Association between the Consumption of Sugar-Sweetened Beverages and Poor Mental Health among Adults in the United States.

ABSTRACT

ASSOCIATION BETWEEN THE CONSUMPTION OF SUGAR-SWEETENED BEVERAGES AND POOR MENTAL HEALTH AMONG ADULTS IN THE UNITED STATES.

By

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INTRODUCTION: Mental health disorders are significant public health problems in the United States due to their association with increased morbidity. Available evidence suggests a relationship between nutritional quality and mental health outcomes. This relationship is in line with emerging evidence that diet is essential in the treatment and management of psychiatric disorders. Diet is directly linked with obesity which in turn is a major risk factor for several chronic diseases, including psychiatric disorders. Given the current obesity epidemic in the US population, it is important to understand how various nutritional behaviors potentially contribute to the burden of mental health disorders in the United States. However, little is known regarding the association between sugar-sweetened beverage (SSB) consumption and the risk of poor mental health in adults 18 years or older.

AIM: To examine the association between the consumption of sugar-sweetened beverage and poor mental health among U.S. adults, and to determine the role of obesity in any potential association between SSB consumption and risk of poor mental health.

METHODS: Cross-sectional data from the 2017 Behavioral Risks Factor Surveillance System (BRFSS) was used for this study. Poor mental health was based on self-report of diagnosis and symptoms within the past 30 days. SSB intake was quantified as the number of times regular soda, or fruit drinks were consumed within a 30-day period, while obesity status was calculated based on the subject's measured weight and height. Using multivariable logistic regression, adjusted odds ratios (aOR) for the association between frequency of SSB intake and poor mental health was calculated controlling for age, gender, race and other variables (smoking, physical activity, hypertension, etc.).

RESULTS: Drinking 1 or more sugar-sweetened beverages per day was associated with increased odds of poor mental health (OR= 1.41, 95% CI=1.21-1.63) after adjusting for covariates. The presence of obesity resulted in a similar trend of poor mental health outcomes upon consumption of 1 or more sugar-sweetened beverages per day (OR= 1.42, 95% CI=1.23-1.64)

DISCUSSION/CONCLUSION: This study indicates that sugar sweetened beverages are associated with poor mental health. A public health message on the detrimental effects of consumption of sugar-sweetened beverages may help alleviate the burden of mental health disorders.

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Author's Statement

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Onyanehi Ajuma Ugbabe

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CHAPTER ONE

INTRODUCTION

1.1 Background of study.

Worldwide, over 300 million people; equivalent to 4.4% of the world's population are estimated to suffer from depression and anxiety disorders. Depression is ranked by the World Health Organization (WHO) as the single most significant contributor to global disability (7.5% of all years lived with disability in 2015) while anxiety disorders ranked at the 6th position (3.4%). (World Health Organization [WHO], 2017). The consequences of these disorders are enormous as depression is also considered the most significant contributor to suicidal deaths, which is estimated at 800 000 per year worldwide (WHO, 2017). Although the determinants of mental health are complicated, emerging and compelling evidence indicate that nutrition is a crucial factor in the high incidence and prevalence of mental disorders. Indeed, current evidence suggests that diet is an essential part of psychiatric, cardiologic, endocrinologic, and gastroenterologic treatments. (Sarris et al., 2015). Several studies have analyzed the role of dietary patterns, foods, food groups and nutrients in the prevention of depression. (Sanchez-Villegas et al., 2019). Although still scarce, there is increasing evidence suggesting connections between nutritional quality and mental health outcomes. (Opie et al., 2017).

In today's world, there is a steady upward trend in sugar consumption and this exponential increase is associated with an increased risk and prevalence of several chronic diseases including obesity, Type 2 diabetes, kidney disease, cardiovascular diseases, non-alcoholic fatty liver disease (NAFLD), gout, cognitive decline, and even some cancers (CDC, 2017; Rippe & Angelopoulos, 2016).

Over the past few years, several prospective studies have observed an association between metabolic disturbances and inflammation with depression risk. Obesity is associated with elevated cortisol secretion and higher hypothalamic–pituitary–adrenal (HPA) axis reactivity to psychological and physiological stress, which may lead to altered endocrine and stress responses (McInni et al., 2014). Moreover, a bi-directional relationship between obesity and depression cannot be ruled out as risk factors for obesity may also be associated with the development of depressive disorders.

1.2 Statement of the Problem.

Depression and other mental health problems are significant public health problems in the United States. WHO reported in the year 2012 that nearly 18% of all deaths among young adults aged 15-29 years in high-income countries were attributable to suicide resulting from depression. In the United States, more than 40,000 lives are lost to suicide annually (Centers for Disease Control and Prevention [CDC], 2017) making it the leading cause of disability in the U.S. among individuals between ages 15 to 44 years. More than 16.1 million American adults aged 18 years and older, comprising 6.7% of the U.S. population, are affected by a major depressive disorder each year. (National Institute of Mental Health, 2019). These alarming figures show the need for extensive empirical examination of factors associated with depressive illnesses. Sugar consumption correlates with obesity, diabetes, cardiovascular diseases as well as numerous physiological and psychological diseases, and is potentially addictive (Ólafsdóttir, 2017). It has also been found that sugar consumption can change brain neurochemistry, especially when consumed in excessive quantities (Avena, Rada, & Hoebel, 2008). While some studies link sugar consumption to a variety of psychological issues, such as stress, major depression, psychological distress, and suicidal ideation (Ólafsdóttir, 2017), many other studies have found lack of associations between

consumption of sugar-sweetened beverages(SSBs) and mental health outcomes (Sanchez-Villegas et al., 2018).

Given the potential effects of SSB consumption on mental health outcomes among adults in the United States, we aim to investigate the association between sugar-sweetened beverage consumption and poor mental health. Understanding the true connection between sugar-sweetened beverage consumption and mental health may help in the development and implementation of interventions aimed at reducing the consumption of SSBs. Such intervention when targeted at risk groups may help to decrease the prevalence of various adverse health outcomes including obesity and other cardiometabolic disorders.

1.3 Aim/Objectives of the Study.

The main aim of this study is to assess the association between the consumption of sugar-sweetened beverages and poor mental health among American adults. We also sought to determine the role of obesity in the association using data from the Behavioral Risk Factor Surveillance System.

The specific objectives are;

1. To determine if the frequent consumption of sweetened beverages is associated with a higher risk of poor mental health among adults in the US.

2. To determine if the association between the consumption of sugar-sweetened beverages and poor mental health is modified by obesity.

1.4 Research Questions

This study is expected to answer the following research questions;

1. Is there an association between the frequent consumption of sugar-sweetened beverages and poor mental health?

2. Is obesity a modifier of the association between the consumption of sugar-sweetened beverages and poor mental health?

1.5 Hypothesis

The following hypotheses are formulated for testing;

1. The consumption of sugar-sweetened beverages will be associated with poor mental health.

2. Obesity will be a modifier of the association between the use of sugar-sweetened drinks and poor mental health.

1.6 Significance of the study

The study to determine the association between the consumption of sugar-sweetened beverages and poor mental health among adults in the United States is designed to provide information on the risk of mental health problems as a result of frequent consumption of SSBs and the role obesity may play. The findings from this study may ultimately lead to a better-informed population that can make informed choices to avoid the potential health risk that is associated with the consumption of SSBs.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

2.2 Sugar-sweetened Beverages

Sugar-sweetened beverages (SSB's) are any liquids that are sweetened with various forms of added sugars like brown sugar, corn sweetener, corn syrup, dextrose, fructose, glucose, high-fructose corn syrup, honey, lactose, malt syrup, maltose, molasses, raw sugar, and sucrose ("Get the Facts: Sugar-Sweetened Beverages and Consumption | Nutrition | CDC," 2017).

2.3 Difference between added sugar and natural sugar

As the name implies “Natural sugars” are found naturally in foods such as fruit (fructose) and milk (lactose), while “added sugars” are sugars or caloric sweeteners that are added to foods or beverages during processing or preparation. They include natural sugars such as white sugar, brown sugar, and honey as well as other caloric sweeteners that are chemically manufactured. (American Heart Association, 2018).

Despite its sweetness, sugar consumption is detrimental to health. (Vartanian, Schwartz, & Brownell, 2007). Liquid sugar (sugar in beverages like soda and sports drinks) rates as the largest source of added sugar in an American diet (36%). ("Sugar-Sweetened Beverages," 2018; AHA, 2018). Sugar-sweetened beverages provide calories with no added nutrients which can alter metabolism in the long run. (Kris Gunnars, 2018). Hence, drinking copious amounts of sugar-sweetened beverages can lead to serious health problems. (Boston Public Health Commission [BPHC], 2014). Soft drinks are a significant source of extra calories that provide no nutritional

benefits but rather contribute to increased body weight and provide no nutritional benefits. Despite their high caloric value, research suggests that liquid carbohydrates such as SSBs are less satisfying than the solid forms thereby causing people to continue to feel hungry after drinking them. (Pan & Hu, 2011). According to the CDC, the consumption of sweetened beverages is also associated with unhealthy behaviors like smoking, inadequate sleep and exercise patterns, eating junk food and not enough fruits regularly. (CDC, 2017).

2.4 Sugar-Sweetened Beverage Consumption trends in the US.

Over the past years, increased sugar consumption has become a significant concern in the United States due to the advent of increased sugar-sweetened beverage production. Changes in sugar-sweetened beverage intake have also been observed as was noted in a study by Nielsen & Popkin, (2004). They found that between the years 1977 to 1996, the consumption of SSBs doubled among all age categories in the United States.

In 2000, the United States Department of Agriculture (USDA) recommended no more than 40 grams of sugar per day being equivalent to one 12-ounce soft drink, yet the average American citizen consumed 260 grams of sugar per day. (Burleson, Anderson, Copeland & Sullivan, 2016)

In 2008, about 660 pounds (28kg) of added sugar was consumed per year, an average intake of 76.7 grams per day, which is equivalent to 19 teaspoons or 306 calories. (Welsh, Sharma, Grellinger & Vos, 2011). The above study concluded that the rate of sugar consumption decreased by 23% between the year 2000 and 2008 as a result of a decrease in SSB consumption. However, the mean intakes continue to exceed recommended limits. (Welsh et al., 2011). The average adult intake of Sugar in 2012 was 77 grams per day. (Powell, Smith-Taillie & Popkin, 2016). According to the 2017 CDC statistical report, the consumption of SSBs varies by age, race-ethnicity, sex,

geography, and socio-economic status. The American Heart Association recommends a maximum of 450 kilocalories (kcal) of sugar-sweetened beverages, i.e., less than three 12-oz cans of carbonated cola—per week (Lloyd-Jones et al., 2010), yet in 2011-2014, almost two-thirds of U.S. youth and about one-half of U.S. adults consumed at least one sugar-sweetened beverage on a given day with men (53.6%) and women (45.1%) drinking an average of 179 kcal and 113kcal respectively. It was also observed that men were more likely to consume two or more sugar-sweetened beverages in a given day compared to women. The consumption of sugar-sweetened drinks was higher among non-Hispanic blacks and low-income adults, and a steady decrease in use was observed as age increased in both sexes. (Rosinger, Herrick, Gahche & Park, 2017). In the United States, the majority (52%) of SSB calories are consumed in the comfort of the home. (Kit, Fakhouri, Park, Nielsen & Ogden, 2013).

2.5 Mental Health Illness

Mental illness is a condition that affects a person's thinking, feeling or mood. (National Alliance on Mental Illness (NAMI), "Statistics," 2019). Such illnesses present with unique experiences and can influence an individual's ability to carry out his or her daily activities and interactions.

As stated by the National Institute of Mental Health (NIMH) mental health disorders are one of the leading causes of disability, especially in developed countries such as the US. They affect people of all ages, gender, and race. Types of mental health disorders include major depression, manic depression, schizophrenia, and obsessive-compulsive disorder. (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019).

About 26% of Americans aged 18 and older are estimated to suffer from a diagnosable mental disorder in a given year. Commonly, most people suffer from multiple mental disorders

simultaneously as seen in depressive illnesses which frequently coexist with substance abuse and anxiety disorders. (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019).

2.6 Mental Health Disorders in the US.

Depression: Also called “clinical depression” affects approximately 6.7% (more than 16 million) of American adults each year. (Substance Abuse and Mental Health Services Administration, 2014). Women are considered twice as likely to suffer from major depression compared to men, with an average age of onset during the mid-20s. (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019).

Bipolar disorder: Also called “manic depression," has an average age onset for a first manic episode is the early 20's affecting about 2.6% of Americans age 18 and older in a given year. (Mental Health Disorders Statistics, John Hopkins School of Medicine, 2019).

Schizophrenia: Affects less than 2% of Americans. It is predominantly found in men, with an average age of onset at the late teenage years to the early 20s. It commonly presents in women at a later period during their 20s or early 30s. (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019).

Anxiety disorder: 18% of people age 18- 54 are estimated to have an anxiety disorder in a given year. Anxiety disorders include panic disorder, obsessive-compulsive disorder (OCD), post-traumatic stress disorder (PTSD), generalized anxiety disorder (GAD), and phobias (social phobia, agoraphobia, and specific phobia). (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019).

Mental health disorders can be severe enough to lead to suicide. Women are more likely to attempt suicide while men are four times more likely to commit suicide. Hence, the highest suicide rates

in the US is among Caucasian men over the age of 85. Suicide is also considered the leading cause of death among adolescents and adults aged 15 to 24 in the United States. (Johns Hopkins, "Mental Health Disorder Statistics & Facts" 2019). The cause of a mental illness is usually a result of multiple factors including genetics, environment, and lifestyle. Biochemical processes, circuits, and primary brain structure may also play a role. (NAMI, 2019).

2.7 Sugar and the Brain

The brain is rich in nerve cells called neurons. It is the most energy-demanding organ in the body making use of one-half of all the sugar energy in the form of glucose. (Harvard Mahoney Neuroscience Institute, [HMNI], 2019).

The brains capacity to carry out its primary functions including thinking, memory, and learning is mainly dependent on circulatory glucose levels. Hence, a healthy amount of glucose supply to the brain promotes the production of neurotransmitters that foster the communication between neurons. On the other hand, low circulatory glucose levels may result in decreased energy for attention and cognitive function.

Even though the brain needs glucose, too much of it may be deleterious. Research shows that eating sugar produces characteristics of craving and withdrawal, along with chemical changes in the brain's reward center, "the limbic region." [HMNI, 2019].

According to sugar science, a study by the U.S. National Institute on Drug Abuse using brain scanning technology was among the first to show that the effects of sugar on people's brain were similar to those in people addicted to cocaine and alcohol. (Sugar science,.n.d; Volkow & Li, 2004). This evidence became the driving force for further research on the potentially addictive properties of sugar.

Using operant conditioning to investigate the consumption of sugar after abstinence in rats, Avena et al., (2008) found that animals may become dependent on sugar under selected dietary circumstances. Another study by Lenoir, Serre, Cantin & Ahmed, 2007 demonstrated that intense sweetness could surpass cocaine reward, even in drug-sensitized and -addicted individuals. This experiment was tested on animal models which were allowed to choose mutually-exclusively between water sweetened with saccharin and intravenous cocaine. 94% of the animals preferred the sweet taste of saccharin in spite of being addicted or sensitized to cocaine (Lenoir et al., 2007). This may be because foods high in sugar affect the serotonergic, dopamine, and opioid receptors in the brain, changing the neurochemistry of the brain in similar ways as seen in the consumption of addictive drugs (Colantuoni et al., 2002). Disproportionate and repeated exposure to food dense in energy, such as sugar, causes similar effects as demonstrated in drug abuse, such as craving, bingeing, and withdrawal (Avena et al., 2005; Colantuoni et al., 2002). It has also been found that the number of dopamine receptors in the brain is increased by recurrent bingeing of sugar, as sugar bingeing causes intermittent and excessive dopamine to be released in the brain. (Hoebel, Avena, Bocarsly, & Rada, 2009; Spangler et al., 2004).

2.8 Sugar Consumption and Mental Health

There are several convincing biological explanations for an association of chronic sugar intake and subsequent long-term risks of mental health disorders.

Firstly, low levels of the growth factor brain-derived neurotrophic factor (BDNF) have been discussed as facilitating neurogenesis and hippocampal atrophy in depression. (Sen, Duman, & Sanacora, 2008). Rodents fed on high-fat high-sugar diets, but not high-fat foods only, show a decrease in BDNF level, which could be a mechanistic link between diets high in sugar and depression. (Molteni, Barnar, Ying, Roberts & Gomez-Pinilla, 2002).

Secondly, carbohydrate consumption has been linked with increased circulating inflammatory markers, which may alter mood. (Kivimäki et al., 2014; Knuppel et al., 2017). Thirdly, high sugar diets could induce hypoglycemia through an exaggerated insulin response and thereby influence hormone levels and potentially mood states. (Knuppel et al., 2017). Fourthly, sugar is more addictive compared to cocaine (Ahmed, Guillem Vandaele, et al., 2013). Hence, the addiction-like effects of sugar suggest dopaminergic neurotransmission mechanisms might connect regular sugar intake with depression. (Avena et al., 2008). Lastly, obesity could be a mediating factor between a sugar-dense diet and depression not only via inflammatory but also psycho-social factors like weight discrimination. (Te Morenga, Mallard, & Mann, 2013; Knuppel et al., 2017).

Hu et al., (2018) evaluated sugar-sweetened beverage consumption and the risk of depression in a meta-analysis observational study involving 37,131 depression cases among 365,289 participants. The authors found a nonlinear dose-response relationship (Pnonlinearity = 0.0103) for depression risk and SSB consumption and when compared with SSBs nondrinkers, there was a 5% (RR = 1.05; 95% CI 1.01-1.09) possible increase in the risk of depression among those who drank the equivalent of 2 cups/day of cola while those who drank the equivalent of 3cans/day of cola might have approximately 25% higher risk of depression. The authors concluded that SSB consumption might be associated with a modestly higher risk of depression and suggested further confirmation of the results. Sanchez-Villegas et al., (2018) examined the association between added sugars and sweetened beverage consumption and the risk of depression in a prospective cohort of 15,546 subjects. The authors used Cox regression modeling to estimate hazard ratios (HR) of depression according to the consumption of added sugars and sweetened drinks. A total of 769 incident cases of depression were observed where the highest quartile of added sugars consumption showed a significant increase in the risk of depression (HR=1·35; 95 % CI 1·09,

1·67, P=0·034), while those in the highest quartile of Carbohydrate Quality Index (CQI) showed a relative risk reduction of 30 % compared with those in the lowest quartile of the CQI (HR=0·70; 95 % CI 0·56, 0·88). However, no significant association between sugar-sweetened beverage consumption and depression risk was found. Hence, the authors concluded that higher added sugars and lower quality of carbohydrate consumption were associated with depression risk in the cohort. Accordingly, further research was suggested to confirm the reported results. The Whitehall II study by Knüppel et al., 2017 investigated systematically, cross-sectional and prospective associations between sweet food/beverage intake, common mental disorder (CMD) and depression. The researchers also examined the role of reverse causation (influence of mood on consumption) as a potential explanation for the observed linkage. Random effects regression was used repeatedly to analyze a 23,245 person-observation from the Whitehall II study. The researchers found positive associations in the cross-sectional analysis. In the prospective analyses, men in the highest tertile of sugar intake from sweet food/beverages had a 23% increased odds of incident CMD after five years (95% CI: 1.02, 1.48) independent of health behaviors, socio- demographic and diet-related factors, adiposity and other diseases. The odds of recurrent depression were increased in the highest tertile for both sexes, but not statistically significant when diet-related factors were included in the model (OR 1.47; 95% CI: 0.98, 2.22). Their research confirmed an adverse effect of sugar intake from sweet food/beverage on long-term psychological health and suggested that lower consumption of sugar may be associated with better mental health. Park, Akinbami, McGuire & Blanck, (2013) evaluated the associations between SSB intake and current asthma among U.S. adults, and the role of obesity in the association. Data were obtained from the BRFSS 2013, and multivariable logistic regression was used to estimate associations between current asthma and SSB consumption frequency (none, <1 time/day, once/day, ≥2

times/day) of SSB intake (soda, fruit drink, sweet tea, and sports/energy drink). Covariates included age, sex, race/ethnicity, education, and smoking. Obesity, based on self-reported height and weight, was assessed as an effect modifier. The authors found that of 9.1% of adults who reported current asthma, 8.5% of adults who did not consume SSBs had current asthma compared to 12.1% of adults who consumed SSBs ≥2 times/day. Among non-obese adults, the odds of having current asthma were higher among those who drank SSBs ≥2 times/day (aOR=1.66, 95%CI=1.39, 1.99) than non-SSB consumers. However, SSB intake frequency was not associated with asthma among obese adults. They concluded that frequent SSB consumption was associated with asthma among non-obese adults. Hence, it will be of benefit to evaluate the role of obesity in the association between the use of sugar-sweetened beverages and mental health outcomes. A cross-sectional study using data from the 2012 and 2013 BRFSS by Burleson, Chad, Anderson, Copeland & Sullivan (2016) was carried out to ascertain the association between the consumption of sugar-sweetened beverage and increased odds of depression. The authors found that the odds of depression increased by 5% for every sugary drink consumed (odds ratio (OR) =1.06, 95% confidence interval (CI) =1.02-1.10) after adjusting for confounders. Depression was associated with race, employment status, educational level, and gender. Non -Hispanic blacks were 60% more likely to be depressed than non-Hispanic whites. Being unemployed and having a high school or less education was independently associated with depression while the association of depression and consumption of sugar-sweetened beverages was stronger among women than men. The authors concluded that consuming sugary drinks are associated with increased odds of depression.

It remains inconsistent whether SSBs consumption increases the risk of depression and common mental health problems in general as some studies have reported no association (Sanchez- Villegas

et al., 2018), some have reported positive associations (Burleson et al., 2016) and all have suggested the need for more research on this issue.

CHAPTER THREE

METHODOLOGY

3.1. Sample and Survey Administration

This research will analyze data from the Behavioral Risk Factor Surveillance System (BRFSS). BRFSS is the nation's premier system of health-related telephone surveys that collect data about residents from all 50 states regarding their health-related risk behaviors; chronic health conditions and use of preventive services ("CDC - BRFSS," 2018). The BRFSS is under the oversight of CDC's Population Health Surveillance Branch, under the Division of Population Health at the National Center for Chronic Disease Prevention and Health Promotion. ("CDC - BRFSS", 2016). Data of this survey are used in epidemiological studies and health sciences research, which help build effective public health initiative and policy. Also, information from the survey supports the public health professionals in determining disease prevalence, predisposing factors, assess nutritional status assessment and its association to health promotion and prevention ("CDC - BRFSS," 2017).

Eligibility criteria: Adults' ≥ 18 years who participated in the 2017 BRFSS, and had non-missing information on questions and measurements related to SSB consumption, mental health, and BMI are included in the study.

3.2. Variables

Dependent Variable: "Poor Mental Health" was determined by positive responses to two survey questions.

1. (Ever told) you have a depressive disorder, including depression, major depression, dysthymia, or minor depression?

2. Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? ("CDC - BRFSS", 2017)

A person who reported that their mental health was not good for greater than or equal to 14 of the preceding 30 days was defined as having frequent mental distress. The 14 days minimum period is used because physicians and researchers often use a similar period as a marker for clinical depression and anxiety disorders.

Independent Variable: "Consumption of Sugar-Sweetened Beverages" intake was determined by two survey questions:

1. During the past 30 days, how often did you drink regular soda or pop that contains sugar? Do not include diet soda or diet pop. ("CDC - BRFSS", 2017)

2. During the past 30 days, how often did you drink sugar-sweetened fruit drinks (such as Kool-Aid and lemonade), sweet tea, and sports or energy drinks (such as Gatorade and Red Bull)? Do not include 100% fruit juice, diet drinks, or artificially sweetened drinks. ("CDC - BRFSS", 2017).

Respondents reported the number of times per day, week, or month they consumed these beverages. Weekly and monthly intake was converted to daily intake, and SSB intake frequency was calculated by combining consumption frequency from both questions. Three mutually exclusive SSB categories of consumption frequency (0, >0 to <1, and ≥1 times/day) were created (CDC, 2017).

COVARIATES

Age in years

The participants were evenly distributed across three age categories: young adults (18-44) years, middle-aged adults (45-64) years and older aged adults (≥65).

Race

This variable was categorized into Non-Hispanic white, Non-Hispanic Black, Asian Non-Hispanics, Hispanics, and Others.

Gender

This variable was reported as the gender of the participants at the time of screening. Classified as male and female based on self-reported data.

Marital status

For this study, participant's marital status is categorized as Married and Others (Divorced, widowed, separated, never married or a member of an unmarried couple).

Educational level

Categorized into ≤ High School and > High school.

Family Income

The annual household income from all sources was used in this study as a measure of socioeconomic status and was further classified into three groups. '<$35,000', '$35,000 to <$75,000' and '≥ $75,000';

BMI

Based on body mass index (BMI) (kg/m2) calculated from self-reported weight and height data, weight status was classified as underweight (BMI < 18.5), normal weight (BMI 18.5–<25), overweight (BMI 25–<30), and obese (BMI ≥ 30).

Physical Activity

Physical activity was categorized into two groups: physically active and physically inactive. Participants were allocated to this group based on their response to the following question: During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise? ("CDC - BRFSS", 2017).

Employment

This demographic variable was classified as "employed" and "unemployed."

Smoking

Classified based on a three-level smoker status.

Current cigarettes smokers: Participants who reported they still smoked cigarettes on some days or every day.

Former smokers: Participants who have smoked cigarettes in their lifetime but currently do not smoke.

Never smoker: Consists of those who have never smoked cigarettes.

Diabetes

Respondents who have ever been told they have diabetes

Hypertension

Participants who have ever been told by a doctor, nurse or other health professionals that they have high blood pressure.

Myocardial infarction

Respondents that have ever reported having coronary heart disease (CHD) or myocardial infarction (MI).

Coronary Heart Disease

Participants were categorized based on their response to the question "(Ever told) you had angina or coronary heart disease?"

Obesity

Adults who have a body mass index greater than 25.00 (Overweight or Obese).

3.3 Statistical Analysis

In the 2017 BRFSS, 450,016 adults participated in the SSB optional module, which included two questions. 396,379 adults who had missing data on one of the SSB questions were excluded yielding a final analytic sample of 53,637 adults. Descriptive statistics were conducted for all

participant characteristics including age, gender, race, marital status, education, income status, physical activity, smoking employment status and BMI. Chi-square test ($\chi 2$) was used to examine the bivariate associations of sociodemographic characteristics with mental health with $p < 0.05$ to evaluate statistical significance for all analyses. Using multivariable logistic regression analysis, the crude adjusted odds ratios (aOR) and 95% confidence intervals (CI) for the relationship between frequency of SSB intake and poor mental health was calculated, after controlling for age, sex, race/ethnicity, education, income, marital status, smoking status, and chronic diseases including: diabetes, hypertension, coronary heart disease, myocardial infarction and obesity. In addition to the general model, a separate model stratified by obesity was evaluated to assess possible effect modification. All analyses were performed using SAS 9.4 (Statistical Analysis System, Cary, NC, USA) and survey procedures were used for frequency and logistic processes.

CHAPTER FOUR

RESULTS

4.1. Descriptive Statistics

Overall, 53637 participants composed of 23,437 (48.3%) males and 30,160 (51.7%) females aged 18 years and older were included in this analysis. Participants with missing data on the variable of interest were excluded. Most respondents were between 18 and 44 years (42.2%), and more than half of the participants who self-reported for the consumption of sugar-sweetened beverages were Non-Hispanic whites (69.8%). Majority attained above high school education (96.5%), were married (51.8%), physically active (73.4%), not employed for wages (53.03%), earn a yearly household income within $35,000 to <$75,000 per year (41.7%), have never smoked (56%), and are overweight (35.1%). A major percentage of the population 88.12% are not diagnosed with diabetes, myocardial infarction (95.4%) nor coronary heart disease (95.5%). 22,655 (43.3%) consumed >0 to <1 sugar-sweetened beverage per day while only a minority of participants, 10597 (20.96%) had poor mental health.

4.2. Results of Bivariate Analysis

Results revealed a statistically significant difference between mental health and each of the participant's demographic characteristics (age, gender, race, marital status, employment status, income group, physical activity, smoking, BMI and the independent variable (consumption of sugar-sweetened beverages per day) - $P < 0.01$ for all). There was a statistically significant difference ($P < 0.01$) between mental health and preexisting diseases; Diabetes, Hypertension, Myocardial Infarction, and Coronary Heart disease. However, no statistically significant difference

was observed between educational levels p= (0.3916) and obesity p= (0.1450) on mental health. (Table 2).

4.3. Results of Multivariate Analysis

In the unadjusted model, the odds of poor mental health among those who consumed one or more sugar-sweetened beverages per day was 1.64 times the odds among those who drank none. (OR=1.64, 95% CI =1.64, 1.82)(Table 3). After adjusting for sociodemographic (age, gender, race, marital status, employment status, income), behavioral characteristics (smoking, physical activity) and preexisting diseases (diabetes, obesity, myocardial infarction, hypertension and coronary heart disease), it was found that drinking 1 sugar-sweetened beverage per day increases the likelihood of poor mental health by 41% (aOR=1.41, 95% CI=1.21-1.63) (Table 4). The presence of obesity resulted in a similar trend of poor mental health upon consumption of 1 or more sugar-sweetened beverages per day (OR=1.42, 95% CI=1.23-1.64). (Table 5)

Among covariates, gender was most strongly associated with poor mental health, with women being more than twice as likely to suffer from mental health problems (aOR=2.20, 95% CI 1.97-2.45) compared to males. Being unmarried and unemployed were also associated with poor mental health. (aOR =1.34, 95% CI=1.19- 1.51; aOR=1.62, 95% CI=1.44- 1.83, respectively). There was a protective factor associated with exercise, as those who did not engage in regular physical activity, other than their regular job were 17% more likely to suffer from poor mental health in comparison with their counterparts who did exercise (aOR=1.17, 95% CI 1.04-1.31).

Similarly, having an underlying case of diabetes, or a cardiovascular disease; myocardial infarction and coronary heart disease was associated with poor mental health among those who consumed

sugar-sweetened beverages (aOR=1.36, 95% CI= 1.17, 1.58; aOR=1.03, 95% CI = 1.41, 1.45; aOR=1.79, 95% CI =1.41, 2.28, respectively).

In the obesity-stratified analysis to test for effect modification, the odds of poor mental health was less among non-obese who consume one or more sugar-sweetened beverages per day (OR=0.47, 95% CI =0.39- 0.58). However, there was no association between the frequency of SSB consumption and poor mental health in both obese and non-obese groups. Hence, obesity does not seem to modify the association. (Table 6).

CHAPTER FIVE

5.1 Discussion

The purpose of this research was to evaluate the association between the consumption of sugar-sweetened beverages and poor mental health among adults in the United States of America as well as to assess the role of obesity in this association. Overall, results from this study suggest that the consumption of sugar-sweetened beverages was positively associated with poor mental health with or without controlling for measures of sociodemographic & socio-economic status, behavioral characteristics and preexisting chronic diseases. For every one or more sugary drink consumed daily, the odds of poor mental health increased by 64%. In the adjusted analyses, it was found that adults who consumed SSBs ≥1 times/day had 41% higher odds of having poor mental health than non-SSB consumers.

This study is the first to compare adult age groups, as well as examine the direct association between sugary drinks and mental health problems in the United States as other researchers have focused on adolescents, specific diets and outcomes such as asthma and depression while others have used a setting other than the United States.

Using available data from 6 countries; Korea, the USA, France, Germany, Canada, and New Zealand, Westover et al., 2002 found a positive correlation between major depression and national sugar consumption. Their sugar consumption rates (cal/cap/day) were correlated with the annual rate of major depression, using the Pearson correlation coefficient (Pearson correlation 0.948, P=0.004). (Westover & Marangell, 2002)

A cross-sectional study conducted in South Australia reported that individuals who consumed more than a half liter of soft drinks per day had approximately 60% greater risk of having

depression, stress, suicidal ideation, and psychological distress than those who did not consume soft drinks. Hence, a positive association between the consumption of soft drinks and mental health problems among adults in South Australia was determined. (Shi, Taylor & Witter, 2010).

A population-based cross-sectional study was conducted among students aged 12-19 years in 100 schools in Jiangsu Province, China. The study found an association between soda intake and suicidal plans or attempts as individuals who consumed 3 or more drinks per day were 80% more likely to attempt suicide than those who did not. (Pan, Zhang & Shi, 2011).

Whitaker et al., 2014 found a significant association between depressive symptoms and total daily caloric intake from saturated fat and total sugars (<0.05). Depressive symptoms were also positively associated with sweetened beverage consumption (p=.06). (Whitaker, Sharpe, Wilcox & Hutto, 2014).

Although potential mechanisms for associations between daily high-SSB intake and poor mental health are uncertain, data from the Framingham Heart Study (FHS), have shown that people who frequently consume sugary sweetened beverages are more likely to have poorer episodic memory, smaller hippocampal and total brain volumes (all $P < .01$). The authors also found that people who drank diet soda daily were three times as likely to develop stroke and dementia when compared to those who did not consume diet soda (all $P < .05$). (Pase et al., 2017).

In this thesis, poor mental health was also independently associated with gender, marital status, employment status, physical activity and some preexisting diseases including diabetes, myocardial infarction, and coronary heart disease. The odds were higher among females, unmarried, unemployed and physically inactive individuals compared to their counterparts. Similar associations were observed in previous studies. A cross-sectional study in 2016 reported that the

association of depression and consumption of sugar-sweetened beverages was stronger among women than men, unemployed than employed and among those who do not engage in physical exercise other than their regular job. (OR=1.17, 95%CI= 1.01-1.3; OR=2.12, 95% CI=1.80-2.5; OR= 1.71, 95% CI= 1.45-2.0 respectively). The researchers found depression to be associated with race, non-Hispanic blacks being 60% more likely to be depressed than non-Hispanic whites; and education level, with having a high school or less education associated with higher odds depression (OR=1.89, 95% CI=1.62-2.18). However, contrary to the findings in the general group, age was not independently associated with depression among women. (Burleson et al., 2016).

This thesis also found no significant association between frequency of SSB intake and poor mental health among obese adults to suggest that sugar-sweetened beverages may have a more significant effect among obese than non-obese (OR=0.91, 95% CI= 0.68, 1.21). Contrary to my findings on the obesity stratified model, Park et al., (2013) found that among non-obese adults who consumed SSBs ≥2 times/day, the odds of having current asthma were higher (aOR=1.66, 95%CI=1.39, 1.99) compared to those who drank none. However, SSB intake frequency was still not associated with asthma among obese adults. (Park et al., 2013). This may be because the data did not include information on inflammatory or other biologic markers. Also, it is possible that underlying low-level chronic inflammation associated with obesity (Dixon et al., 2010) might have masked any effects that SSB intake could have on poor mental health (Park et al., 2013). Similarly, Body mass index(BMI) provided no significance on the association between the consumption of SSB and poor mental health, however, an examination of BMI, specific food intake, and severity of depression reported that higher consumption of high-calorie sweet food, such as chocolate, soda, and sweetened fruit drinks, were associated with depressive symptoms ($p<0.01$) but not BMI. The opposite was true for high-calorie non-sweet food, such as fried foods, hamburgers, and whole-

milk, where there was an association between BMI but not with depressive symptoms. (Jacka, Pasco & Mykletun, 2009). This may suggest that sugar and not caloric surplus plays a more significant role in depression and other mental health problems. People who frequently consume diet soda or SSB are known to be more likely to be diabetic, which is believed to increase the risk of dementia and other mental health problems. In accordance with the results of this thesis, Pase et al., (2017) also found that preexisting conditions such as cardiovascular disease, diabetes, obesity, and high blood pressure did not wholly explain the findings because even after controlling for these preexisting conditions, sweetened beverage consumption was still associated with the risk of dementia and poor mental health.

5.2 Strength and Limitations of the study

Despite the apparent strength of using a nationally representative survey for this analysis, this study is subject to limitations. Firstly, BRFSS is a cross-sectional survey from which no causal inferences can be made. This design cannot establish temporality because information about whether the SSB consumption preceded the development of a poor mental health state is not available. Hence, the possibility of reverse causality bias cannot be ruled out. Secondly, information on the particular type of SSB, the quantity of sugar and volume of the beverage was not considered in the survey. Therefore, a clearly defined amount of one drink is essential. Also, SSB consumption and mental health symptoms were assessed via self-reported data instead of validated measures. This makes the data subject to reporting bias. Furthermore, it is premature to say these observations represent cause and effect; therefore, more detailed longitudinal studies are required to confirm these findings.

5.3. Conclusion and Policy Implications of Findings

The association between the consumption of sugar-sweetened beverages and poor mental health adds to the emerging evidence linking the consumption of added sugar to negative mental health outcomes. With increasing rates of SSB consumption and limited research on its potential impact on mental health, policymakers, especially at the state level, should understand this lack of knowledge is a notable barrier not only to scientific understanding but to the improvement of public policy and public health. This data can provide additional support for policymakers as they advocate against high sugar contents in both foods and beverages. Reducing the allowable sizes of sugar-sweetened beverages available for purchase or informing consumers of the health consequences of their beverage choices is vital in the prevention and control of mental health problems alongside other associated morbidities.

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TABLE 1. CHARACTERISTICS OF SURVEY PARTICIPANTS (N=53,637)

SURVEY CHARACTERISTIC	FREQUENCY N (%)
Sex	
Male	23437 (48.3%)
Female	30160 (51.70%)
Missing = 40	
Age (Years)	
18-44	13475 (42.2%)
44-64	20219 (34.6%)
65+	19943 (23.2%)
Race	
Non-Hispanic White	38166 (69.8%)
Non-Hispanic Black	4789 (11.5%)
Asian Non-Hispanic	2591 (3.6%)
Hispanic	3595 (10.2%)
Others	4496 (5.0%)
Marital Status	
Married	27209 (51.79%)
Others	26113 (48.21%)
Missing=315	
Education	
<= High School	1076 (3.50%)
>High School	52395 (96.50%)
Missing = 166	
Employment Status	
Employed	21182 (46.97%)
Unemployed	32120 (53.03%)
Missing=335	
Income Level (Household,$/year)	
<35,000	11942 (27.62%)
35,000 - <75,000	18907 (41.66%)
≥ 75,000	14808 (30.76%)
Missing = 7980	
Exercise	
Yes	39344 (73.44%)
No	14211 (26.56%)
Missing=82	
Smoking status	
Current Smoker	7910 (17.63%)

Former smoker	15886 (26.38%)
Never smoker	29536 (55.99%)
Missing=305	
Body Mass Index (BMI)	
Under weight	896 (1.79%)
Normal weight	16083 (30.89%)
Overweight	18030 (35.06%)
Obese	15451 (32.26%)
Missing = 3177	
Diabetes	
Yes	7281 (11.88%)
No	44808 (88.12%)
Missing=1548	
Hypertension	
Yes	31263 (64.52%)
No	22254 (35.48%)
Missing=120	
Myocardial Infarction	
Yes	3109(4.57%)
No	50287(95.43%)
Missing=241	
Coronary Heart disease	
Yes No	3054 (4.55%)
Missing=1891	48692 (95.45%)
Obesity	
Yes	33481 (67.31%)
No	16979 (32.69%)
Missing=3177	
Characteristic 1 **Sugary-drink consumption (#/day)**	
None	18640 (25.98%)
>0 to <1	22655 (43.31%)
≥1	12342 (30.71%)
Characteristic 2 **Poor Mental Health**	
Yes	10597 (20.96%)
No	42873 (79.04%)
Missing = 3177	

TABLE 2: Chi-square distribution of Poor Mental Health among independent variables and covariates

	MENTAL HEALTH		
Participant Characteristics	**Poor MH**	**Good/Better MH**	**P-value**
	N (%)	**N (%)**	
	10,597 (20.96%)	42,873(79.04%)	
Age (years)			**<.0001[c]**
18-44	2900 (9.6)	10535 (32.6)	
45-64	4585 (7.6)	15573 (27.0)	
≥ 65	3112 (3.8)	16765 (19.4)	
Missing = 167			
Gender (N=53,431)			**<0.0001[c]**
Male	3503 (7.6)	19861 (40.8)	
Female	7081 (13.4)	22986 (38.3)	
Missing = 206			
Race (N=53470)			**<.0001[c]**
Non-Hispanic white	8104 (15.8)	29947 (54.1)	
Non-Hispanic Black	769 (2.0)	4002 (2.0)	
Asian Non-Hispanic	199 (0.3)	2387 (3.3)	
Hispanics	653 (1.8)	2927 (8.4)	
Others	872 (1.1)	3610 (3.9)	
Missing = 167			
Marital status			**<.0001 [c]**
Married	4,252 (8.6)	22,898(43.3)	
Other	6,289 (12.4)	19,727(35.8)	
Missing = 471			
Education			0.3916 [c]
≤ High School	250 (0.7)	817(2.8)	
> High school	10320 (20.3)	41922 (76.2)	
Missing = 328			
Employment status (N=43,140)			**<.0001 [c]**
Employed	3462 (8.0)	7663 (39.0)	
Unemployed	7084 (13.0)	24931 (40.0)	
Missing = 497			
Income Level			**<.0001 [c]**
<35,000	3622 (8.7)	8269 (18.9)	
35,000 - <75,000	3589 (8.3)	15276 (33.3)	
≥ 75,000	1930 (4.1)	12862 (36.7)	
Missing = 8089			
Exercise (N=47,129)			**<.0001 [c]**
Yes	6960(14.2)	32279(59.3)	
No	3618(6.7)	10536(19.8)	
Missing=244			

Smoking status (N=53,169)			**<.0001** [c]
Current smoker	2634(6.3)	5246(11.3)	
Former smoker	3278(5.8)	12564(20.6)	
Never smoker	4643(8.9)	24804(47.1)	
Missing = 468			
Body Mass Index (N=40,031)			**<.0001** [c]
Under weight	203(0.5)	690(1.3)	
Normal weight	2751(6.2)	13285(24.7)	
Overweight	3139(6.2)	14844(28.8)	
Obese	3976(8.3)	1143(24.0)	
Missing = 3313			
Diabetes (N=51,938)			**<.0001** [c]
Yes	1930 (3.3)	5334(8.6)	
No	8299 (17.5)	36375(70.6)	
Missing = 1699			
Hypertension			**<.0001** [c]
Yes	5460 (12.4)	25725 (52.1)	
No	5112 (8.5)	17062 (26.9)	
Missing = 278			
Myocardial Infarction (N=53,239)			**<.0001** [c]
Yes	865(1.3)	2228(3.2)	
No	9666(19.6)	40480(75.9)	
Missing = 398			
Coronary Heart disease (N=51,594)			**<.0001** [c]
Yes	924(1.51)	2117(3.0)	
No	9208(19.3)	39345(76.1)	
Missing=2043			
Obesity (N=50,324)			0.1450 [c]
Yes	7115(14.5)	26280(52.8)	
No	2954(6.7)	13975(26.0)	
Missing = 3313			
Sugary-drink consumption (#/day) (N=53,470)			**<.0001** [c]
None	3235 (4.6)	15346 (21.4)	
>0 to <1	4186 (8.4)	18402 (34.9)	
≥1	3176(8.0)	9125 (22.7)	

*p-value highlighted in bold indicate the finding is statistically significant at α=0.05 (p< .05)

[c] Chi-square statistical test was used to test for association

TABLE 3. Bivariate Analysis of selected independent variables and Poor Mental Health

PARTICIPANTS CHARACTERISTIC	OR (95% CI) * Crude
Sugary-drink consumption (#/day)	
None	**Ref**
>0 to <1	1.11 (1.01, 1.23)
≥1	1.64 (1.64, 1.82)
Age (Years)	
18-44	**Ref**
44-64	0.97 (0.88, 1.06)
65+	0.67 (0.60, 0.74)
Gender	
Male	**Ref**
Female	1.89(1.74, 2.06)
Race	
Non-Hispanic White	**Ref**
Non-Hispanic Black	0.97 (0.88, 1.06)
Asian Non-Hispanic	0.29 (0.22, 0.38)
Hispanic	0.75 (0.64, 0.89)
Others	0.93 (0.79, 1.10)
Marital Status	
Married	**Ref**
Others	1.74 (1.60, 1.90)
Education	
<= High School	0.90 (0.70, 1.15)
>High School	**Ref**
Employment Status	
Employed	**Ref**
Unemployed	0.54 (0.49, 0.60)
Income Level (Household,$/year)	
<35,000	**Ref**
35,000 - <75,000	0.54 (0.49, 0.60)
≥ 75,000	0.33 (0.30, 0.38)
Missing = 7980	
Exercise	
Yes	**Ref**

No	1.42 (1.30, 1.56)
Smoking status	
Current Smoker	**Ref**
Former smoker	0.50 (0.45, 0.57)
Never smoker	0.34 (0.30, 0.38)
Body Mass Index (BMI)	
Under weight	**Ref**
Normal weight	0.65 (0.49, 0.88)
Overweight	0.57 (0.42, 0.76)
Obese	0.91 (0.68, 1.21)
Diabetes	
Yes	1.53 (1.37, 1.72)
No	**Ref**
Hypertension	
Yes	0.75 (0.69, 0.82)
No	**Ref**
Myocardial Infarction	
Yes	1.61 (1.36, 1.92)
No	**Ref**
Coronary Heart disease	
Yes	1.96 (1.68, 2.29)
No	**Ref**
Obesity	
Yes	1.07 (0.98, 1.18)
No	**Ref**

Abbreviations: OR, Odds ratio; CI, confidence Interval; Ref, Reference category.

Table 4: Multivariable adjusted OR for Consumption of Sugar Sweetened Beverages and Mental Health controlling for all other significant variables

PARTICIPANTS CHARACTERISTIC	OR (95% CI) * Adjusted
SSB Category[a]	
>0 to <1	1.12 (0.98 ,1.27)
>=1	1.41 (1.21 ,1.63)
Age[b]	
45-64	0.79 (0.70 , 0.89)
65+	0.36 (0.31 , 0.43)
Gender[c]	
Female	2.20 (1.97, 2.45)
Race/Ethnicity [d]	
Other /Multi racial	0.70(0.57, 0.85)
Asian non-Hispanic	0.32 (0.24, 0.43)
Hispanic	0.76 (0.62, 0.94)
Non-Hispanic black	0.58 (0.47, 0.71)
Other/Marital status[e]	1.34 (1.19 ,1.51)
Education[f]	
<=High school	0.87 (0.63 ,1.24)
Income Level (Household,$/year)[g]	
$35,000 - < $75,000	0.74 (0.65 ,0.84)
≥ $75,000	0.59 (0.50 ,0.69)
Employment[h]	
Unemployed	1.62 (1.44 ,1.83)
Exercise[i]	
No exercise	1.17 (1.04 ,1.31)
Smoking[j]	
Former Smoker	0.71 (0.61 ,0.83)
Never Smoker	0.46 (0.40 ,0.52)
BMI[k]	
Normal Weight	1.02 (0.71,1.46)
Obese	1.30 (0.90 ,1.87)
Overweight	1.02 (0.71 ,1.47)
Diabetes[l]	
Diabetic	1.36 (1.17, 1.58)
Hypertension[m]	
Hypertensive	0.79 (0.70, 0.82)
Myocardial Infarction[n]	
Yes-Myocardial infarction	1.03 (1.41, 1.45)
Coronary Heart Disease[o]	
Yes- Coronary heart disease	1.79 (1.406, 2.275)

abbreviations: OR, odds ratio; CI, confidence interval;
* adjusted model included the following covariates: age, gender, race, marital, status, educational level, income level, employment status, exercise, cigarette smoking status, body mass index, diabetes, hypertension, myocardial infarction, coronary heart disease.
a; reference category for Consumption of SSB—none drinker,
b; reference category for age group—age group 18-44 years
c; reference category for gender – male
d; reference category for race—Non- Hispanic whites
e; reference category for marital status— married
f; reference category for level of education— > high school
g; reference category for income level— <$35,000
h; reference category for employment - employed
I; reference category for exercise – physically active
j; reference category cigarette smoking— current smoker
k; reference category for BMI- underweight
l; reference category for diabetes – non diabetic
m; reference category for hypertension – not hypertensive
n; reference category for myocardial infarction – 'no' myocardial infarction
o; reference category for coronary heart disease – 'no' coronary heart disease

Table 5: Multivariable adjusted OR for Consumption of Sugar Sweetened Beverages and Poor Mental Health controlling for all other variables excluding obesity.

PARTICIPANTS CHARACTERISTIC	OR (95% CI) * Adjusted
SSB Category[a]	
>0 to <1	1.14 (1.01 ,1.29)
>=1	1.42 (1.23 ,1.64)
Age[b]	
45-64	0.79 (0.70 , 0.89)
65+	0.35 (0.30 , 0.41)
Gender[c]	
Female	2.20 (1.95, 2.42)
Race/Ethnicity [d]	
Other /Multi racial	0.70(0.56, 0.83)
Asian non-Hispanic	0.30 (0.22, 0.40)
Hispanic	0.71 (0.60, 0.87)
Non-Hispanic black	0.58 (0.47, 0.70)
Other/Marital status[e]	1.36 (1.21 ,1.52)
Education[f]	
<=High school	0.84 (0.60 ,1.16)
Income Level (Household,$/year)[g]	
$35,000 - < $75,000	0.60 (0.50 ,0.84)
≥ $75,000	0.59 (0.50 ,0.66)
Employment[h]	
Unemployed	1.60 (1.41 ,1.77)
Exercise[i]	
No exercise	1.20 (1.07 ,1.34)
Smoking[j]	
Former Smoker	0.71 (0.62 ,0.82)
Never Smoker	0.46 (0.40 ,0.53)
Diabetes[l]	
Diabetic	1.46 (1.30, 1.67)
Hypertension[m]	
Hypertensive	0.75 (0.67, 1.53)
Myocardial Infarction[n]	
Yes-Myocardial infarction	1.08 (0.77, 1.53)
Coronary Heart Disease[o]	
Yes- Coronary heart disease	1.76(1.38, 2.23)

abbreviations: OR, odds ratio; CI, confidence interval;
* adjusted model included the following covariates: age, gender, race, marital, status, educational level, income level, employment status, exercise, cigarette smoking status, diabetes, hypertension, myocardial infarction, coronary heart disease.
a; reference category for Consumption of SSB—none drinker,
b; reference category for age group—age group 18-44 years
c; reference category for gender – male
d; reference category for race—Non- Hispanic whites
e; reference category for marital status— married
f; reference category for level of education— > high school
g; reference category for income level— <$35,000
h; reference category for employment - employed
I; reference category for exercise – physically active
j; reference category cigarette smoking— current smoker
l; reference category for diabetes – non diabetic
m; reference category for hypertension – not hypertensive
n; reference category for myocardial infarction – 'no' myocardial infarction
o; reference category for coronary heart disease – 'no' coronary heart disease

Table 6: Prevalence and Odds of Poor Mental Health among non-obese and obese U.S. adults by SSB Categories (n=10,069)

	Non-Obese	**Obese**
SSB Category	**Prevalence of Poor Mental Health n (%)**	
SSB=0	962 (4.3)	2118 (4.8)
>0 to <1 time/day	1122 (7.8)	2860 (8.7)
≥1times/day	870 (8.3)	2137 (8.1)
	Odds of Poor Mental Health (OR, 95% CI)	
SSB=0	**Ref**	**Ref**
>0 to <1 time/day	0.81(0.67, 0.98)	0.95(0.84, 1.08)
≥1times/day	0.47(0.39, 0.58)	0.69(0.61, 0.79)