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Short Communication

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

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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.

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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

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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), overweight (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/m^2) (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