



Published in final edited form as:

Prev Med. 2016 October ; 91: 58–61. doi:10.1016/j.ypmed.2016.08.004.

Association of sugar-sweetened beverage intake frequency and asthma among U.S. adults, 2013

Sohyun Park, PhD^{a,*}, Lara J. Akinbami, MD^b, Lisa C. McGuire, PhD^a, and Heidi M. Blanck, PhD^a

^aDivision of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia

^bDivision of Health and Nutrition Examination Surveys, National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD, USA

Abstract

Objectives—Sugar-sweetened beverage (SSB) intake among U.S. adults is associated with obesity and type 2 diabetes. An association between SSB intake and asthma has been shown among U.S. children and Australian adults, but scant published information exists for U.S. adults. We examined associations between SSB intake and current asthma among U.S. adults, and the role of obesity in this association.

Methods—We analyzed 2013 Behavioral Risk Factor Surveillance System data for 146,990 adults (>18 years) from 23 states and the District of Columbia. We used multivariable logistic regression to estimate associations between current asthma and frequency (none, <1 time/day, once/day, ≥2 times/day) of SSB intake (soda, fruit drink, sweet tea, and sports/energy drink). SSB intake was measured using two questions. Covariates included age, sex, race/ethnicity, education, and smoking. Obesity, based on self-reported height and weight, was assessed as an effect modifier.

Results—Overall, 9.1% of adults reported current asthma: 8.5% of adults who did not consume SSBs had current asthma vs 12.1% of adults who consumed SSBs ≥2 times/day. There was no difference in asthma prevalence with SSB intake <1 time/day (8.7%) or once/day (8.7%). Among non-obese adults, the odds of having current asthma were higher among those who consumed 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.

Conclusions—Frequent SSB consumption was associated with asthma among non-obese adults. Research on asthma prevention should further consider the potential adverse effects of high SSB intake among U.S. adults.

*Corresponding author at: Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 4770 Buford Highway, Mailstop F79, NE, Atlanta, GA 30341, USA. spark3@cdc.gov (S. Park).

Conflict of interest statement S Park, LJ Akinbami, LC McGuire, and HM Blanck, report no conflicts of interest.

Financial disclosure No financial disclosures were reported by the authors of this paper.

Publisher's Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Keywords

Sugar-sweetened beverage; Asthma; BRFSS; Adults

1. Introduction

On average, U.S. adults consume 151 kcal/day from sugar-sweetened beverages (SSB) on a given day (Kit et al., 2013). Frequent SSB intake is associated with adverse health outcomes including obesity (Malik and Hu, 2012), type 2 diabetes (Malik and Hu, 2012), cardiovascular disease (Duffey et al., 2010; Malik and Hu, 2012), and dental caries (Bernabe et al., 2014). Whether asthma is associated with SSBs has not been well described. Asthma is common among adults, with 8% of U.S. adults (18 years) reporting current asthma in 2012 (Centers for Disease Control and Prevention, 2012). Several factors have been related to greater risk for asthma, including smoking, allergens, obesity, and food preservatives (Baena-Cagnani and Badellino, 2011; Freedman, 1980; Ilmarinen et al., 2015). Also, it is possible that asthmatic individuals might be more sensitive to certain food preservatives (e.g., sodium benzoate) used in sodas and foods (Genton et al., 1985; Steinman and Weinberg, 1986; Vally et al., 2009). Evidence suggests that younger adults, non-Hispanic blacks, adults with lower education, and lower-income adults are more likely to have current asthma than their counterparts (Centers for Disease Control and Prevention, 2012); they are also high consumers of SSBs (Ogden et al., 2011). Several studies examined relationships between current asthma and SSB intake and found that higher SSB intake was significantly associated with greater odds of having asthma; however, most studies were conducted among children (Berentzen et al., 2015; DeChristopher et al., 2015; Park et al., 2013), except one study conducted among Australian adults (Shi et al., 2012). Furthermore, weight status has been associated with both SSB intake (Malik and Hu, 2012) and asthma (Dixon et al., 2010), and may confound or modify the association between SSB intake and asthma. We examined whether SSB intake is associated with asthma among U.S. adults and assessed the effect of weight status on any association.

2. Methods

2.1. Sample and survey administration

We used 2013 Behavioral Risk Factor Surveillance System (BRFSS) data for which the median response rate was 46.4% (Centers for Disease Control and Prevention, 2014). BRFSS is a state-based, random-digit-dialed telephone survey conducted annually by the Centers for Disease Control and Prevention (CDC) and state health departments. BRFSS is designed to monitor respondents' health conditions and behaviors associated with public health issues. Every year, several optional modules are offered on the BRFSS questionnaires. In 2013, an optional module on SSB intake was used by 23 states and the District of Columbia. The CDC Human Research Protection Office determined BRFSS to be exempt research.

2.2. Variables

Current asthma status was determined by affirmative responses to both of two survey questions: Has a doctor, nurse, or other health professional ever told you that you had asthma? and *Do you still have asthma?* Daily SSB intake was determined by two survey questions: 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. and 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. For each question, respondents reported the number of times per day, per week, or per month they consumed these beverages. We converted weekly or monthly intake to daily intake and calculated SSB intake frequency by combining consumption frequency from both questions. We created four mutually exclusive SSB categories of consumption frequency (0, >0 to <1, 1 to <2, or ≥2 times/day).

Covariates were age group (18–29, 30–39, 40–49, 50–59, 60–69, or ≥70 years); sex; race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other); and education (<high school, high school, some college, and college graduate). Smoking status was categorized as nonsmoker, former smoker, and current smoker, which was derived from questions regarding past and current cigarette smoking habit. Based on body mass index (BMI) (kg/m^2) calculated from self-reported weight and height data, weight status was classified as underweight (BMI < 18.5), normal weight (BMI 18.5–<25), over-weight (BMI 25–<30), and obese (BMI ≥ 30).

2.3. Statistical analysis

Sample weights were applied to all analyses to provide valid estimates for the civilian noninstitutionalized adult population in each state after adjusting for nonresponse, noncoverage, and uneven probability of selection. We used SAS software version 9.3 (SAS Institute Inc., Cary, NC) to perform all statistical analyses and to account for the complex sampling design.

In the 2013 BRFSS, 159,562 adults participated in the SSB optional module, which included two questions. We excluded 12,572 (8.3%) adults who had missing data on one of the SSB questions ($n = 1894$), current asthma status ($n = 999$), weight status ($n = 7318$), or covariates ($n = 2361$), yielding a final analytic sample of 146,990 adults. Compared with those who were excluded, the analytic sample tended to be older and to include a higher proportion of males and non-Hispanic whites (χ^2 -test, $p < 0.05$).

We used χ^2 tests to examine the bivariate associations of sociodemographic characteristics with current asthma and $p < 0.05$ to evaluate statistical significance. Based on previous studies on obesity and asthma as well as obesity and SSBs (Everett Jones et al., 2006; Malik and Hu, 2012), we tested for an interaction between SSB intake and obesity status to assess potential effect modification. Using multivariable logistic regression analysis, we calculated adjusted odds ratios (aOR) and 95% confidence intervals (CI) for the relationship between frequency of SSB intake and current asthma, after controlling for age, sex, race/ethnicity, education, and smoking status.

3. Results

Overall, among BRFFS respondents in the 23 states and the District of Columbia that included the SSB optional module, 9.1% reported having current asthma. The prevalence of current asthma was 8.5% among non-SSB consumers and 12.1% among those who consumed SSBs 2 times/day ($p < 0.0001$) (Table 1). There was no difference in prevalence of current asthma among adults who consumed SSBs >0 to <1 time or 1 to <2 times per day (8.7% for both) in comparison to non-SSB consumers.

We found a significant interaction between SSB intake and obesity status (p for interaction = 0.01). Among non-obese adults, the odds of having current asthma were significantly higher among adults who consumed SSBs 2 times/day (aOR = 1.66; 95% CI = 1.39, 1.99) compared with non-SSB consumers, after controlling for covariates. Conversely, there was no association between frequency of SSB intake and asthma in obese adults (Table 2). Based on supplemental analysis, there was a significant association between consuming SSBs 2 times/day and asthma among overweight adults (aOR = 1.45; 95% CI=1.14, 1.83, data not shown). Because of a large percentage of missing data (11%), annual household income was excluded from the study; however, when annual household income was controlled for, key findings remained the same among respondents with data on income status (data not shown).

4. Discussion

In adjusted analyses, we found that non-obese adults who consumed SSBs 2 times/day had 66% higher odds of having current asthma than did non-SSB consumers. However, among adults with obesity, there was no significant association between frequency of SSB intake and current asthma status. Previous work showed that the odds of having asthma were significantly higher among Australian adults who drank 0.5 L/day (16.9 oz) of soft drinks than among those who did not drink soft drinks, after controlling for sociodemographic and behavioral characteristics and for overweight or obese status (BMI > 25 kg/m²) (Shi et al., 2012).

Potential mechanisms for associations between daily high-SSB intake and asthma are uncertain. Although added sugars and certain food preservatives (e.g., sulphites, sodium benzoate) found in some SSBs have been proposed (Freedman, 1977; Steinman and Weinberg, 1986), this association remains undetermined. An animal study reported that high sugar intake was associated with allergic inflammation of airways in mice (Kierstein et al., 2008). Other studies suggested that certain food preservatives may be associated with increased asthma symptoms in humans or asthmatic individuals might be more sensitive to certain food preservatives (Freedman, 1980; Genton et al., 1985; Steinman and Weinberg, 1986; Vally et al., 2009). Furthermore, another study postulated that dental disease might provide a biologic mechanism by increasing underlying inflammation (Maupome et al., 2010).

SSB intake was not associated with current asthma among obese adults in our study. Although the data we analyzed did not include information on inflammatory or other biologic markers, 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 asthma status.

While several factors are associated with higher risk for asthma (Baena-Cagnani and Badellino, 2011; Freedman, 1980; Ilmarinen et al., 2015), exposure to modifiable risk factors (e.g., smoking and food preservatives) could be prevented. Clinicians are already urged to advise their patients to limit exposure to factors known to cause asthma (National Heart, Lung and Blood Institute, National Institutes of Health, 2007), although SSB is not currently one of these factors. There are other benefits of reducing SSB intake including reduced risk for type 2 diabetes, cardiovascular disease, and dental caries (Bernabe et al., 2014; Duffey et al., 2010; Malik and Hu, 2012). Because this study is cross-sectional and based on self-reported data, additional confirmatory studies are needed to support any clinical recommendations about SSB intake and asthma.

Furthermore, although we could not examine associations between artificially-sweetened beverages and asthma due to a lack of data on artificially-sweetened beverage intake in BRFSS, a previous study reported that consumption of artificially-sweetened carbonated soft drink during pregnancy was significantly associated with child asthma (Maslova et al., 2013). Another study found that while asthma was not associated with artificially-sweetened beverage, higher SSB intake was significantly associated with greater odds for having asthma among children (Berentzen et al., 2015).

Our study has several limitations. First, BRFSS is a cross-sectional survey, and causality cannot be determined. Second, BRFSS also relies on self-reported information that could bias associations. For example, it is known that obesity prevalence is underestimated when height and weight are based on self-report rather than on measured data (Yun et al., 2006). Third, asthma status was based on self-reported medical diagnoses and not confirmed by medical records. Fourth, BRFSS findings may not be generalizable to the entire U.S. adult population. Fifth, SSB intake was measured by frequency of consumption in the survey, so we could not estimate the volume of SSBs consumed. Lastly, although BRFSS had relatively low response rate, the use of survey weights provided adjustment for nonresponse.

In conclusion, frequent SSB consumption was associated with asthma status among non-obese adults. Research on asthma prevention should further consider the potential adverse effects of high SSB intake among U.S. adults.

Acknowledgments

We'd like to thank the BRFSS State Coordinators and Dr. Liping Pan and Ms. Suzianne Garner for their efforts with questionnaire development and survey administration.

References

- Baena-Cagnani CE, Badellino HA. Diagnosis of allergy and asthma in childhood. *Curr. Allergy Asthma Rep.* 2011; 11:71–77. [PubMed: 21052877]
- Berentzen NE, van Stokkom VL, Gehring U, Koppelman GH, Schaap LA, Smit HA, Wijga AH. Associations of sugar-containing beverages with asthma prevalence in 11-year-old children: the PIAMA birth cohort. *Eur. J. Clin. Nutr.* 2015; 69:303–308. [PubMed: 25117998]

- Bernabe E, Vehkalahti MM, Sheiham A, Aromaa A, Suominen AL. Sugar-sweetened beverages and dental caries in adults: a 4-year prospective study. *J. Dent.* 2014; 42:952–958. [PubMed: 24813370]
- Centers for Disease Control and Prevention. Summary Health Statistics for U.S. National Health Interview Survey, Adults. 2012. http://www.cdc.gov/nchs/data/series/sr_10/sr10_260.pdf
- Centers for Disease Control and Prevention. Behavioral risk factor surveillance system. 2013 Summary Data Quality Report. 2014. http://www.cdc.gov/brfss/annual_data/2013/pdf/2013_dqr.pdf
- DeChristopher, LR.; Uribarri, J.; Tucker, KL. *Public Health Nutr.* 2015. Intakes of apple juice, fruit drinks and soda are associated with prevalent asthma in US children aged 2–9 years; p. 1-8.
- Dixon AE, Holguin F, Sood A, Salome CM, Pratley RE, Beuther DA, Celedon JC, Shore SA, American Thoracic Society Ad Hoc Subcommittee on, O. et al. An official American thoracic society workshop report: obesity and asthma. *Proc. Am. Thorac. Soc.* 2010; 7:325–335. [PubMed: 20844291]
- Duffey KJ, Gordon-Larsen P, Steffen LM, Jacobs DR Jr, Popkin BM. Drinking caloric beverages increases the risk of adverse cardiometabolic outcomes in the coronary artery risk development in young adults (CARDIA) study. *Am. J. Clin. Nutr.* 2010; 92:954–959. [PubMed: 20702604]
- Everett Jones S, Merkle SL, Fulton JE, Wheeler LS, Mannino DM. Relationship between asthma, overweight, and physical activity among U.S. high school students. *J. Community Health.* 2006; 31:469–478. [PubMed: 17186641]
- Freedman BJ. Asthma induced by sulphur dioxide, benzoate and tartrazine contained in orange drinks. *Clin. Allergy.* 1977; 7:407–415. [PubMed: 412611]
- Freedman BJ. Sulphur dioxide in foods and beverages: its use as a preservative and its effect on asthma. *Br. J. Dis. Chest.* 1980; 74:128–134. [PubMed: 7426352]
- Genton C, Frei PC, Pécoud A. Value of oral provocation tests to aspirin and food additives in the routine investigation of asthma and chronic urticaria. *J. Allergy Clin. Immunol.* 1985; 76:40–45. [PubMed: 2861222]
- Ilmarinen P, Tuomisto LE, Kankaanranta H. Phenotypes, risk factors, and mechanisms of adult-onset asthma. *Mediat. Inflamm.* 2015; 2015:514868.
- Kierstein S, Krytska K, Kierstein G, Hortobágyi L, Zhu X, Haczku A. Sugar consumption increases susceptibility to allergic airway inflammation and activates the innate immune system in the lung. *J. Allergy Clin. Immunol.* 2008; 121:S196.
- Kit BK, Fakhouri TH, Park S, Nielsen SJ, Ogden CL. Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999–2010. *Am. J. Clin. Nutr.* 2013; 98:180–188. [PubMed: 23676424]
- Malik VS, Hu FB. Sweeteners and risk of obesity and type 2 diabetes: the role of sugar-sweetened beverages. *Curr. Diab. Rep.* 2012; 12:195–203.
- Maslova E, Strom M, Olsen SF, Halldorsson TI. Consumption of artificially-sweetened soft drinks in pregnancy and risk of child asthma and allergic rhinitis. *PLoS One.* 2013; 8:e57261. [PubMed: 23460835]
- Maupome G, Shulman JD, Medina-Solis CE, Ladeinde O. Is there a relationship between asthma and dental caries?: a critical review of the literature. *J. Am. Dent. Assoc.* 2010; 141:1061–1074. [PubMed: 20807905]
- National Heart, Lung and Blood Institute, National Institutes of Health. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. 2007u. National Asthma Education and Prevention Program.
- Ogden, CL.; Kit, BK.; Carroll, MD.; Park, S. NCHS Data Brief. 2011. Consumption of sugar drinks in the United States, 2005–2008; p. 1-8.
- Park S, Blanck HM, Sherry B, Jones SE, Pan L. Regular-soda intake independent of weight status is associated with asthma among US high school students. *J. Acad. Nutr. Diet.* 2013; 113:106–111. [PubMed: 23260727]
- Shi Z, Dal Grande E, Taylor AW, Gill TK, Adams R, Wittert GA. Association between soft drink consumption and asthma and chronic obstructive pulmonary disease among adults in Australia. *Respirology.* 2012; 17:363–369. [PubMed: 22142454]
- Steinman HA, Weinberg EG. The effects of soft-drink preservatives on asthmatic children. *S. Afr. Med. J.* 1986; 70:404–406. [PubMed: 3764611]

- Vally H, Misso NL, Madan V. Clinical effects of sulphite additives. *Clin. Exp. Allergy*. 2009; 39:1643–1651. [PubMed: 19775253]
- Yun S, Zhu BP, Black W, Brownson RC. A comparison of national estimates of obesity prevalence from the behavioral risk factor surveillance system and the National Health and Nutrition Examination Survey. *Int. J. Obes*. 2006; 30:164–170.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Characteristics of respondents and associations with current asthma prevalence among U.S. adults, BRFSS 2013 (unweighted $n=146,990$).

	<u>All respondents</u>	<u>Current asthma^a prevalence</u>	
	<u>% (95% CI)^b</u>	<u>% (95% CI)</u>	<u>p-Value^c</u>
Total sample	100	9.1 (8.8, 9.4)	
Frequency of SSB intake ^d			<0.0001
None	26.1 (25.6, 26.6)	8.5 (7.9, 9.0)	
>0 to <1 time/day	44.8 (44.2, 45.4)	8.7 (8.2, 9.2)	
1 to <2 times/day	14.9 (14.4, 15.3)	8.7 (7.9, 9.5)	
2 times/day	14.2 (13.8, 14.6)	12.1 (11.0, 13.2)	
Age, years			0.03
18–29	19.9 (19.3, 20.4)	10.0 (9.0, 11.0)	
30–39	16.1 (15.6, 16.5)	8.7 (7.9, 9.6)	
40–49	17.3 (16.9, 17.8)	9.1 (8.4, 9.9)	
50–59	19.3 (18.9, 19.8)	9.2 (8.6, 9.9)	
60–69	14.6 (14.3, 15.0)	9.1 (8.4, 9.9)	
70	12.9 (12.6, 13.2)	8.0 (7.4, 8.7)	
Sex			<0.0001
Men	50.0 (49.4, 50.6)	6.6 (6.2, 7.1)	
Women	50.0 (49.4, 50.6)	11.6 (11.0, 12.1)	
Race/ethnicity			<0.0001
White, non-Hispanic	66.4 (65.8, 67.1)	9.1 (8.7, 9.4)	
Black, non-Hispanic	11.1 (10.7, 11.5)	11.8 (10.5, 13.0)	
Hispanics	14.2 (13.7, 14.7)	7.4 (6.4, 8.4)	
Other, non-Hispanic	8.3 (7.8, 8.7)	8.9 (7.4, 10.4)	
Education level			<0.0001
<High school	14.0 (13.5, 14.5)	11.2 (10.1, 12.3)	
High school	27.8 (27.3, 28.3)	9.1 (8.4, 9.7)	
Some college	31.2 (30.6, 31.7)	9.6 (9.0, 10.2)	
College graduate	27.0 (26.5, 27.5)	7.6 (7.1, 8.1)	
Weight status			<0.0001
Underweight (BMI <18.5 kg/m ²)	1.9 (1.7, 2.1)	9.4 (7.2, 11.8)	
Normal weight (BMI 18.5 to <25 kg/m ²)	33.9 (33.3, 34.5)	7.2 (6.6, 7.7)	
Overweight (BMI 25 to <30 kg/m ²)	35.8 (35.2, 36.4)	7.9 (7.3, 8.4)	
Obese (BMI ≥30 kg/m ²)	28.5 (27.9, 29.0)	13.0 (12.3, 13.7)	
Smoking status			<0.0001
Nonsmoker	57.2 (56.7, 57.8)	8.2 (7.8, 8.7)	
Former smoker	24.7 (24.3, 25.2)	9.2 (8.6, 9.8)	
Current smoker	18.0 (17.6, 18.5)	11.9 (11.0, 12.7)	

BMI, body mass index; BRFSS, Behavioral Risk Factor Surveillance System; SSB, sugar-sweetened beverage.

^aHad ever been told by a doctor, nurse, or other health professional that they had asthma, and who still had asthma at the time of the survey.

^bWeighted column percentage is presented and may not total 100% because of rounding.

^c χ^2 tests were used for each variable to examine differences across categories.

^dSSBs included regular soda or pop, fruit-flavored drink, sweet tea, sports drink, and energy drink during the past 30 days (not including 100% fruit juice, diet drinks, or artificially sweetened drinks).

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Current asthma prevalence among non-obese and obese U.S. adults by frequency of SSB intake, BRFSS 2013 (unweighted $n=146,990$).

	Current asthma ^a status			
	Non-obese adults (unweighted $n = 102,957$)		Obese adults ^b (unweighted $n = 44,033$)	
	Prevalence % (95% CI) ^c	Adjusted odds ratio ^c (95% CI) ^d	Prevalence % (95% CI) ^c	Adjusted odds ratio ^c (95% CI) ^d
Frequency of SSB ^e intake				
None	6.7 (6.1, 7.2)	Reference	13.1 (11.8, 14.4)	Reference
>0 to <1 time/day	7.2 (6.7, 7.8)	1.13 (1.00, 1.28)	12.6 (11.4, 13.8)	0.99 (0.85, 1.16)
1 to <2 times/day	7.1 (6.3, 8.0)	1.08 (0.91, 1.28)	12.4 (10.7, 14.0)	0.96 (0.79, 1.17)
2 times/day	11.1 (9.7, 12.4)	1.66 (1.39, 1.99)^f	14.5 (12.5, 16.4)	1.13 (0.91, 1.38)

BRFSS, Behavioral Risk Factor Surveillance System; SSB, sugar-sweetened beverage.

^aHad ever been told by a doctor, nurse, or other health professional that they had asthma, and who still had asthma at the time of the survey.

^bBody mass index (kg/m^2) ≥ 30 .

^cWeighted percentages.

^dMultivariable logistic regression model analysis adjusted for age, sex, race/ethnicity, education level, and smoking status.

^eSSBs included regular soda or pop, fruit-flavored drink, sweet tea, sports drink, and energy drink during the past 30 days (not including 100% fruit juice, diet drinks, or artificially sweetened drinks).

^fBoldface indicates statistical significance.