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ECONOMICS

Soda consumption and hospital admissions among Californian adults with asthma

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ABSTRACT

Introduction: Asthma prevalence has been increasing consistently since 1995 in California. Recent studies have found that consuming soda and sugar-containing drinks may pose a risk for asthma. Research that examines the relationship between soda intake and asthma among adult asthmatics is limited. **Objective:** This study investigated the relationship between sugar-sweetened soda consumption and asthma hospitalization among adult asthmatics in California. **Methods:** This cross-sectional study was based on the 2011–2012 California Health Interview Survey (CHIS) data and included 3,784 adults who were diagnosed with asthma by a doctor and who currently reported either that they still had asthma, or that they had suffered from an asthma attack in the last 12 months. The analysis was survey weighted. The exposure variable was soda intake measured as the number of times soda was consumed in the last week. The health outcome measure was overnight hospital admission due to asthma. Logistic regression was used to examine the association between soda consumption and overnight hospital admission after adjusting for age, education, sex, race/ethnicity, weight status, smoking status, and self-rated health. **Results:** Adults with asthma who drank soda three or more times per week reported higher odds of overnight hospitalization (adjusted odds ratio = 2.77, 95% CI: 1.51–5.10, $p = 0.001$). **Conclusions:** Our findings suggest that efforts designed to limit soda consumption would benefit asthma sufferers by reducing hospital admissions. This, however, needs further research to confirm a direct causal association.

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Introduction

Asthma prevalence has been increasing consistently over the past 25 years in the United States. In California, the percentage of lifetime asthma prevalence has increased at a rate of 0.2% per year since 1995 [1]. In 2010, over half of adult asthmatics in California reported asthma attacks in the last month, while 12% reported an asthma related hospitalization and 3% reported an emergency room visit, costing California over \$1 billion [1].

Several factors are known to be associated with asthma symptom exacerbation in adults. The most recognized factors include (but are not limited to) environmental exposure to tobacco and both indoor and outdoor air pollution [2], obesity [3–6], and western diet [7–9]. Evidence of a link between diet and asthma prevalence has increased [10], due perhaps from the reduction of antioxidant intake [7] and the increase in consumption of foods that promote inflammation [5].

Soda is prevalent in the western diet. The body of literature that examines the association between soda and asthma is very small with the majority focusing on children and adolescents. Recent studies have found that the consumption of soda/soft drinks and sugar-containing

drinks may be an important risk factor for asthma [11–13]. High-fructose corn syrup contained in soda has been found to be associated with asthma in children [14]. One potential mechanism for the association of soda and asthma is the high amount of sugar and or sweeteners contained in soft drinks that promotes inflammation [15]. Another mechanism involves the preservatives contained in soda, such as sodium benzoate, which has been found to be associated with worsening of asthma symptoms [16].

Although previous studies have documented a link between sugar intake and asthma among children and adolescents, little is known about the relationship between sweetened soda consumption and complications related to asthma in adults. The purpose of this study was to investigate the relationship between sugar-sweetened soda (soda) consumption and hospitalization due to asthma among adult asthmatics. Using data from the California Health Interview Survey (CHIS), we examined whether excess consumption of soda was related to overnight admissions to a hospital for asthma. We hypothesized that the increase consumption of soda among asthmatics is associated with asthma-related hospital admissions.

Methods

We examined adult asthmatics in the adult public use file of the 2011–2012 California Health Interview Survey (CHIS) during the final year when the survey included questions regarding hospital admissions for asthma. The CHIS is a cross-sectional survey of households in California. The CHIS is a random digit dial survey fielded by the University of California Los Angeles Center for Health Policy Research (UCLA CHPR) in collaboration with the California Department of Public Health (CDPH) and the California Department of Health Care Services (CDHCS), and is used to provide a detailed overview of the health status of California citizens. The CHIS samples both landlines and cellphones in the state of California. The combined response rate for landlines and cellphones for the 2011–2012 survey is 35.1%, which is comparable to the 2011 Behavioral Risk Factor Surveillance System (BRFSS) combined response rate of 35.4%. The data use in the analysis is publicly available and exempted from Institutional Review Board (IRB) approval as it does not contain any personal identifiable information. Data was downloaded from: <http://healthpolicy.ucla.edu/chis/Pages/default.aspx>. The adult sample for 2011–2012 contained 42,935 individuals over 18, of which 3,784 were adults who had ever been diagnosed with asthma by a doctor and who currently reported either that they still had asthma, or that they had suffered from an asthma attack in the last 12 months.

Variables

We used overnight (or longer) admittance to a hospital due to asthma as the outcome variable. Respondents were asked “if they had an overnight hospital admission that was attributable to asthma in the last 12 months.” A response of “yes” was coded as 1, and “no” was coded as 0.

The main exposure variable was soda intake. This was measured as the number of times respondents consumed soda in the last week. Respondents were asked to exclude diet soda and canned or bottled juices or teas in their response. We used three or more times per week as a cut-off as 21.2% of our sample reported consuming soda at least three times or more per week.

It was expected that many people with asthma would have other health conditions that might lead to hospital admissions [12]. The analysis described that follows was controlled for age (18–24, 25–34, 44, 45–64, 65 or above), education (below high school, high school/GED, some college, college or advanced degree), sex, race/ethnicity (non-Hispanic [NH] White, NH Black, Latino, NH Other), weight status (using CDC

definitions), obesity, smoking status (smoker or non-smoker), and self-rated health.

Statistical analysis

The analysis was survey weighted. Weighted percentages were estimated for the main characteristics of the study population. We used binary logistic regression models to examine the association between soda consumption and being admitted to a hospital overnight for asthma. Based on stepwise logistic regression and previous research [12], the logistic models were adjusted for age, education, sex, race/ethnicity, weight status, and smoking status. We also adjusted for self-rated health. We calculated crude odds ratios (OR) and adjusted odds ratios (OR_{adj}) with 95% confidence intervals (CIs). Statistical significance was considered for p values < 0.05 (two-sided tests). All statistical analyses were performed using STATA version 13 [17].

Results

The sample used in this study consisted of 3,784 adults who were diagnosed with asthma in California. Characteristics of respondents are shown in Table 1. Approximately 65% of the adult asthmatics were 40 years of age and older. The majority of the respondents were female (64%), NH White (53%), and 88% had a high school education or higher. Slightly above one third of respondents were considered obese (36%), and over 60% of respondents were either obese or overweight. Forty-five percent of adults reported consuming soda at least once a week, and 21% of adults reported consuming soda at least three or more times per week. For adults with asthma that were admitted overnight to the hospital, 60% had consumed one or more servings of soda per week, 47% had consumed two or more servings of soda per week, and 42% had consumed three or more servings of soda per week.

Table 2 shows the OR and OR_{adj} for overnight admission to the hospital for asthma and soda consumption. Adults with asthma who reported drinking soda three or more times per week experienced higher odds of overnight hospitalization ($OR_{adj} = 2.77$, CI: 1.51–5.10, $p = 0.001$). No demographic variable was significant, and being either obese, overweight, or a smoker was not associated with overnight hospital admissions for asthma. Good-to-excellent self-rated health was associated with lower odds ($OR_{adj} = 0.23$, CI: 0.11–0.45, $p = 0.001$) of hospital admissions.

Discussion

Asthma is an inflammatory disease [9], and foods with low nutritional value (such as sodas) are associated with

Table 1. Selected characteristics of adult asthmatics in the adult public use file of the 2011–2012 California Health Interview Survey (CHIS).

	Unweighted N	Weighted % (95% CI)
Total N	3784	
<i>Age</i>		
18–24	251	15.1% (13.3–17.2)
25–34	277	16.8% (14.6–19.2)
35–44	429	14.6% (12.7–16.7)
45–64	1611	36.7% (34.5–38.9)
65 or older	1216	16.9% (15.4–18.5)
<i>Education</i>		
Below high school	428	11.7% (10–13.8)
High school / GED	833	23.8% (22.1–25.5)
Some college	1129	29.1% (26.7–31.6)
College or higher	1394	35.4% (33–38)
<i>Sex</i>		
Female	2682	63.6% (60.5–66.6)
Male	1102	36.4% (33.4–39.5)
<i>Race/ethnicity</i>		
NH White	2426	53.4% (50.8–56.1)
NH Black	261	8.8% (7.4–10.5)
Latino	624	24.3% (22.1–26.6)
NH Other	473	13.5% (11.7–15.7)
<i>Weight status</i>		
Under or Normal weight	1223	34% (31.5–36.5)
Overweight	1187	32.9% (30.6–35.4)
Obese	1374	33.1% (30.8–35.5)
<i>Self-rated health</i>		
Poor or fair	2425	30.1% (27.7–32.6)
Good-to-excellent	1359	69.9% (67.5–72.3)
<i>Smoking Status</i>		
Smoker	545	15.8% (13.7–18)
Non-smoker	3239	84.2% (82–86.3)
<i>Soda consumption</i>		
0 times/week	2,502	55.2% (52.2–58.2)
1 time/week	468	15.6% (13.9–17.5)
2 times/week	196	7.9% (6.2–10.1)
3 or more drinks per week	618	21.2% (19.1–23.7)

inflammation response [5, 15]. The results of this study indicate that the consumption of soda is positively associated with the increase in hospital overnight admissions for adult asthmatics in California. This relationship exists both as a direct association and when controlling for the other factors that influence health status. Assuming overnight hospital admission is one of the worst health outcomes possible where asthma is severe, soda consumption poses a significant health threat and is likely increasing health costs. Thus, these findings provide further evidence that asthmatic adults should limit their consumption of sodas.

The findings of this study suggest that prevention of soda consumption can play an important role in asthma management. Although a direct causal link of soda and asthma is not established in this study, the intriguing association shows the need for further and more extensive research. This important topic has limited publications available [11,12,14–16] regarding soda and sugar-containing beverages, and asthma. Only one [11] of the five studies focused on adults, the other four studied children and adolescents. All studies found positive

Table 2. Associations between consumption of soda and asthma related overnight hospital admission among California adult asthmatics.

	OR ^a	p	(95% CI)	OR _{adj} ^b	p	(95% CI)
<i>Age</i>						
25–34	1.45	0.625	(0.32, 6.51)	1.6	0.538	(0.35, 7.33)
35–44	0.35	0.049	(0.13, 0.99)	0.42	0.105	(0.15, 1.2)
45–64	1.52	0.305	(0.68, 3.41)	2.01	0.124	(0.82, 4.93)
65 or older	1.42	0.399	(0.62, 3.26)	2.02	0.15	(0.77, 5.28)
<i>Education</i>						
Below high school	1.24	0.662	(0.47, 3.3)	1.09	0.853	(0.41, 2.89)
High school / GED	2.12	0.09	(0.89, 5.07)	1.94	0.112	(0.85, 4.4)
Some college	2.12	0.046	(1.01, 4.42)	1.91	0.08	(0.92, 3.93)
<i>Sex</i>						
Female	1.01	0.986	(0.49, 2.05)	1.14	0.71	(0.56, 2.32)
<i>Race/ethnicity</i>						
NH Black	1.53	0.297	(0.68, 3.4)	1.44	0.395	(0.61, 3.39)
Latino	0.82	0.637	(0.35, 1.91)	0.74	0.493	(0.31, 1.75)
NH Other	1.74	0.184	(0.76, 3.94)	1.85	0.12	(0.85, 4.03)
<i>Weight status</i>						
Overweight	0.98	0.957	(0.45, 2.13)	0.89	0.772	(0.4, 1.96)
Obese	1.24	0.597	(0.55, 2.82)	1.14	0.738	(0.52, 2.53)
<i>Smoking Status</i>						
Smoker	1.77	0.152	(0.81, 3.91)	1.42	0.371	(0.66, 3.06)
<i>Self-rated health</i>						
Good	0.22	0.001	(0.11, 0.43)	0.23	0.001	(0.11, 0.45)
-to-excellent						
<i>Soda consumption</i>						
1 drink per week	1.18	0.701	(0.51, 2.71)	1.15	0.763	(0.46, 2.9)
2 drinks per week	0.84	0.78	(0.24, 2.94)	0.9	0.869	(0.26, 3.1)
3 or more drinks per week	2.78	0.002	(1.46, 5.3)	2.77	0.001	(1.51, 5.1)
<i>Constant</i>	0.03	0.001	(0.01, 0.1)	0.02	0.001	(0, 0.07)
N	3784			3784		

Note. ^aCrude Logistic regression model including one exposure variable. ^bMultivariable logistic regression model adjusted for age, education, sex, race/ethnicity, weight status, smoking status, and self-rated health.

associations between soda consumption, including the consumption of sugar-containing beverages, and asthma. While the sample for this study was asthmatic adults, the findings are consistent with previous studies showing a positive relationship between soda consumption and asthma. In previous studies, the risk of asthma was higher for individuals who had higher consumption compared to those who did not drink soda [11,12]. The OR and OR_{adj} values in this study were higher than other published studies possibly because the population is both older and asthmatic.

This study found that for adult asthmatics consuming three or more sodas per week increased their risk (OR_{adj} = 2.77) to be hospitalized. The study by Park et al. in 2012 [12] found that for US High School students, consuming two sodas per day and three or more per day (OR_{adj} = 1.28, and OR_{adj} = 1.64, respectively) had higher odds of having asthma. Among adults in Australia, consuming more than half a liter of soda per day increased the odds (OR_{adj} = 1.26) of having asthma [11]. DeChristopher et al. 2015 [14] reported that for US children aged 2–9 years, consuming beverages containing

excess free fructose five times per week or more increased their likelihood to have asthma ($OR_{adj} = 2.43$). Beverages (included those sweetened with high-fructose corn syrup) containing excess free fructose included apple juice, non-diet soft drinks (soda), and fruit drinks. Based on the information above, it is likely that sweetened beverages, including soda, consumption have a bigger impact on children and adult asthmatics than in adolescents and adults. However, given how few studies exist on this topic, the findings of this study need to be confirmed. The association between soda, including all sweetened beverages, needs to be further investigated. The question of what quantity of soda is too much in particular warrants further investigation and needs to include longitudinal studies to provide more information and corroborate casual association.

One factor that might be associated with soda intake is consumption of fast foods. Fast foods are typically high in non-vegetable carbohydrate and unhealthy fat, as well as sugar and salt, and thus are risk factors for asthma symptoms [18]. These foods also can replace the consumption of more nutritious options and lead to a less nutritious diet. The intake of nutrients from more nutritious options, such as vegetables and fruits, are inversely associated with asthma symptoms [10, 19].

Limitations

The study was conducted from data collected from CHIS, a self-reported cross-sectional survey of households in California. As a result, our findings are subject to the limitation of recall bias. Because the definition of an asthmatic relies on an official diagnosis by a physician, this data may underestimate the number of individuals with asthma in California who lack access to health care or who do not seek medical treatment for reasons such as cultural, language, financial, and structural barriers. Additionally, the survey did not ask about the amount of soda consumed, but the number of times per week that the beverage was consumed, so we could not control for serving size.

Conclusion

Our analysis indicates that for adult asthmatics, consuming three or more sodas per week is associated with greater odds for severe asthma symptoms (overnight hospital admissions) after controlling for confounders. Our finding suggest that even after being diagnosed with asthma, intake of soda and other sugary foods can exacerbate the health problems facing adults with asthma. Policies designed to limit soda consumption would benefit asthma sufferers by reducing hospital admissions.

Removing consumption of soda from the diet of asthmatics could additionally lead to a reduction in obesity or increased consumption of vegetables and fruit and the associated lowering of asthma symptoms. Interventions focusing on how specific food consumption exacerbates symptoms may help to address this problem. The consumption of soda is linked to increased symptom severity among asthmatics in California. This, however, needs to be studied further to confirm a direct causal association.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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