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Brief Research

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Consumption of Sugar-Sweetened Beverages Associated With Increased Odds of Depression

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ABSTRACT

Objective: To evaluate the association between depression and sugary drink intake using participant data from the Behavioral Risk Factor Surveillance Survey (BRFSS).

Design: Cross-sectional data from the 2012 and 2013 BRFSS were examined (N=44,603). Depression was based on self-report of symptoms within the past 30 days. Covariates included age, sex, race, employment status, body mass index (BMI), education level, and exercise in the past 30 days.

Setting: Data from a national telephone survey (BRFSS) were used to assess risk factors associated with health of the participants.

Subjects: Participants in the 2012 and 2013 BRFSS were included in this analysis (N=44,603).
Results: Adjusting for confounders, 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). Depression was also associated with race, with non-Hispanic blacks being 60% more likely to be depressed than non-Hispanic whites. Unemployment and having a high school or less education were independently associated with depression. The association of depression and consumption of sugar sweetened beverages was stronger among women than men.

Conclusion: This study indicates that consuming sugary drinks are associated with an increased odds of depression. These findings support advocacy efforts for an overall healthy lifestyle. In addition, future research should evaluate this association using a cohort design in order to establish the temporality of this association.

KEYWORDS: Mental health; Epidemiology; Diet; Soda.

ABBREVIATIONS: BRFSS: Behavioral Risk Factor Surveillance Survey; USDA: United States Department of Agriculture; NIH: National Institutes of Health; BMI: Body Mass Index; IRB: Institutional Review Board.

INTRODUCTION

Increased sugar intake has become a major concern in the United States over the past few decades, with particular concern related to sugar sweetened beverages. Between 1977 and 1996 all age groups in the United States (US) more than doubled their consumption of sugary beverages.¹ In 2000, the average American citizen consumed 260 grams of sugar per day, although the United States Department of Agriculture (USDA) recommends no more than 40 grams per day. This recommended amount would be equivalent to one 12-ounce soft drink.² The United States also has an increasing rate of mental health disorders, especially depression and anxiety. According to the National Institutes of Health (NIH), 15.7 million adults reported having at least one major depressive episode in 2013, accounting for 6.7% of the overall US population. The NIH also reported that an estimated 18% of the adult population identifies themselves as having an anxiety disorder, with 4% of these being classified as "severe".³ The increased levels of sugar intake and increased reporting of mental illness are both major public health concerns

in the US.

Overwhelming evidence suggests that added dietary sugar has a negative impact on an individual's mental health. Research has provided many examples of sugar consumed excessively leading to altered mental health, however the association between the concentrated sugar contents in manufactured sugary beverages and depressive symptoms has not been examined. With the current increase in both sugary beverage intake as well as reported depression in the US, the objective of this study was to evaluate the possible association between sugary beverage intake and reported depression symptoms using data from the Behavioral Risk Factor Surveillance System (BRFSS).

METHODS

The BRFSS is a national telephone survey used to assess risk factors associated with health of the participants.⁴ It is conducted on an annual basis throughout the US. Response data for the years 2012 and 2013 were included in this analysis.

Inclusion and Exclusion Criteria

For participants to be included in this analysis, answers for both the outcome and exposure variables (described below) must have been valid. Any missing responses to the aforementioned variables excluded the participant from the analysis.

Outcome

BRFSS participants were asked how often during the past month they felt "so depressed that nothing could cheer (them) up?"^{4,5} Participants who self-reported depression in this manner were categorized as depressed.

Exposure

The primary exposure for this analysis was intake of sugar sweetened beverages. Two questions in the BRFSS provide these data, asking participants to report their consumption in the past 30 days:

1. "About how often do you drink regular soda or pop that contains sugar?"^{4,5}
2. 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)?"^{4,5}

Participants were asked to not include 100 percent fruit juice, diet drinks, or artificially sweetened drinks such as diet soda or diet pop. Responses to these questions were standardized to the number of drinks consumed per day and this variable was considered continuous.

Covariates

Covariates for the study included participant's age, sex, race,

employment status, body mass index (BMI), education level, and exercise in the past 30 days. Age was categorized as 18-24, 25-34, 35-44, 45-54, 55-64, and 65+ years. Race was classified as Non-Hispanic white (reference group), Non-Hispanic black, or other; employment status was categorized as employed (employed for pay or self-employed) or not employed (retired, student, homemaker or looking for work); education was coded as high school or less or more than high school, and exercise was dichotomized to indicate if the participant exercised at all outside of their employment during the past month. BMI was treated as a continuous variable and was calculated by BRFSS based on participants' self-reported weight and height. These covariates were considered as possible confounders.

Analysis

The bivariate association between each covariate and depression and sugar sweetened beverages (separately) was evaluated using *t*-tests and Chi-square tests, as appropriate. Means and standard errors (SE) were calculated for continuous variables and frequencies were obtained for categorical variables. A logistic regression model was constructed to evaluate the association between sugar sweetened beverages and depression, controlling for confounders. In addition to the model for the entire sample, separate models were evaluated stratified by sex in order to assess possible effect modification. Survey weights were used throughout the analysis, which was performed using SAS version 9.4.⁶ Survey procedures were used for mean, frequency and logistic procedures.

RESULTS

Table 1 shows the unadjusted demographic distribution by depression status. Among those depressed, more than 60% of the study population was 44 years of age or older, income level was fairly evenly distributed among the participants, education was also fairly even for those obtaining a high school degree and higher, some college or technical school and finishing college. Those not participating in exercise reported depression more frequently than those who did exercise (32.8% crude fibre (cf.) 20.1%, respectively), although the majority of both groups did not exercise. There was also a lower percentage of employed and retired individuals in the depressed group (43.5% of depressed participants were employed and 18.7% were retired cf. 56.8% employment and 28.0% retirement among non-depressed participants); however in the depressed group there was also a large percentage (18%) of individuals classified as "unable to work".

After adjusting for confounders using logistic regression, it was found that drinking one sugary beverage per day increases the likelihood of depression by 6% (OR=1.06, 95% CI=1.02-1.10) (Table 2). Among other covariates, race was most strongly associated with depression, with black non-Hispanics being approximately 60% more likely to be depressed (OR=1.62, 95% CI=1.19-2.20) and other races being more than twice as likely to be depressed (OR=2.16, 95% CI 1.79-2.62) compared to white non-Hispanics. Being unemployed and hav-

Variables	Depressed (N=5,439)	Non-Depressed (N=39,164)	p-Value (crude)
	N (%)	N (%)	
Sex			
Male	2,119 (39.0%)	16,498 (42.1%)	<0.0001
Female	3,320 (61.0%)	22,666 (57.9%)	
Age (years)			
18-24	377 (6.9%)	1,829 (4.7%)	<0.0001
25-34	659 (12.1%)	3,869 (9.9%)	
35-44	794 (14.6%)	5,068 (12.9%)	
45-54	1,236 (22.7%)	6,991 (17.6%)	
55-64	1,246 (22.9%)	9,020 (23.0%)	
65 and Older	1,127 (20.1%)	12,387 (31.6%)	
Employment Status			
Employed for Wages	1,988 (36.6%)	18,439 (47.1%)	<0.0001
Self-employed	373 (6.9%)	3,805 (9.7%)	
Out of work for more than 1 year	354 (6.5%)	756 (1.9%)	
Out of work for less than a year	269 (4.9%)	778 (2.0%)	
A homemaker	273 (5.0%)	2,101 (5.4%)	
A student	170 (3.1%)	857 (2.2%)	
Retired	1,018 (18.7%)	10,980 (28.0%)	
Unable to work	981 (18.0%)	1,332 (3.4%)	
Missing=129			
Income Level (Household, \$/year)			
Less than 10,000	603 (11.1%)	1,114 (2.8%)	<0.0001
Less than 15,000	518 (9.5%)	1,451 (3.7%)	
Less than 20,000	593 (10.9%)	2,229 (5.7%)	
Less than 25,000	636 (11.7%)	3,086 (7.9%)	
Less than 35,000	607 (11.2%)	3,834 (9.8%)	
Less than 50,000	616 (11.3%)	5,477 (14.0%)	
Less than 75,000	557 (10.2%)	6,239 (15.9%)	
75,000 or more	729 (13.4%)	11,199 (28.6%)	
Missing=5,115			
Education			
Never attended school or only kindergarten	16 (0.3%)	33 (0%)	<0.0001
Grades 1 through 8 (elementary)	209 (3.8%)	538 (1.4%)	
Grades 9 through 11 (some high school)	466 (8.6%)	1,321 (3.4%)	
Grade 12 or GED (high school graduate)	1,722 (31.7%)	10,211 (26.1%)	
College 1 to 3 years	1,608 (29.6%)	11,494 (29.3%)	
College 4 years or more years	1,408 (25.9%)	15,482 (39.5%)	
Missing=95			
Race			
White non-Hispanic	4,186 (80.0%)	34,561 (88.2%)	<0.0001
Black non-Hispanic	308 (5.7%)	1,142 (2.9%)	
Asian non-Hispanic	95 (1.7%)	530 (1.4%)	
American Indian/Alaskan Native	182 (3.3%)	631 (1.6%)	
Hispanic	473 (8.7%)	1,444 (3.7%)	
Other race non-Hispanic	195 (3.9%)	856 (2.2%)	
Exercise			
Yes	1,783 (32.8%)	7,864 (20.1%)	<0.0001
No	3,642 (67.2%)	31,248 (79.9%)	
Missing=66			
Continuous Variables	Mean±SE	Mean±SE	p-value
BMI	27.87±0.19	27.16±0.07	0.0004
Sugary-drink consumption (#/day)	1.12±0.13	0.62±0.02	<0.0001

SE: Standard Error.

Table 1: Demographics.

ing a high school education or less were also associated with depression status (OR=2.12, 95% CI=1.80-2.51; OR=1.89, 95% CI=1.62-2.18, respectively).

Consistent with prior research, there also was a protective factor associated with exercise, as those who did not partake in regular exercise, outside of their profession, were 71% more likely to be depressed in comparison with their counterparts who did exercise. This protective factor was also seen in individuals of “retirement age” in the 65 years and older category, which is

also consistent with a greater percentage of non-depressed retirees seen (Table 1).

It should also be noted that there was a greater percentage of women that self-reported depression with women having a 17% greater chance of depressive symptoms. In the sex-stratified analysis, the odds of depression was higher among women than men, although the confidence intervals overlapped (Table 3). Contrary to the whole-group findings, age was not independently associated with depression among women.

	Odds Ratio	95% CI
Sugary Beverages (#per day)	1.06	1.02-1.10
Sex		
Male	Ref	
Female	1.17	1.01-1.36
Age		
18-24 years	Ref	
25-34 years	1.50	1.10-2.02
35-44 years	1.18	0.88-1.58
45-54 years	1.25	0.94-1.65
55-64 years	0.99	0.74-1.33
65+ years	0.43	0.31-0.59
Race		
White, non-Hispanic	Ref	
Black, non-Hispanic	1.61	1.18-2.19
Other	2.06	1.70-2.50
BMI	1.01	1.00-1.03
Employment		
Employed for pay	Ref	
Not employed	2.12	1.79-2.51
Education		
More than high school	Ref	
High school graduate or less	1.78	1.53-2.02
Exercise	1.71	1.45-2.02
Yes	Ref	
No	1.71	1.45-2.02

Each measure is adjusted for other variables in table.
CI: Confidence Interval; Ref: Reference group.

Table 2: Odds of depression (adjusted*) (n=44,243).

	Men	Women
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Sugary Beverages (#per day)	1.05 (1.02-1.08)	1.11 (1.01-1.22)
Age		
18-24 years	Ref	
25-34 years	2.19 (1.34-3.57)	1.09 (0.75-1.58)
35-44 years	1.47 (0.92-2.35)	1.03 (0.70-1.50)
45-54 years	1.75 (1.12-2.73)	0.97 (0.68-1.39)
55-64 years	1.64 (1.05-2.57)	0.66 (0.46-0.96)
65+ years	0.65 (0.40-1.05)	0.32 (0.21-0.49)
Race		
White, non-Hispanic	Ref	
Black, non-Hispanic	1.28 (0.78-2.12)	1.85 (1.24-2.76)
Other	1.96 (1.47-2.61)	2.03 (1.58-2.60)
BMI	1.00 (0.97-1.02)	1.02 (1.01-1.04)
Employment		
Employed for pay	Ref	
Not employed	2.19 (1.66-2.88)	2.11 (1.71-2.60)
Education		
More than high school	Ref	
High school graduate or less	2.05 (1.66-2.53)	1.59 (1.28-1.97)
Exercise		
Yes	Ref	
No	1.30 (1.02-1.65)	2.05 (1.63-2.57)

Each measure is adjusted for other variables in table.
CI: Confidence Interval; Ref: Reference group.

Table 3: Sex-specific Odds of Depression (adjusted*).

DISCUSSION

We found that sugary drink consumption was positively associated with depression, controlling for age, sex, and measures of socio-economic status. For every sugary drink consumed daily, the odds of depression increased by 5%. Depression was also independently associated with younger age as well as race, with non-Hispanic blacks being 60% more likely to be depressed than non-Hispanic whites. There also appeared to be an effect modification showing sugary sweetened beverages may have a greater effect on women than men (OR=1.17).

This study is one of the few to compare men and women of all adult age groups, as well as to examine the direct association between sugary drinks and depression. Previous studies have typically focused solely on youth or women, as well as specific diets.⁷⁻¹⁴ An ecologic study evaluated the association between major depression and national sugar consumption in Korea, the US, France, Germany, Canada, and New Zealand and found a positive correlation ($p=0.004$).⁷ Whitaker et al⁸ found a significant association between depressive symptoms and saturated fat and sugar intake (<0.05) and, although not statistically significant, a positive association between depressive symptoms and sweetened beverage consumption ($p=0.06$).

The association between sugar and depression is especially concerning in children and adolescents, as rates for both are dramatically increasing in this age group. An Australian study reported that individuals who consumed more than a half litre of soft drinks per day had approximately a 60% greater risk of having depression, stress, suicidal ideation, and psychological distress than those who did not consume soft drinks.⁹ A cross-sectional study in China of 12-19 year old students found an association between soda intake and suicidal plans or attempts. Individuals who consumed at least three soft drinks per day were 80% more likely to attempt suicide than non-consumers.¹⁰ Additionally, a survey in 2005 in California reported 40% of 2-11 year old children consumed at least one soda per day.¹¹ A significant association between soda consumption and withdrawn behavior, attention, and aggressive behaviors ($p<0.05$) has been reported among urban 5-year olds, which may influence the occurrence of mental disorders as the children grow.¹²

High consumption of sugar may also affect women differently than men. Women who consumed a traditional diet based on vegetables, meats, fish, fruits, and whole grains were shown to have a lower risk of having depression while those who consumed a Western diet consisting of processed or fried foods, refined grains, sugary products, and beer were more likely to have depression (OR=1.52).¹³ An examination of BMI, specific food intake, and severity of depression reported that greater 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. This may suggest sugar and

not caloric surplus plays a more significant role in depression.¹⁴

The large, nationally representative sample included in the BRFSS is the primary strength of this study. However, there were limitations in the methodology. Importantly, the survey did not clearly define an amount for what constituted one drink. Variables such as the particular sugar sweetened beverage, the volume of beverage or sugar content contained in the beverage can vary widely, leading to information bias. The results are further limited by participants' self-report of depressive symptoms in lieu of a validated measure of depression. The BRFSS is a national survey in which questions are categorized in modules and many modules are only offered semi-annually. Additionally, variables included in the survey are generally limited to specific options for response. Expanding these options would enhance analytic options in future research. Due to the cross-sectional nature of the data, the temporal relation between consumption of sugary drinks and depression cannot be established and should be further investigated.

Another limitation is that the BRFSS does not account for the effects of caffeine. Caffeine can be found in many sugar sweetened beverages, especially sodas and pops. The association between sugar consumption and depression may be confounded by caffeine intake. In 2011, Lucas et al¹⁵ investigated this issue, surveying 50,739 US women with a mean age of 63 years who were free from depressive symptoms at baseline. They prospectively assessed caffeine and coffee consumption and depressive symptoms. During the 10 year follow-up 2,607 incident cases of depression were observed.

Consistent with established risk factors for depression, we found employment status (OR=2.12), race (non-Hispanic blacks (OR=1.61), and races other than non-Hispanic white (OR=2.06)) accounted for the highest odds for development of depression. Further analysis of these sub-populations could establish more demographically deterministic information on sugar and depression. Furthermore, because women were shown to be an effect modifier, in the future it might be advantageous to look at gender specifically when doing research on the topic.

CONCLUSIONS

The association among consumption of sugary sweetened beverages and depression adds to the volume of evidence negatively linking health and sugar. As policymakers look to advocate against high sugar contents in both foods and beverages, this data can provide additional support for their recommendations. Lowering the allowable sizes of sugar sweetened beverages available for purchase or informing consumers of the health consequences of their beverage choices is important to begin to reduce the prevalence and incidence of preventable morbidities.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board (IRB) of Georgia Southern University.

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