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ORIGINAL ARTICLE

Cigarette smoking and emergency care utilization among asthmatic adults in the 2011 Asthma Call-back Survey

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Abstract

Objective: Estimate the association between smoking and emergency care in the past 12 months among asthmatic adults in a nationally representative sample. *Methods*: Using the 2011 Asthma Call-Back Survey, the association between smoking status and emergency department (ED) and urgent visits among asthmatic adults ($n = 12\,339$) was assessed through multivariable logistic regression by a cross-sectional study design. Analyses used survey weights for US population-based estimates. Attributable and population attributable risk were calculated to describe the potential benefits of smoking cessation. *Results*: Adjusting for potential confounders, during the past 12 months former smokers had 1.30 (95% CI: 0.97, 1.74) times the odds and current smokers had 1.46 (95% CI: 1.05, 2.03) times the odds of visiting the ED compared to never smokers. Former smokers had 1.28 (95% CI: 0.99, 1.65) times the odds and current smokers had 1.29 (95% CI: 0.96, 1.73) times the odds of urgent visits compared to never smokers. Among adult asthmatics, an estimated 9% of ED visits and 6% of urgent visits can be attributed to current smoking while 7% of ED visits and 7% of urgent visits can be attributed to former smoking. *Conclusions*: Current and former smokers are more likely to need emergency care than never smokers. About 10% of emergency care visits among asthmatics can be attributed to smoking assuming smoking is causally related to emergency care. Long-term effective management of asthma, particularly the prevention and cessation of smoking, could reduce emergency care use and health care costs.

Keywords

Emergency department, healthcare costs, tobacco use, uncontrolled asthma, urgent care

History

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Introduction

Tobacco use, a dominant risk factor for mortality and the leading preventable cause of death, has resulted in greater than 20 million premature deaths since the initial Surgeon General's Report in 1964. The prevalence of current cigarette smoking among US adults is 18%, with high economic costs attributable to treating tobacco-related diseases, loss in productivity as a result of premature death and public health costs from secondhand smoke exposure [1]. Tobacco use is responsible for approximately 5% of adult ED visits, 7% of admissions to the hospital and 10% of charges from the hospital [2].

Cigarette smoking has also been recognized as the most important risk factor for the development of acute and chronic respiratory illness, acute exacerbations of respiratory illness and related morbidity and mortality [3]. Silverman et al. found that cigarette smoking was common among asthmatic adults who visited the ED with 35% of patients ages 18 and 54 years comprising current smokers and 23% classified as former smokers [4]. Smoking exacerbates chronic asthma, decreases lung function and weakens short-term therapeutic responses to corticosteroids [5,6]. In fact, among acute asthmatics current and past smoking were related to a higher risk of ED visits, and when compared to never smokers, current smokers were prospectively associated with a greater risk of hospitalization and hospital-based care for asthma [7,8].

ED visits are particularly expensive, increasing rapidly (e.g. a 77% increase from 2000 to 2010) and representing about 4% of health care costs in the US [9]. In 2009, there were roughly 2 million adult asthma-related ED visits and 480 000 asthma-related hospitalizations, resulting in approximately $56 billion in healthcare costs [10–12]. Asthmatic adults who depend on ED services are generally considered to have substandard asthma control and poor prognosis [13]. Lenhardt et al. revealed that asthmatic adults who visited the ED for their condition had a large burden of disease in the month preceding their ED visit and the month following their visit. Furthermore, these asthmatic adults demonstrated low asthma-specific and general quality-of-life scores post-ED visit [14]. Additional costs to the healthcare system among asthmatics arise from physician visits. In 2009, asthmatic patients had 8.9 million physician visits, many of which were

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likely due to needs for urgent visits [15]. The overall estimated annual cost for patients with difficult-to-control asthma is more than $2500 per patient as opposed to an average annual cost of $1238 per asthmatic patient [7].

The purpose of this study is to estimate nationally the extent to which smoking contributes to the use of emergency care for asthma in a nationally representative sample using the Asthma Call-Back Survey (ACBS). In addition, we calculated attributable and population attributable risk to describe the potential benefits of smoking cessation in this population.

Methods

Survey data description

The Behavioral Risk Factor Surveillance System (BRFSS) is a national, cross-sectional, state-based, random-digit dialed telephone survey conducted by state health departments and developed by the Centers for Disease Control and Prevention (CDC). The BRFSS uses a disproportionate, stratified sampling plan and includes an iterative proportional fitting weighting method to adjust for the under-represented groups in the sample and more accurately portray a nationally representative sample [16]. The 2011 BRFSS survey included 506 467 individuals in their monthly landline telephone interviews and obtained information on state-specific data on preventative health practices and health risk behaviors related to chronic disease and injury from a random sample of adults, one per household, using a standardized questionnaire [17,18]. Adults 18 years or older who live in households are asked to participate in this survey comprised of core questions that were asked by all states and optional modules that each state selected to use on their questionnaire [16].

Two weeks after the annual BRFSS survey was conducted, a follow-up ACBS was administered to participants who responded ''yes'' to the BRFSS question ''have you ever been told by a doctor, nurse or other health professional that you had asthma?'' The ACBS record for a respondent includes the entire BRFSS interview record followed by the ACBS data. From the parent survey (BRFSS), the ACBS inherits the complex sampling design. The BRFSS includes a question on smoking status. The linked adult ACBS provides information about adults with asthma, including demographics, symptoms, asthma self-management practices, healthcare utilization and associated costs [19]. In the 2011 ACBS, 41 states participated and there were a total of 16 693 participants who completed the ACBS survey. The 2011 BRFSS landline interview median response rate was 52.9% and the 2011 ACBS median response rate was 93.1% [20,21]. Response rates for both surveys were calculated using standards set by the American Association of Public Opinion Research Response Rate Formula #4 [22]. The weighting scheme for both surveys accounts for the non-coverage bias.

Analytic sample

The 2011 ACBS dataset consists of a total of 16 693 initial observations [23]. However, only current asthmatic adults, defined as those who responded ''yes'' to the question ''do you still have asthma?'' with valid values for smoking status, were included in the final analytic sample ($n = 12\,339$ respondents; Figure 1).

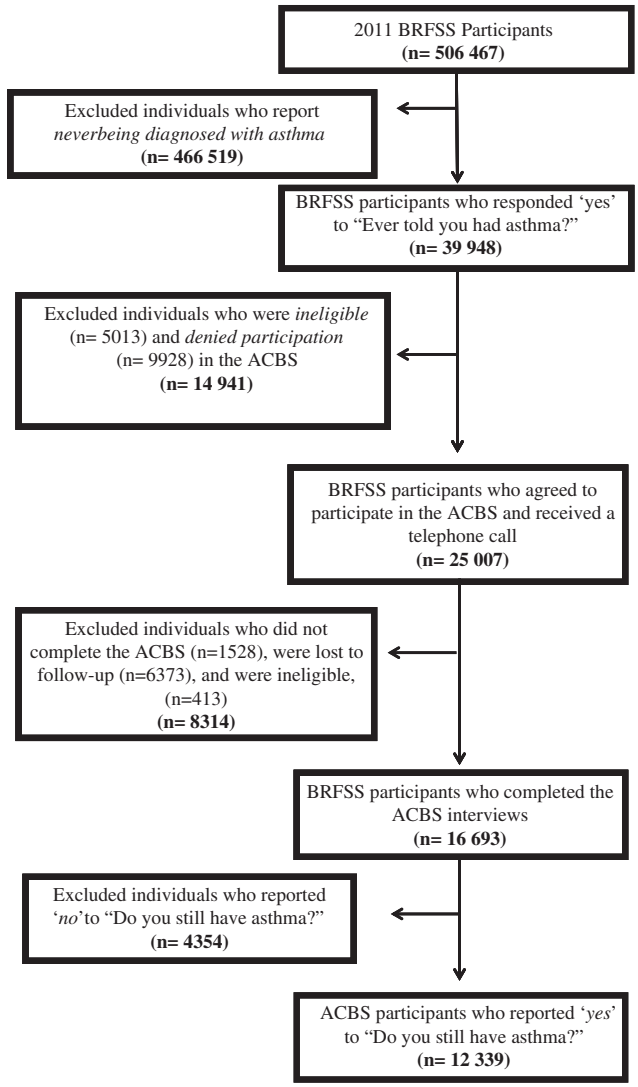

Figure 1. Schema of analytic sample.

Assessment of dependent variables

Emergency care included ED visits and urgent treatment visits. Having ED visits was operationalized using the question ''during the past 12 months, how many times did you visit an emergency room or urgent care center because of your asthma?'' The number of ED visits was categorized into a binary, mutually exclusive, variable labeled as ''no visits'' and ''any visits''. Having urgent treatment visits was operationalized using the question ''during the past 12 months, how many times did you see a doctor or other health professional for urgent treatment of worsening asthma symptoms or for an asthma episode or attack?'' Both the number of ED visits and urgent care visits were categorized into dichotomous variables labeled as ''no visits'' and ''any visits'', and excluded ''don't know/not sure'' and/or ''refused to answer''.

Assessment of independent variables

Smoking status was operationalized by two separate questions. The first question asked ''have you smoked at least 100

Table 1. Sociodemographic characteristics of asthmatic adults in the 2011 Asthma Call-Back Survey by smoking status.

	Never smokers ($N = 6082$) [n (Weighted %)]	Former smokers ($N = 4176$) [n (Weighted %)]	Current smokers ($N = 2045$) [n (Weighted %)]	p Value[a]
Age				<0.0001
18–48 years old	1792 (63.02)	550 (37.83)	675 (59.97)	
49–59 years old	1552 (17.40)	943 (22.56)	716 (24.79)	
60–68 years old	1312 (10.57)	1252 (20.02)	428 (10.26)	
69 years or older	1397 (9.01)	1419 (19.59)	215 (4.98)	
Sex				0.264
Male	1370 (35.60)	1311 (39.43)	529 (39.61)	
Female	4712 (64.40)	2865 (60.57)	1516 (60.39)	
Body mass index (kg/m^2)				0.001
Underweight/normal	1503 (29.71)	939 (23.78)	622 (34.57)	
Overweight	1791 (30.79)	1278 (27.49)	598 (29.18)	
Obese	2488 (39.51)	1786 (48.73)	768 (36.25)	
Race/ethnicity				<0.0001
White	4585 (63.14)	3450 (79.52)	1510 (67.21)	
Black	550 (13.41)	260 (7.03)	206 (14.01)	
Hispanic	513 (15.27)	189 (8.33)	118 (9.81)	
Other	389 (8.19)	244 (5.11)	188 (8.97)	
Household income				<0.0001
<$25 000	1688 (29.98)	1542 (36.25)	1176 (51.04)	
$25 000 to <$50 000	1357 (18.14)	989 (23.84)	396 (22.43)	
≥$50 000	2358 (39.76)	1249 (30.58)	253 (12.06)	
Don't' Know	679 (12.11)	396 (9.34)	220 (14.47)	
Education level				<0.0001
Grade 8 or less	431 (10.55)	428 (14.15)	380 (23.83)	
High school	1376 (21.29)	1200 (27.38)	748 (36.80)	
College	4267 (68.16)	2542 (58.47)	914 (39.37)	
Health coverage				<0.0001
Yes	5625 (89.99)	3930 (91.05)	1684 (77.01)	
No	441 (10.01)	244 (8.95)	357 (22.99)	
Physical Activity in the past 30 days				<0.0001
Yes	4303 (76.72)	2747 (69.03)	1106 (58.31)	
No	1769 (23.28)	1423 (30.97)	934 (41.69)	
Urgent Treatment visits for asthma past 12 months				0.009
No visits	4562 (78.89)	3132 (73.82)	1420 (72.82)	
Any visits	1446 (21.11)	992 (26.18)	596 (27.18)	
ED visits for asthma past 12 months				0.000
No visits	5378 (88.73)	3640 (86.10)	1657 (81.28)	
Any visits	695 (11.27)	517 (13.90)	380 (18.72)	

ED = Emergency Department.
[a]p values were calculated by the Pearson's Chi-square test.

cigarettes in your entire life?'' to which adults' responded with ''yes'', ''no'', ''don't know/not sure'' or ''refused to answer''. The second question asked ''do you now smoke cigarettes every day, some days or not at all?'' Adults chose one of three options to identify their frequency of smoking: ''every day'', ''some days'' or ''not at all''. The exposure variable was grouped into three smoking categories: ''never smokers'', ''former smokers'', and ''current smokers'' and excluded data from those who answered ''don't know/not sure'' and/or ''refused to answer''.

Potential confounders of the association between ED visits and smoking among asthmatic patients included demographics and socioeconomic variables (Table 1). Based on the prior literature, we included relevant individual characteristics (i.e. age, sex, body mass index and race/ethnicity) [24–33], socioeconomic variables (i.e. household income, health coverage status and education level) and other related variables (i.e. physical activity in the past 30 days) in the analyses [27,34,35].

Age was categorized into four discrete intervals (18–48, 49–59, 60–68 and 69 years or older). Body mass index (kg/m^2) was categorized as underweight ($12.00 \leq \text{BMI} < 18.50$), normal weight ($18.50 \leq \text{BMI} < 25.00$), overweight ($25.00 \leq \text{BMI} < 30.00$) and obese ($30.00 \leq \text{BMI} < 99.99$). Race was categorized into four separate groups White, Black, Hispanic or Other. The ''Other'' category included Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaskan Native, Multiracial and other race. Household income was determined by respondents' self-reported annual income from all sources and divided into four discrete intervals (''<$25 000'', ''$25 000 ≤ $50 000'', ''≥$50 000'' and ''Don't Know''). Education was categorized as ''grade eight or less'', ''high school'' and ''college''. Health coverage was determined by whether respondents were covered by any kind of health care coverage, including health insurance, prepaid plans such as HMOs or government plans such as Medicare or an Indian Health Service. Physical activity was measured as self-reported participation in any physical activity or exercise during the past 30 days, other than their regular job. Physical activity was assessed by the following question ''during the past month, other than your regular job, did you participate in any physical activities or

Table 2. Sociodemographic characteristics of asthmatic adults in the 2011 Asthma Call-Back Survey by emergency treatment.

	Any emergency department visits for asthma in the past 12 months ($N = 1595$ of 12 303) [n (Weighted %)]	p Value[a]	Any urgent treatment visits for asthma in the past 12 months ($N = 3039$ of 12 181) [n (Weighted %)]	p Value[a]
Smoking Status		0.000		0.009
Never smokers	695 (11.27)		1446 (21.11)	
Former smokers	517 (13.90)		992 (26.18)	
Current smokers	380 (18.72)		596 (27.18)	
Age		<0.0001		<0.0001
18–48 years old	433 (12.72)		724 (21.41)	
49–59 years old	490 (18.70)		906 (29.52)	
60–68 years old	358 (12.84)		746 (25.13)	
69 years or older	310 (9.19)		654 (22.96)	
Sex		<0.0001		<0.0001
Male	308 (9.58)		585 (17.96)	
Female	1287 (15.92)		2454 (27.16)	
Body mass index (kg/m^2)		0.000		0.027
Underweight	25 (7.91)		35 (27.30)	
Normal Weight	319 (10.19)		635 (20.11)	
Overweight	403 (12.67)		818 (23.04)	
Obese	770 (16.48)		1424 (26.81)	
Race/ethnicity		0.094		0.061
White	1088 (12.49)		2212 (22.75)	
Black	207 (17.93)		338 (30.88)	
Hispanic	157 (13.50)		241 (22.10)	
Other	135 (16.17)		227 (24.12)	
Household income		0.000		0.002
<$25 000	780 (17.31)		1345 (28.05)	
$25 000 to <$50 000	307 (12.97)		590 (21.24)	
≥$50 000	340 (9.44)		805 (19.87)	
Don't know	168 (13.95)		299 (24.88)	
Education level		<0.0001		0.002
Grade 8 or less	256 (19.84)		402 (30.83)	
High school	461 (15.63)		825 (25.52)	
College	876 (11.12)		1809 (21.26)	
Health coverage		0.127		0.019
Yes	1442 (13.13)		2815 (24.61)	
No	151 (16.69)		221 (17.85)	
Physical activity in the past 30 days		0.026		0.009
Yes	939 (12.58)		1887 (22.30)	
No	651 (15.81)		1147 (27.09)	

[a]p values were calculated by the Pearson's Chi-square test.

exercises such as running, calisthenics, golf, gardening or walking for exercise?''

Analysis

All statistical analyses were performed using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC) [36]. Bivariate analyses were conducted to examine relationships between demographic characteristics, smoking status (i.e. never smokers, former smokers and current smokers) and ED and urgent treatment visits using Pearson chi-squared tests. All p values are two-sided, with $p < 0.05$ considered statistically significant. Separate models were run for ED visits and for urgent treatment visits.

The BRFSS and ACBS weighting process included design weighting and iterative proportional fitting. All data were analyzed using statements of stratification, clustering and sample weight to account for the complex sampling design of survey data. Weighted data were used to estimate population parameters and account for non-response and non-coverage at both the BRFSS and ACBS interview. Both unweighted frequency (N) and weighted percentages are reported in Table 1. Simple logistic regression was used to determine crude odds ratios. The multivariable logistic regression model adjusted for all potential confounders. Both crude and adjusted odds ratios are reported in Table 2. We calculated the attributable risk percent and population attributable risk percent using the adjusted odds ratio for current and former smokers and the weighted prevalence of current and former smoking. The estimate of population attributable risk percent is calculated as $100^* [P_x^*(OR - 1)]/1 + [P_x^*(OR - 1)]$ [37]. Finally, we conducted sensitivity analyses by running all multivariable logistic regression models when restricting the sample to participants aged 18–48 years.

Results

Asthmatic adults were predominantly female (62.5%), white (68.17%) and had health insurance (87.41%). In this study population, over half (52.9%) were never smokers, 25.3% former smokers and 21.8% current smokers. Never smokers tended to have higher income, higher education and were

Table 3. Unadjusted and adjusted odds of emergency care visits among asthmatic adults in the 2011 ACBS.

	Any emergency department visits for asthma in the past 12 months[a] ($N = 1595$ of 12 303)		Any urgent treatment visits for asthma in the past 12 months[a] ($N = 3039$ of 12 181)	
	Crude OR (95% CI)	Adjusted OR (95% CI)[b]	Crude OR (95% CI)	Adjusted OR (95% CI)[b]
Smoking status				
Never smokers	REF	REF	REF	REF
Former smokers	1.27 (0.96, 1.69)	1.30 (0.97, 1.74)	1.33 (1.06, 1.66)	1.28 (0.99, 1.65)
Current smokers	1.82 (1.36, 2.42)	1.46 (1.05, 2.03)	1.40 (1.08, 1.80)	1.29 (0.96, 1.73)

Both crude and adjusted odds ratios were weighted using survey logistic and ACBS weighting variables (_psu, ststr, landwt_f).
[a]Confidence intervals calculated by the Wald test.
[b]Adjusted odds ratios included all sociodemographic variables (smoking status, age, sex, BMI, race/ethnicity, income, education, health coverage and physical activity in the past 30 days).

more likely to have exercised in the past 30 days. Former smokers were more likely to be white, tended to be older and have a higher BMI. Current smokers tended to be younger, have lower income, have less education and were less likely to have health coverage or have exercised in the past 30 days (Table 1).

Table 2 shows the distribution of demographic characteristics in this asthmatic population by emergency care visits (ED visits and urgent treatment visits). Asthmatic females (15.9%) were more likely than males (9.5%) to visit the ED; also females were more likely to visit a health professional for an urgent treatment visit (27.1% versus 17.9%). Asthmatic adults, who were obese, were more likely to visit the ED or a health professional for an urgent treatment visit. Asthmatic adults without health coverage were more likely to visit the ED; however, asthmatic adults with health coverage were more likely to visit their doctor for urgent treatment.

In the unadjusted model (Table 3), among asthmatic adults, former smokers had 1.27 (95% CI: 0.96, 1.69) times the odds of having visited the ED as compared to never smokers during the past 12 months while current smokers had 1.82 (95% CI: 1.36, 2.42) times the odds of having visited the ED compared to those who have never smoked. Furthermore, former smokers had 1.33 (95% CI: 1.06, 1.66) times the odds and current smokers had 1.40 (95% CI: 1.08, 1.80) times the odds of visiting a doctor or other health professional for urgent treatment of worsening asthma symptoms during the past 12 months compared to never smokers.

In the adjusted models, most associations were attenuated but remained significant (Table 3). Adjusting for all relevant confounders, former smokers had 1.30 (95% CI: 0.97, 1.74) times the odds and current smokers had 1.46 (95% CI: 1.05, 2.03) times the odds of visiting the ED during the past 12 months as compared to never smokers. In addition, former smokers had 1.28 (95% CI: 0.99, 1.65) times the odds and current smokers had 1.29 (0.96, 1.73) times the odds of visiting a doctor or other health professional for urgent treatment of worsening asthma symptoms during the past 12 months.

Among adult asthmatic current smokers, 32% of ED visits and 23% of urgent treatment visits can be attributed to their current smoking. Among adult asthmatic former smokers, 23% of ED visits and 22% of urgent treatment visits can be attributed to their former smoking. Among the population of adult asthmatics, the percentage of ED visits and urgent treatment visits that would not occur if current cigarette smoking were eliminated was 9 and 6%, respectively. An estimated 7% of ED visits and 7% of urgent treatment visits can be attributed to former smoking.

Discussion

Among asthmatic adults, current smokers were significantly more likely to have an emergency care visit and similarly, among former smokers there was an elevated although non-significant increase in likelihood to have an emergency care visit. More specifically, current smokers had significantly higher odds of an ED visit and significantly higher odds of making an urgent treatment visit to their health professional compared to never smokers when adjusting for confounders.

Previous studies have indicated current smokers report increased asthma attacks and asthma-related symptoms during the month than those who do not smoke [6,8,38–40]. The elimination of smoking among asthmatics will likely reduce ED visits and urgent treatment visits among asthmatic adults and therefore healthcare spending. For example, Kent et al. found that admissions to the ED due to acute pulmonary illness decreased significantly following the implementation of a smoking ban, from 439 admissions per 100 000 population per year in the 2 years preceding to the ban to 396 admissions per 100 000 population per year in the 2 years succeeding the ban. The smoking ban contributed to a relative reduction of 15% in overall ED admissions with acute pulmonary disease [41]. Scientific evidence increasingly shows that tobacco smoking by individuals with asthma exacerbates the asthmatic condition by damaging cilia in the airways and allowing dust and mucus to accumulate in the airways triggering an asthma attack, which in turn may lead to emergency care visits [5,6,8,38–40]. If we assume a causal relationship between smoking and emergency care, our study findings suggest that eliminating smoking (both former and current smoking) among the population of asthmatic adults will reduce their ED visits by 16% and urgent treatment visits by 13%.

Study findings provide new empirical evidence of the relationship between smoking status and both ED and urgent treatment visits among a nationally representative sample of asthmatic adults. With approximately 1.9 million ED visits for asthma in 2009 [15], understanding the association of smoking and emergency care visits in this population will have implications for patients and emergency care

professionals. Lenhardt et al. [14] found that although adults with asthma exacerbations presented to the ED improved with treatment, there was continued decline of the adults' asthmatic condition after the ED visit. Exposure to tobacco smoke, likely linked to uncontrolled asthma, may increase asthma-related emergencies; therefore, to reduce the potential for costly emergency care services, this population should be targeted for smoking prevention, smoking cessation programs and chronic disease management education.

There were some limitations of this study. For example, inferences from these results were limited by the cross-sectional nature of the data; thus reverse causality cannot be ruled out. In addition, information about both ED visits and urgent treatment visits referred to ''the past 12 months'' while the smoking status information asked ''do you now smoke cigarettes?'' Due to this slight difference in timeframe of each question, we were unable to ascertain smoking status exactly at the time of emergency care. We considered the issue of severity of disease; however, as the data were cross-sectional, it was impossible to discern whether the measures used to determine asthma severity such as medication use and asthmatic attacks were before or after the emergency care visits.

In order to calculate the attributable risk, certain assumptions were made. Odds ratios were assumed to approximate risk ratios though they are likely an overestimate and both current and former smoking was assumed to be causally related to emergency care visits. However, these attributable fractions may be underestimates because asthmatic adults who require emergency care visits have multiple visits annually, on average. In fact, those who visit the ED average 2.4 (95% CI: 2.06, 2.77) visits per year and those who visit their doctor for urgent treatment of asthma average 2.7 (95% CI: 2.44, 2.95) visits per year. Given the sample included asthmatic adults from a broad range of ages (e.g. 18 through 85 years) and that age may be associated with ED visits, we restricted our sample to those aged 18–48 years. Age groupings were based on rough quartile distributions. Results showed associations to be similar but slightly higher than when conducted among the whole sample. According to the National Center for Health Statistics, females had higher asthma prevalence than males (9.2% compared with 7.0%) for the period 2008–2010. Our asthmatic adult sample indicates there are 1.6 times as many females as males who have asthma, which is fairly consistent with these estimates [42].

The median survey response rate for the 2011 BRFSS was 52.9% and the response rate of the 2011 ACBS was 93.1% [20,21]. Although the BRFSS is limited by low response rates, the survey is considered one of the few available large, nationally representative health surveys. The BRFSS data are timely and the data are available within 6 months from end of the calendar year of data collection. For those who participated in the ACBS, the response rate was very high and the ACBS was used specifically to address asthma needs. A significant limitation of this study is that the ACBS was based on self-reported responses and participants may be prone to social desirability bias and recall bias. Potential residual confounding may have existed from other comorbidities.

The validity of self-reported asthma status in the BRFSS is unknown. According to a 1993 review of asthma questionnaires, the sensitivity and specificity of self-reported asthma when compared to a clinical diagnosis of asthma has been reported to be anywhere between 48–100% (sensitivity) and 78–100% (specificity) [43]. The BRFSS questions ask whether respondents have been told by a health professional they have asthma; however, it is possible that either the physician's diagnosis or the respondent's recall of that diagnosis might be inaccurate. Using a self-reported asthma measure may lead to a sample where many true asthmatic patients are not included or patients with other lung conditions are included. The question we proposed to examine is whether asthmatic adults who smoke have more frequent ED or urgent care visits than those who do not smoke. Since sensitivity is likely lower than specificity, we may have missed some of the asthmatics that were not asked to participate in the ACBS. However, the question is still relevant for those who recall being told by a health care provider that they had asthma and for those who still classify themselves as ''current asthmatics''. In addition, even though self-reported surveys have limitations, one study done by the Minnesota Department of Health demonstrated a good correlation between a positive answer and the presence of an asthma diagnosis in the medical record [44]. The BRFSS also remains the largest telephone survey in the world and a comprehensive source of state-level surveillance data for asthma and other chronic conditions [45].

Despite these limitations, this study included a large sample of asthmatic adults and was the first examination of this study question, to the best of our knowledge, among the US nationally representative sample. Study findings provided new empirical evidence on the relationship between smoking status and emergency care visits generalizable to asthmatic adults in the US.

Results suggest a health policy of increasing asthma management education, smoking cessation strategies and smoking prevention techniques may be effective and result in better asthma control and management. As a key site for care, both EDs and physician offices may serve as a prime location to address and implement smoking interventions. An intervention by healthcare professionals – by providing advice, counseling and pharmacotherapy – may improve this population's chance of quitting smoking. Moreover, additional research should focus on a better understanding of how altering smoking behavior can help improve asthma management and prevent asthma exacerbations. In our study, we calculated absolute measures of association as a way to estimate the potential public health impact if smoking was eliminated among asthmatics and the potential burden in this population if they do not quit smoking. The public health impact measurements only hold if smoking is causally related to emergency care visits among asthmatics. Both the ED and physician offices may want to consider offering cessation services within their site or referring patients to smoking cessation programs in the area. Evidence-based chronic disease self-management programs have shown improvement in the management of chronic disease and these types of programs could help patients change their smoking behavior to lower their risks for exacerbations of chronic illness and thereby avoid emergency care visits and future hospitalizations [46,47].

Conclusions/key findings

Although there are many tobacco control laws and policies at both the federal and state level, a more rigorous effort of smoking prevention and smoking cessation should be directed at this asthmatic population specifically among both current and former smokers. Smoking cessation and smoking prevention has the potential to improve pulmonary function in asthmatic patients, eliminate more than 10% of emergency care usage in this population assuming a causal relationship between smoking and emergency care, and prevent unnecessary health care costs.

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Declaration of interest

The authors report no conflicts of interest.

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