. One cup of plain fat free or skim milk has 12.5g of sugar and 86 calories. One cup of plain soymilk has 6g of sugar and 100 calories. (Calorie Count, 2011)

Consumption

During 1971-2000, a statistically significant increase in average energy intake in kcals for both men and women occurred. Although the mean percentage of kcals from total fat and saturated fat decreased, absolute fat intake increased (Ernst et al., 1997). The mean percentage of kcals from protein decreased, while the mean percentage of kcals from carbohydrate increased. The increase in energy intake is attributable primarily to an increase in carbohydrate intake, with a 62.4-gram increase among women and a 67.7-gram increase among men. (Wright et al., 2004) Only in the past decade from 1999-2008 has the average carbohydrate intake significantly decreased and average protein intake increased in both men and women. (Wright & Wang, 2010)

The primary sources of the increase in carbohydrates consumed were sugar-sweetened beverages (Caballero, 2007). Consumption of caloric sweetener from beverages has increased in the USA and in most European countries the past few decades. One study found that the increased consumption of caloric sweetener represented a 74-kcal/d increase in the world's dietary changes between 1962 and 2000. U.S data showed an 83-kcal/d increase of caloric sweetener consumed representing a 22% increase in the proportion of energy from caloric sweetener. Of this increase, 80% came from sugared beverages and soft drinks (Popkin and Nielsen, 2003)

Other studies have also found increases in soft drink or sugar-sweetened beverage consumption. One study estimated that the U.S. consumption of soft drinks for 2-18 year-olds has doubled from 3% to 6.9% of total daily calorie intake between 1977 and 2001 (Nielsen and Bopkin, 2004). A more recent study found that the caloric intake from beverages has increased by 222 calories from 1965 to 2002, and in 2002 beverages accounted for 21% of daily caloric intake (Duffey and Popkin, 2007).

Consumption of caloric sweetened beverages at restaurants and fast food sources represented over 40% of the total increase. 50% of the increase came from snacks, an element of the diet representing <20% of total energy intake. Soft drinks, fruit drinks, desserts, sugar and jellies, candy, and cereals were the major food groups contributing to the increased consumption of caloric sweeteners. (Popkin and Nielsen, 2003)

One study analyzing NHANES data from 1988-1994 to 1999-2004 found that the percentage of adults drinking sugar sweetened beverages on survey day had increased from 58% to 63% ($p<0.001$), per capital consumption increased by 46 kcal/d ($p=0.001$), and daily consumption among drinkers increased by 6 oz. ($p<0.001$). In both survey periods, consumption was highest among young adults (231-289 kcal/d) and lowest among the elderly (68-83 kcal/d). Young blacks had the highest percentage of drinkers and consumption compared with white and Mexican American adults. Among young adults, 20% of calories from sugar-sweetened beverages were consumed at work. (Bleich et al., 2009)

While sugar-sweetened beverage consumption increased, milk consumption has declined. According to the USDA, from 1947 to 2001, per capita consumption of carbonated soft drinks tripled while milk consumption decreased by almost one-half. In

1947, Americans consumed on average 11 gallons of carbonated soft drinks and 40 gallons of milk. In 2001, American's consumption of soft drinks increased to 49 gallons, but milk consumption dropped to 22 gallons. (USDA, 2004)

Biological Mechanisms

Several biological mechanisms linking intake of sugar-sweetened beverages to increased overweight and obesity have been proposed. Evidence for such mechanisms is necessary in order to establish a cause and effect relationship. A simple mechanism is the increase in total calories consumed from sugar-sweetened beverages. The energy balance is disrupted with increases in energy intake compared to energy expenditure, which results in increased adiposity and weight gain. (Bachman et al., 2006) This simple mechanism, however, does not explain whether or not consumption of certain foods increases the risk of obesity through specific metabolic effects.

A more complex mechanism is that sugar-sweetened beverage consumption causes a high glycemic load, which triggers an elevated sugar-metabolism response that leads to increased adiposity. This mechanism concerns the type of sugar consumed, not just the total calories. (Bachman et al., 2006) Foods with a higher glycemic index (GI) produce a higher peek in blood glucose after consumption, which leads to a higher glycemic load (Foster-Powell et al., 2002). Consumption of high-GI sugar-sweetened beverages can lead to hyperglycemia and hyperinsulinemia, which can lead to insulin resistance and obesity. Whether sweetened-beverages influence weight gain by this mechanism is unclear, as studies have shown inconsistent results. (Bachman et al., 2006)

One explanation linking sugar-sweetened beverage consumption and weight gain concerns how liquid forms of energy may be less satiating than solid foods, resulting in more calories being consumed. (Bachman et al., 2006) A systematic review concluded that the likely mechanism by which sugar-sweetened beverages may lead to weight gain is the low satiety of liquid carbohydrates and the resulting incomplete compensation of energy at subsequent meals (Malik et al., 2006). Furthermore, some evidence suggests that the palatability of sugar-sweetened beverages increases subjective hunger and hence energy intake (Canty & Chan, 1991).

Several studies investigated the proposed mechanism linking beverage intake and satiety. One study concluded that consuming calories from sugar-sweetened beverages brings less satiation than consuming solid foods, causing more calories to be consumed at a given meal and thereby a higher daily energy intake (Bawa, 2005). Intake of calorically sweetened beverages can fail to trigger physiological satiety, resulting in larger meal portions and more calories consumed at subsequent meals later in the day (Almiron-Roig et al., 2003). A study using meta-analysis showed that people consuming soft drinks failed to compensate for the energy consumed from those drinks and thus had a higher food intake (Vartanian et al., 2007).

It has also been suggested that intake of calorically sweetened beverages may cause a lower thermogenesis, leading to positive energy balance (Mølgaard et al., 2003). Thermogenesis refers to the effect of food intake on increasing energy expenditure above resting metabolic rate, due to the cost of processing food for storage and use. Dietary fat and beverages are very easy to process and have very little thermic effect, while protein is hard to process and has a large thermic effect (Christensen, 2005). The lower thermogenesis of sugar-sweetened beverages may also contribute to its less satiating effects and thus overconsumption.

Studies in biochemistry suggest that diets high in sucrose or high-fructose corn syrups (HFCS) used in manufactured foods and sugar-sweetened beverages can lead to large amounts of fructose and glucose entering the blood stream. During metabolism, glycolysis is the major pathway for glucose break down. Fructose bypasses a regulatory step in glycolysis, so it is broken down more rapidly in the liver than glucose. As a result fructose floods the metabolic pathways in the liver, leading to increases in fatty acid synthesis and esterification. Very-low-density-lipoprotein (VLDL) secretion also increases, which causes a raise in serum triacylglycerols and LDL cholesterol concentrations. (Murray et al., 2003) According to another study, however, there is insufficient evidence to indicate that HFCS disrupts energy balance or appetite and food intake more so than other types of sugars (Melanson et al., 2008)

The consumption of fructose in sugar-sweetened beverages may increase energy intake without producing as much satiety as other forms of sugars. Some reviews concluded that the digestion, absorption, and metabolism of fructose differ from those of glucose. In addition, the reviews suggested that fructose (unlike glucose) does not stimulate insulin secretion or enhance leptin production, two important signals in the regulation of food intake and body weight. Supposedly glucose provides satiety signals to the brain that fructose cannot provide because it is not transported into the brain. Fructose also facilitates the formation of fatty acids inside cells more efficiently than does glucose. A diet high in fructose does not produce satiety to inhibit food intake, thus resulting in overconsumption and weight gain. (Bray et al., 2004; Tappy & Le, 2010)

Other explanations connecting sugar-sweetened beverages and obesity have been proposed. Increased intake of sugar-sweetened beverage could displace intake of milk and its nutritional benefits. Milk may have more satiating effects than sugar-sweetened beverages because it contains nutrients like fat and protein in addition to carbohydrate. Milk provides fewer calories from sugar than do sugar-sweetened beverages. Calcium from milk may also favor weight loss by increasing lipolysis and thermogenesis and by decreasing fatty acid absorption, thus reducing obesity. (Zernel, 2005) It has also been suggested that genes may predispose certain people toward obesity when they consume sugar-sweetened beverages. (Bachman et al., 2006)

For each of the mechanisms proposed, the results remain inconclusive. Some evidence supported a positive relationship between sweetened beverages and obesity, other studies supported no such relationship, and a few showed a negative relationship. (Bachman et al., 2006) The role of insulin is also unclear, as one mechanism suggested that too much insulin will lead to insulin resistance and obesity, while another mechanism suggested that too little insulin will fail to trigger satiety to prevent overeating. HFCS used in making sugar-sweetened beverages seem to have both extreme effects of insulin in the body. Because many physiological mechanisms regulate body weight, it is difficult to determine whether consumption of one isolated food group is correlated to overweight and obesity.

Review Conclusions

Most recent reviews investigating the relationship between consumption of calorically sweetened beverages and obesity have summarized that there is a positive association (CDC, 2006). Some reviews concluded otherwise, citing that most studies done were cross-sectional and not permitted to make conclusions on causal links. One review found numerous clinical studies that have shown that sugar-containing liquids, when consumed in place of usual meals, can lead to significant and sustained weight loss. The liquid meal replacement shakes contain sugar, often high-fructose corn syrup, presented in amounts comparable to those in soft drinks. Supposedly these drinks help in controlling hunger and promoting weight loss. (Drewnowski & Bellisle, 2007)

Possible explanations for the inconsistent conclusions include how intake of beverages was measured, how amount of energy intake was measured, and what confounders were adjusted (Pereira 2006). Another explanation could be the motivations and bias of the researchers since many sugar studies have been contaminated by source of funding. One review summarized that results were significantly related to funding source and that experimental studies with complete industry support were less likely to have an inauspicious conclusion (Lesser et al., 2007). Also, a meta-analysis summarized that studies funded by the food industry found significantly smaller associations between soft drink consumption and energy intake than other studies (Vartanian et al., 2007).

Does drinking a lot of sugar-sweetened beverages increase a person's risk for weight gain and obesity? Consumption of calories from sugar-sweetened beverages or from other food sources will contribute to weight gain if a person's caloric intake exceeds the total number of calories required to maintain current weight. Several studies have been done to examine whether people who consume sugar-sweetened beverages are at risk of consuming more total calories than they need. These studies were either longitudinal or cross-sectional. (CDC, 2006)

Longitudinal Prospective Studies

Longitudinal prospective studies investigated beverage consumption and weight gain over time. The two categories of longitudinal studies were observational or experimental. Observational studies followed a cohort of participants over time but did not attempt to change their beverage consumption behavior. Most of these studies used children and adolescent populations; few focused on adults. With observational studies it is possible to make repeated assessments of exposure and outcome, allowing researchers to assess the temporal relationship between exposure and outcome (Pereira, 2006). However, many biases cannot be removed from observational studies.

Observational Studies

One prospective observational study collected self-reported weight and beverage intake information multiple times from 51,603 women in the Nurses' Health Study II (1991-1999). The researchers adjusted for baseline and change in lifestyle variables including age, postmenopausal hormone use, oral contraceptive use, physical activity, and other potential dietary confounders. It was found that weight gain and increases in BMI were highest among participants who increased their sugar-sweetened carbonated soft drink intake from ≤ 1drink/week to ≥ 1 drink/day. Weight gain and increases in BMI were lowest among women who decreased their intake from ≥ 1 drink/day to ≤ 1 drink/week. However, women who reported stable beverage consumption had no significant weight gain. This study also found that women consuming one or more sugar-sweetened soft drinks per day had an increased relative risk of type 2 diabetes, compared to those who consumed less than one per month. (Schulze et al., 2004)

Most other observational studies used children or adolescent populations, but still found similar results. A 19-month study of 548 ethnically diverse school children in grades 6-7 found that changes in consumption of sugar-sweetened drinks were associated with overweight. The beverages included in this study were soda (non-diet), sweetened fruit drink (not 100% juice), and sweetened iced tea (non-diet). The researchers adjusted for baseline anthropometrics, demographics, dietary factors, physical activity, and television-viewing. There was no statistically significant increase in weight associated with baseline beverage consumption, but there was a significant association with change in beverage consumption. The risk of becoming overweight increased 1.4 times for each additional sugar-sweetened beverage consumed daily, and this risk increased to 1.6 when controlling for total energy intake. (Ludwig et al., 2001)

A 3-year longitudinal cohort study of more than 10,000 children aged 9-14 also found similar results. Sugar-sweetened beverages included soda, sweetened iced tea, and noncarbonated fruit drinks. Variables controlled included age, race, pubertal status, intake of other beverages, physical activity and inactivity, height, and previous BMI Z score. It was found that boys and girls who increased their beverage consumption over 1 year had greater increases in BMI than those who did not. The BMI increases were statistically significant for boys who consumed an additional 1-2 servings of sugar-sweetened beverages a day, and for girls who consumed an additional two servings a day. When adjusting for total energy intake, the increases were diminished and no longer significant, suggesting that increased total caloric intake contributed to the increase in BMI. (Berkey et al., 2004)

Other longitudinal studies did not look at changes in beverage consumption and BMI, but still found a positive association. A 10-year study of 2,379 black and white girls aged 9-10 at enrollment investigated the relationship between beverage consumption and BMI. The sugar-sweetened beverages included soda (non-diet) and fruit drinks/ades (not 100% juice). Physical activity was not controlled, but the researchers adjusted for other beverages consumed, study site, race, and total caloric intake. It was found that non-diet soda intake had a very small but significant association with increased BMI (0.01 BMI units increase for every 100g of soda consumed). (Striegel-Moore et al., 2006)

Another longitudinal study of growth and development examined 196 girls from preadolescence (aged 8-12) to adolescence (until four years after menarche). Height, weight, and food frequency were collected. The model was adjusted for age at menarche, parental overweight, and servings of fruit and vegetables. A positive longitudinal relationship was found between the percentage of calories from soda and BMI Z scores, but not with bioelectrical impedance analysis (used to calculate percent body fat and lean body mass). Percentage of calories from soda consumption was broken down into four quartiles, with first being the least and fourth the most. Girls in the third and fourth quartiles had BMI Z scores ~0.17 units higher than girls in the first quartile. When the data were stratified by menarcheal status, this relationship was significant only among post menarcheal girls. (Phillips et al., 2004)

Some studies did not find an association between beverage consumption and BMI, but they tend to focus on young children. One 6-12 month study utilized 1,345 children (aged 2-5) participating in the North Dakota Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Height and weight were directly measured, and the analysis controlled for age, sex, energy intake, baseline BMI, change in height, birth weight, and other socio-demographic variables, but not physical activity. It was found that baseline intake of fruit drinks or sodas and changes in intake of these beverages were not significantly associated with weight change or BMI. It is of importance that the average total of these beverages consumed by the children was less than 3.5 fluid ounces daily. (Newby et al., 2004)

Another study that did not find association utilized 166 primarily white students in grades 3-5. Researchers collected data on beverage intake and total caloric intake using one 24-hour food recall at baseline and another two years later. Height and weight were directly measured, but physical activity data were not collected. The sugar-sweetened beverages included soda, Hi-C, sports drinks, Kool-Aid, fruit-flavored drinks, ice tea, and hot chocolate. No relationship was found between sugar-sweetened beverage intake (baseline, change, or follow-up) and BMI Z score. However, it was reported that total caloric intake decreased significantly between baseline and follow-up, and there was a positive association between diet soda intake and BMI score at follow-up. (Blum et al., 2005)

A retrospective cohort study examined the relationship between sweet drink consumption and overweight at follow-up among 10,904 low-income children aged 2-3 years. These children were enrolled in public health nutrition programs between January 1999 and December 2001, had food data collected, and had height/weight data collected one year later. The researchers defined the exposure variable “sweet drinks” as including all sugar-sweetened and naturally sweet drinks: vitamin C juice (orange juice), other juices, fruit drinks (Hi-C, Kool-Aid, lemonade), and soda (soft drink, pop, non-sugar free). Logistic regression was used to adjust for age, gender, race/ethnicity, birth weight, intake of high-fat foods, sweet foods, and total energy. (Welsh et al., 2005)

In the statistical analysis, the researchers categorized sweet drinks consumption as follows: 0 to <1 drink/day, 1 to <2 drinks/day, 2 to <3 drinks/day, and ≥3 drinks/day. It was found that energy intake increased as the consumption of sweet drinks increased from one category to the next. Normal or underweight children who consumed one or more sweet drinks/day were 1.3 to 1.5 times (not statistically significant) as likely to become overweight as the referent group (<1 drink/day). Children who were at risk for overweight at baseline and consumed 1 to ≥3 sweet drinks/day were significantly more likely to become overweight than the referent group. Also, overweight children who consumed 1 to ≥3 sweet drinks/day were more likely to remain overweight. (Welsh et al., 2005)

Experimental Studies

Experimental Studies are also referred to as randomized controlled trials. They are used as a definitive test of causality while controlling for bias. Due to the higher cost and difficulty of experimental studies, fewer of them have been done concerning the association between sweetened beverages and BMI. In experimental studies the participants usually received beverages and foods and were instructed to consume them every day along with their normal diets without being aware of the true purpose of the studies. One study found that sugar-sweetened soda significantly increased body weight in both men and women, while artificially sweetened soda produced a significant decrease in body weight in men only. These results occurred in only three weeks during which normal weight men and women were required to consume four bottles of soda daily. (Tordoff and Alleva, 1990)

In another experimental study, fifteen adults consumed 450 kcal/day of either soda (liquid) or jellybean (solid) supplements for four weeks. The participants reported consuming jellybeans as a snack more often than soda, but they consumed soda more often when eating a meal. It was found that when consuming jellybeans, energy intake from other foods and beverages was significantly lower than at baseline. However, when drinking soda, total daily energy intake increased in an amount exceeding the supplement. The participants' body weight and BMI increased significantly only during the supplement phase. (DiMeglio and Mattes, 2000).

Cross-Sectional Studies

The present study is cross-sectional. Because cross-sectional studies investigate relationships between variables at only one point in time, it is unknown whether beverage consumption preceded weight change or vise-versa. Only an association between variables can be established, not causation. (CDC, 2006) Furthermore, variables in cross-sectional studies (such as beverage consumption) cannot be manipulated or tracked overtime as they can be in longitudinal studies. One review suggested that cross-sectional studies are of limited value due to the many assumptions and possible biases, including confounding, residual confounding, and lack of within person comparisons (Pereira, 2006). An advantage of cross-sectional studies is that it is relatively low cost and large national data can be used. The results are more generalizable and more diverse populations can be studied.

One cross-sectional study used data from the U.S. Department of Agriculture (USDA) survey 1994-1996, and found that children consuming 26 ounces or more of soft drinks had an estimated total daily energy intake of 2,605 kcal, while those who reported no soft drink intake had 1,984 kcal (Harnack et al., 1999). Using data from National Health and Nutrition Examination Survey 1988-1994, another study found sugar-sweetened beverages contributed more to total energy intake than any other beverage type. For 12-19 year olds, it was estimated that 10-11% of their total energy intake was from sugar-sweetened beverages. Soft drinks were found to contribute more energy to the diets of overweight youth than to the diet of normal weight youth. (Toriano et al., 2000)

One cross-sectional study analyzed self-reported height, weight, and lifestyle data from 928 males and 889 females, aged 18-99 years old, from rural Wyoming, Montana, and Idaho. Increased likelihood of overweight or obesity was found to be associated with greater frequency of the following: drinking sweetened beverages such as soft drinks/soda pop, ordering super-sized portions, eating while doing other activities, and watching television. Adjustments were made for other dietary factors, physical activity, and socio-demographics. (Liebman, 2003)

Some cross-sectional studies looked the odds of being overweight or obese from consuming sugar-sweetened beverages. In the Bogalusa Heart Study, elevated odds of overweight per each serving of sugar-sweetened beverage were found for Caucasian males (1.68, 95% CI=1.21–2.33) and females (1.53, 95% CI=1.05–2.22), but not African-American males and females. Adjustments were made only for age and energy intake. (Nicklas, 2003)

Another cross-sectional study looked at 385 school children in Santa Barbara County, CA. Body fat and BMI were measured directly, while diet and lifestyle data were collected by questionnaire. The odds of being overweight were 46% higher (95% CI 2-110%) among the students who reported consuming three or more servings of sugar-sweetened beverages per day compared to those consuming fewer servings. Adjustments were made for age, gender, ethnicity, and television viewing, but many other lifestyle and dietary factors were not considered. (Giammattei et al., 2003)

Using data from the National Health and Nutrition Examination Survey 1999-2002, one cross-sectional study investigated associations between types and amounts of beverages consumed and weight status in preschool children aged 2-5 (O'Connor et al., 2006). Beverages were classified into several groups. Fruit drinks included any sweetened fruit juice, fruit-flavored drink (natural or artificial), or drink that contained fruit juice in part. Milk included any type of cow milk and then was subcategorized by percentage of milk fat (skim, 1%, 2% and whole milk), with chocolate and flavored milk as separate categories. Soda included any sweetened soft drink (caffeinated or uncaffeinated). Diet drinks included any fruit drink, tea, and soda that were sweetened by low-calorie sweetener. (O'Connor et al., 2006)

The researchers used X^2 analysis to evaluate the association of categorical variables on BMI categories. After beverage consumption was presented as means with SE among BMI categories, analysis of covariance was conducted to test the association of serving size of a beverage to energy intake and BMI. It was found that none of the drinks was significantly associated with weight status of the children aged 2-5. Increased consumption of milk, 100% fruit juice, fruit drinks, and soda were all associated with an increased total energy intake, but they had no association with BMI. (O'Connor et al., 2006)

There were no statistically significant differences in BMI between boys and girls or among the ethnicities. The different weight groups did have a statistically significant difference in age, with overweight children being older than normal-weight children. The study also found that the mean volume of total beverages, excluding water, consumed by the children was 26.93 oz. The mean milk intake was 12.32 oz., mean 100% fruit juice consumed was 4.70 oz., and mean sweetened fruit drink and soda consumed was 4.98 oz. (O'Connor et al., 2006)

The researchers suggested several reasons why beverage consumption was associated with increased total energy intake but not an increase in BMI. First, the prevalence of overweight in preschool-aged children might be too low to detect an association. Second, the children may be too young for increased total energy intake to have an effect on BMI. Because mean adiposity rebound occurs at ~5.5-6 years of age, the researchers would have had to follow the children past age six to see if increased energy intake leads to increased BMI. NHANES is a cross-sectional study and does not provide longitudinal data for such follow-up. (O'Connor et al., 2006)

Another limitation with NHANES data is that the physical activity data for 2-5 year-olds is not specific. It asks only how many times per week the child plays or exercises until he or she sweats or breathes hard. There is no information on the amount of time the children are physically active, which may be a more important variable. Also, the single 24-hour dietary recall used in NHANES may not be a fair representation of the typical dietary consumption of the children. Since some of the children spend time away from their parents at preschool or childcare, the parents cannot truly be aware of everything their children consumed. As a result, there can be under or over-reporting (O'Connor et al., 2006)

Several other cross-sectional studies focused only on 100% fruit juices such as 100% orange juice and apple juice, which are not considered sugar-sweetened beverages. One study utilized NHANES 1999-2002 to analyze children 2-11 years of age, and found no significant differences in weight between juice consumers and non-consumers.

Children consuming 100% fruit juices had significantly higher intake of energy and nutrients such as Vitamin C. (Nicklas et al., 2008) Another study using secondary data looked at preschoolers 3-5 years of age, and found no significant differences in 100% fruit juice intake among various BMI categories (Rysdale et al., 2009). A review concluded that most studies found no association between consumption of 100% fruit juice and overweight in children and adolescents. Consumption of 100% fruit juice in moderate amounts may be an important strategy to help children meet the current fruit recommendations. (O'Neil & Nicklas, 2008)

Other Disorders

Other than obesity and weight gain, other medical disorders have been linked to consumption of sugar-sweetened beverages. Higher consumption of these beverages has been found to be associated with the development of metabolic syndrome and type 2 diabetes. Sugar-sweetened beverages may increase the risk of these metabolic disorders not only through obesity, but also by increasing dietary glycemic load and insulin resistance (Malik et al., 2010). Another study confirmed that there is an association between sugar-sweetened beverage consumption and insulin resistance, which could lead to hyperinsulinemia and diabetes (Yoshida et al., 2007).

Regular consumption of soft drinks has been found to play an independent role in the development of pancreatic cancer. Beverages that induce hyperglycemia and hyperinsulinemia could expose pancreatic cells to high concentrations of insulin, which might lead to pancreatic cancer (Mueller et all, 2010). One study found that consumption of sugar-sweetened soft drinks and fructose was strongly correlated with an increased risk of gout, a common inflammatory arthritis, in men. Soft drinks contain large amounts of fructose that can increase uric acid levels, which is associated with people suffering from gout. (Choi and Curhan, 2008)

Summary

The increasing consumption of sugar-sweetened beverages has coincided with the increasing rates of obesity in the United States and other westernized worlds. This has led to an increase in the number of studies done to investigate the relationship between sugar-sweetened beverage consumption and BMI or obesity. Various types of studies have been used, including longitudinal observational studies, experimental studies, and cross-sectional studies. Several studies found positive association, some negative association, and others no association. Several biological mechanisms have been proposed to explain the possible link between sugar-sweetened beverage consumption and weight gain, but the research also shows conflicting results. Some proposed mechanisms include: excess calorie intake, glycemic index and glycemic load, the role of high-fructose sugar, and the low satiety of sugar-sweetened beverages leading to overconsumption of other foods.

As stated in the introduction, the purpose of this study was to evaluate the association between sugar-sweetened beverage consumption and BMI of the U.S. adult population using NHANES FFQ 2003-2004. Many studies have investigated the relationship between sugar sweetened beverage consumption and obesity or BMI in children and adolescent populations. Fewer studies have been done looking at the adult population, even though it has been shown that consumption was highest among young adults (Bleich et al., 2009). Other cross-sectional studies have utilized data from NHANES, but not the FFQ part, in studying the relationship between sugar-sweetened beverage consumption and obesity.

CHAPTER III – METHODS AND PROCEDURES

Data Source

Data from the National Health and Nutrition Examination Survey (NHANES) 2003-2004 were used for this study. NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States using interviews and physical examinations. It is conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC). Each year the survey examines a nationally representative sample of about 5,000 persons of all ages and located in counties across the country. To produce reliable statistics, persons 60 and older, African Americans, and Hispanics are over-sampled. The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions, while the examination includes medical, dental, physiological measurements, and laboratory tests. (CDC, 2010) For the purpose of this study, demographic factors (gender, age, ethnicity, education, household income, pregnancy status), body measurements (weight, BMI), and sugar-sweetened beverage consumption were examined. (CDC, 2011)

From NHANES 2003-2004, the Demographics file was used to obtain each subject's gender, age, ethnicity, education level, household income, and pregnancy status. The Body Measurement examination file was used to obtain each subject's weight, height, and body mass index. The Smoking and Tobacco Use Questionnaire was used to obtain smoking status. A person who has smoked at least 100 cigarettes in his/her entire life was considered a smoker, and those who has not was considered a nonsmoker. The

Alcohol Use Questionnaire was used to obtain alcohol drinking status. A person who has had at least 12 alcohol drinks per 1 year was considered a drinker, and those who has not was considered a nondrinker. The Physical Activity Questionnaire was used to obtain physical activity level. The question utilized concerns the average level of physical activity performed each day. Demographic variables, smoking status, alcohol consumption, and daily physical activity level were controlled for in this study. (CDC, 2011)

The Food Frequency Questionnaire (FFQ) part of NHANES 2003-2004 was used to obtain frequency of sugar-sweetened beverage consumption. FFQ was first added to NHANES 2003-2004. It was previously referred to as the NHANES Food Propensity Questionnaire (FPQ). The FFQ collects information on the frequency of food consumption during the past 12 months. It augments the two 24-hour dietary recall interviews and interviews on dietary supplement use, food security, and dietary behavior. (CDC, 2011)

The NHANES FFQ was developed by the National Institutes of Health, National Cancer Institute (NCI). NHANES FFQ was based on the NCI Diet History Questionnaire (DHQ), a 124-item food frequency instrument that is widely used in nutritional epidemiology research. The FFQ is different from the DHQ in several aspects. Portion size is collected in the DHQ but not the FFQ because the FFQ was not intended to be used to derive estimates of absolute intake for either nutrients or foods (Subar 2006). Also several DHQ questions on added fats and oils were excluded from the FFQ. Frequency of use for added fats, spreads, and oils is difficult for respondents to estimate. (CDC, 2008)

All English or Spanish-speaking examinees 2+ years of age who completed at least one 24-hr dietary recall interview were eligible for the FFQ component. The printed FFQ questionnaires were mailed to survey participants' homes. A parent or proxy respondent completed the questionnaire for children less than 6 years old. A proxy assisted children 6-11 years old and persons who could not complete the questionnaire by themselves. Subjects more than 12 years old completed their own questionnaire. Subjects who responded and returned their FFQ form received $30 remuneration. The FFQ data were scanned and added to the NHANES database. (CDC, 2008) A Diet*Calc software was used to produce daily consumption frequencies for drinks and foods on the FFQ.

The FFQ was designed to help estimate the usual intakes of episodically consumed foods and drinks. Although the 24-hour recall data provide detailed information about the amount consumed on consumption days, they do no provide information on frequency of consumption. The FFQ data provide the frequency to consume or probability to consume on any given day. The probability of consuming a food on a given day multiplied by the usual amount consumed on consumption days would equal the total amount consumed. The CDC does not recommend using FFQ data alone to estimate absolute intakes of foods or nutrients, because significant measurement errors have been shown to occur. (CDC, 2008) In the present study no estimates of quantity consumed was made. All analysis applied to consumption frequency.

Subjects

NHANES 2003-2004 contained data from 10,122 people sampled. The present study only looked at adults (20+ years old), so the age variable was transformed to discount subjects younger than 20, leaving 5,041 cases. Age 20 instead of 18 was chosen as the minimum adult age because the NHANES questionnaires on smoking and alcohol use were only given to participants 20+ years old. Data from NHANES 2003-2004 showed that the age range was 20-85, with the mean being 50.8 years old. 233 females were pregnant since they reported they were pregnant and/or were determined so by examination. These cases were eliminated from this study because pregnancy affects BMI, leaving 4,808 cases. Of these remaining cases, 377 had missing BMI data, leaving 4,431 valid cases.

Research Design

The present study utilized FFQ questions 2-6 for frequency of fruit juice consumption. The questions used were: “2. How often did you drink orange juice or grapefruit juice?”, “3. How often did you drink apple juice?”, “4. How often did you drink grape juice?”, “5. How often did you drink other 100% fruit juice or 100% fruit juice mixtures (such as pineapple, prune, or others)?”, “6. How often did you drink other fruit drinks (such as cranberry cocktail, Hi-C, lemonade, or Kool-Aid, diet or regular)?”, and “6a. How often were your fruit drinks diet or sugar-free drinks?”

Orange and grapefruit juice, apple juice, grape juice, and other 100% fruit juice were all considered non-sugar-sweetened fruit juices. Orange and grapefruit juice were renamed to 100% orange juice in this study. Fruit drinks (including cocktails, Hi-C, lemonade, or Kool-Aid) were considered sugar-sweetened fruit drinks. The fruit drinks variable was renamed to sugar-sweetened fruit drinks for the purpose of this study.

FFQ questions 9(a-d) were utilized for frequency of soda consumption. The questions used were “9. Over the past 12 months, did you drink soft drinks, soda, or pop?”, “9a. How often did you drink soft drinks, soda, or pop in the summer?”, “9b. How often did you drink soft drinks, soda, or pop during the rest of the year?", "9c. How often were these soft drinks, soda, or pop diet or sugar-free?", "9d. How often were these soft drinks, soda, or pop caffeine-free?"

The FFQ questions on beverage consumption provided the following categorical choices: (1) never, (2) 1 time per month or less, (3) 2-3 times per month, (4) 1-2 times per week, (5) 3-4 times per week, (6) 5-6 times per week, (7) 1 time per day, (8) 2-3 times per day, (9) 4-5 times per day, (10) 6 or more times per day. For questions concerning diet or sugar-free drinks, the categorical choices were: (1) Almost never or never, (2) About ¼ of the time, (3) About ½ of the time, (4) About ¾ of the time, (5) Almost always or always. Please see **Appendix D** for relevant parts of the FFQ used in this study.

Statistical Analysis

PASW Statistics 18 by SPSS Inc. was used for statistical analysis. GNU PSPP running on a Linux computer was also used. The control variables used were gender, age (years), race/ethnicity, education level, annual household income, smoking status, average daily physical activity level, and alcohol consumption. The independent variable analyzed was beverage consumption frequency. The beverages considered were 100% orange juice, apple juice, grape juice, other 100% fruit juices, sugar-sweetened fruit drinks, diet or sugar-free fruit drinks, soft drinks during summer, soft drinks during rest of year, diet or sugar-free soft drinks, and caffeine-free soft drinks. The dependent variable was mean BMI (kg/m^2). For each variable analyzed, descriptive statistics were generated, including number of cases, unadjusted mean BMI, and 95% confidence intervals.

One-way analysis of variance (ANOVA) was done to compare the mean BMI across each beverage consumption frequency to see whether there were significant differences. A BMI category variable was created to distinguish people considered normal or underweight (BMI≤25.99), overweight (BMI=25-29.99), and obese (BMI>30). Relative risks (RR) of overweight and obesity were calculated by hand for certain beverage consumption frequency (100% orange juice, sugar-sweetened fruit juice, soft drinks during summer, and soft drinks during rest of year). Category 2 (1 time per month or less) and category 8 (2-3 times per day) were used. Using SPSS, odds ratios (OR) and relative risks (RR) were calculated for having normal weight and for being obese. SPSS calculated risks in the opposite direction, but the results were the same.

Linear regressions were done next to explore the strength of the association between beverage consumption frequency and mean BMI. A univariate study was done to determine the independent association between each of the independent variables and the dependent variable BMI. The independent variables included gender, age, race/ethnicity, education level, annual household income, smoking status, physical activity level, and alcohol consumption. Beverage consumption frequencies were included for 100% orange juice, sugar-sweetened fruit juice, soft drinks during summer, and soft drinks during rest of year. The univariate study was first done for the total population, then separately for males and females.

After the univariate study, a multiple linear regression study was done to explore the association between the independent variables and the dependent variable BMI while controlling for all the other potential confounding variables. Multiple regression analysis was also done separately for the four beverage variables of interest (100% orange juice, sugar-sweetened fruit juice, soft drinks during summer, and soft drinks during rest of year) to ensure that collinearity between the variables was not masking the true relationship with BMI. These studies were first done for the total population, then separately for males and females.

Finally a stepwise linear regression was done to sequentially test for confounding effects among the drinking variables. Before regression analysis was ran in SPSS, the beverage consumption frequency variables were placed into blocks in the following order: soft drink consumption during rest of year, then 100% orange juice consumption, then sugar-sweetened fruit juice consumption, and finally soft drink consumption during summer. Data tables and graphs of all analyses were generated using Microsoft Excel.

IRB Approval

The present study was reviewed and approved by the Georgia State University Institutional Review Board (IRB) on June 16, 2011. The submission type was Protocol H11563 and the review type was exempt review. Solomon Ike Okosun was the principal investigator and the Institute of Public Health was the protocol department. Please see **Appendix C** for the IRB approval letter.

CHAPTER IV - RESULTS

Descriptive Statistics

Please see **Table 1** and **Figure 1** for all descriptive statistics. **Table 1** shows the mean BMI and BMI categories (normal, overweight, obese) for each control variable (gender, age, race/ethnicity, education level, annual household income, smoking status, daily physical activity level). Of the total 4808 subjects in the study population, there were 2418 (50.3%) males and 2390 (49.7%) females. The mean BMI of the adult population was 28.36 (95%CI 28.18-28.55). The mean BMI was 27.94 (95%CI 27.72-28.17) for males, and 28.79 (95%CI 28.50-29.09) for females. A BMI category variable was created to distinguish people considered normal or underweight (BMI≤24.99), overweight (BMI=25-29.99), and obese (BMI≥30). There were 1416 (32.0%) people in the normal category, 1564 (35.3%) people overweight and 1451 (32.7%) people obese.

Age was transformed from a continuous variable to a discrete one. There were 774 (16.1%) adults 20-29 years old, 737 (15.3%) adults 30-39 years old, 787 (16.4%) adults 40-49 years old, 609 (12.7%) adults 50-59 years old, 773 (16.1%) adults 60-69 years old, 611 (12.7%) adults 70-79 years old, and 517 (10.8%) adults 80 and over. The mean BMI was 27.08 (26.59-27.58) for adults 20-29 year old, 28.37 (27.87-28.86) for adults 30-39 years old, 29.25 (28.79-29.72) for adults 40-49 years old, 29.36 (28.81-29.90) for adults 50-59 years old, 29.41 (28.98-29.84) for adults 60-69 years old, 28.16 (27.73-28.59) for adults 60-69 years old, and 26.21 (25.80-26.63) for adults 80 years old and over.

For race/ethnicity, there were 923 (19.2%) Mexican Americans, 147 (3.1%) other Hispanics, 2573 (53.3%) non-Hispanic whites, 956 (19.9%) non-Hispanic blacks, and 209 (4.3%) other race including multi-racial people. The mean BMI was 28.88 (28.51-29.25) for Mexican Americans, 27.55 (26.75-28.35) for other Hispanics, 27.81 (27.57-28.05) for non-Hispanic whites, 30.00 (29.52-30.48) for non-Hispanic blacks, and 25.87 (25.01-26.72) for other races.

For education level, 709 (14.7%) adults achieved less than 9th grade, 721 (15.0%) achieved 9-11th grade (including 12th grade with no diploma), 1222 (25.4%) achieved high school graduation / GED or equivalent, 1296 (27.0%) achieved some college or associate degree, and 847 (17.6%) achieved college graduation or above.

For annual household income, 78 (1.6%) adults made $0 to $4,999, 244 (5.1%) made $5,000 to $9,999, 447 (9.3%) made $10,000 to $14,999, 381 (7.9%) made $15,000 to $19,999, 409 (8.5%) made $20,000 to $24,999, 629 (13.1%) made $25,000 to $34,999, 531 (11.0%) made $35,000 to $44,999, 410 (8.5%) made $45,000 to $54,999, 253 (5.3%) made $55,000 to $64,999, 218 (4.5%) made $65,000 to $74,999, and 845 (17.6%) made $75,000 and over.

For smoking status, 2422 (50.4%) adults smoked at least 100 cigarettes in life, and 2381 (49.5%) has not. Those who smoked had a mean BMI of 28.22 (27.97-28.47), and those who has not had a mean BMI of 28.52 (28.25-28.79). For alcohol consumption, 2956 (58.8%) adults had at least twelve alcoholic drinks per one year. They had a mean BMI of 28.17 (27.94-28.40). 1356 (27.0%) adults did not have at least twelve alcoholic drinks per one year. They had a mean BMI of 29.12 (28.74-29.49).

For daily physical activity level, 1263 (26.3%) adults sit during the day and do not walk about very much. They had a mean BMI of 29.16 (28.74-29.58). 2492 (51.8%) adults stand or walk about a lot during the day, but do not have to carry or lift things very often. They had a mean BMI of 28.19 (27.95-28.43). 702 (14.6%) adults lift light load or have to climb stairs or hills often. They had a mean BMI of 27.93 (27.47-28.38). 347 (7.2%) adults do heavy work or carry heavy load. They had a mean BMI of 27.79 (27.19-28.39).

Analysis of Variance (ANOVA)

One-way analysis of variance (ANOVA) was done to compare the mean BMI across each beverage consumption frequency. A p value less than .01 was considered significant. For 100% orange juice, of the total 3393 people who took the FFQ questionnaire, there were 29 blanks and 36 errors. Mean BMI increased in general as the frequency increased. ANOVA found that the mean BMI in each category was significantly different from each other (p=.001). Please see **Table 2** and **Figure 2** for 100% orange juice consumption frequency vs. mean BMI.

For 100% apple juice, of the total 3393 people who took the FFQ questionnaire, there were 32 blanks and 26 errors. No obvious pattern of BMI change occurred as the frequency increased. ANOVA found that the mean BMI in each category was not significantly different from each other (p=.487). Please see **Table 3** and **Figure 3** for 100% apple juice consumption frequency vs. mean BMI.

For 100% grape juice, of the total 3393 people who took the FFQ questionnaire, there were 32 blanks and 24 errors. No obvious pattern of BMI change occurred as the frequency increased. ANOVA found that the mean BMI in each category was not significantly different from each other (p=.117). Please see **Table 4** and **Figure 4** for 100% orange juice consumption frequency vs. mean BMI.

For other 100% fruit juice, of the total 3393 people who took the FFQ questionnaire, there were 27 blanks and 29 errors. No obvious pattern of BMI change occurred as the frequency increased. However, ANOVA found that the mean BMI in each category was significantly different from each other (p=.002). Please see **Table 5** and **Figure 5** for 100% fruit juice consumption frequency vs. mean BMI.

For sugar-sweetened fruit drinks, of the 3393 people who took the FFQ questionnaire, there were 63 blanks and 36 errors. Mean BMI increased in general as frequency of consumption increased. ANOVA found that the mean BMI in each category was significantly different from each other (p<.001). Please see **Table 6** and **Figure 6** for sugar-sweetened fruit drink consumption frequency vs. mean BMI.

For diet or sugar-free fruit drinks, of the 3393 people who took the FFQ questionnaire, there were 911 blanks and 2 errors. Mean BMI increased in general as percentage of consumption increased. ANOVA found that the mean BMI in each category was significantly different from each other (p=.001). Please see **Table 7** and **Figure 7** for diet or sugar-free fruit drink consumption frequency vs. mean BMI.

For soft drinks consumed during summer, of the 3393 people who took the FFQ questionnaire, there were 271 blanks and 30 errors. Mean BMI increased in general as the frequency of consumption increased. ANOVA found that the mean BMI in each category was significantly different from each other (p<.001). Please see **Table 8** and **Figure 8** for soft drink consumption frequency during summer vs. mean BMI.

For soft drinks consumed during rest of the year, of the 3393 people who took the FFQ questionnaire, there were 268 blanks and 33 errors. Mean BMI also increased in general as the frequency of consumption increased. ANOVA found that the mean BMI in each category was significantly different from each other ($p<.001$). Please see **Table 9** and **Figure 9** for soft drink consumption frequency during rest of year vs. mean BMI.

For diet or sugar-free soft drinks, of the 3393 people who took the FFQ questionnaire, there were 302 blanks and 3 errors. Mean BMI increased then decreased as the percentage of consumption increased. ANOVA found that the mean BMI in each category was significantly different from each other ($p<.001$). Please see **Table 10** and **Figure 10** for diet or sugar-free soft drink consumption frequency vs. mean BMI.

For caffeine-free soft drinks, of the 3393 people who took the FFQ questionnaire, there were 317 blanks and 3 errors. No obvious pattern of BMI change occurred as the percentage of consumption increased. ANOVA found that the mean BMI in each category was not significantly different from each other ($p=.361$). Please see **Table 11** and **Figure 11** for caffeine-free soft drink consumption frequency vs. mean BMI.

ANOVA was also done for daily physical activity level. Of the 4431 people who took the Physical Activity Questionnaire, 1119 people sit mostly during the day. 2316 people stand or walk about a lot during the day. 669 people lift light load or have to climb stairs or hills often. 324 people do heavy work or carry heavy load, and 3 people answered “don’t know.” Mean BMI decreased as the level of physical activity increased. ANOVA found that the mean BMI in each category was significantly different from each other ($p<.001$). Please see **Table 12** and **Figure 12** for physical activity level vs. mean BMI.

Relative Risk

The relative risks (RR) for overweight and obesity by beverage consumption frequency were calculated by hand for 100% orange juice, sugar-sweetened fruit drinks, soda consumed during summer, and soda consumed during rest of year. Category 2 (1 time per month or less) and category 8 (2-3 times per day) were used. Using SPSS odds ratios (OR) and relative risks (RR) were calculated for having normal weight and for being obese.

For 100% orange juice consumption, people in category 8 had a decreased risk of being overweight (RR=.936) but an increased risk of being obese (1.282). The combined risk of being overweight and obese was increased (1.108). Using SPSS it was found that people in category 2 had increased odds (OR=1.681, 95%CI 1.046-2.701) and risk (RR=1.353, 95%CI 1.006-1.820) for having normal BMI, but decreased risk (RR=.805 95%CI .672-.964) for being obese. Please see **Table 2** for calculations.

For sugar-sweetened fruit drinks, people in category 8 had a decreased risk of being overweight (.743) but an increased risk of being obese (1.417). The combined risk of being overweight and obese was slightly increased (1.064). Using SPSS it was found that people in category 2 had increased odds (OR=1.627 95%CI 1.074-2.465) and risk (RR=1.312, 95%CI 1.024-1.682) for having normal BMI, but decreased risk (RR=.807 95%CI .681-.955) for being obese. Please see **Table 6** for calculations.

For soft drinks consumed during summer, people in category 8 had a decreased risk of being overweight (.909) but an increased risk of being obese (1.749). The combined risk of being overweight and obese was increased (1.252). Using SPSS it was found that people in category 2 had increased odds (OR=2.773, 95%CI 1.913-4.020) and risk (RR=1.666, 95%CI 1.400-1.983) for having normal BMI, but decreased risk (RR=.601, 95%CI .488-.739) for being obese. Please see **Table 8** for calculations.

For soft drinks consumed during rest of year, people in category 8 had a decreased risk of being overweight (.870) but an increased risk of being obese (1.580). The combined risk of being overweight and obese was increased (1.169). Using SPSS it was found that people in category 2 had increased odds (OR=2.255, 95%CI 1.609-3.161) and risk (RR=1.537, 95%CI 1.285-1.837) for having normal BMI, but decreased risk (RR=.681, 95%CI .577-.804) for being obese. Please see **Table 9** for calculations.

The relative risks for overweight and obesity by average daily physical activity level were also calculated. Category 1 (sits mostly) and category 4 (does heavy work) were used. People in category 4 had an increased risk of being overweight (1.120) but a decreased risk of being obese (.775). The combined risk of being overweight and obese was slightly decreased (.938). Using SPSS it was found that people in category 1 had decreased odds (OR=.677, 95%CI .496-.924) and risk (RR=.819, 95%CI .704-.953) for having normal BMI, but increased risk (RR=1.210, 95%CI 1.030-1.422) for being obese. Please see **Table 12** for calculations.

Univariate Linear Regression

A univariate linear regression analysis was done to explore the association between each independent variable, including the controls, and mean BMI. A p value less than .01 was considered significant. For the total study population (males and females), a statistically significant relationship was found for gender (beta=.068, p<.001), daily physical activity level (beta=-.067, p<.001), and alcohol consumption (beta=.063, p<.001). Concerning beverage consumption, 100% orange juice consumption frequency was not significant (beta=.030, p=.088), sugar-sweetened fruit juice consumption frequency was significant (beta=.086, p<.001), soft drink consumption frequency (during summer) was significant (beta=.113, p<.001), and soft drink consumption frequency (during rest of year) was also significant (beta=.104, p<.001). Please see **Table 13** for the results of the univariate linear regression of each independent variable vs. mean BMI.

The univariate study was then done separately for males and females. For males, a statistically significant relationship with mean BMI was found for annual household income (beta=.058, p=.008). Concerning beverage consumption, 100% orange juice consumption frequency was not significant (beta=.016, p=.516), sugar-sweetened fruit juice consumption frequency was significant (beta=.070, p=.005), soft drink consumption frequency (during summer) was significant (beta=.085, p=.001), and soft drink consumption frequency (during rest of year) was not significant but close (beta=.064, p=.012).

For females, a statistically significant relationship with mean BMI was found for education level (beta=-.095, p<.001) and daily physical activity level (beta=-.102, p<.001). Annual household income (beta=-.046, p=.036) and alcohol consumption (beta=.055, p=.014) were not significant but close. Concerning beverage consumption, 100% orange juice consumption frequency was not significant (beta=.039, p=.105), sugar-sweetened fruit juice consumption frequency was significant (beta=.094, p<.001), soft drink consumption frequency (during summer) was significant (beta=.142, p<.001), and soft drink consumption frequency (during rest of year) was significant (beta=.142, p<.001).

Multiple Linear Regression

After the univariate study, a multiple linear regression analysis was done to explore which independent variables in the model contributed to the prediction of the dependent variable, mean BMI. Potential confounding variables (gender, age, race/ethnicity, education level, annual household income, smoking status, alcohol consumption, daily physical activity level) were included. The consumption frequencies of the four beverages of interest (100% orange juice, sugar-sweetened fruit juice, soft drinks during summer, soft drinks during rest of year) were also included. Please see **Table 14a** for the results of the multiple linear regression analysis.

For the total population (male and female), a statistically significant relationship was found for education level (beta=-.066, p=.001) and daily physical activity level (beta=-.091, p<.001). Concerning beverage consumption, 100% orange juice was not significant (beta=.011, p=.561), sugar-sweetened fruit juice consumption frequency was significant (beta= .056, p=.004), soft drink consumption frequency during summer was significant (beta=.134, p=.001), and soft drink consumption frequency during rest of year was not significant (beta=-.005, p=.908).

For males, a statistically significant relationship was found for annual household income (beta=.075, p=.008). Concerning beverage consumption, 100% orange juice was not significant (beta=-.012, p=.666), sugar-sweetened fruit juice consumption frequency was not significant (beta= .043, p=.122), soft drink consumption frequency during summer was not significant (beta=.139, p=.017) but close, and soft drink consumption frequency during rest of year was not significant (beta=-.043, p=.469).

For females, a statistically significant relationship was found for education level (beta=-.082, p=.005) and daily physical activity level (beta=-.131, p<.001). Concerning beverage consumption, 100% orange juice was not significant (beta=.026, p=.342), sugar-sweetened fruit juice consumption frequency was not significant (beta=.061, p=.027) but close, soft drink consumption frequency during summer was not significant (beta=.133, p=.023) but close, and soft drink consumption frequency during rest of year was not significant (beta=.014, p=.816).

Multiple linear regression analysis was done separately for each of the four beverage consumption frequencies of interest to identify any collinearity between the variables. Concerning 100% orange juice, analysis was done for the total population, then for males and females separately. For the total population, a statistically significant relationship with mean BMI was found for age (beta=-.068, p<.001), education level (beta=-.081, p<.001) and daily physical activity level (beta=-.088, p<.001), but not 100% orange juice (beta=.032, p=.083), For males, a statistically significant relationship with mean BMI was found for annual household income (beta=.078, p=.003) but not 100% orange juice (beta=.011, p=.686). For females, a statistically significant relationship with mean BMI was found for age (beta=-.086, p=.001), education level (beta=-.110, p<.001), daily physical activity level (beta=-.125, p<.001), but not 100% orange juice (beta=.044, p=.087). These results are similar to those of the univariate regression analysis, suggesting that there is little collinearity between 100% orange juice and the control variables. Please see **Table 14b** for the results of the multiple linear regression analysis of 100% orange juice vs. mean BMI.

Concerning sugar-sweetened fruit drink, analysis was done for the total population, then for males and females separately. For the total population, a statistically significant relationship with mean BMI was found for education level (beta=-.076, p<.001), daily physical activity level (beta=-.083, p<.001), and sugar-sweetened fruit drink (beta=.072, p<.001). For males, a statistically significant relationship with mean BMI was found for annual household income (beta=.079, p=.003) only. For females, a statistically significant relationship with mean BMI was found for education level (beta=-.103, p<.001), daily physical activity level (beta=-.119, p<.001), and sugar-sweetened fruit drink (beta=.076, p=.003). These results are similar to those of the univariate regression analysis, suggesting that there is little collinearity between sugar-sweetened fruit drink and the control variables. Please see **Table 14c** for the results of the multiple linear regression analysis of sugar-sweetened fruit drink vs. mean BMI.

Concerning soft drink consumed during the summer, analysis was done for the total population, then for males and females separately. For the total population, a statistically significant relationship with mean BMI was found for education level (beta=-.069, p=.001), daily physical activity level (beta=-.091, p<.001), and soft drink consumption during summer (beta=.127, p<.001). For males, a statistically significant relationship with mean BMI was found for annual household income (beta=.074, p=.007) and soft drink consumption during summer (beta=.099, p<.001). For females, a statistically significant relationship with mean BMI was found for education level (beta=-.093, p=.001), daily physical activity level (beta=-.129, p<.001), and soft drink consumption during summer (beta=.143, p<.001). These results are similar to those of the univariate regression analysis, suggesting that there is little collinearity between soft drink consumed during summer and the control variables. Please see **Table 14d** for the results of the multiple linear regression analysis of soft drink consumed during summer vs. mean BMI.

Concerning soft drink consumed during rest of the year, analysis was done for the total population, then for males and females separately. For the total population, a statistically significant relationship with mean BMI was found for education level (beta=-.071, p=.001), daily physical activity level (beta=-.089, p<.001), and soft drink consumption during the year (beta=.118, p<.001). For males, a statistically significant relationship with mean BMI was found for annual household income (beta=.075, p=.007) and soft drink consumption during the year (beta=.079, p=.006). For females, a statistically significant relationship with mean BMI was found for education level (beta=-.093, p=.001), daily physical activity level (beta=-.123, p<.001), and soft drink consumption during the year (beta=.139, p<.001). These results are similar to those of the univariate regression analysis, suggesting that there is little collinearity between soft drink consumed during the year and the control variables. Please see **Table 14e** for the results of the multiple linear regression analysis of soft drink consumed during rest of the year vs. mean BMI.

Results from the multiple linear regression analysis done separately for each of the four beverage consumption frequencies vs. mean BMI (Table 14b-e) were consistent with the results from the univariate linear regression analysis (Table 13). This suggests that there is minimal collinearity between the beverage variables and the control variables (gender, age, race/ethnicity, education level, annual household income, smoking status, daily physical activity level, alcohol consumption). The results of the the multiple linear regression analysis for all variables (Table 14a) deviated from that of the univariate linear regression analysis (Table 13). For the total population, soft drink consumption during the year was no longer significant. For males and females separately, sugar-sweetened fruit drink, soft drink consumed during summer, and soft drink consumed during rest of year were no longer significant. This suggests that there is collinearity among the drinking variables.

Stepwise Linear Regression

Soft drink consumption frequency during rest of year showed significant association vs. mean BMI in the univariate linear regression, but not in the multiple linear regression with all variables. To investigate this conundrum a stepwise linear regression was done with the beverage variables put into blocks. In the first block, soft drink consumption frequency during rest of year was significant ($p<.001$). In the second block, soft drink consumption during rest of year and 100% orange juice consumption were considered together. Soft drink consumption during rest of year was significant ($p=.107$), and 100% orange juice was not significant ($p=.217$).

In the third block, soft drink consumption during rest of year, 100% orange juice consumption, and sugar-sweetened fruit juice consumption were tested together. Soft drink consumption during rest of year remained significant ($p<.001$), 100% orange juice consumption remained not significant ($p=.560$), and sugar sweetened fruit juice consumption was significant ($p=.001$).

In the final block, soft drink consumption during rest of year, 100% orange juice consumption, sugar-sweetened fruit juice consumption, and soft drink consumption during summer were tested together. Soft drink consumption during rest of year became not significant ($p=.789$), 100% fruit juice consumption remained not significant ($p=.552$), sugar-sweetened fruit juice consumption remained significant ($p=.001$), and soft drink consumption during summer was significant ($p=.001$). These results suggest that there was collinearity between soft drink consumed during summer and soft drink consumed during rest of the year. Please see **Table 15** for results of linear regression with independent variable blocks vs. mean BMI.

The correlation coefficient R and coefficient of determination R^2 were given for all linear regression analyses, as shown in Table 13 and Table 14a-d. The values of R range from 0 to 1, indicating no relationship to a perfectly linear relationship between the independent and independent variables. R^2 indicates the percent of variance in the dependent variable explained by the independent variables. In multiple linear regression analysis this refers to the combined effects of the independent variables. As can be seen in the results, the R and R^2 values were quite small for all the variables studied. This indicated that the independent variables, including controls and beverage variables, were not good predictors of the dependent variable, mean BMI. In the univariate linear regression analysis, the highest correlation coefficient was for soft drink consumed during summer and rest of year for females (R=.142, R^2=.020). In the multiple linear regression analysis, the highest correlation coefficient was for females (R=.243, R^2=.059).

CHAPTER V – DISCUSSION AND CONCLUSION

General Findings

The univariate linear regression analysis showed that mean BMI was associated with certain beverage consumption frequency but not others. There was no significant association between mean BMI and 100% orange juice consumption frequency. There was a significant positive association between mean BMI and sugar-sweetened fruit juice, soft drink consumed during summer, and soft drink consumed during rest of the year. As indicated by the positive beta values, the linear relationship was positive. As beverage consumption frequency increased, mean BMI also increased.

When all the variables were controlled for in the multiple linear regression analysis, fewer significant results were found. There still was no significant association between mean BMI and 100% orange juice consumption frequency. Mean BMI still had a positive relationship with consumption frequency of sugar-sweetened fruit juice and soft drink consumed during summer, but mean BMI was no longer significantly associated to soft drink consumption frequency during rest of year. In fact, multiple linear regression analysis done separately for each beverage variable along with the stepwise linear regression showed that there was collinearity between soft drink consumed during summer and soft drink consumed during rest of the year. It is likely that people who drank a lot of soft drink during the summer also did so during the year.

From the linear regression analyses, one thing of note is that the positive association between mean BMI and soft drink consumption frequency was stronger (beta=.134) than the positive correlation between mean BMI and sugar-sweetened fruit drinks (beta=.056). As can be seen from the figures, the positive correlation between soft drink consumption frequency and mean BMI was quite smooth. The relationship between fruit juice consumption frequency and mean BMI was quite erratic or exhibited no association.

In both the univariate linear regression and multiple linear regression analyses, there was a significant positive association between mean BMI and annual household income for males only. As annual household income increased for males, mean BMI also increased. In the univariate linear regression analysis, there was a significant negative association between mean BMI and education level for females. As education level increased for females, the mean BMI decreased. In all the multiple linear regression analyses, there was a significance positive association between BMI and education level for the total population and for females separately.

The findings of this study suggested that mean BMI is significantly associated with average daily physical activity. In both the univariate linear regression and multiple linear regression analyses, significance was found for total population and for females, but not for males. As indicated by the negative beta values, the linear relationship is negative. As the level of physical activity performed each day increased, the mean BMI decreased. Concerning BMI and weight control, the role of physical activity and exercise may be more important than beverage consumption or diet in general.

The relative risks study was done for 100% orange juice, sugar-sweetened fruit drinks, soda consumed during summer, and soda consumed during rest of year. The results showed that people with a higher beverage consumption frequency had a slightly decreased risk of being overweight but increased risk of being obese. The decreased risk of being overweight could be caused by people moving from the overweight category to the obese category as consumption frequency increased. Using SPSS, odds ratios and relative risks were calculated in the opposite direction, but the results were the same. For all the beverages, it found that people with a lower beverage consumption frequency had increased odds and risk for having normal BMI, but decreased risk for being obese. The risk increases/decreases were larger for soft drinks than for orange juice or sugar-sweetened fruit drinks. Daily physical activity level had the opposite effect on BMI. People with a higher physical activity level had an increased risk of being overweight but a decreased risk of being obese. Using SPSS it was found that people with a lower physical activity level had decreased odds and risk for having normal BMI, and increased risk for being obese.

Literature Support

The findings of this analysis support a previous study by Schulze et al. (2004) that found a positive association between soft drink consumption frequency and BMI. In the study by Schulze et al., it was found that BMI increases were highest for participants who increased their soft drink intake frequency, lowest for participants who decreased their soft drink intake frequency, and stayed the same for participants who had stable beverage consumption. Unlike the study by Schulze et al., which only looked at female adults, this analysis looked at both male and female adults.

The findings of this analysis support a few other studies, even though they utilized a longitudinal study design and children as study population. Berkey et al. (2004) looked at children 9-14, and found that those who consumed additional servings of sugar-sweetened beverages a day had statistically significant BMI increases. Striegel-Moore et al. (2006) looked at girls aged 9-10, and found that non-diet soda intake had a very small but significant association with increased BMI. Phillips et al. (2004) looked at girls aged 8-12, and found that those who had more soda consumption also had higher BMI. Unlike those studies, this analysis was cross-sectional and performed on national data, representing a large and diverse population of adults 20 years or older. O'Connor et al. (2006) also used a cross-sectional design but looked at children aged 2-5, and found that sugar-sweetened beverage consumption was associated with total energy intake, but not BMI. Generalizations of studies between children and adult are limited because of physiological differences of the two populations. Unlike adults, children are still growing and their bodies may respond to food and beverages differently.

Limitations

Results from this study indicate the difficulty in studying diet and beverage consumption. Because the FFQ is a self-administered questionnaire, it is limited by human error, judgment, memory, and truthfulness. As a 24-hour dietary recall, it is subject to under or over-reporting. It may not be representative of what the subject consumes from day to day over the course of a year. The FFQ only asks the frequency of consumption, so the results of this study apply only to the correlation between frequency (not quantity or volume) of consumption and BMI. Subjects could potentially interpret frequency differently. For example, drinking from the same glass twice a day could be interpreted as drinking once a day by one person and drinking twice a day by another. The actual amount drank can also be different. For example, one person drinking a 12 oz can of soda and another person drinking a 20 oz bottle of soda could both have counted their drinking frequency as one. One way to control for this bias is to have questions worded more specifically.

Often there is not a direct relationship between diet and weight or BMI. There are a lot of confounding variables, including genetics and environmental factors. As indicated by the multiple linear regression analysis, after confounding variables were controlled for the association between beverage consumption and BMI became less significant. Despite adjusting for controls, it is extremely difficult to tease out the effects of other foods and beverages on BMI. Although the results of this study show a significant relationship between BMI and consumption frequency of certain beverages, it is possible that a subject who drank more frequently also consumed more calories from other sources. It would be impractical to try to control for everything the subject consumed over the course of a year. Some studies have tried to overcome this problem by controlling for total calorie intake.

Another limitation of this study concerns its cross-sectional design by utilizing NHANES data. The present study cannot be used to suggest causation between beverage consumption and BMI changes, but only associations can be made. Whether one variable preceded the other in time also cannot be known. An advantage of using NHANES data, however, is that the results are more representative of the U.S. population and can be generalized more easily. The financial cost and time investment of doing such a study is also relatively low compared to experimental studies.

Some variables controlled for in this study, such as smoking status, alcohol consumption, and physical activity, are measured in many ways through the NHANES questionnaires. The present study only utilized one measurement for each variable for convenience. For smoking status, the measurement used was chosen because it had the most response data. Having smoked 100 cigarettes in a lifetime, however, may not indicate whether or not the subject is a current smoker. For alcohol consumption, the measurement was chosen because it had the most response data. Drinking 12 alcoholic beverages per one year, however, may not indicate whether or not someone is a drinker. For physical activity, the measurement was also chosen because it had the most response data. Daily physical activity level, however, only measured activities related to daily life or work. It did not include activities considered exercise or recreation. A better measure would also include the frequency and intensity of regular exercise.

Recommendations

As obesity rates continue to increase, obesity reduction remains an important goal for public health in the next couple decades. The Dietary Guidelines for Americans 2010 stress the importance of regular physical activity and a healthy diet, while limiting the consumption of certain foods like sodium, saturated fats, trans fats, cholesterol, added sugars, refined grains, alcohol, and sugar-sweetened beverages (USDA, 2010). It has been suggested that eating whole fruits is better than drinking juices, and drinking 100% juices is better than drinking sugar-sweetened fruit drinks and beverages. In fact several studies have been done to investigate the effects of reducing sugar-sweetened beverage consumption on obesity. One randomized and controlled behavioral intervention trial found that a reduction in liquid calorie intake from sugar-sweetened beverages had a stronger effect on weight loss than did a reduction in solid calorie intake (Chen et al., 2009).

The importance of beverage consumption as part of normal diet has motivated the Beverage Guidance Panel to develop a guidance system for beverage consumption. According to the guide, drinking water should be the preferred beverage to fulfill daily water needs, followed by tea and coffee, low fat (1.5% or 1%) and skim (nonfat) milk and soy beverages, non-calorically sweetened beverages, beverages with some nutritional benefits (fruit and vegetables juices, whole milk, alcohol, and sports drinks), and finally sugar-sweetened, nutrient-poor beverages. The Beverage Guidance Panel recommends that beverages with few or no calories added should be chosen for consumption over more energy-dense beverages. (Popkin et al., 2006)

One strategy to lower BMI is to reduce portion size of foods and beverages consumed. By choosing foods with lower energy density but larger food weight or volume, consumers can reduce energy intake *and* eat satisfying portions. Emphasis should be placed not only on limiting the consumption of foods high in energy density, but also on increasing the consumption of foods low in energy density, such as fruits and vegetables. (Ledikwe et al., 2005) A more comprehensive strategy is to lobby for changes in the farm bill so that processed foods do not remain cheaper than fruits and vegetables. Processed foods with high energy density and sugar content should not become the main diet of the U.S. population. (Pollan, 2007)

Nationwide programs, such as increasing taxes or regulations on certain foods and beverages, could prove beneficial. One study looked at policies used in schools to reduce consumption of sugar-sweetened beverages by students. The strongest policies were statewide legislative mandates implemented explicitly by an administrative agency. The most effective policies were those that prohibited sales of all sugar-sweetened beverages, imposed portion limits, applied throughout the school day, and applied to all grade levels, with age adjustments for container sizes. Voluntary guidelines for the beverage industry to self-regulate their sales and marketing at schools were not as effective. To improve the efficacy of legislation, public school systems and government agencies can work with the beverage industry to provide more healthy products at schools while maintaining sales. (Mello et al., 2007) Similar legislation can work in other areas outside of school as well. To be effective changes are needed in consumer diet choices, attitudes toward nutrition, items offered at restaurants and stores, industry sales and marketing strategies, food production processes, and the overarching food culture in the U.S. society.

Future Studies

Rates of overweight and obesity continue to increase in the United States and around the world. Changes in diet and increases in sugar-sweetened beverage consumption play a critical role in affecting people's weight. Due to potential biases of the present study, further studies investigating the relationship between sugar-sweetened beverage consumption and BMI need to be done. They should take into account total energy intake and consumption of other foods. Other types of sugar-sweetened beverages should be studied too, including milk, tea, coffee, sports drinks, alcohol, etc.

According O'Connor et al. (2006), when studying the children population, future studies should include various age and ethnic groups, and should follow the children longitudinally during critical periods of excessive weight gain. More studies need to be done concerning the adult population also, since they consumed the most soft drinks and other sugar-sweetened beverages. As mentioned by Pereira (2006), only high-quality randomized trials or experimental studies will provide the necessary data to accurately evaluate the link between changes in sugar-sweetened beverage intake and obesity risk. Future studies should also focus on the biological mechanisms of weight gain from consuming sugar-sweetened beverages, in order to establish concrete evidence for the associations between beverage consumption and BMI.

REFERENCES

Almiron-Roig E, Chen Y, Drewnowski A (2003). Liquid calories and the failure of satiety: how good is the evidence? *Obesity Reviews, 4,* 201–212.

Anon (2005). OECD Factbook: Economic, Environmental and Social Statistics. Organization for Economic Co-operation and Development.

Bachman CM, Baranowski T, Nicklas TA (2006). Is there an association between sweetened beverages and adiposity? *Nutrition Reviews*, *64,* 153–174.

Bawa S (2005). The role of the consumption of beverages in the obesity epidemic. *Journal of the Royal Society of Health (J R Soc Health), 125,* 124–128.

Berkey C, Rockett H, Field A, Gillman M, Colditz G (2004). Sugar-added beverages and adolescent weight change. *Obesity Research, 12(5),* 778-788.

Beverages (2011, May). Sugar Stacks. Retrieved from http://www.sugarstacks.com/beverages.htm.

Bleich S, Cutler D, Murray C, Adams A (2008). Why is the developed world obese?. *Annual Review of Public Health, 29,* 273–95. Retrieved from http://arjournals.annualreviews.org/doi/abs/10.1146/annurev.publhealth.29.020907.090954

Bleich S, Wang CY, Wang Y, Gortmaker SL (2009). Increasing consumption of sugar-sweetened beverages among US adults: 1988-1994 to 1999-2004. *The American Journal of Clinical Nutrition, 89, 372-381*. Retrieved from http://www.ajcn.org/cgi/content/full/89/1/372

Blum J, Jacobsen D, Donnelly J. (2005). Beverage consumption patterns in elementary school aged children across a two-year period. *Journal of the American College of Nutrition, 24(2),* 93-98.

Bray GA (2004). Medical consequences of obesity. *The Journal of Clinical Endocrinology & Metabolism, 89(6),* 2583–9. Retrieved from http://jcem.endojournals.org/cgi/content/abstract/89/6/2583

Bray GA, Nielsen SJ, Popkin BM. (2004). Consumption of high fructose corn syrup in beverages may play a role in the epidemic of obesity. *The American Journal of Clinical Nutrition, 79,* 537–543. Retrieved from http://www.ajcn.org/content/79/4/537.full

Caballero B (2007). The global epidemic of obesity: An overview. *Epidemiologic Reviews 29,* 1–5. Retrieved from http://epirev.oxfordjournals.org/cgi/content/extract/29/1/1

Calorie Count (2011). Milk. Retrieved from http://caloriecount.about.com/calories-milk-ic0105

Canty DJ, Chan MM (1991). Effects of consumption of caloric vs noncaloric sweet drinks on indices of hunger and food consumption in normal adults. *The American Journal of Clinical Nutrition, 53,* 1159–64.

CDC (2006). Does Drinking Beverages with Added Sugars Increase the Risk of Overweight? Retrieved from http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/r2p_sweetend_beverages.pdf

CDC (2009). Overweight and Obesity. Retrieved from http://www.cdc.gov/obesity/

CDC (2008). Prevalence of overweight, obesity and extreme obesity among adults: United States, trends 1960-62 through 2005-2006. National Center for Health Statistics. Retrieved from http://www.cdc.gov/nchs/data/hestat/overweight/overweight_adult.htm

CDC (2008). Dietary Screener Module (DTQ) Questionnaire: MEC. NHANES 2009-2010. Retrieved from http://www.cdc.gov/nchs/data/nhanes/nhanes_09_10/mi_dtq_f.pdf

CDC (2011). National Health and Nutrition Examination Survey (NHANES). Retrieved from http://www.cdc.gov/nchs/nhanes.htm

Chen L, Appel LJ, Loria C, Lin PH, Champagne CM, Elmer PJ, Ard JD, Mitchell D, Batch BC, Svetkey LP, Caballero B (2009). Reduction in consumption of sugar-sweetened beverages is associated with weight loss: the PREMIER trial. *The American Journal of Clinical Nutrition, 89(5),* 1299-2306. Retrieved from http://www.ajcn.org/content/89/5/1299.full

Choi HK, Curhan G (2008). Soft drinks, fructose consumption, and the risk of gout in men: prospective cohort study. *British Medical Journal BMJ, 336(7639)*, 309-. Retrieved from http://www.bmj.com/content/336/7639/309.full

Clauson A (2000, September). Spotlight on national food spending. *Food Review,* 15–17.

DiMeglio D, Mattes R. (2000). Liquid versus solid carbohydrate: effects on food intake and body weight. *International Journal of Obesity and Related Metabolic Disorders, 24(6),* 794-800.

Drewnowski A (2009). Obesity, diets, and social inequalities. *Nutrition Reviews, 67(s1),* S36-S39. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1753-4887.2009.00157.x/full

Drewnowski A, Bellisle (2007). Liquid calories, sugar, and body weight. *The American Journal of Clinical Nutrition, 85(3),* 651–661. Retrieved from http://www.ajcn.org/content/85/3/651.long

Drewnowski A, Specter SE (2004). Poverty and obesity: the role of energy density and energy costs. *The American Journal of Clinical Nutrition, 79(1),* 6–16. Retrieved from http://www.ajcn.org/cgi/content/full/79/1/6

Duffey KJ, Popkin BM (2007). Shifts in patterns and consumption of beverages between 1965 and 2002. *Obesity (Silver Spring), 15*, 2739–2747.

Ernst ND, Obarzanek E, Clark MB, Briefel RR, Brown CD, Donato K (1997). Cardiovascular health risks related to overweight. *Journal of the American Dietetic Association, 97(suppl),* S47--S51.

FAO (2009). Compendium of food and agriculture indicators - 2006. *Food and Agriculture Organization of the United Nations.* Retrieved from http://www.fao.org/statistics/compendium_2006/list.asp.

FAO (2009). Calories per capita per day (gif). *UN Food and Agriculture Organization.* Retrieved from http://www.fao.org/statistics/chartroom/chart.asp?image=img/charts/fbs/chart08.gif.

Foster-Powell K, Holt SHA, Brand-Miller JC (2002). International table of glycemic index and glycemic load values: 2002. *American Journal of Clinical Nutrition, 76(1),* 5-56. Retrieved from http://www.ajcn.org/content/76/1/5.full

Giammattei J, Blix G, Marshak HH, Wollitzer AO, Pettitt DJ (2003). Television watching and soft drink consumption: associations with obesity in 11- to 13-year-old schoolchildren. *Archives of Pediatrics & Adolescent Medicine, 157,* 882–886.

Grundy SM (2004). Obesity, metabolic syndrome, and cardiovascular disease. *The Journal of Clinincal Endocrinology & Metabolism, 89(6),* 2595–600.

Harnack L, Stang J, Story M (1999). Soft drink consumption among US children and adolescents: nutritional consequences. *Journal of the American Dietetic Association, 99*, 436–441.

Haslam DW, James WP. (2005, October). Obesity. *Lancet, 366(9492),* 1197-1209. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0140673605674831

Hogbin MB, Hess MA. (1999). Public confusion over food portions and servings. *Journal of the American Dietetic Association, 99(10),* 1209-11. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10524382

Isganaitis E, Lustig RH. (2005) Fast food, central nervous system insulin resistance, and obesity. *Arteriosclerosis, Thrombosis, and Vascular Biology, 25,* 2451–2462.

James WP (March 2008). The fundamental drivers of the obesity epidemic. *Obesity Reviews, 9 Suppl 1,* 6–13. Retrieved from http://www3.interscience.wiley.com/journal/119421184/abstract?CRETRY=1&SRETRY=0#ss2

Jeffery RW, Baxter J, McGuire M, Linde J. (2006) Are fast food restaurants an environmental risk factor for obesity? *The International Journal of Behavioral Nutrition and Physical Activity, 3,* 2.

Kral TV, Roe LS, Rolls BJ. (2004). Combined effects of energy density and portion size on energy intake in women. *The American Journal of Clinical Nutrition, 79(6),* 962-8. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15159224

Lau DC, Douketis JD, Morrison KM, Hramiak IM, Sharma AM, Ur E (April 2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *Canadian Medical Association Journal CMAJ, 176(8),* S1–13.

Ledikwe JH, Ello-Martin JA, Rolls BJ (April 2005). Portion sizes and the obesity epidemic. *The Journal of Nutrition. 135(4),* 905–9. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15795457

Lesser LI, Ebbeling CB, Goozner M, Wypij D, Ludwig DS. (2007). Relationship between funding source and conclusion among nutrition-related scientific articles. *PLoS Medicine, 4,* e5.

Liebman M, Pelican S, Moore SA, Holmes B, Wardlaw MK, Melcher LM et al. (2003). Dietary intake, eating behavior, and physical activity-related determinants of high body mass index in rural communities in Wyoming, Montana, and Idaho. *International Journal of Obesity (Int J Obes Relat Metab Disord), 27,* 684–692.

Lin BH, Guthrie J and Frazao E (1999). Nutrient contribution of food away from home. in Frazão E. Agriculture Information Bulletin No. 750: America's Eating Habits: Changes and Consequences. *Washington, DC: US Department of Agriculture,* *Economic Research Service*, 213–239. Retrieved from http://www.ers.usda.gov/publications/aib750/.

List of preventable causes of death (2009). Wikipedia. Retrieved from http://en.wikipedia.org/wiki/Preventable_causes_of_death

Lochhead C (2007). Huge farm bill offers more of same for agribusiness: Draft before House fails to limit big crop subsidies. *Chronicle Washington Bureau.* Retrieved from http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2007/07/26/MNG9AR6V6S1.DTL&type=printable

Lopez AD et al. (2006). Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *The Lancet, 367(9524),* 1747-1757. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0140673606687709

Ludwig D, Peterson K, Gortmaker S. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *The Lancet, 357(9255),* 505-508.

Malik VS, Schulze MB, Hu FB (2006, August). Intake of sugar-sweetened beverages and weight gain: a systematic review. *The American Journal of Clinical Nutrition, 84(2),* 274–88. Retrieved from http://www.ajcn.org/cgi/content/full/84/2/274

Malik VS, Popkin BM, Bray GA, Despres JP, Willett WC, Hu FB (2010). Sugar Sweetened Beverages and Risk of Metabolic Syndrome and Type 2 Diabetes: A Meta-analysis. *Diabetes Care, 33(11),* 2477-2483. Retrieved from http://care.diabetesjournals.org/content/33/11/2477.full

Melanson KJ, Angelopoulos TJ, Nguyen V, Zukley L, Lowndes J, Rippe JM (2008). High-fructose corn syrup, energy intake, and appetite regulation. *American*

Journal of Clinical Nutrition, 88(6), 1738S-1744S. Retrieved from http://www.ajcn.org/content/88/6/1738S.full

Mello MM, Pomeranz J, Moran P (2007). The interplay of public health law and industry self-regulation: the case of sugar-sweetened beverage sales in schools. *American Journal of Public Health, 98(4),* 595-604. Retrieved from http://ajph.aphapublications.org/cgi/content/full/98/4/595

Mokdad AH et al. (2004). Actual causes of death in the United States, 2000. *The Journal of the American Medical Association JAMA, 291(10),* 1238-1245. Retrieved from http://jama.ama-assn.org/cgi/content/abstract/291/10/1238

Mølgaard C, Andersen NL, Barkholt V, Grunnet N, Hermansen K, Nyvad B, Pedersen BK, Raben A, Stender S (2003). The influence of sugar on health. *Ernæringsrådet.*

Mueller NT, Odegaard A, Anderson K, Yuan JM, Gross M, K WP, Pereira MA (2010). Soft drink and juice consumption and risk of pancreatic cancer: the Singapore Chinese Health Study. *Cancer Epidemiology, Biomarkers & Prevention, 19(2),* 447-55. Retrieved from http://cebp.aacrjournals.org/content/19/2/447.full

Murray RK, Granner DK, Rodwell VW (2003). *Harper's Illustrated Biochemistry 27th Edition.* New York: Lange Medical Books/McGraw Hill.

National Restaurant Association (2005). Quick Service Restaurant Trends. *National Restaurant Association,* Washington DC.

Nestle M, Jacobson MF (2000). Halting the obesity epidemic: A public health policy approach. *Public Health Reports, 115(1),* 12–24. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1308552/?tool=pmcentrez

Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. (2004). Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota. *Journal of the American Dietetic Association, 104(7),* 1086-1094.

Nicklas TA, O'Neil CE, Kleinman R (2008). Association between 100% juice consumption and nutrient intake and weight of children aged 2 to 11 years. *Archives of Pediatrics & Adolescent Medicine, 162(6),* 557-565. Retrieved from http://archpedi.ama-assn.org/cgi/content/full/162/6/557

Nicklas TA, Yang SJ, Baranowski T, Zakeri I, Berenson G (2003). Eating patterns and obesity in children. The Bogalusa Heart Study. *American Journal of Preventive Medicine, 25,* 9–16.

Nielsen SJ, Popkin BM (2004). Changes in beverage intake between 1977 and 2001. *American Journal of Preventive Medicine*, 27, 205–210.

O'Connor TM, Yang SJ, Nicklas TA. (2006). Beverage Intake Among Preschool Children and Its Effect on Weight Status. *Pediatrics, 118(4),* e1010-e1018. Published online October 2, 2006. Retrieved from http://pediatrics.aappublications.org/cgi/content/full/118/4/e1010

Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM (2006). Prevalence of overweight and obesity in the United States, 1999–2004. *Journal of the American Medical Association JAMA, 295(13),* 1549–55. Retrieved from http://jama.ama-assn.org/content/295/13/1549

Olsen NJ, Heitmann BL (January 2009). Intake of calorically sweetened beverages and obesity. *Obesity Reviews, 10(1),* 68–75. Retrieved from http://www3.interscience.wiley.com/journal/121392571/abstract?CRETRY=1&SRETRY=0

O'Neil CE, Nicklas TA (2008). A review of the relationship between 100% fruit juice consumption and weight in children and adolescent. *American Journal of Lifestyle Medicine, 2(4),* 315-354. Retrieved from http://ajl.sagepub.com/content/2/4/315

Pereira MA (2006). The possible role of sugar-sweetened beverages in obesity etiology: a review of the evidence. *International Journal of Obesity (Lond), 30(Suppl. 3),* S28–S36. Retrieved from http://www.nature.com/ijo/journal/v30/n3s/full/0803489a.html

Pereira MA, Kartashov AI, Ebbeling CB, Van Horn L, Slattery ML, Jacobs DR Jr, Ludwig DS. (2005). Fast-Food Habits, Weight Gain, and Insulin Resistance (the CARDIA Study): 15-year prospective analysis. *The Lancet, 365,* 36–42.

Phillips S, Bandini L, Naumova E, et al. (2004) Energy-dense snack food intake in adolescence: longitudinal relationship to weight and fatness. *Obesity Research, 12(3),* 461-472.

Pollan, Michael (2007, April 22). You Are What You Grow. *New York Times.* Retrieved from http://www.nytimes.com/2007/04/22/magazine/22wwlnlede.t.html?ex=1186027200&en=bbe0f6a2c10e3b3c&ei=5070.

Popkin BM, Armstrong LE, Bray GM, Caballero B, Frei B, Willett WC (2006). A new proposed guidance system for beverage consumption in the United States. *American Journal of Clinical Nutrition, 83(3),* 529-542. Retrieved from http://www.ajcn.org/content/83/3/529.full

Popkin BM and Nielsen SM (2003). The sweetening of the world's diet. *Obesity Research, 11,* 1325–1332. Retrieved from http://www.nature.com/oby/journal/v11/n11/abs/oby2003179a.html

Rosenheck R (November 2008). Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obesity Reviews, 9(6),* 535–47. Retrieved from http://www3.interscience.wiley.com/journal/120125875/abstract?CRETRY=1&SRETRY=0

Rysdale LA, Brunelle PL, Simpson JR, Knee CA, Keller HH (2009). Evaluation of fruit juice intake and body mass index within a sample of Ontario preschoolers. *Infant, Child, & Adolescent Nutrition, 1(3),* 170-175. Retrieved from http://can.sagepub.com/content/1/3/170.abstract

Schulze M, Manson J, Ludwig D, et al. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *Journal of the American Medical Association JAMA, 292(8),* 927-934.

Steenhuis IH, Vermeer WM (2009). Portion size: review and framework for interventions. *The International Journal of Behavioral Nutrition and Physical Activity, 6,* 58. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2739837/?tool=pmcentrez

Striegel-Moore RH, Thompson D, Affenito SG, et al. (2006). Correlates of beverage intake in adolescent girls: The National Heart, Lung, and Blood Institute Growth and Health Study. *Journal of Pediatrics, 148(2),* 183-187.

Tappy L, Le KA (2010). Metabolic Effects of Fructose and the Worldwide Increase in Obesity. *Physiological Reviews, 90(1),* 23-46. Retrieved from http://physrev.physiology.org/content/90/1/23.full

Tordoff MG, Alleva AM. (1990). Effect of drinking soda sweetened with aspartame or high-fructose corn syrup on food intake and body weight. *The American Journal of Clinical Nutrition, 51(6),* 963-969.

Troiano RP, Briefel RR, Carroll MD, Bialostosky K (2000). Energy and fat intakes of children and adolescents in the United States: data from the national health and nutrition examination surveys. *The American Journal of Clinical Nutrition, 72 (5 Suppl),* 1343S–1353S.

U.S Department of Agriculture and U.S. Department of Health and Human Service, USDA (2010). *Dietary guideline for Americans, 2010.* 7th Edition, Washington DC: U.S. Government Printing Office. Retrieved from http://www.health.gov/DietaryGuidelines/

USDA (2004). Indicators. *Agricultural Outlook,* 2(1). Retrieved from http://www.ers.usda.gov/Amberwaves/April04/pdf/indicators.pdf, www.ers.usda.gov/publications/AgOutlook

Vartanian LR, Schwartz MB, Brownell KD. (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health, 97,* 667–675.

Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. (2005). Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999-2002. *Pediatrics, 115(2),* e223-

e229. Retrieved from http://pediatrics.aappublications.org/cgi/content/full/115/2/e223?ijkey=7e23d62e4e36a12d9fa218035ddf50ad60248bde

Whitlock G, Lewington S, Sherliker P, et al. (March 2009). Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet, 373(9669),* 1083–96. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2662372/?tool=pmcentrez

WHO (2009). Obesity. Retrieved from http://www.who.int/topics/obesity/en/, http://www.who.int/en/

WHO (2009). Obesity and overweight. World Health Organization. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/index.html

Wright JD, Kennedy-Stephenson J, Wang CY, McDowell MA, Johnson CL (2004, February). Trends in intake of energy and macronutrients—United States, 1971–2000. *CDC MMWR Morbidity and Mortality Weekly Report, 53(4),* 80–2. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5304a3.htm

Wright JD, Wang CY (2010). Trends in Intake of Energy and Macronutrients in Adults From 1999-2000 Through 2007-2008. *CDC/National Center for Health Statistics NCHS Data Brief 49.* Retrieved from http://www.cdc.gov/nchs/data/databriefs/db49.htm

Yoshida M, McKeown NM, Rogers G, Meigs JB, Saltzman E, D'Agostino R, Jacques PF (2007). Surrogate markers of insulin resistance are associated with consumption of sugar-sweetened drinks and fruit juice in middle and older-aged adults. *Journal* *of Nutrition, American Society for Nutrition, 137,* 2121-2127. Retrieved from http://jn.nutrition.org/content/137/9/2121.full

Zernel MB (2005) Calcium and diary modulation of obesity risk. *Obesity Research, 13(1),* 192-193. Retrieved from http://www.nature.com/oby/journal/v13/n1/full/oby200526a.html

APPENDIX

Table 1. Descriptive Statistics

	Number	%	Mean BMI (95% CI)	Normal (%)	Overweight (%)	Obese (%)
All	4808	100	28.36 (28.18-28.55)	1416 (32.0)	1564 (35.3)	1451 (32.7)
Gender						
Male	2418	50.3	27.94 (27.72-28.17)	686 (30.7)	893 (39.9)	658 (29.4)
Female	2390	49.7	28.79 (28.50-29.09)	730 (33.3)	671 (30.6)	793 (36.1)
Age						
20-29	774	16.1	27.08 (26.59-27.58)	342 (46.7)	193 (26.3)	198 (27.0)
30-39	737	15.3	28.37 (27.87-28.86)	239 (34.9)	222 (32.5)	223 (32.6)
40-49	787	16.4	29.25 (28.79-29.72)	187 (25.2)	276 (37.1)	280 (37.7)
50-59	609	12.7	29.36 (28.81-29.90)	151 (26.6)	198 (34.9)	219 (38.6)
60-69	773	16.1	29.41 (28.98-29.84)	163 (22.9)	266 (37.4)	282 (39.7)
70-79	611	12.7	28.16 (27.73-28.59)	156 (27.7)	239 (42.5)	168 (29.8)
≥80	517	10.8	26.21 (25.80-26.63)	178 (41.5)	170 (39.6)	81 (18.9)
Race/Ethnicity						
Mexican Americans	923	19.2	28.88 (28.51-29.25)	213 (24.4)	346 (39.6)	314 (36.0)
Other Hispanics	147	3.1	27.55 (26.75-28.35)	45 (33.6)	56 (41.8)	33 (24.6)
Non-Hispanic Whites	2573	53.5	27.81 (27.57-28.05)	835 (35.4)	829 (35.2)	693 (29.4)
Non-Hispanic Blacks	956	19.9	30.00 (29.52-30.48)	221 (25.2)	279 (31.8)	376 (42.9)
Other Race – Including Multi-Racial	209	4.3	25.87 (25.01-26.72)	102 (53.4)	54 (28.3)	35 (18.3)
Education Level						
Less Than 9th Grade	709	14.7	28.06 (27.65-28.47)	191 (29.3)	259 (39.7)	202 (31.0)
9-11th Grade (Includes 12th grade with no diploma)	721	15.0	28.08 (28.29-29.32)	206 (31.5)	216 (33.1)	231 (35.4)
High School Grad/GED or Equivalent	1222	25.4	28.74 (28.36-29.11)	339 (30.1)	394 (35.0)	392 (34.8)
Some College or AA degree	1296	27.0	28.57 (28.20-28.94)	380 (31.5)	419 (34.7)	409 (33.9)
College Graduate or above	847	17.6	27.44 (27.03-27.86)	295 (37.6)	273 (34.8)	217 (27.6)
Annual Household Income						
$0 to $4,999	78	1.6	28.60 (27.19-30.01)	21 (29.6)	28 (39.4)	22 (31.0)
$5,000 to $9,999	244	5.1	29.07 (28.10-30.04)	77 (34.5)	61 (27.4)	85 (38.1)
$10,000 to $14,999	447	9.3	28.45 (27.86-29.05)	134 (32.0)	140 (33.4)	145 (34.6)
$15,000 to $19,999	381	7.9	28.03 (27.35-28.70)	125 (36.0)	109 (31.4)	113 (32.6)
$20,000 to $24,999	409	8.5	28.76 (28.12-29.41)	113 (29.4)	143 (37.2)	128 (33.3)
$25,000 to $34,999	629	13.1	28.07 (27.58-28.56)	198 (33.7)	206 (35.1)	183 (31.2)
$35,000 to $44,999	531	11.0	28.76 (28.18-29.35)	144 (30.2)	166 (34.8)	167 (35.0)
$45,000 to $54,999	410	8.5	27.89 (27.33-28.46)	123 (32.2)	144 (37.7)	115 (30.1)
$55,000 to $64,999	253	5.3	28.63 (27.80-29.45)	64 (26.9)	98 (41.2)	76 (31.9)
$65,000 to $74,999	218	4.5	28.17 (27.34-28.99)	66 (32.2)	68 (33.2)	71 (34.6)
$75,000 and Over	845	17.6	28.31 (27.90-28.73)	242 (30.8)	293 (37.3)	251 (31.9)
Smoking Status						
Smoked at least 100 cigarettes in life – Yes	2422	50.4	28.22 (27.97-28.47)	720 (32.1)	811 (36.2)	710 (31.7)
Smoked at least 100 cigarettes in life – No	2381	49.5	28.52 (28.25-28.79)	694 (31.7)	753 (34.4)	741 (33.9)
Daily Physical Activity Level						
Sits during the day and does not walk about very much	1263	26.3	29.16 (28.74-29.58)	328 (29.3)	373 (33.3)	418 (37.4)
Stands or walks about a lot during the day, but does not have to carry or lift things very often	2492	51.8	28.19 (27.95-28.43)	744 (32.1)	836 (36.1)	736 (31.8)
Lifts light load or has to climb stairs or hills often	702	14.6	27.93 (27.47-28.38)	233 (34.8)	234 (35.0)	202 (30.2)
Does heavy work or carries heavy load	347	7.2	27.79 (27.19-28.39)	109 (33.6)	121 (37.3)	94 (29.0)
Alcohol Consumption						
Had at least 12 alcoholic drinks/1 year – Yes	2956	58.8	28.17 (27.94-28.40)	904 (32.4)	1012 (36.3)	875 (31.4)
Had at least 12 alcoholic drinks/1 year – No	1356	27.0	29.12 (28.74-29.49)	363 (29.2)	414 (33.3)	468 (37.6)

Table 2. 100% Orange juice consumption frequency vs. BMI

Frequency Categories	**Number**	**Mean BMI**	**95% Confidence Interval**		**Standard Deviation**	**BMI Categories** Normal	Overweight	Obese
(1) Never	275	27.62	26.89	28.34	6.11	97 35.3%	107 38.9%	71 25.8%
(2) 1 time per month or less	609	28.5	27.99	29.01	6.41	192 31.5%	210 34.5%	207 34.0%
(3) 2-3 time per month	703	28.59	28.12	29.05	6.28	210 29.9%	265 37.7%	228 32.4%
(4) 1-2 times per week	509	28.71	28.16	29.26	6.28	160 31.4%	165 32.4%	184 36.1%
(5) 3-4 times per week	415	28.44	27.78	29.10	6.80	135 32.5%	143 34.5%	137 33.0
(6) 5-6 times per week	206	29.21	28.33	30.09	6.38	51 24.8%	76 36.9%	79 38.3%
(7) 1 time per day	441	27.81	27.31	28.30	5.33	141 32.0%	170 38.5%	130 29.5%
(8) 2-3 times per day	133	29.95	28.77	31.13	6.88	32 24.1%	43 32.3%	58 43.6%
(9) 4-5 times per day	22	31.38	27.63	35.12	8.45	6 27.3%	4 18.2%	12 54.5%
(10) 6 or more times per day	15	30.51	26.00	35.03	8.15	7 46.7%	1 6.7%	7 46.7%
Total	3393	28.53	28.31	28.74	6.31	1045 30.8%	1208 35.6%	1140 33.6%
ANOVA: Mean Square Between Groups: 120.017 Within Groups: 39.645	**F** 3.027	**p-value** .001				**Relative Risk:** (8) / (2) = 32.3 / 34.5 = .936 43.6% / 34.0% = 1.282 Combined = 1.108		

Table 3. 100% Apple Juice consumption frequency vs. BMI

Frequency Categories	**Number**	**Mean BMI**	**95% Confidence Interval**		**Standard Deviation**
(1) Never	1074	28.28	27.90	28.66	6.34
(2) 1 time per month or less	1063	28.45	28.09	28.81	6.04
(3) 2-3 time per month	588	28.52	28.00	29.04	6.43
(4) 1-2 times per week	281	29.11	28.35	29.87	6.45
(5) 3-4 times per week	145	28.71	27.64	29.78	6.49
(6) 5-6 times per week	52	29.71	27.63	31.80	7.48
(7) 1 time per day	65	29.53	27.92	31.14	6.49
(8) 2-3 times per day	43	28.88	26.74	31.02	6.95
(9) 4-5 times per day	12	29.77	24.93	34.61	7.62
(10) 6 or more times per day	12	28.05	23.73	32.38	6.81
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 37.583 Within Groups: 39.891	**F** .942	**p-value** .487			

Table 4. 100% Grape juice consumption frequency vs. BMI

Frequency Categories	**Number**	**Mean BMI**	**95% Confidence Interval**		**Standard Deviation**
(1) Never	1537	28.24	27.92	28.55	6.25
(2) 1 time per month or less	1001	28.58	28.20	28.97	6.18
(3) 2-3 time per month	410	28.80	28.17	29.43	6.51
(4) 1-2 times per week	190	29.56	28.55	30.57	7.06
(5) 3-4 times per week	84	28.46	27.10	29.82	6.26
(6) 5-6 times per week	24	29.72	26.91	32.53	6.66
(7) 1 time per day	55	28.73	26.87	30.59	6.87
(8) 2-3 times per day	23	29.86	27.07	32.66	6.47
(9) 4-5 times per day	9	32.05	27.93	36.17	5.36
(10) 6 or more times per day	4	26.88	21.65	32.10	3.29
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 62.992 Within Groups: 39.987	**F** 1.575	**p-value** .117			

Table 5. Other 100% fruit juice consumption frequency vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation
(1) Never	1091	28.11	27.76	28.46	5.87
(2) 1 time per month or less	1024	28.59	28.19	28.98	6.38
(3) 2-3 time per month	573	29.13	28.59	29.68	6.59
(4) 1-2 times per week	252	27.99	27.22	28.76	6.20
(5) 3-4 times per week	142	29.59	28.38	30.81	7.32
(6) 5-6 times per week	72	29.01	27.32	30.70	7.19
(7) 1 time per day	100	28.09	27.09	29.10	5.07
(8) 2-3 times per day	52	28.38	26.28	30.47	7.52
(9) 4-5 times per day	14	33.62	27.98	39.25	9.76
(10) 6 or more times per day	17	29.78	25.64	33.92	8.06
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 118.558 Within Groups: 39.879	**F** 2.973	**p-value** .002			

Table 6. Sugar-sweetened fruit drink consumption frequency vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation	BMI Categories Normal	Overweight	Obese
(1) Never	817	27.92	27.52	28.31	5.78	266 32.6%	314 38.4%	237 29.0%
(2) 1 time per month or less	759	28.20	27.79	28.62	5.85	246 32.4%	269 35.4%	244 32.1%
(3) 2-3 time per month	619	28.63	28.14	29.13	6.23	177 28.6%	219 35.4%	223 36.0%
(4) 1-2 times per week	377	28.80	28.14	29.46	6.56	113 30.0%	134 35.5%	130 34.5%
(5) 3-4 times per week	249	28.35	27.54	29.16	6.47	80 32.1%	92 36.9%	77 30.9%
(6) 5-6 times per week	143	30.77	29.51	32.02	7.60	30 21.0%	48 33.6%	65 45.5%
(7) 1 time per day	113	28.19	27.02	29.35	6.26	40 35.4%	34 30.1%	39 34.5%
(8) 2-3 times per day	156	30.30	29.02	31.57	8.06	44 28.2%	41 26.3%	71 45.5%
(9) 4-5 times per day	43	28.68	26.04	31.31	8.56	18 41.9%	12 27.9%	13 30.2%
(10) 6 or more times per day	18	31.06	27.37	34.75	7.43	6 33.3%	2 11.1%	10 55.6%
Total	3393	28.53	28.31	28.74	6.31	1045 30.8%	1208 35.6%	1140 33.6%
ANOVA: Mean Square Between Groups: 195.739 Within Groups: 39.694	**F** 4.931	**p-value** <.001				**Relative Risk:** (8) / (2) = 26.3% / 35.4% = .743 45.5% / 32.1% = 1.417 Combined = 1.064		

Table 7. Diet or sugar-free fruit drink consumption frequency vs. BMI

Frequency Categories	**Number**	**Mean BMI**	**95% Confidence Interval**		**Standard Deviation**
(1) Almost never or never	1744	28.14	27.85	28.43	6.17
(2) About ¼ of the time	188	29.94	28.84	31.04	7.65
(3) About ½ of the time	171	30.63	29.53	31.72	7.25
(4) About ¾ of the time	84	29.06	27.56	30.57	6.94
(5) Almost always or always	293	30.47	29.74	31.20	6.34
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 1988.807 Within Groups: 424.802	**F** 4.682	**p-value** <.001			

Table 8. Soft drink consumption frequency (during summer) vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation	BMI Categories Normal	Overweight	Obese
(1) Never	46	27.25	25.82	28.68	4.80	14 30.4%	18 39.1%	14 30.4%
(2) 1 time per month or less	267	26.99	26.32	27.65	5.51	108 40.4%	94 35.2%	65 24.3%
(3) 2-3 time per month	439	28.29	27.74	28.84	5.88	132 30.1%	162 36.9%	145 33.0%
(4) 1-2 times per week	467	28.32	27.77	28.88	6.09	140 30.0%	195 41.8%	132 28.3%
(5) 3-4 times per week	459	28.44	27.86	29.01	6.28	147 32.0%	159 34.6%	153 33.3%
(6) 5-6 times per week	241	28.65	27.89	29.42	6.03	68 28.2%	82 34.0%	91 37.8%
(7) 1 time per day	417	28.89	28.27	29.50	6.37	122 29.3%	146 35.0%	149 35.7%
(8) 2-3 times per day	557	29.88	29.28	30.48	7.20	142 25.5%	178 32.0%	237 42.5%
(9) 4-5 times per day	132	29.06	27.84	30.28	7.09	43 32.6%	39 29.5%	50 37.9%
(10) 6 or more times per day	67	30.11	28.38	31.84	7.09	19 28.4%	19 28.4%	29 43.3%
Total	3393	28.53	28.31	28.74	6.31	1045 30.8%	1208 35.6%	1140 33.6%
ANOVA: Mean Square Between Groups: 221.438 Within Groups: 40.216	**F** 5.506	**p-value** <.001				**Relative Risk:** (8) / (2) = 32.0% / 35.2% = .909 42.5% / 24.3% = 1.749 Combined = 1.252		

Table 9. Soft drink consumption frequency (during rest of year) vs. BMI

Frequency Categories	**Number**	**Mean BMI**	**95% Confidence Interval**		**Standard Deviation**	**BMI Categories** Normal	Overweight	Obese
(1) Never	126	27.06	26.10	28.03	5.47	44 34.9%	49 38.9%	33 26.2%
(2) 1 time per month or less	405	27.56	27.00	28.12	5.70	146 36.0%	150 37.0%	109 26.9%
(3) 2-3 time per month	478	28.44	27.92	28.97	5.88	141 29.5%	175 36.6%	162 33.9%
(4) 1-2 times per week	461	28.56	27.99	29.13	6.23	129 28.0%	190 41.2%	142 30.8%
(5) 3-4 times per week	378	28.34	27.72	28.97	6.16	119 31.5%	136 36.0%	123 32.5%
(6) 5-6 times per week	212	28.94	28.06	29.82	6.50	64 30.2%	64 30.2%	84 39.6%
(7) 1 time per day	402	29.12	28.48	29.76	6.48	115 28.6%	134 33.3%	153 38.1%
(8) 2-3 times per day	463	29.94	29.28	30.59	7.16	117 25.3%	149 32.2%	197 42.5%
(9) 4-5 times per day	103	28.89	27.50	30.28	7.13	35 34.0%	31 30.1%	37 35.9%
(10) 6 or more times per day	64	29.13	27.22	31.04	7.64	23 35.9%	18 28.1%	23 35.9%
Total	3393	28.53	28.31	28.74	6.31	1045 30.8%	1208 35.6%	1140 33.6%
ANOVA: Mean Square Between Groups: 194.293 Within Groups: 40.179	**F** 4.836	**p-value** <.001				**Relative Risk:** (8) / (2) = 32.2% / 37.0 = .870 42.5% / 26.9% = 1.580 Combined = 1.169		

Table 10. Diet or sugar-free soft drink consumption frequency vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation
(1) Almost never or never	1794	27.88	27.60	28.17	6.08
(2) About ¼ of the time	226	29.49	28.66	30.31	6.30
(3) About ½ of the time	195	30.14	29.16	31.12	6.96
(4) About ¾ of the time	138	29.89	28.83	30.94	6.29
(5) Almost always or always	735	29.73	29.24	30.21	6.68
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 3576.804 Within Groups: 410.828	**F** 8.706	**p-value** $<.001$			

Table 11. Caffeine-free soft drink consumption frequency vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation
(1) Almost never or never	1692	28.29	27.99	28.58	6.24
(2) About ¼ of the time	433	29.01	28.41	29.62	6.43
(3) About ½ of the time	303	29.37	28.58	30.16	6.99
(4) About ¾ of the time	157	29.57	28.53	30.61	6.60
(5) Almost always or always	488	28.97	28.42	29.51	6.18
Total	3393	28.53	28.31	28.74	6.31
ANOVA: Mean Square Between Groups: 450.940 Within Groups: 414.600	**F** 1.088	**p-value** .361			

Table 12. Average daily physical activity level vs. BMI

Frequency Categories	Number	Mean BMI	95% Confidence Interval		Standard Deviation	BMI Categories Normal	Overweight	Obese
(1) Sits during the day and does not walk about very much	1119	29.16	28.74	29.58	7.15	328 29.3%	373 33.3%	418 37.4%
(2) Stands or walks about a lot during the day, but does not have to carry or lift things very often	2316	28.19	27.95	28.43	5.92	744 32.1%	836 36.1%	736 31.8%
(3) Lifts light load or has to climb stairs or hills often	669	27.93	27.47	28.38	6.00	233 34.8%	234 35.0%	202 30.2%
(4) Does heavy work or carries heavy load	324	27.79	27.19	28.39	5.46	109 33.6%	121 37.3%	94 29.0%
Total	4431	28.36	28.18	28.55	6.25	1416 32.0%	1564 35.3%	1451 32.7%
ANOVA: Mean Square Between Groups: 253.546 Within Groups: 38.814	**F** 6.532	**p** <.001				**Relative Risk:** (4) / (1) = 37.3% / 33.3% = 1.120 29.0% / 37.4% = .775 Combined = .938		

Table 13. Univariate linear regression of each variable vs. mean BMI

Independent Variable	Beta Value	p Value	R	R^2
All				
Gender	.068	<.001	.068	.005
Age	.002	.910	.002	.000
Age Categories	-.002	.894	.002	.000
Race/Ethnicity	-.011	.481	.011	.000
Education Level	-.034	.022	.034	.001
Annual Household Income	-.003	.856	.003	.000
Smoking Status	.017	.270	.017	.000
Daily Physical Activity Level	-.067	<.001	.067	.004
Alcohol Consumption	.063	<.001	.063	.004
100% Orange Juice consumption frequency	.030	.088	.030	.001
Sugar-sweetened fruit drink consumption frequency	.086	<.001	.086	.007
Soft drink consumption frequency (during summer)	.113	<.001	.113	.013
Soft drink consumption frequency (during rest of year)	.104	<.001	.104	.011
Male				
Age	-.002	.942	.002	.000
Age Categories	-.003	.904	.003	.000
Race/Ethnicity	-.025	.241	.025	.001
Education Level	.037	.081	.037	.001
Annual Household Income	.058	.008	.058	.003
Smoking Status	.038	.075	.038	.001
Daily Physical Activity Level	-.018	.401	.018	.000
Alcohol Consumption	.028	.210	.028	.001
100% Orange Juice consumption frequency	.016	.516	.016	.000
Sugar-sweetened fruit drink consumption frequency	.070	.005	.070	.005
Soft drink consumption frequency (during summer)	.085	.001	.085	.007
Soft drink consumption frequency (during rest of year)	.064	.012	.064	.004
Female				
Age	-.001	.973	.001	.000
Age Categories	-.007	.749	.007	.000
Race/Ethnicity	-.001	.969	.001	.000
Education Level	-.095	<.001	.095	.009
Annual Household Income	-.046	.036	.046	.002
Smoking Status	-.023	.282	.023	.001
Daily Physical Activity Level	-.102	<.001	.102	.010
Alcohol Consumption	.055	.014	.055	.003
100% Orange Juice consumption frequency	.039	.105	.039	.002
Sugar-sweetened fruit drink consumption frequency	.094	<.001	.094	.009
Soft drink consumption frequency (during summer)	.142	<.001	.142	.020
Soft drink consumption frequency (during rest of year)	.142	<.001	.142	.020

Table 14a. Multiple linear regression of all variables vs. mean BMI

Independent Variable	Beta Value	p Value	R	R^2
All			.194	.038
Gender	.037	.066		
Age	-.008	.703		
Race/Ethnicity	.040	.043		
Education Level	-.066	.001		
Annual Household Income	.029	.142		
Smoking Status	.020	.307		
Daily Physical Activity Level	-.091	<.001		
Alcohol Consumption	.028	.163		
100% Orange Juice consumption frequency	.011	.561		
Sugar-sweetened fruit drink consumption frequency	.056	.004		
Soft drink consumption frequency (during summer)	.134	.001		
Soft drink consumption frequency (during rest of year)	-.005	.908		
Male			.151	.023
Age	.007	.826		
Race/Ethnicity	.016	.583		
Education Level	-.028	.346		
Annual Household Income	.075	.008		
Smoking Status	.054	.054		
Daily Physical Activity Level	-.039	.174		
Alcohol Consumption	.009	.735		
100% Orange Juice consumption frequency	-.012	.666		
Sugar-sweetened fruit drink consumption frequency	.043	.122		
Soft drink consumption frequency (during summer)	.139	.017		
Soft drink consumption frequency (during rest of year)	-.043	.469		
Female			.243	.059
Age	-.021	.481		
Race/Ethnicity	.052	.060		
Education Level	-.082	.005		
Annual Household Income	-.015	.567		
Smoking Status	-.011	.693		
Daily Physical Activity Level	-.131	<.001		
Alcohol Consumption	.038	.171		
100% Orange Juice consumption frequency	.026	.342		
Sugar-sweetened fruit drink consumption frequency	.061	.027		
Soft drink consumption frequency (during summer)	.133	.023		
Soft drink consumption frequency (during rest of year)	.014	.816		

Table 14b. Multiple linear regression of 100% orange juice vs. mean BMI

Independent Variable	**Beta Value**	**p Value**	**R**	**R^2**
All			.139	.019
Gender	.027	.155		
Age	-.068	<.001		
Race/Ethnicity	.035	.067		
Education Level	-.081	<.001		
Annual Household Income	.029	.120		
Smoking Status	.005	.802		
Daily Physical Activity Level	-.088	<.001		
Alcohol Consumption	.038	.049		
100% Orange Juice consumption frequency	.032	.083		
Male			.109	.012
Age	-.043	.121		
Race/Ethnicity	-.002	.948		
Education Level	-.032	.251		
Annual Household Income	.078	.003		
Smoking Status	.043	.110		
Daily Physical Activity Level	-.035	.194		
Alcohol Consumption	.027	.311		
100% Orange Juice consumption frequency	.011	.686		
Female			.190	.036
Age	-.086	.001		
Race/Ethnicity	.060	.022		
Education Level	-.110	<.001		
Annual Household Income	-.015	.567		
Smoking Status	-.029	.266		
Daily Physical Activity Level	-.125	<.001		
Alcohol Consumption	.043	.107		
100% Orange Juice consumption frequency	.044	.087		

Table 14c. Multiple linear regression of sugar-sweetened fruit drink vs. mean BMI

Independent Variable	Beta Value	p Value	R	R^2
All			.151	.023
Gender	.029	.128		
Age	-.050	.010		
Race/Ethnicity	.032	.091		
Education Level	-.076	<.001		
Annual Household Income	.027	.151		
Smoking Status	.003	.873		
Daily Physical Activity Level	-.083	<.001		
Alcohol Consumption	.036	.061		
Sugar-sweetened fruit drink consumption frequency	.072	<.001		
Male			.121	.015
Age	-.029	.307		
Race/Ethnicity	.003	.914		
Education Level	-.030	.285		
Annual Household Income	.079	.003		
Smoking Status	.038	.163		
Daily Physical Activity Level	-.033	.232		
Alcohol Consumption	.022	.400		
Sugar-sweetened fruit drink consumption frequency	.062	.020		
Female			.169	.038
Age	-.065	.016		
Race/Ethnicity	.051	.053		
Education Level	-.103	<.001		
Annual Household Income	-.019	.457		
Smoking Status	-.028	.288		
Daily Physical Activity Level	-.119	<.001		
Alcohol Consumption	.043	.105		
Sugar-sweetened fruit drink consumption frequency	.076	.003		

Table 14d. Multiple linear regression of soft drink (during summer) vs. mean BMI

Independent Variable	Beta Value	p Value	R	R^2
All			.182	.033
Gender	.035	.076		
Age	-.018	.366		
Race/Ethnicity	.042	.030		
Education Level	-.069	.001		
Annual Household Income	.028	.145		
Smoking Status	.029	.136		
Daily Physical Activity Level	-.091	<.001		
Alcohol Consumption	.032	.104		
Soft drink consumption frequency (during summer)	.127	<.001		
Male			.142	.020
Age	-.002	.932		
Race/Ethnicity	.015	.593		
Education Level	-.023	.423		
Annual Household Income	.074	.007		
Smoking Status	.055	.046		
Daily Physical Activity Level	-.040	.151		
Alcohol Consumption	.011	.685		
Soft drink consumption frequency (during summer)	.099	<.001		
Female			.229	.052
Age	-.029	.294		
Race/Ethnicity	.059	.030		
Education Level	-.093	.001		
Annual Household Income	-.017	.519		
Smoking Status	-.004	.878		
Daily Physical Activity Level	-.129	<.001		
Alcohol Consumption	.042	.125		
Soft drink consumption frequency (during summer)	.143	<.001		

Table 14e. Multiple linear regression of soft drink (during rest of year) vs. mean BMI

Independent Variable	Beta Value	p Value	R	R^2
All			.174	.030
Gender	.033	.093		
Age	-.015	.474		
Race/Ethnicity	.041	.037		
Education Level	-.071	<.001		
Annual Household Income	.027	.164		
Smoking Status	.025	.192		
Daily Physical Activity Level	-.089	<.001		
Alcohol Consumption	.033	.095		
Soft drink consumption frequency (during rest of year)	.118	<.001		
Male			.125	.016
Age	.003	.907		
Race/Ethnicity	.014	.614		
Education Level	-.029	.321		
Annual Household Income	.075	.007		
Smoking Status	.053	.057		
Daily Physical Activity Level	-.038	.172		
Alcohol Consumption	.010	.703		
Soft drink consumption frequency (during rest of year)	.079	.006		
Female			.227	.052
Age	-.029	.321		
Race/Ethnicity	.057	.035		
Education Level	-.093	.001		
Annual Household Income	-.020	.463		
Smoking Status	.000	.989		
Daily Physical Activity Level	-.123	<.001		
Alcohol Consumption	.044	.106		
Soft drink consumption frequency (during rest of year)	.139	<.001		

Table 15. Stepwise linear regression of beverage variables vs. mean BMI

Independent Variable Blocks	Beta Value	p Value
Soft drink consumption frequency (during rest of year)	.106	.000
Soft drink consumption frequency (during rest of year) 100% orange juice consumption frequency	.107 .022	.000 .217
Soft drink consumption frequency (during rest of year) 100% orange juice consumption frequency Sugar-sweetened fruit drink consumption frequency	.100 .011 .062	.000 .560 .001
Soft drink consumption frequency (during rest of year) 100% orange juice consumption frequency Sugar-sweetened fruit drink consumption frequency Soft drink consumption frequency (during summer)	-.010 .011 .062 .124	.789 .552 .001 .001

Figure 1.

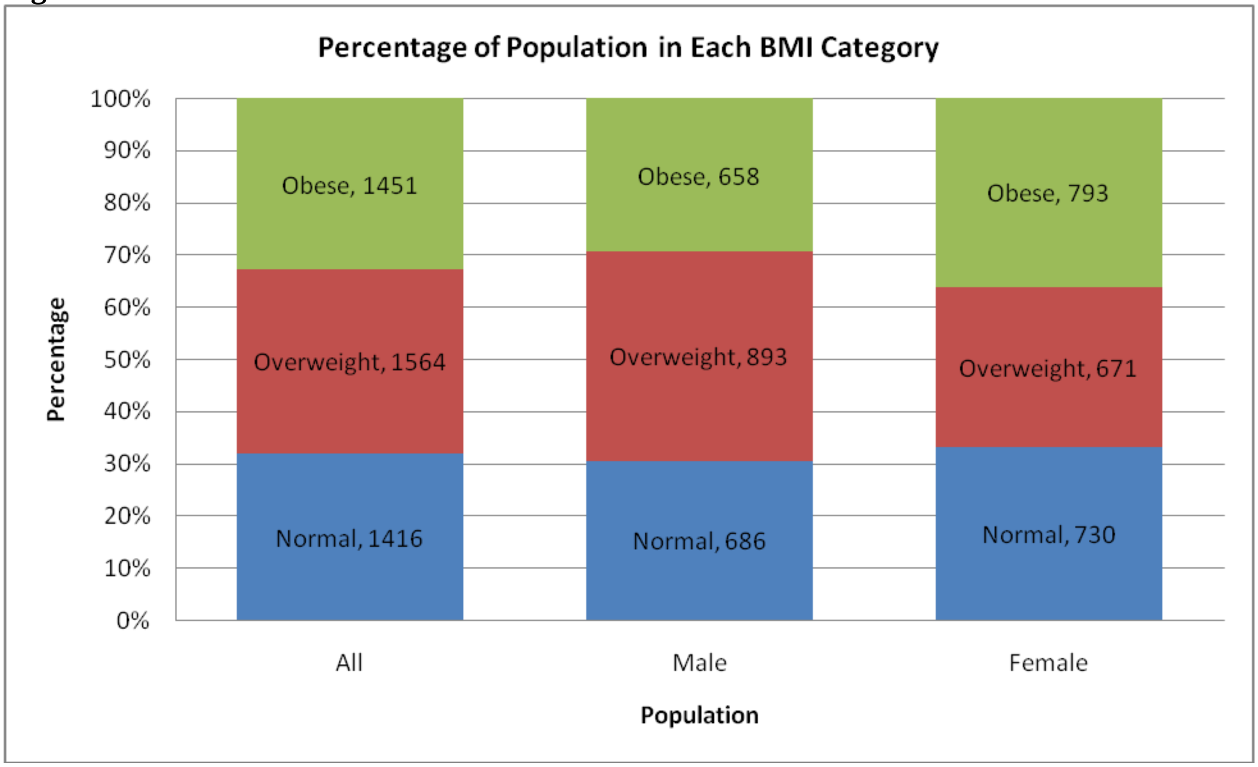

Percentage of Population in Each BMI Category
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
Obese, 1451
Overweight, 1564
Normal, 1416
Obese, 658
Overweight, 893
Normal, 686
Obese, 793
Overweight, 671
Normal, 730
All
Male
Female
Population

Figure 2a.

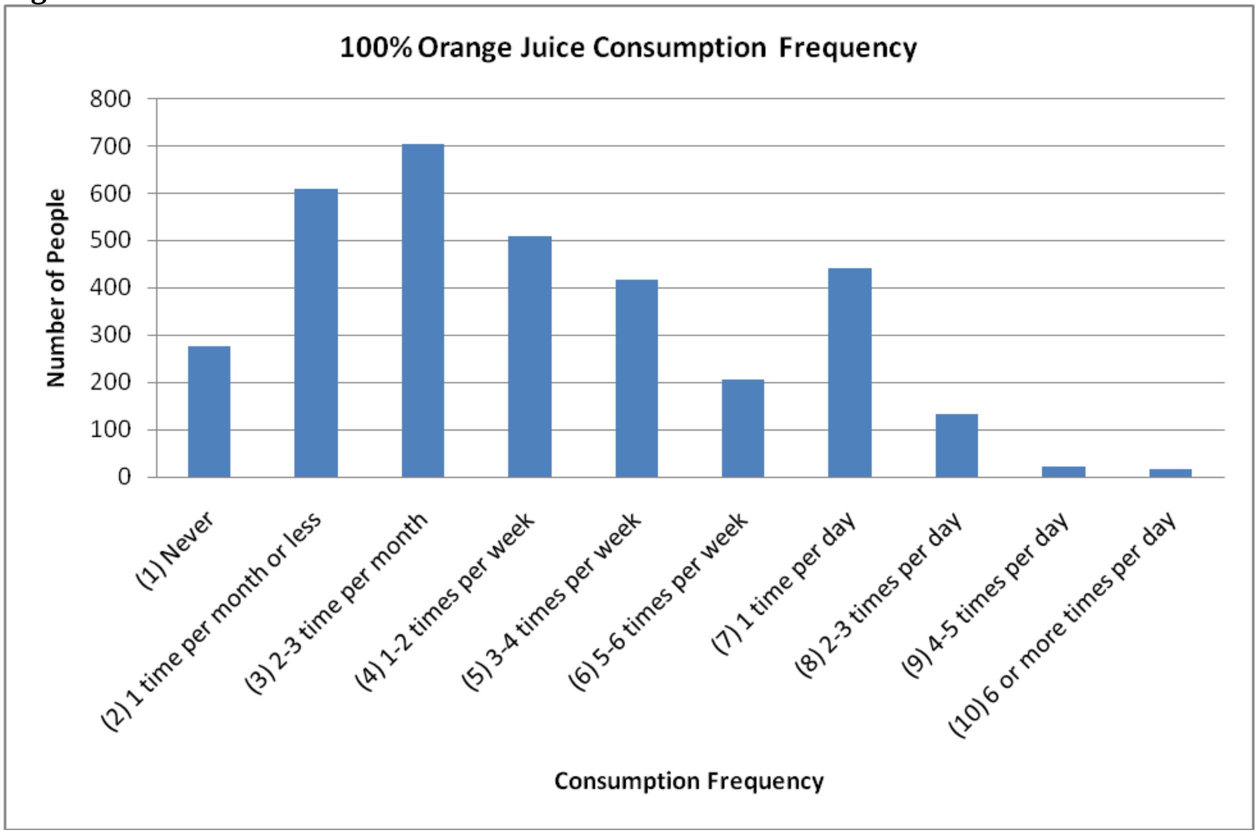

100% Orange Juice Consumption Frequency
Number of People
800
700
600
500
400
300
200
100
0
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10)6 or more times per day
Consumption Frequency

Figure 2b.

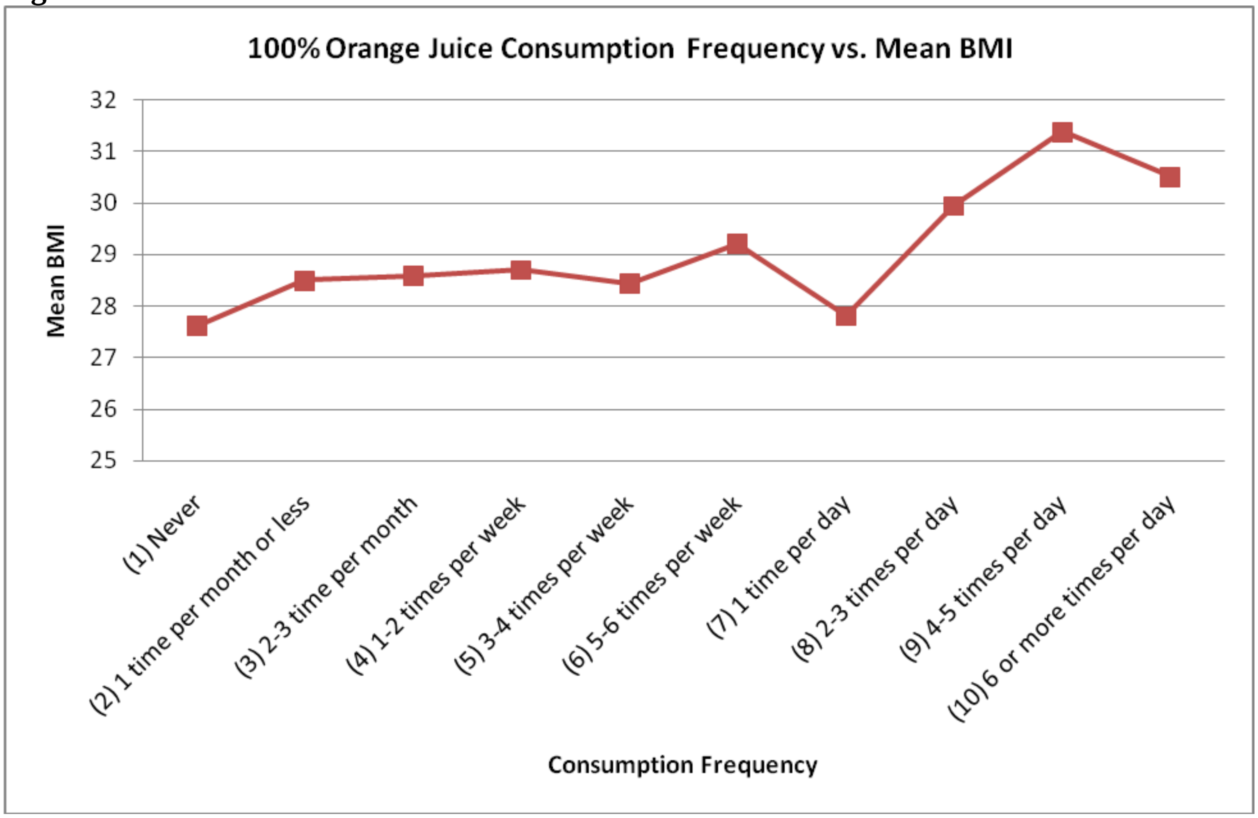

100% Orange Juice Consumption Frequency vs. Mean BMI
Mean BMI
32
31
30
29
28
27
26
25
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10)6 or more times per day
Consumption Frequency

Figure 3a.

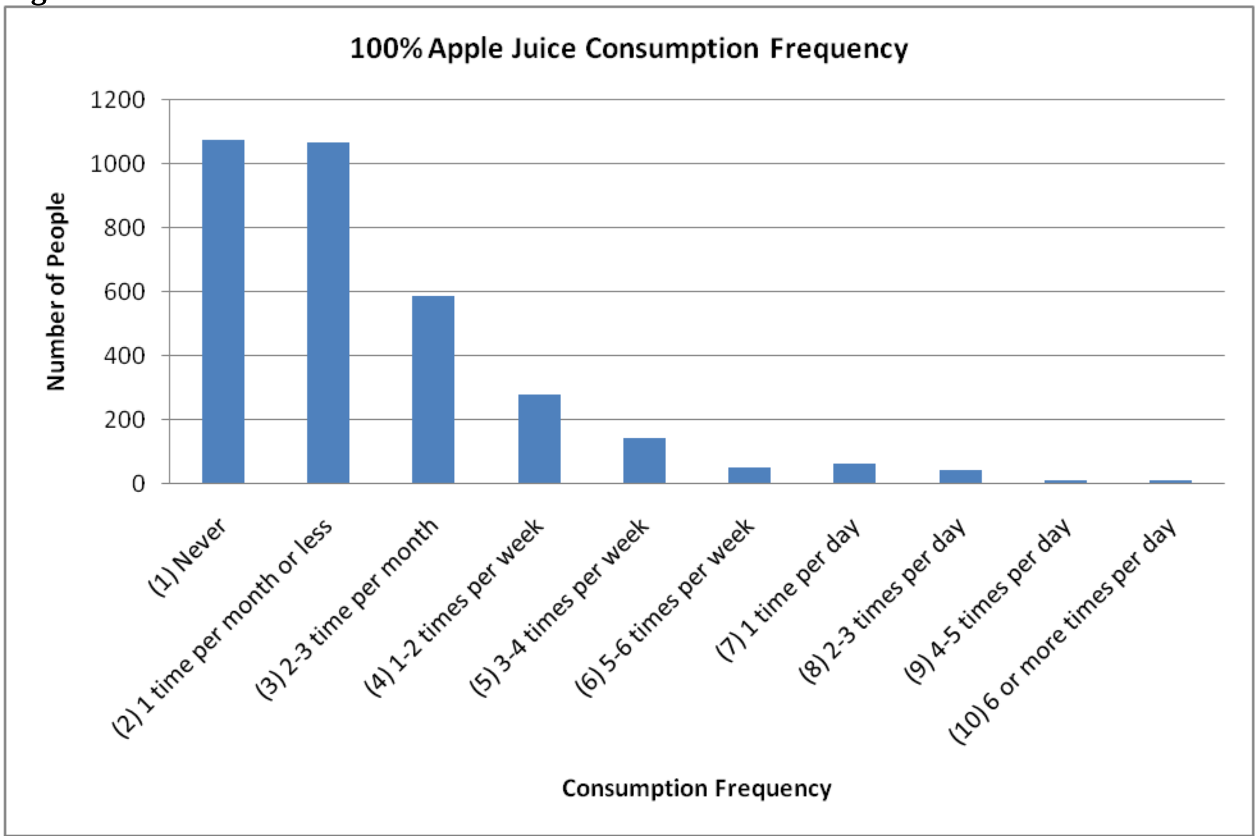

100% Apple Juice Consumption Frequency
1200
1000
800
600
400
200
0
Number of People
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 3b.

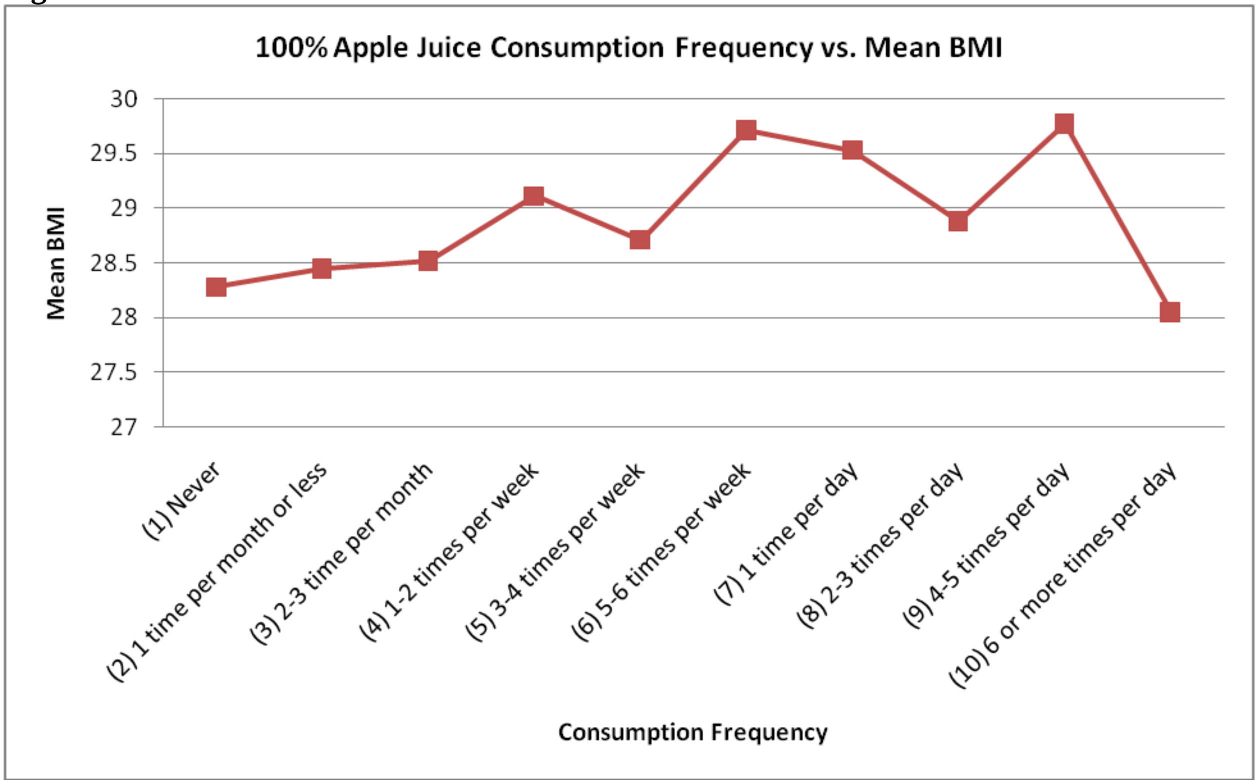

100% Apple Juice Consumption Frequency vs. Mean BMI
Mean BMI
30
29.5
29
28.5
28
27.5
27
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10)6 or more times per day
Consumption Frequency

Figure 4a.

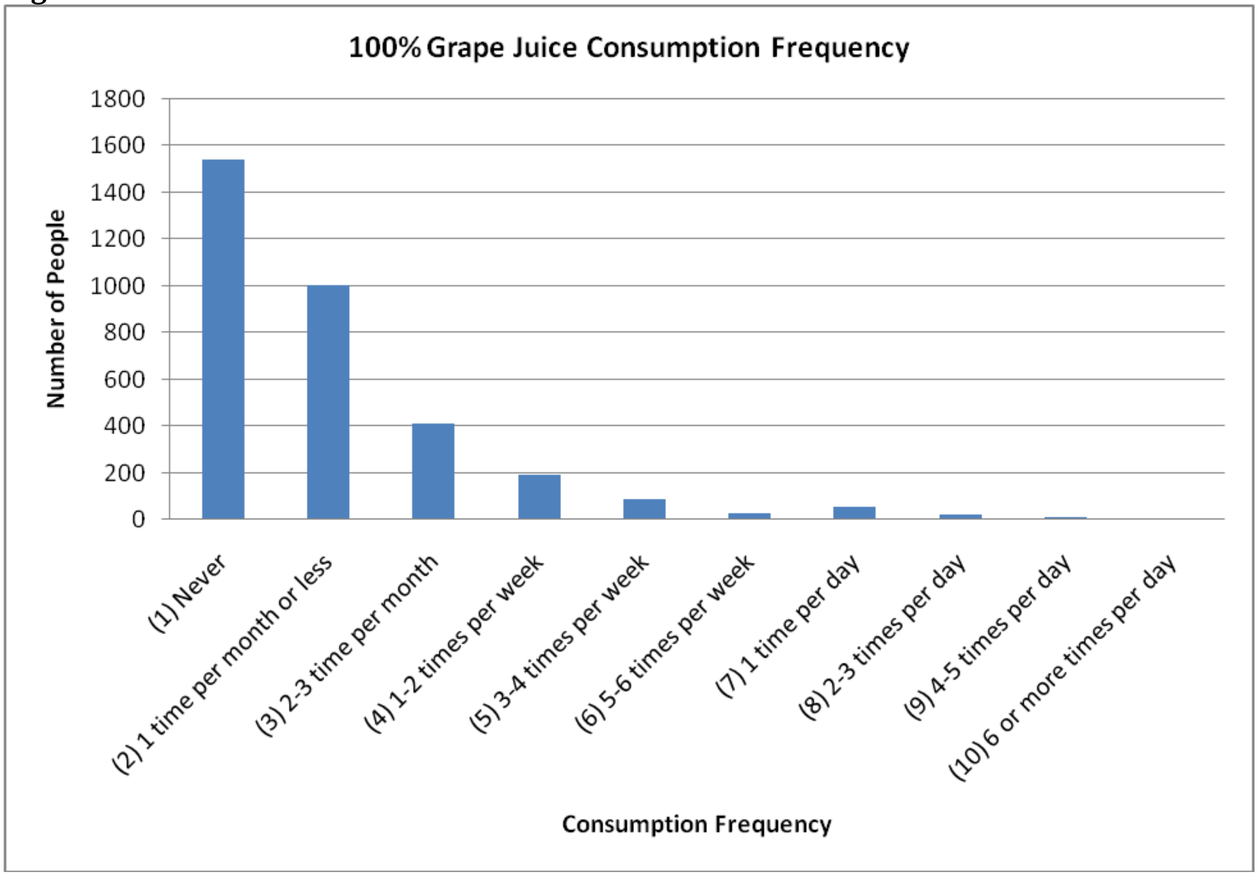

100% Grape Juice Consumption Frequency
Number of People
1800
1600
1400
1200
1000
800
600
400
200
0
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 4b.

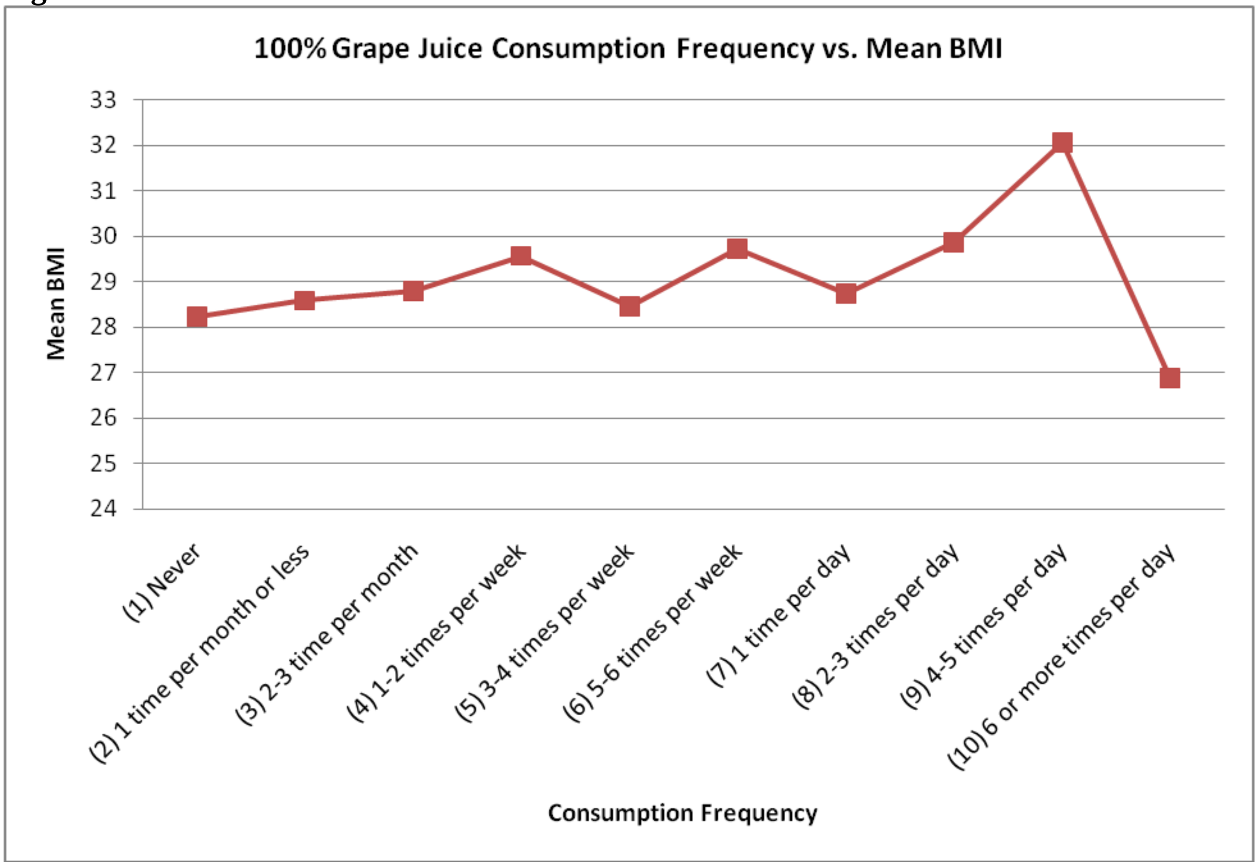

100% Grape Juice Consumption Frequency vs. Mean BMI
Mean BMI
33
32
31
30
29
28
27
26
25
24
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 5a.

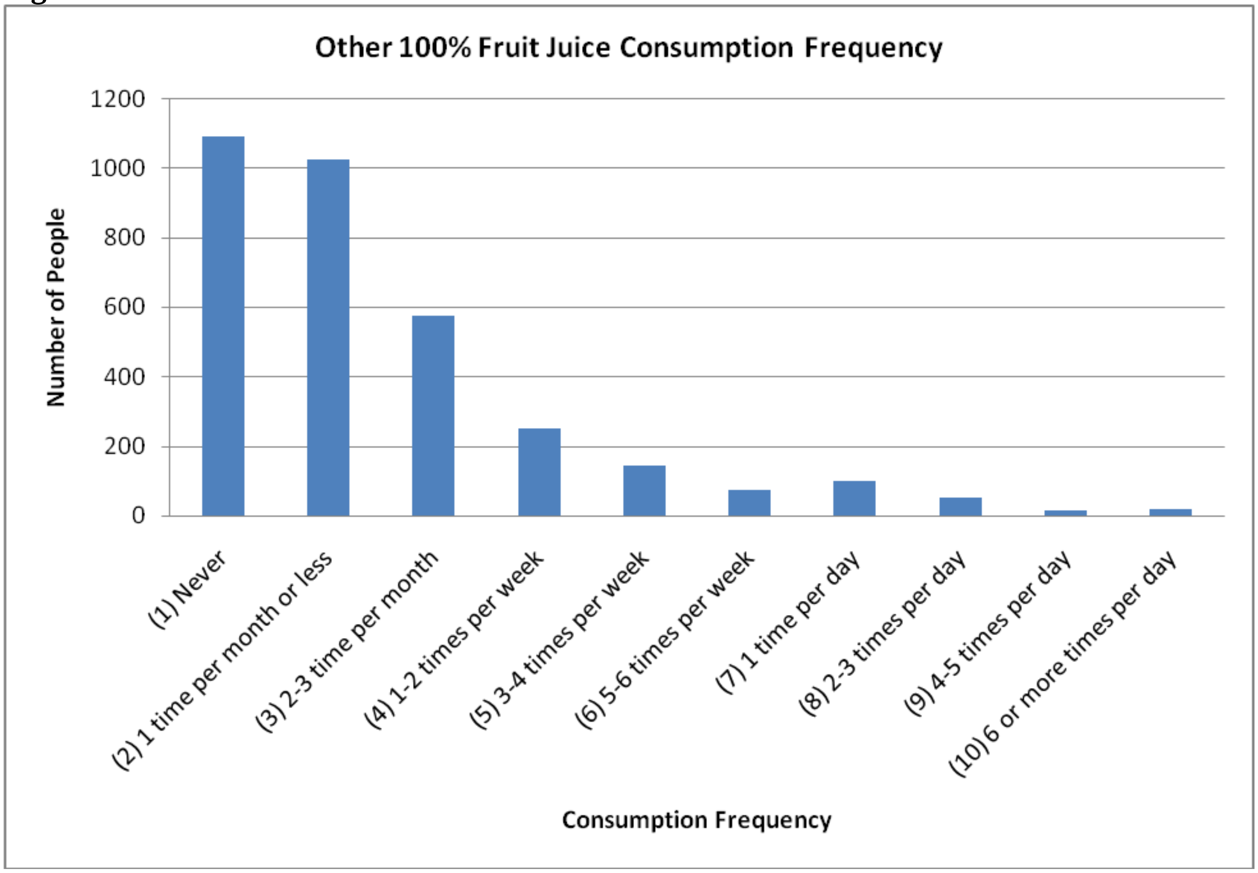

Other 100% Fruit Juice Consumption Frequency
1200
1000
800
600
400
200
0
Number of People
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10)6 or more times per day
Consumption Frequency

Figure 5b.

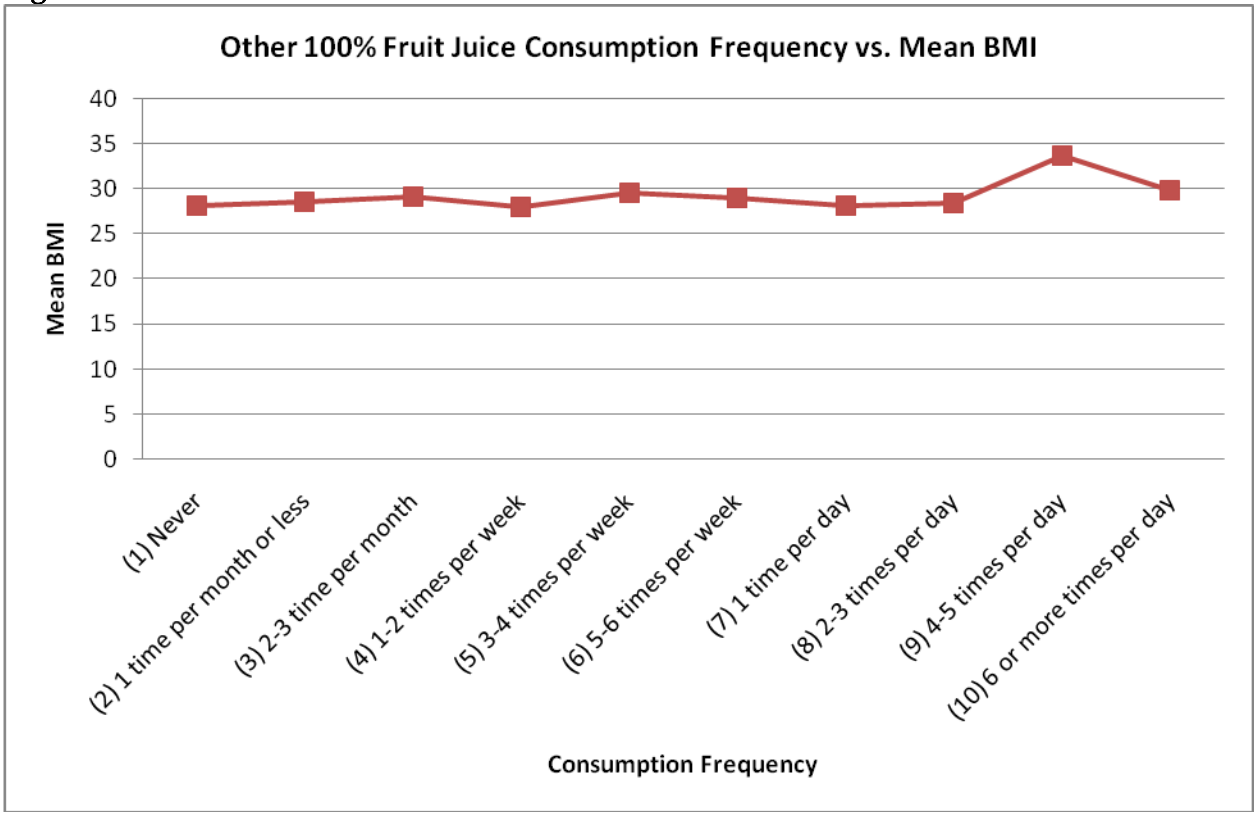

Other 100% Fruit Juice Consumption Frequency vs. Mean BMI
40
35
30
25
20
15
10
5
0
Mean BMI
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 6a.

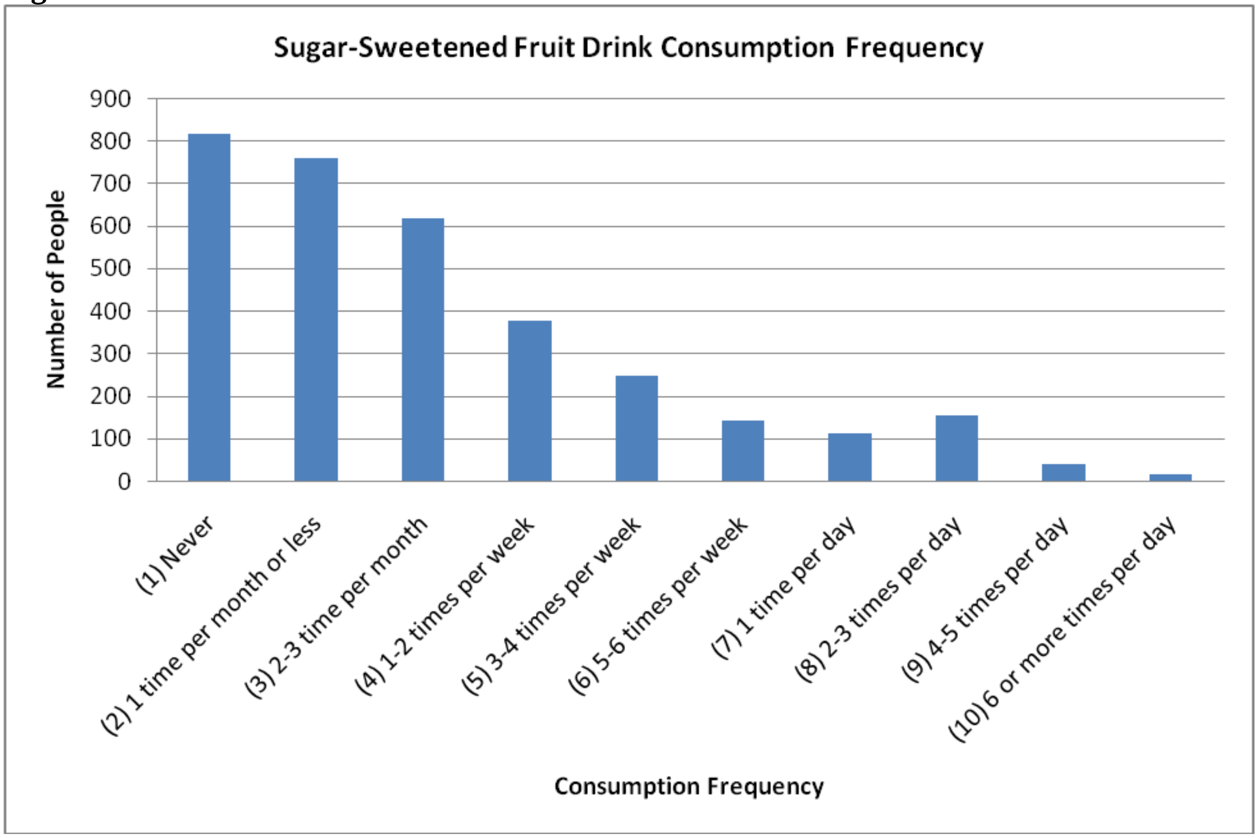

Sugar-Sweetened Fruit Drink Consumption Frequency
900
800
700
600
500
400
300
200
100
0
Number of People
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 6b.

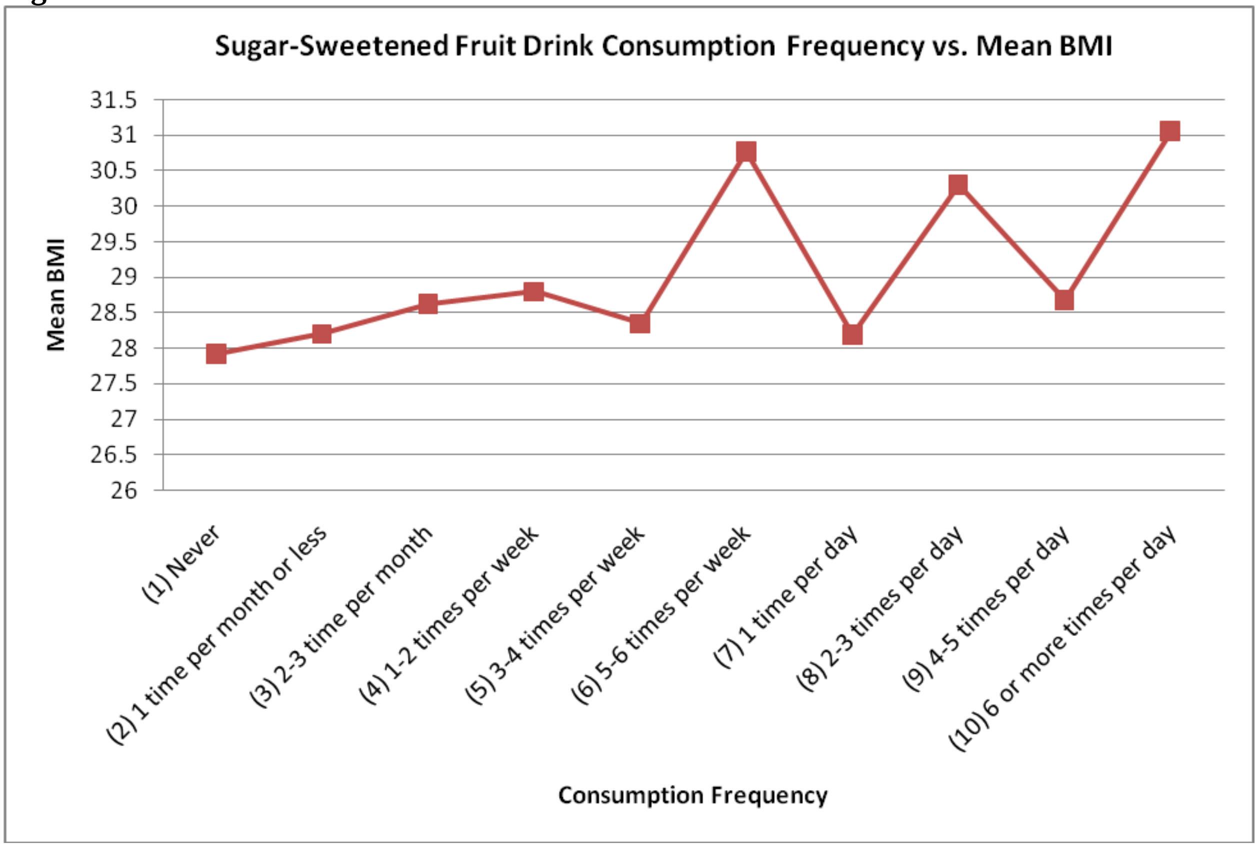

Sugar-Sweetened Fruit Drink Consumption Frequency vs. Mean BMI
Mean BMI
31.5
31
30.5
30
29.5
29
28.5
28
27.5
27
26.5
26
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 7a.

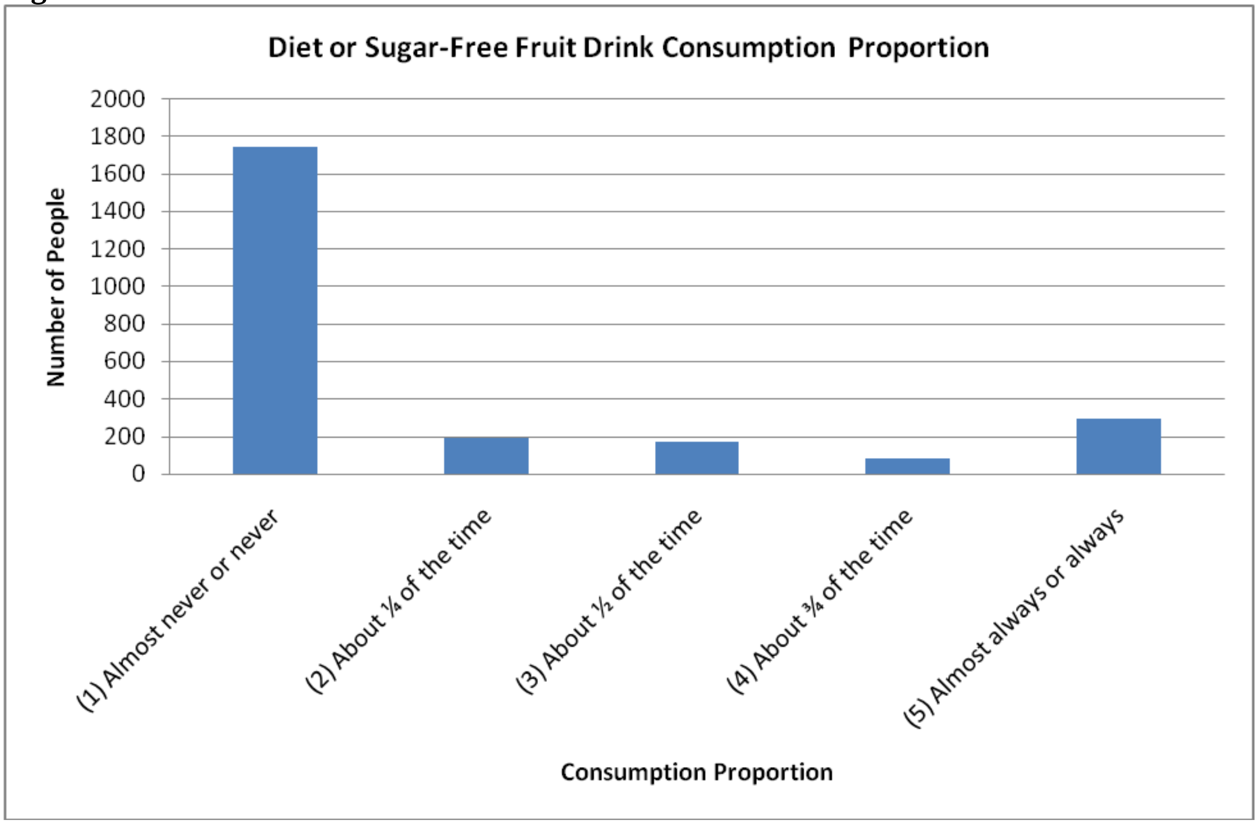

Diet or Sugar-Free Fruit Drink Consumption Proportion
Number of People
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 7b.

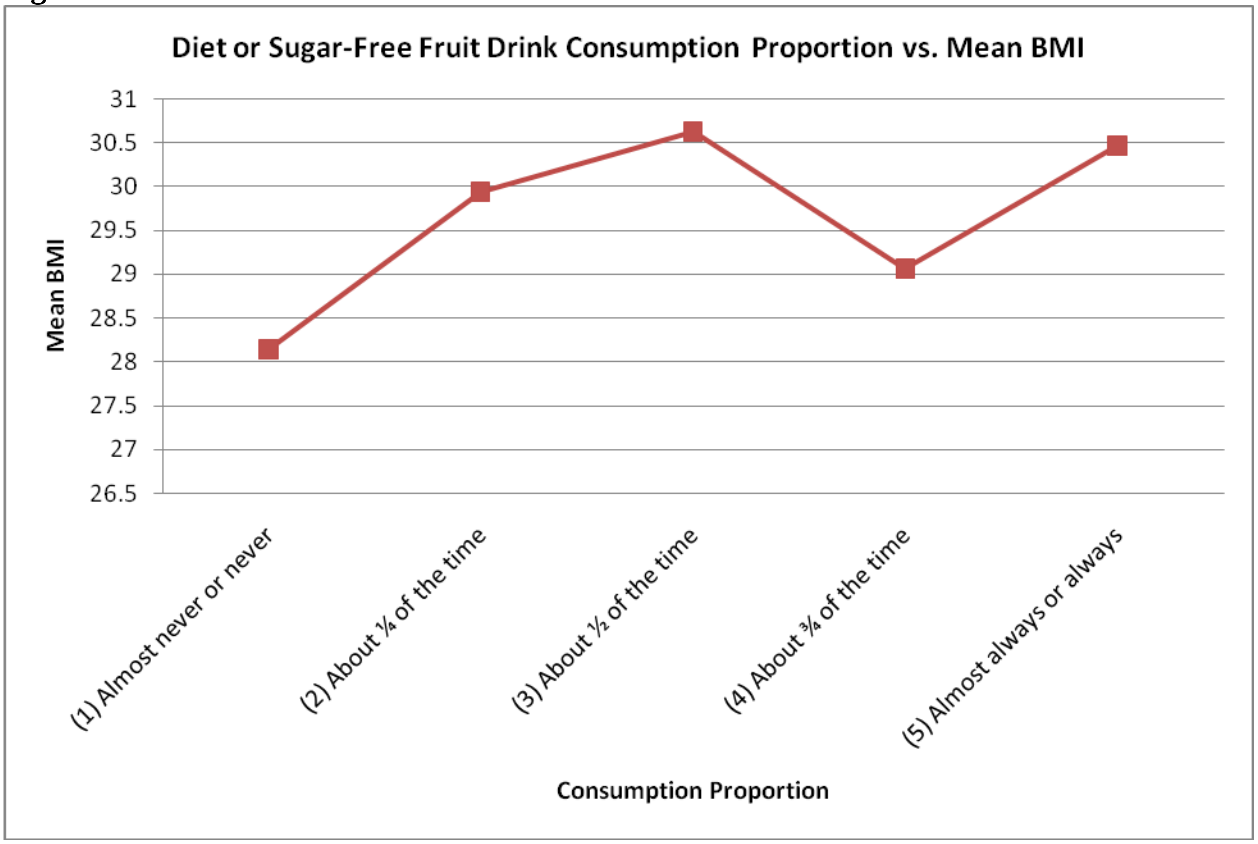

Diet or Sugar-Free Fruit Drink Consumption Proportion vs. Mean BMI
31
30.5
30
29.5
29
28.5
28
27.5
27
26.5
Mean BMI
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 8a.

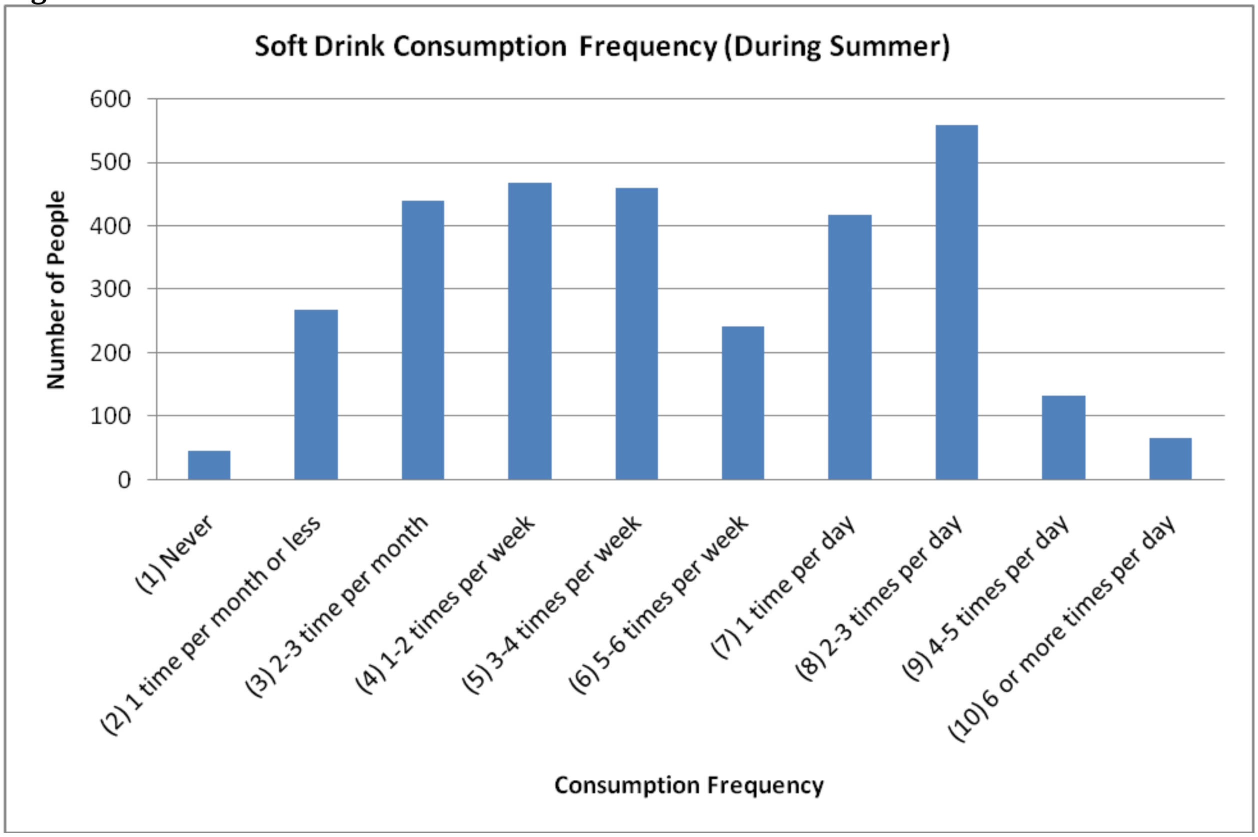

Soft Drink Consumption Frequency (During Summer)
Number of People
600
500
400
300
200
100
0
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 8b.

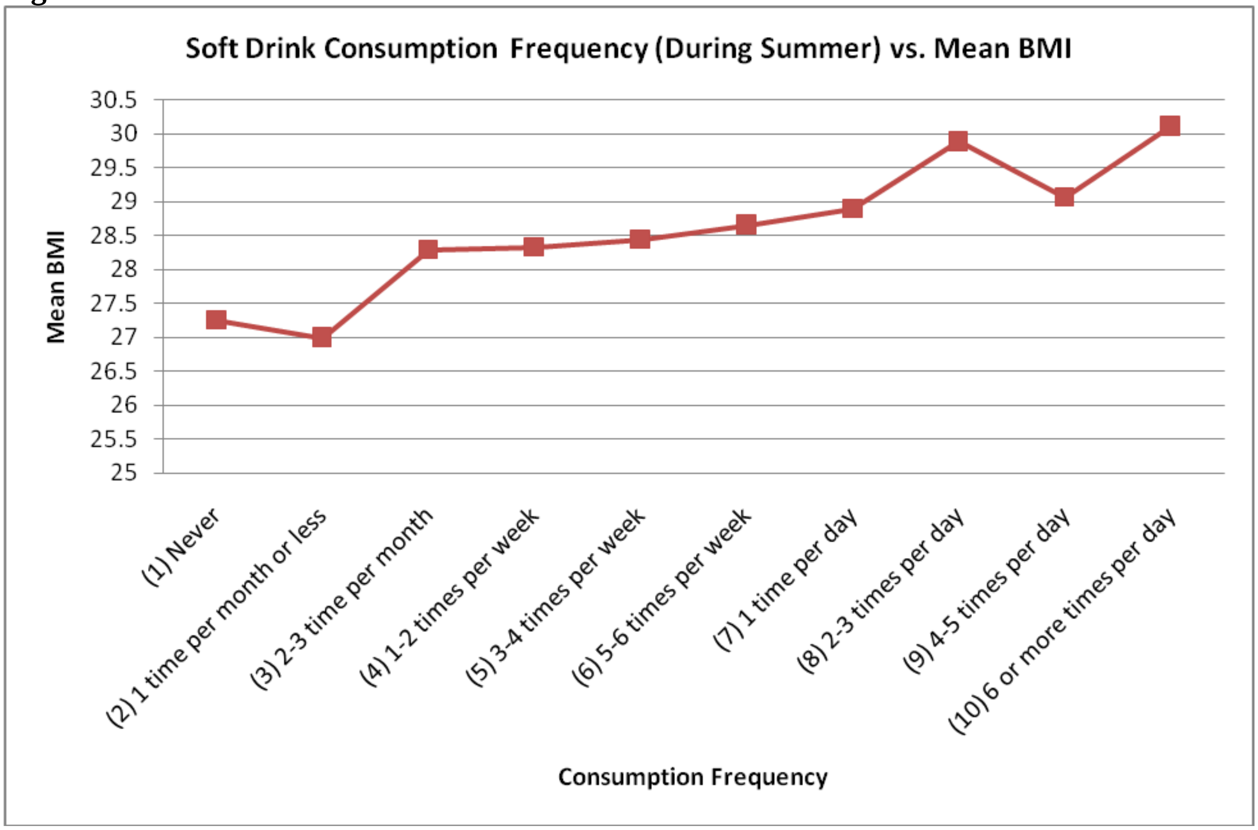
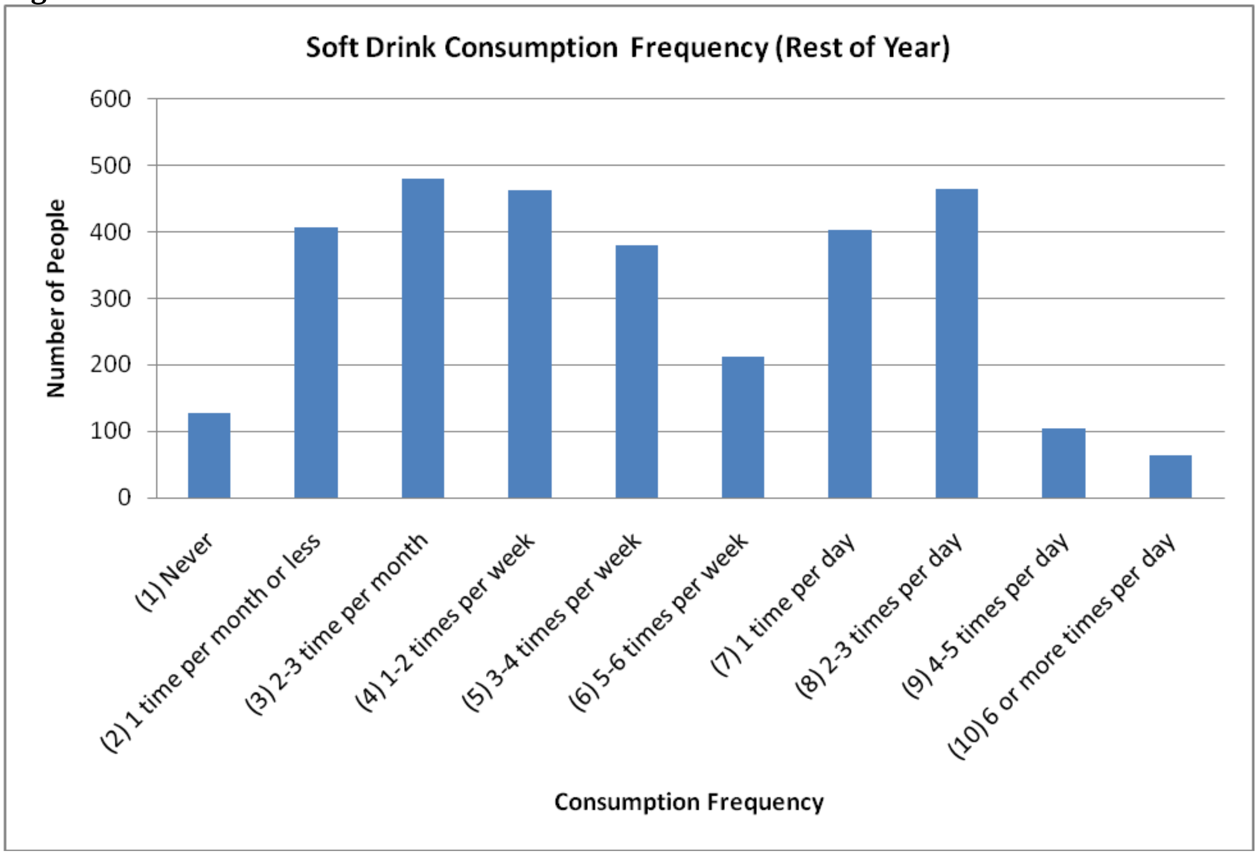

Soft Drink Consumption Frequency (During Summer) vs. Mean BMI
Mean BMI
30.5
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
25
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 9a.



Soft Drink Consumption Frequency (Rest of Year)
Number of People
600
500
400
300
200
100
0
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10) 6 or more times per day
Consumption Frequency

Figure 9b.

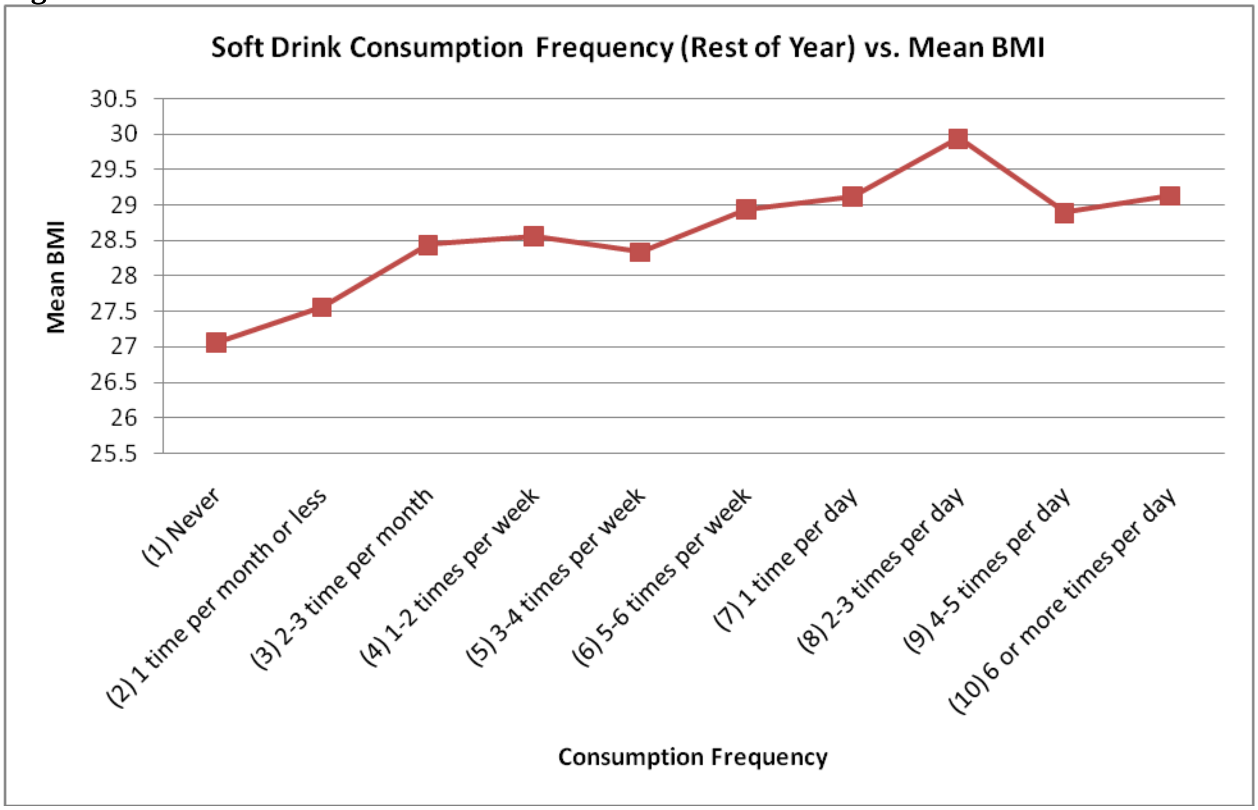

Soft Drink Consumption Frequency (Rest of Year) vs. Mean BMI
Mean BMI
30.5
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
(1) Never
(2) 1 time per month or less
(3) 2-3 time per month
(4) 1-2 times per week
(5) 3-4 times per week
(6) 5-6 times per week
(7) 1 time per day
(8) 2-3 times per day
(9) 4-5 times per day
(10)6 or more times per day
Consumption Frequency

Figure 10a.

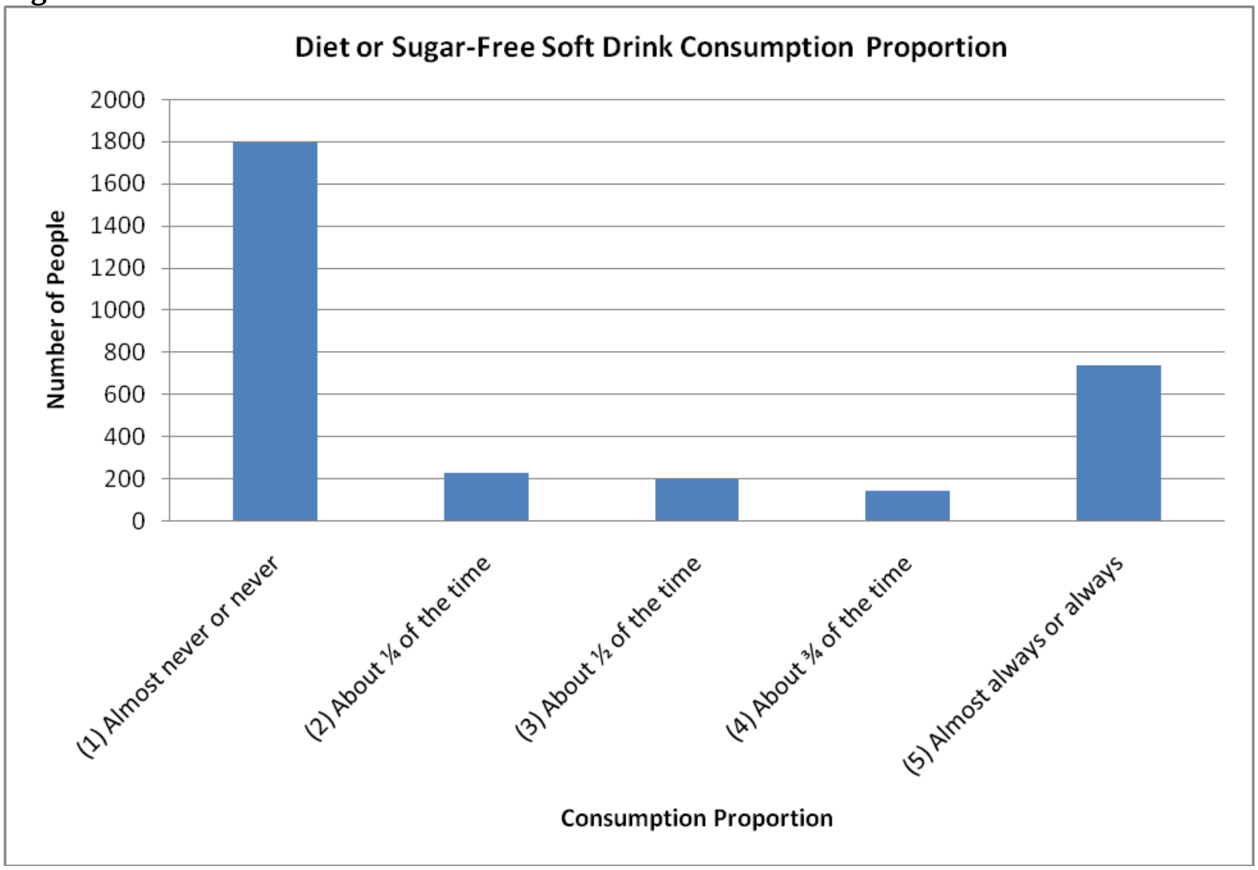

Diet or Sugar-Free Soft Drink Consumption Proportion
Number of People
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 10b.

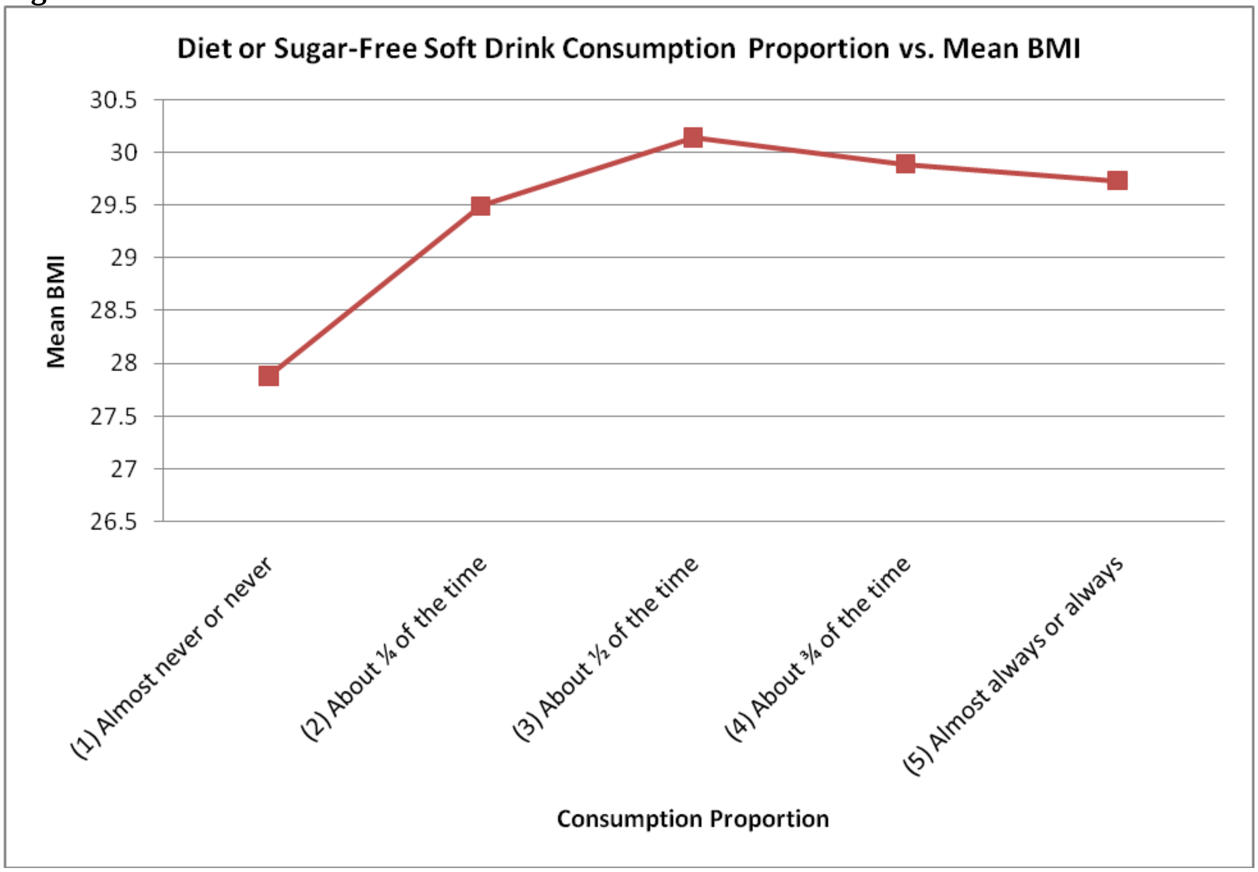

Diet or Sugar-Free Soft Drink Consumption Proportion vs. Mean BMI
Mean BMI
30.5
30
29.5
29
28.5
28
27.5
27
26.5
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 11a.

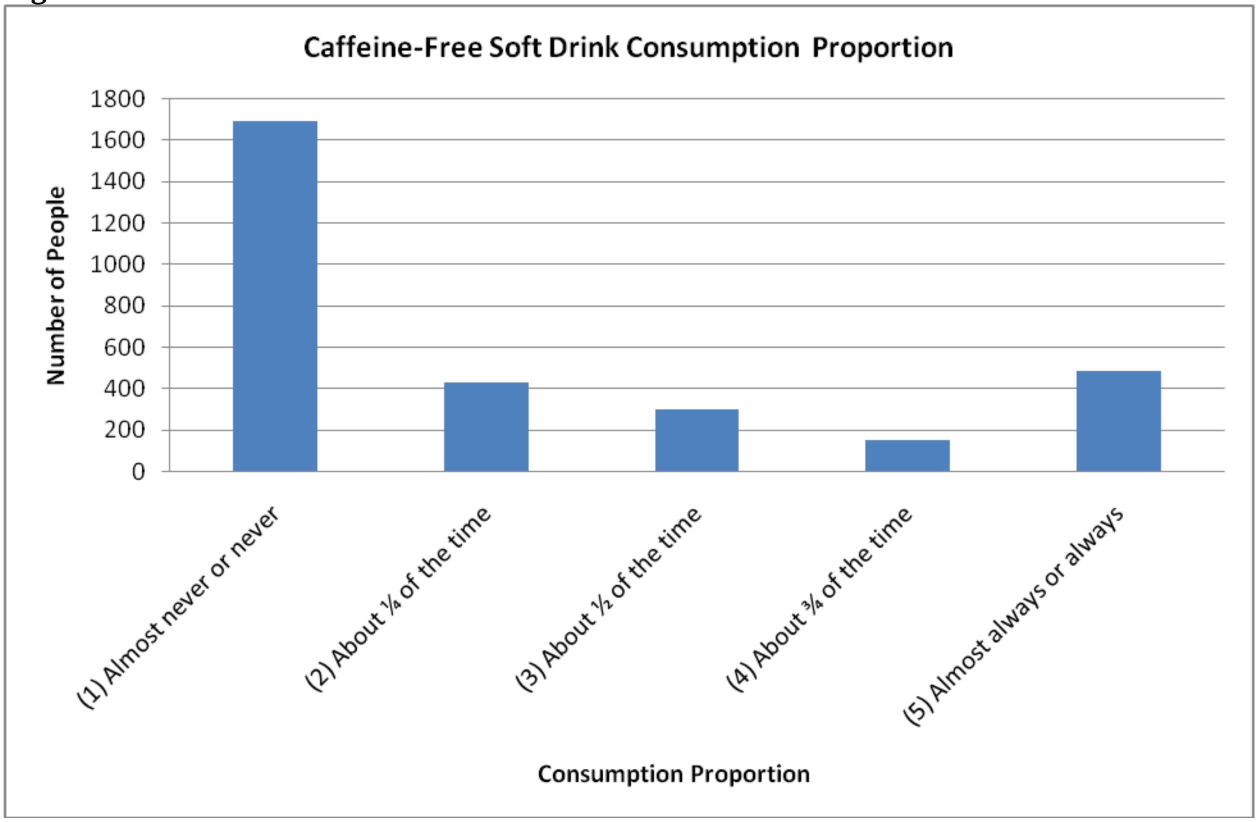

Caffeine-Free Soft Drink Consumption Proportion
Number of People
1800
1600
1400
1200
1000
800
600
400
200
0
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 11b.

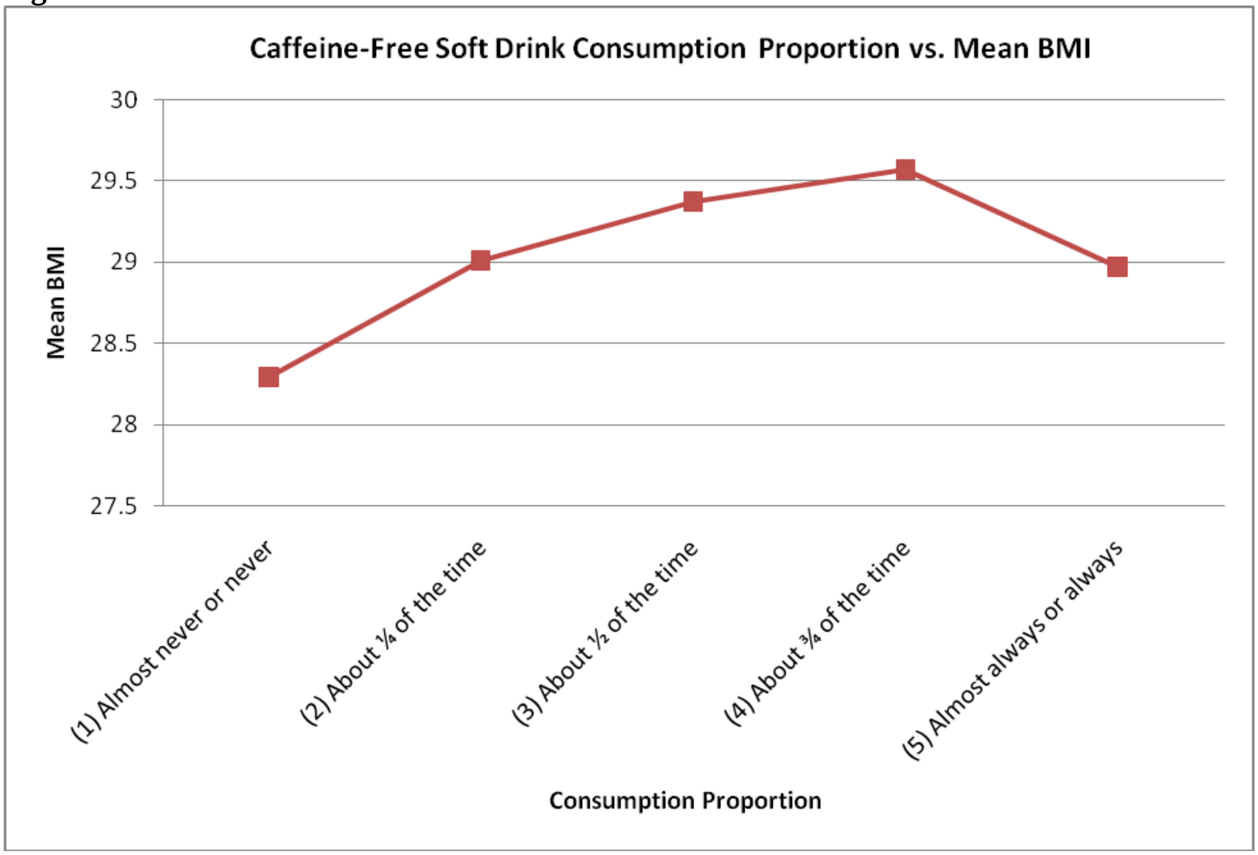

Caffeine-Free Soft Drink Consumption Proportion vs. Mean BMI
30
29.5
29
28.5
28
27.5
Mean BMI
(1) Almost never or never
(2) About ¼ of the time
(3) About ½ of the time
(4) About ¾ of the time
(5) Almost always or always
Consumption Proportion

Figure 12a.

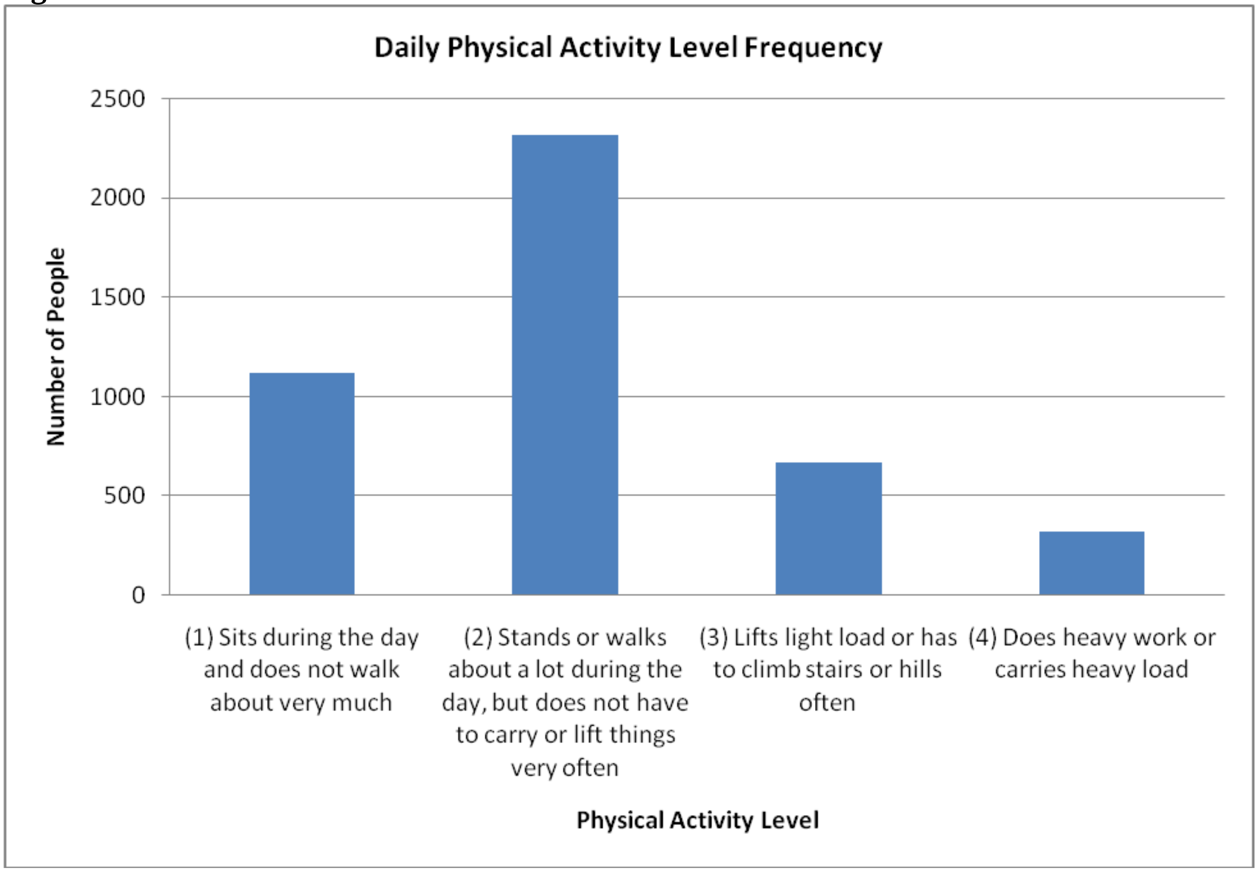
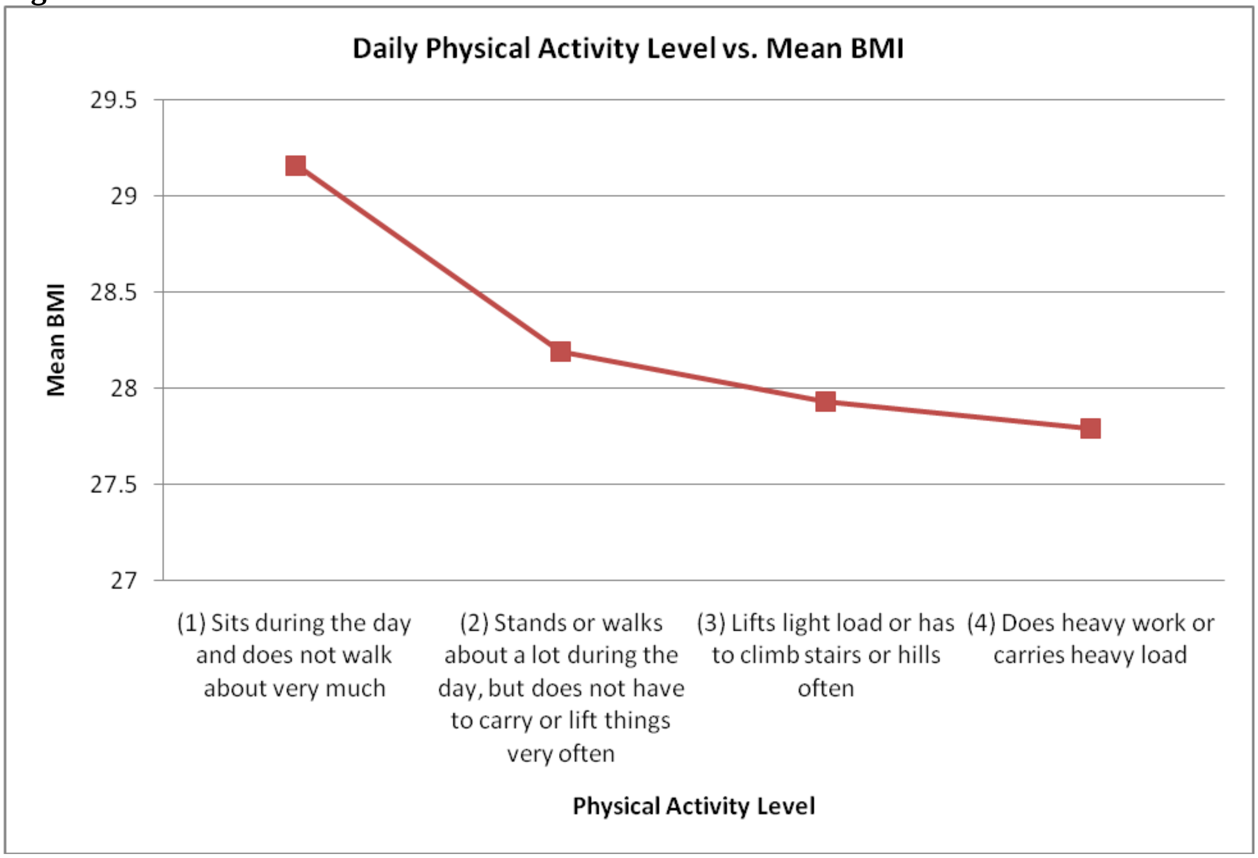

Daily Physical Activity Level Frequency
Number of People
2500
2000
1500
1000
500
0
(1) Sits during the day and does not walk about very much
(2) Stands or walks about a lot during the day, but does not have to carry or lift things very often
(3) Lifts light load or has to climb stairs or hills often
(4) Does heavy work or carries heavy load
Physical Activity Level

Figure 12b.


Daily Physical Activity Level vs. Mean BMI
Mean BMI
29.5
29
28.5
28
27.5
27
(1) Sits during the day and does not walk about very much
(2) Stands or walks about a lot during the day, but does not have to carry or lift things very often
(3) Lifts light load or has to climb stairs or hills often
(4) Does heavy work or carries heavy load
Physical Activity Level

INSTITUTIONAL REVIEW BOARD

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June 16, 2011

Principal Investigator: Okosun, Solomon Ike

Protocol Department: Institute of Public Health

Protocol Title: Sugar-Sweetened Beverage Consumption Frequency vs. BMI: National Health and Nutrition Examination Survey 2003-2004

Submission Type: Protocol H11563

Review Type: Exempt Review

Approval Date: June 16, 2011

The Georgia State University Institutional Review Board (IRB) reviewed and approved your IRB protocol entitled Sugar-Sweetened Beverage Consumption Frequency vs. BMI: National Health and Nutrition Examination Survey 2003-2004. The approval date is listed above.

Exempt protocols do not require yearly renewal. However, if any changes occur in the protocol that would change the category of review, you must re-submit the protocol for IRB review. When the protocol is complete, a Study Closure Form must be submitted to the IRB.

Any adverse reactions or problems resulting from this investigation must be reported immediately to the University Institutional Review Board. For more information, please visit our website at www.gsu.edu/irb.

Sincerely,

Susan K. Laury

Susan Laury, IRB Chair

Federal Wide Assurance Number: 00000129

NHANES Food Questionnaire

More than one member of your household may have received a questionnaire. Please make sure this is your booklet before answering any questions.

LABEL HERE

GENERAL INSTRUCTIONS

- Answer each question as best you can. Estimate if you are not sure. A guess is better than leaving a blank.
- Use only a No. 2 pencil.
- Be certain to completely blacken in each of the answers.
- Erase completely if you make any changes.
- Do not make any stray marks on this form.
- If you blacken NEVER or NO for a question, please follow any arrows or instructions that direct you to the next question.

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #

Public reporting burden of this collection of information is estimated to be 45 minutes per response for total participation, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspects of this collection of information, including suggestions for reducing burden to: CDC/ATSDR Reports Clearance Officer, 1800 Clifton Road, MS D-24, Atlanta, GA 30333, Attention: PRA (0920-0237).

244004 - 1/

1. Over the <u>past 12 months</u>, how often did you drink **tomato juice or vegetable juice**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

2. How often did you drink **orange juice or grapefruit juice**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

3. How often did you drink **apple juice**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

4. How often did you drink **grape juice**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

5. How often did you drink **other 100% fruit juice or 100% fruit juice mixtures** (such as pineapple, prune, or others)?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

6. How often did you drink other **fruit drinks** (such as cranberry cocktail, Hi-C, lemonade, or Kool-Aid, diet or regular)?

- NEVER (GO TO QUESTION 7)
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

6a. How often were your fruit drinks **diet or sugar-free drinks**?

- Almost never or never
- About $^1/_4$ of the time
- About $^1/_2$ of the time
- About $^3/_4$ of the time
- Almost always or always

7. How often did you drink **milk as a beverage** (NOT in coffee, NOT in cereal)? (Please include chocolate milk and hot chocolate.)

- NEVER (GO TO QUESTION 8)
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

7a. What kind of **milk** did you usually drink?

- Whole milk
- 2% fat milk
- 1% fat milk
- Skim, nonfat, or $^1/_2$% fat milk
- Soy milk
- Rice milk
- Raw, unpasteurized milk
- Other

BAR
CODE
LABEL
HERE

Question 8 appears on the next page.

Over the past 12 months...

8. How often did you drink **meal replacement, energy, or high-protein beverages** such as Instant Breakfast, Ensure, Slimfast, Sustacal or others?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

9. Over the past 12 months, did you drink **soft drinks, soda,** or **pop**?

- NO (GO TO QUESTION 10)
- YES

9a. How often did you drink **soft drinks, soda,** or **pop IN THE SUMMER**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

9b. How often did you drink **soft drinks, soda,** or **pop DURING THE REST OF THE YEAR**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

9c. How often were these soft drinks, soda, or pop **diet** or **sugar-free**?

- Almost never or never
- About 1/4 of the time
- About 1/2 of the time
- About 3/4 of the time
- Almost always or always

9d. How often were these soft drinks, soda, or pop **caffeine-free**?

- Almost never or never
- About 1/4 of the time
- About 1/2 of the time
- About 3/4 of the time
- Almost always or always

Question 10 appears in the next column.

10. Over the past 12 months, did you drink **beer**?

- NO (GO TO QUESTION 11)
- YES

10a. How often did you drink **beer IN THE SUMMER**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

10b. How often did you drink **beer DURING THE REST OF THE YEAR**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

11. How often did you drink **wine** or **wine coolers**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

12. How often did you drink **liquor** or **mixed drinks**?

- NEVER
- 1 time per month or less
- 2–3 times per month
- 1–2 times per week
- 3–4 times per week
- 5–6 times per week
- 1 time per day
- 2–3 times per day
- 4–5 times per day
- 6 or more times per day

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