



# HHS Public Access

Author manuscript

*J Asthma*. Author manuscript; available in PMC 2016 November 01.

Published in final edited form as:

*J Asthma*. 2015 November ; 52(9): 974–980. doi:10.3109/02770903.2015.1020389.

## Age at asthma onset and asthma self-management education among adults in the United States

Maria C. Mirabelli, PhD, MPH<sup>1</sup>, Suzanne F. Beavers, MD<sup>1</sup>, Samantha H. Shepler, BS<sup>2</sup>, and Arjun B. Chatterjee, MD, MS<sup>3</sup>

<sup>1</sup>Air Pollution and Respiratory Health Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA

<sup>2</sup>Department of Biostatistics, Rollins School of Public Health, Emory University, Atlanta, GA, USA

<sup>3</sup>Section on Pulmonary, Critical Care, Allergy, and Immunologic Diseases, Department of Internal Medicine, Wake Forest School of Medicine, Winston-Salem, NC, USA

### Abstract

**Objective**—Asthma self-management education improves asthma-related outcomes. We conducted this analysis to evaluate variation in the percentages of adults with active asthma reporting components of asthma self-management education by age at asthma onset.

**Methods**—Data from 2011 to 2012 Asthma Call-back Surveys were used to estimate percentages of adults with active asthma reporting six components of asthma self-management education. Components of asthma self-management education include having been taught to what to do during an asthma attack and receiving an asthma action plan. Differences in the percentages of adults reporting each component and the average number of components reported across categories of age at asthma onset were estimated using linear regression, adjusted for age, education, race/ethnicity, sex, smoking status, and years since asthma onset.

**Results**—Overall, an estimated 76.4% of adults with active asthma were taught what to do during an asthma attack and 28.7% reported receiving an asthma action plan. Percentages reporting each asthma self-management education component declined with increasing age at asthma onset. Compared with the referent group of adults whose asthma onset occurred at 5–14 years of age, the percentage of adults reporting being taught what to do during an asthma attack was 10% lower among those whose asthma onset occurred at 65–93 years of age (95% CI: –18.0, –2.5) and the average number of components reported decreased monotonically across categories of age at asthma onset of 35 years and older.

---

Correspondence: Maria C. Mirabelli, PhD, MPH, Air Pollution and Respiratory Health Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Hwy, NE Mailstop F-60, Atlanta, GA 30341, USA. Tel: +1 770 488 0799. zif7@cdc.gov.

#### Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper. The findings and conclusions in this report are those of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

**Conclusions**—Among adults with active asthma, reports of asthma self-management education decline with increasing age at asthma onset.

### Keywords

Behavior; epidemiology; health; prevention; respiratory; surveillance

---

## Introduction

Effective management of asthma requires that individuals with asthma, or their caregivers, understand and follow treatment recommendations given by their health care providers [1]. One component of asthma care, asthma self-management education, has been shown to improve asthma-related outcomes [2]. Asthma self-management education includes providing patients, or their caregivers, with information about and training in asthma management skills, the monitoring of asthma-related symptoms or peak-flow, and the use of written asthma action plans [1].

We conducted these analyses to examine variation in the percentages of adults with active asthma who report encountering aspects of asthma self-management education. Findings from previous analyses suggest that the frequency and the severity of asthma-related outcomes may vary with the age at which asthma first began [3]. In this analysis, we extend those findings by evaluating the relationship between age at asthma onset and asthma self-management education. Improving our understanding about the extent to which asthma self-management education may be influenced by the timing of asthma onset has the potential to improve our understanding of adults' asthma self-management education needs.

## Methods

We analyzed data from the landline samples of the 2011–2012 Behavioral Risk Factor Surveillance System (BRFSS) adult Asthma Call-back Surveys [4–9], which include data collected in 38 states, the District of Columbia, and Puerto Rico [10,11]. Of the 29 142 eligible respondents, we restricted our analyses to adults with active asthma who provided an age at asthma onset, current age, and years since asthma onset; whose responses regarding age at asthma onset, current age, and years since asthma onset were consistent; and for whom, information about educational attainment, race/ethnicity, and smoking status was not missing ( $n = 20\ 808$ ) (Figure 1). We identified respondents as having active asthma if they reported talking to a doctor or other health professional about his/her asthma, taking asthma medication, or experiencing any symptoms of asthma during the past 12 months [3,12].

To obtain information about asthma self-management education, respondents were asked six questions: (1) “has a doctor or other health care professional ever taught you how to recognize early signs or symptoms of an asthma episode,” (2) “has a doctor or other health professional ever taught you what to do during an asthma episode or attack,” (3) “has a doctor or other health professional ever taught you how to use a peak flow meter to adjust your daily medications,” (4) “has a doctor or other health professional ever given you an asthma action plan,” (5) “have you ever taken a course or class on how to manage your

asthma,” and (6) “has a health professional ever advised you to change things in your home, school, or work to improve your asthma?” As in previous analysis [3,13], uninformative responses (e.g., don’t know, not sure) were categorized as negative responses. A summary metric of asthma self-management education was computed as the total number of positive responses to the six asthma self-management education questionnaire items.

Each respondent reported his/her age at the time of the interview, educational attainment, race/ethnicity, sex, cigarette smoking status, age at asthma onset, and time, in years, since asthma onset. We categorized the distribution of respondent age: 18–34, 35–44, 45–54, 55–64, and 65–99 years. Descriptive analyses of the mean age at asthma onset were conducted using age as a continuous variable, where onset at <1 year of age was set to 0.5 years; all other analyses were conducted using categories of age at asthma onset: <1–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–93 year(s). Years since asthma onset were collected and analyzed in categories: <1, 1–5, and >5 year(s).

We estimated percentages of adults with active asthma who reported each of the six components of asthma self-management education across categories of age, educational attainment, race/ethnicity, sex, smoking status, and years since asthma onset. We also estimated the mean number of positive responses to the six asthma self-management education questionnaire items across categories of the same participant characteristics. Adjusted percentage differences (PDs) and mean differences (MDs) were generated across categories of age at asthma onset using linear regression models, specified with Taylor approximation methods for estimating variance with missing data not missing completely at random and with onset at 5–14 years as the referent category. The age category of 5–14 years was selected as a referent group because of the larger sizes of the surveyed sample and estimated population in this category, compared with those in the remaining categories. Estimates were generated using seven separate models: one model for each of the six asthma self-management education variables and one model for the summary metric of positive asthma self-management education responses. Each model was adjusted for age, educational attainment, race/ethnicity, sex, smoking status, and years since asthma onset as categorical variables. All analyses were conducted using complex sample survey data analysis procedures in SAS version 9.3 (SAS Institute Inc., Cary, NC). The data were weighted to account for non-response and unequal sampling probabilities. The BRFSS Asthma Call-back Survey is exempt from Institutional Review Board (IRB) review at the Centers for Disease Control and Prevention; state-specific IRB requirements apply to each of the participating states, the District of Columbia, and Puerto Rico.

## Results

Characteristics of the 20 808 adults in the 2011–2012 Asthma Call-back Survey sample are presented in Table 1. These respondents ranged in age from 18 to 99 years (mean: 45.9) and represented an estimated 37.8 million US adults with active asthma. Asthma onset was reported at a mean of 24.6 years of age, declined monotonically with educational attainment, and varied across categories of race/ethnicity, sex, and smoking status. Overall, an estimated 76.4% (standard error (SE): 0.8; range across 40 sampled geographic areas: 48.6–93.5%) of adults with active asthma were taught what to do during an asthma attack, 65.6% (SE: 0.9;

range: 52.7–79.2%) were taught to recognize the symptoms of an asthma attack, and 45.2% (SE: 1.0; range: 15.7–60.1%) were taught to use a peak flow meter (Table 2). Lower percentages reported having been advised to change aspects of the home, school, or work environment (mean (SE): 39.6% (1.0); range: 26.3–48.2%), having been given an asthma action plan (mean (SE): 28.7% (0.9); range: 14.7–43.3%), or having taken an asthma management course (mean (SE): 9.2% (0.6); range 4.4–17.7%). Overall, respondents reported an estimated average of 2.6 (SE: 0.03) of the six components of asthma self-management education components; across the 40 sampled geographic areas, this average ranged from 1.8 (SE: 0.2) in Puerto Rico to 3.1 (SE: 0.2) in Wisconsin.

Survey respondents reported the initial onset of asthma as occurring between <1 year of age and 93 years of age. Unadjusted estimates (Table 2) and adjusted differences (Figure 2) in percentages with positive responses to each of the six asthma self-management education questionnaire items both indicated lower prevalences of several components of asthma self-management education across categories of increasing age at asthma onset. For example, among adults with active asthma, the unadjusted estimated percentage of adults reporting being taught what to do during an asthma attack was 56.4% (SE: 2.3) among adults whose asthma onset occurred at 65–93 years of age and 78.6% (SE: 1.6) among those whose asthma onset occurred at 5–14 years of age, the referent category in our analysis. Similarly, adjusted percentage of adults reporting being taught what to do during an asthma attack was 10% lower among those whose asthma onset occurred at 65–93 years of age (PD: –10.2%, 95% CI: –18.0, –2.5) compared with that among individuals in the referent category. In contrast, declines in the percentages reporting being given an asthma action plan were modest and not statistically significant at  $\alpha = 0.05$ . Compared with the referent group, the adjusted mean number of positive responses to the six asthma self-management education questionnaire items was highest among those whose asthma onset occurred at <1–4 year(s) (MD: 0.3 (95% CI: 0.03, 0.5), decreased monotonically across categories of ages 35 years and older, and was lowest among those whose onset occurred at ages 65–93 years (MD: –0.6, 95% CI: –0.9, –0.4).

## Discussion

Using data from the 2011–2012 adult Asthma Call-back Survey, we found that the majority of adults with active asthma reported having been taught what to do during an asthma attack. We also found that several aspects of asthma self-management education, including being given an asthma action plan and being advised to make changes in home, school, or work environments in order to improve one's asthma, were reported less frequently. The percentages reporting each element declined modestly with increasing age at asthma onset, revealing opportunities for improvement in the delivery of asthma self-management education regardless of the age at which asthma first began.

Our results support and extend previous findings about asthma self-management education among adults in the United States [14,15]. Following analysis of 2006–2007 Asthma Call-back Survey data, Zahran et al. [14] reported that older age, lower levels of educational attainment, and smoking were associated with reporting fewer components of asthma self-management education. Similar findings were generated using 2003 National Health

Interview Survey data [15]. Notably, a comparison of findings reported from the 2006–2007 Asthma Call-back Survey to findings from our analysis of the 2011–2012 Asthma Call-back Survey indicates that changes in the estimated percentages of adults reporting each component of asthma self-management education between 2006–2007 and 2011–2012 have been modest. For example, in 2006–2007, an estimated 26.8% (95% CI: 25.3, 28.5) of adults with active asthma reported being given an asthma action plan [14], compared with 28.7% (95% CI: 26.9, 30.4) in 2011–2012. The estimated percentage of adults who were advised to make changes in the home, school, or work environment to improve asthma declined from 43.2% (95% CI: 41.1, 45.1) in 2006–2007 [14] to 39.6% (95% CI: 37.7, 41.5) in 2011–2012. Changes in the survey methods over time preclude us from pooling data from 2011 to 2012 with data from earlier surveys to more efficiently evaluate trends in asthma self-management education, though our use of the landline telephone sample of the 2011–2012 Asthma Call-back Surveys rather than the cellphone sample likely improves the degree to which our data may be comparable with these earlier estimates, which were based on landline telephone samples.

Our results are based on analyses of data collected in 38 US states, the District of Columbia, and Puerto Rico. While the large number of geographic areas represented and the large number of survey respondents across these areas are a notable strengths of our analysis, our results are not representative of the entire US population. Furthermore, our results were generated using a pooled sample and their generalizability is limited to the population of adults with active asthma in the states and regions from which the respondent sample was selected (i.e. Alabama, Arizona, California, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, the District of Columbia, and Puerto Rico); our results do not include area-specific estimates.

For adults with asthma, effective asthma self-management education can provide the knowledge and skills needed to control the symptoms of asthma and improve asthma-related outcomes [1,2,16–18]. Results from both observational and experimental research provide evidence that targeted self-management education can improve self-management skills [19], medication adherence [20,21], and some indicators of asthma control [17–21]. Despite such evidence, the translation of research findings about the benefits of asthma self-management education into practices that consistently improve asthma outcomes has been limited [17,18]. Evidence that health education for chronic health conditions, including asthma, is more frequently delivered by physician assistants and nurse practitioners than by physicians suggests that the delivery of self-management education varies with professional training, though explanations for the difference remain unclear [22].

Health literacy and self-efficacy have been identified as important challenges to the uptake and implementation of asthma self-management strategies among adults with asthma [18,23,24]. In our study, positive responses indicating that respondents encountered the six components of asthma self-management education included in the Asthma Call-back Survey questionnaire do not provide information about the extent to which respondents understood

or recall the provided information or behave differently because of it. Additional information about the delivery and content of the asthma self-management education, as well as the extent to which the respondents in our study incorporated the content into their self-management strategies, would further improve our understanding of effective asthma self-management education.

In addition, the Asthma Call-back Survey did not include questionnaire items designed to identify the timing of any components of asthma self-management education; therefore, we cannot use the data to conduct useful evaluations of the relationships between asthma self-management education and respiratory health outcomes, such as the frequency or severity of asthma symptoms. This limitation prevented us from extending our analyses to evaluate the impact of each element of asthma self-management education on respiratory health. Exploratory adjustment of our final models for indicators of asthma severity, including self-reported asthma attack during the past 12 months, number of days in the past 30 d with symptoms of asthma, number of nights that symptoms of asthma made it difficult to stay asleep, and indicators of persistent versus intermittent asthma symptoms and level of asthma control [25] generated estimates nearly identical to those generated by our final models (data not shown). Although the addition of these indicators did not affect our findings, the interpretation of such results adjusted for asthma severity is limited by the lack of information about whether the asthma outcomes reported may have preceded or followed the components of asthma self-management education. Information about the timing of asthma self-management training, asthma onset, and asthma exacerbations, as well as information about behaviors associated with asthma self-management education and the source of the asthma self-management information would improve our understanding about the extent to which asthma self-management education affects the frequency and severity of asthma symptoms.

As in previous analyses [3], the results presented here may be affected by collinearity among age at interview, age at asthma onset, and years since asthma onset. Our statistical models were adjusted for age at interview and years since asthma onset, both parameterized as categorical variables and, therefore, we cannot exclude the possibility of residual confounding within categories of age or years since asthma onset. However, our final results were robust to modifications such as including age at interview as a continuous measure, including years since asthma onset as a continuous measure, excluding one or both from our analysis, and restricting our analysis to respondents who reported the onset of asthma within the past year (data not shown). In combination with evidence that asthma in older adults is an increasingly serious health issue [26], the findings presented here suggest that adults who develop asthma at older ages may not be fully prepared to self-manage their symptoms. However, previous research shows that self-management education programs targeted towards older adults can be effective in promoting self-care by older people with asthma [27]. Additional information about the extent to which older adults with new-onset asthma encounter self-management education programs adapted to their needs and learning preferences would improve our ability to evaluate the impact of such programs. Our findings are notably strengthened by the large sample of adults with active asthma; the sample of 20 808 men and women in our analysis represents over 37.8 million US adults with active asthma, all of whom are suitable candidates for asthma self-management education.



Existing evidence suggests that asthma self-management education involving a written action plan, self-monitoring, and regular medical review is an effective component of asthma management and reduces asthma-related outcomes [2]. The findings presented here illustrate the use of surveillance data to reveal opportunities for improvement in asthma self-management education, particularly among adults whose asthma onset occurs at older ages.

## Acknowledgments

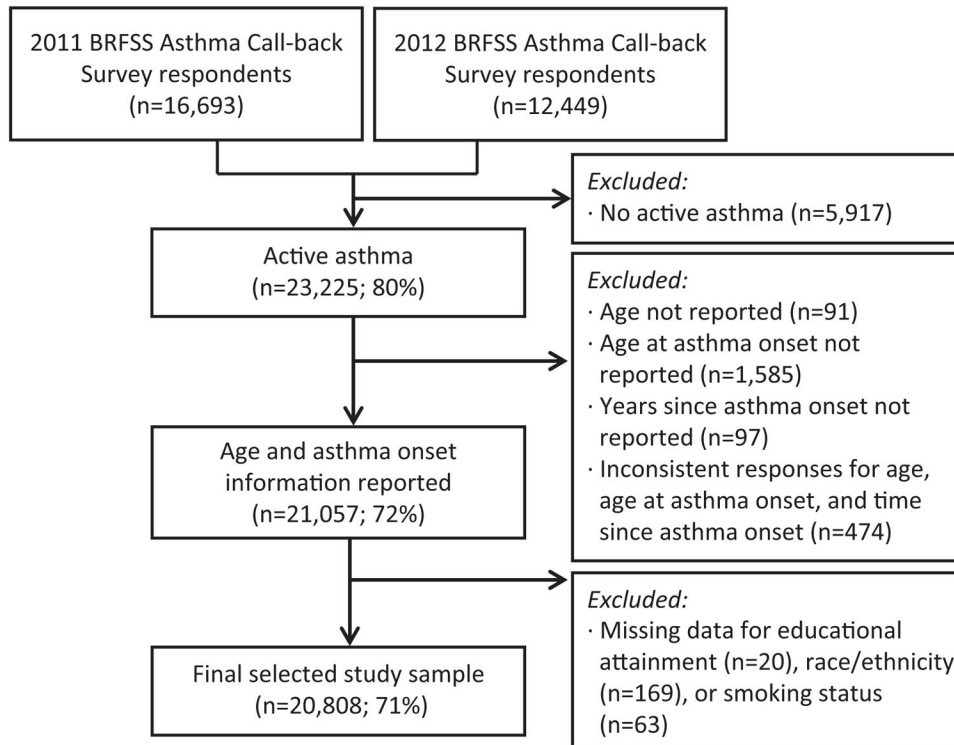
The Asthma Call-back Survey is jointly administered with the Office of Surveillance, Epidemiology and Laboratory Services, Division of Behavioral Surveillance; data collection is managed by BRFSS coordinators in each of the participating states, the District of Columbia, and Puerto Rico.

## References

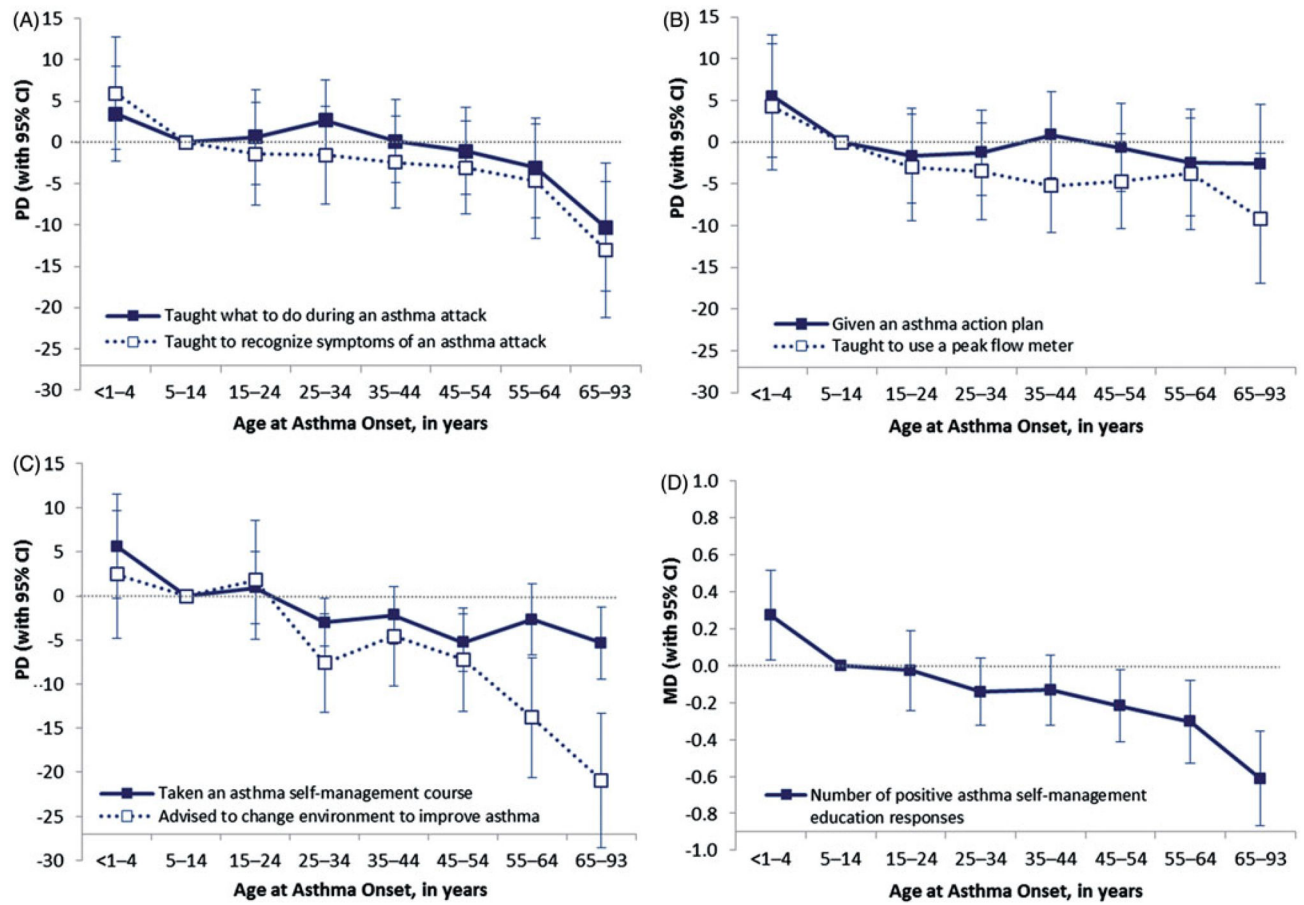
1. EPR-3. NIH Publication No. 07-4051. Bethesda (MD): U.S. Department of Health and Human Services; National Institutes of Health, National Heart, Lung, and Blood Institute; National Asthma Education and Prevention Program; 2007. Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma, Full Report 2007.
2. Gibson PG, Powell H, Coughlan J, Wilson AJ, Abramson M, Haywood P, Bauman A, et al. Self-management education and regular practitioner review for adults with asthma. *Cochrane Database Syst Rev.* 2003; (1):CD001117. [PubMed: 12535399]
3. Mirabelli MC, Beavers SF, Chatterjee AB, Moorman JE. Age at asthma onset and subsequent asthma outcomes among adults with active asthma. *Respir Med.* 2013; 107:1829–1836. [PubMed: 24139624]
4. Centers for Disease Control and Prevention (CDC). [last accessed 23 Jan 2013] Behavioral Risk Factor Surveillance System. Available from: <http://www.cdc.gov/asthma/survey/brfss.html>
5. Xu F, Town M, Balluz LS, Bartoli WP, Murphy W, Chowdhury PP, Garvin WS, et al. Surveillance for certain health behaviors among States and selected local areas – United States, 2010. *MMWR Surveill Summ.* 2013; 62:1–247. [PubMed: 23718989]
6. Centers for Disease Control and Prevention (CDC). [last accessed 13 Nov 2013] 2011 BRFSS Overview. 2012. Available from: [http://www.cdc.gov/brfss/annual\\_data/2011/overview\\_11.rtf](http://www.cdc.gov/brfss/annual_data/2011/overview_11.rtf)
7. Centers for Disease Control and Prevention (CDC). [last accessed 13 Nov 2013] Methodologic changes in the Behavioral Risk Factor Surveillance System in 2011 and potential effects on prevalence estimates. 2013. Available from: <http://www.cdc.gov/surveillancepractice/reports/brfss/brfss.html>
8. Hu SS, Pierannunzi C, Balluz L. Integrating a multimode design into a national random-digit-dialed telephone survey. *Prev Chronic Dis.* 2011; 8:A145. [PubMed: 22005638]
9. Centers for Disease Control and Prevention (CDC). [last accessed 9 Sep 2013] The BRFSS Data User Guide. 2013. Available from: [http://www.cdc.gov/brfss/data\\_documentation/PDF/UserguideJune2013.pdf](http://www.cdc.gov/brfss/data_documentation/PDF/UserguideJune2013.pdf)
10. Centers for Disease Control and Prevention (CDC). [last accessed 13 Nov 2013] 2011 Behavioral Risk Factor Surveillance System Asthma Call-back Survey History and Analysis Guidance (version 1.0.0). 2013. Available from: [http://www.cdc.gov/brfss/acbs/2011/documentations/ACBS\\_2011.pdf](http://www.cdc.gov/brfss/acbs/2011/documentations/ACBS_2011.pdf)
11. Centers for Disease Control and Prevention (CDC). [last accessed 16 Jul 2014] 2012 Behavioral Risk Factor Surveillance System Asthma Call-back Survey Summary Data Quality Report. 2014. Available from: [http://www.cdc.gov/brfss/acbs/2012/pdf/ACBS\\_2012.pdf](http://www.cdc.gov/brfss/acbs/2012/pdf/ACBS_2012.pdf)
12. Mirabelli MC, Beavers SF, Chatterjee AB. Active asthma and the prevalence of physician-diagnosed COPD. *Lung.* 2014; 192:693–700. [PubMed: 24952247]
13. Mirabelli MC, Beavers SF, Flanders WD, Chatterjee AB. Reliability in reporting asthma history and age at asthma onset. *J Asthma.* 2014; 51:956–963. [PubMed: 24894742]

14. Zahran HS, Person CJ, Bailey C, Moorman JE. Predictors of asthma self-management education among children and adults –2006–2007 behavioral risk factor surveillance system asthma call-back survey. *J Asthma*. 2012; 49:98–106. [PubMed: 22216949]
15. Asthma self-management education among youths and adults –United States, 2003. *MMWR Morb Mortal Wkly Rep*. 2007; 56:912–915. [PubMed: 17805222]
16. McDonald VM, Gibson PG. Asthma self-management education. *Chron Respir Dis*. 2006; 3:29–37. [PubMed: 16509175]
17. Morrison D, Wyke S, Agur K, Cameron EJ, Docking RI, Mackenzie AM, McConnachie A, et al. Digital asthma self-management interventions: a systematic review. *J Med Internet Res*. 2014; 16:e51. [PubMed: 24550161]
18. Andrews KL, Jones SC, Mullan J. Asthma self management in adults: a review of current literature. *Collegian*. 2014; 21:33–41. [PubMed: 24772988]
19. Perneger TV, Sudre P, Muntner P, Uldry C, Courtehouse C, Naef AF, Jacquemet S, et al. Effect of patient education on self-management skills and health status in patients with asthma: a randomized trial. *Am J Med*. 2002; 113:7–14. [PubMed: 12106617]
20. Janson SL, McGrath KW, Covington JK, Cheng S-C, Boushey HA. Individualized asthma self-management improves medication adherence and markers of asthma control. *J Allergy Clin Immunol*. 2009; 123:840–846. [PubMed: 19348923]
21. Janson SL, Fahy JV, Covington JK, Paul SM, Gold WM, Boushey HA. Effects of individual self-management education on clinical, biological, and adherence outcomes in asthma. *Am J Med*. 2003; 115:620–626. [PubMed: 14656614]
22. Ritsema TS, Bingenheimer JB, Scholting P, Cawley JF. Differences in the delivery of health education to patients with chronic disease by provider type, 2005–2009. *Prev Chronic Dis*. 2014; 11:E33. [PubMed: 24602587]
23. Burns P, Jones SC, Iverson D, Caputi P. AsthmaWise – a field of dreams? The results of an online education program targeting older adults with asthma. *J Asthma*. 2013; 50:737–744. [PubMed: 23745621]
24. Apter AJ, Wan F, Reisine S, Bender B, Rand C, Bogen DK, Bennett IM, et al. The association of health literacy with adherence and outcomes in moderate-severe asthma. *J Allergy Clin Immunol*. 2013; 132:321–327. [PubMed: 23591273]
25. Zahran HS, Bailey CM, Qin X, Moorman JE. Assessing asthma severity among children and adults with current asthma. *J Asthma*. 2014; 51:610–617. [PubMed: 24506700]
26. Gibson PG, McDonald VM, Marks GB. Asthma in older adults. *Lancet*. 2010; 376:803–813. [PubMed: 20816547]
27. Huang TT, Li YT, Wang CH. Individualized programme to promote self-care among older adults with asthma: randomized controlled trial. *J Adv Nurs*. 2009; 65:348–358. [PubMed: 19040689]





**Figure 1.** Selection of the study sample: 2011–2012 BRFSS Asthma Call-back Survey.



**Figure 2.** Percentage differences (PDs) in reporting each element of asthma self-management education (panels A–C) and mean differences (MDs) in the number of positive responses (panel D) by age at asthma onset. MDs and PDs (with 95% CIs) are adjusted for age, educational attainment, race/ ethnicity, sex, smoking status, and years since asthma onset.

**Table 1**

Demographic characteristics and mean age at asthma onset for the 2011–2012 Asthma Call-back Survey sample and weighted population estimate.

	<u>Survey sample</u>	<u>Weighted population estimate</u>		<u>Age at asthma onset, in years</u>
	No.	No. <sup>a,b</sup>	Percent (95% CI)	Mean (SE)
Total	20 808	37 760		24.6 (0.3)
Age at asthma onset, in years				
<1–4	1733	5206	13.8 (12.0, 15.5)	1.9 (0.1)
5–14	3640	9825	26.0 (24.3, 27.7)	9.4 (0.1)
15–24	2426	6064	16.1 (14.4, 17.7)	19.0 (0.2)
25–34	2781	5304	14.0 (12.8, 15.3)	28.9 (0.1)
35–44	3114	4317	11.4 (10.5, 12.4)	38.8 (0.1)
45–54	3218	3720	9.9 (9.1, 10.6)	48.5 (0.1)
55–64	2356	2050	5.4 (5.0, 5.9)	58.7 (0.1)
65–93	1540	1275	3.4 (3.1, 3.7)	70.9 (0.2)
Age at interview, in years				
18–34	1582	11 931	31.6 (29.4, 33.8)	11.1 (0.4)
35–44	2153	6635	17.6 (16.1, 19.0)	19.4 (0.5)
45–54	3849	6937	18.4 (17.2, 19.6)	27.6 (0.5)
55–64	5929	6331	16.8 (15.8, 17.8)	34.2 (0.5)
65–99	7295	5927	15.7 (14.8, 16.6)	44.0 (0.6)
Educational attainment				
Less than high school	1973	5748	15.2 (13.7, 16.8)	27.1 (1.0)
Graduated high school	5483	9516	25.2 (23.4, 27.0)	25.1 (0.8)
Some college/technical school	6103	12 875	34.1 (32.3, 35.9)	23.9 (0.5)
Graduated college/technical school	7249	9621	25.5 (24.1, 26.9)	23.7 (0.4)
Race/ethnicity				
Black, non-Hispanic	1672	4385	11.6 (10.2, 13.0)	22.6 (1.0)
Hispanic	1172	4628	12.3 (10.6, 13.9)	19.7 (1.2)
Other, non-Hispanic	1356	2807	7.4 (6.3, 8.6)	23.6 (1.2)
White, non-Hispanic	16 608	25 941	68.7 (66.7, 70.7)	25.9 (0.3)
Sex				
Female	15 322	24 347	64.5 (62.6, 66.4)	26.0 (0.4)
Male	5486	13 414	35.3 (33.6, 37.4)	22.1 (0.6)
Smoking status				
Current smoker, smokes every day	2520	6266	16.6 (15.1, 18.1)	23.9 (0.8)
Current smoker, smokes some days	969	2367	6.3 (5.3, 7.2)	22.0 (1.0)
Former smoker	7187	10 019	26.5 (25.0, 28.1)	30.3 (0.6)
Lifetime non-smoker	10 132	19 108	50.6 (48.7, 52.5)	22.2 (0.5)
Years since asthma onset				
<1	593	1034	2.7 (2.2, 3.3)	46.5 (1.7)
1–5	2169	4114	10.9 (9.5, 12.3)	42.6 (1.2)

	<u>Survey sample</u>	<u>Weighted population estimate</u>		<u>Age at asthma onset, in years</u>
	No.	No. <sup>a,b</sup>	Percent (95% CI)	Mean (SE)
>5	18 046	32 613	86.4 (84.9, 87.8)	21.7 (0.3)

<sup>a</sup>In thousands.

<sup>b</sup>Due to rounding, the sum of category-specific weighted population estimates may not equal the total weighted population estimate.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

**Table 2**

Characteristics of the study sample and the population estimate, with percentages reporting asthma self-management education.

	Taught what to do during an asthma attack Percent (SE)	Taught to recognize symptoms of an asthma attack Percent (SE)	Taught to use a peak flow meter Percent (SE)	Advised to change aspects of home, school, or work environment Percent (SE)	Given an asthma action plan Percent (SE)	Taken an asthma self-management course Percent (SE)	Number of asthma self-management education components Mean (SE)
Total	76.4 (0.8)	65.6 (0.9)	45.2 (1.0)	39.6 (1.0)	28.7 (0.9)	9.2 (0.6)	2.6 (0.03)
Age at asthma onset, in years							
<1-4	80.3 (2.4)	73.2 (3.1)	53.6 (3.6)	42.2 (3.4)	34.0 (3.5)	15.1 (3.2)	3.0 (0.1)
5-14	78.6 (1.6)	69.1 (1.8)	49.3 (2.0)	41.1 (2.0)	28.4 (1.9)	8.8 (1.0)	2.8 (0.1)
15-24	77.3 (3.0)	66.5 (3.0)	45.2 (2.9)	45.4 (3.0)	27.4 (2.5)	10.0 (1.8)	2.7 (0.1)
25-34	79.2 (1.9)	66.4 (2.4)	43.9 (2.4)	38.2 (2.2)	28.5 (2.0)	7.1 (0.8)	2.6 (0.1)
35-44	75.7 (2.2)	64.3 (2.2)	41.5 (2.0)	41.8 (2.2)	30.7 (1.8)	8.9 (1.0)	2.6 (0.1)
45-54	71.7 (1.8)	59.6 (1.9)	39.1 (1.8)	36.9 (1.8)	27.4 (1.6)	6.0 (0.7)	2.4 (0.1)
55-64	67.3 (1.9)	54.2 (2.1)	37.4 (2.1)	27.2 (2.0)	23.6 (2.0)	8.3 (1.3)	2.2 (0.1)
65-93	56.4 (2.3)	41.0 (2.2)	28.9 (2.1)	16.0 (1.6)	20.2 (1.9)	4.4 (0.8)	1.7 (0.1)
Age at interview, in years							
18-34	77.5 (2.1)	67.7 (2.4)	49.0 (2.5)	38.1 (2.4)	28.2 (2.3)	8.9 (1.8)	2.7 (0.1)
35-44	81.5 (1.9)	71.7 (2.1)	43.9 (2.2)	47.4 (2.3)	29.6 (1.9)	7.9 (1.0)	2.8 (0.1)
45-54	77.0 (1.6)	67.3 (1.7)	46.0 (1.6)	43.5 (1.6)	30.2 (1.5)	10.2 (0.9)	2.7 (0.1)
55-64	75.6 (1.3)	64.1 (1.4)	42.8 (1.4)	41.7 (1.4)	30.6 (1.4)	10.5 (0.8)	2.7 (0.1)
65-99	68.3 (1.1)	54.2 (1.4)	40.8 (1.2)	27.0 (1.1)	24.7 (1.0)	8.5 (0.6)	2.2 (0.04)
Educational attainment							
Less than high school	64.9 (2.8)	56.5 (2.8)	47.1 (2.8)	34.1 (2.8)	26.9 (2.5)	8.7 (1.8)	2.4 (0.1)
Graduated high school	72.5 (2.1)	61.2 (2.3)	44.7 (2.3)	35.3 (2.1)	26.8 (1.9)	8.4 (1.6)	2.5 (0.1)
College 1-3 years or technical school	80.2 (1.2)	68.4 (1.5)	44.1 (1.6)	40.0 (1.6)	30.5 (1.5)	11.1 (1.1)	2.7 (0.1)
College 4 years or more	81.9 (1.1)	71.7 (1.3)	46.2 (1.5)	46.6 (1.5)	29.0 (1.4)	7.6 (0.6)	2.8 (0.04)
Race/ethnicity							
Black, non-Hispanic	78.1 (2.6)	69.2 (2.9)	56.2 (3.3)	36.7 (3.2)	38.9 (3.2)	13.9 (2.4)	2.9 (0.1)
Hispanic	69.9 (3.2)	61.4 (3.7)	42.0 (3.9)	38.6 (3.7)	25.0 (3.6)	12.3 (3.6)	2.5 (0.1)
Other, non-Hispanic	79.3 (3.1)	66.8 (4.2)	44.2 (4.0)	37.8 (3.9)	30.4 (3.8)	10.9 (2.2)	2.7 (0.1)
White, non-Hispanic	76.9 (0.9)	65.6 (1.0)	44.1 (1.0)	40.5 (1.0)	27.4 (0.9)	7.6 (0.4)	2.6 (0.03)

	Taught what to do during an asthma attack Percent (SE)	Taught to recognize symptoms of an asthma attack Percent (SE)	Taught to use a peak flow meter Percent (SE)	Advised to change aspects of home, school, or work environment Percent (SE)	Given an asthma action plan Percent (SE)	Taken an asthma self-management course Percent (SE)	Number of asthma self-management education components Mean (SE)
Sex							
Female	77.1 (1.1)	67.1 (1.1)	48.1 (1.2)	42.7 (1.2)	31.8 (1.1)	10.1 (0.9)	2.8 (0.04)
Male	74.9 (1.4)	63.0 (1.7)	40.1 (1.8)	33.9 (1.6)	23.0 (1.4)	7.5 (0.7)	2.4 (0.1)
Smoking status							
Current smoker, smokes every day	69.5 (2.5)	59.5 (2.5)	41.9 (2.4)	38.8 (2.4)	25.7 (2.1)	7.2 (0.9)	2.4 (0.1)
Current smoker, smokes some days	77.7 (3.0)	74.2 (2.9)	54.5 (3.8)	38.4 (3.7)	25.3 (3.0)	6.7 (1.2)	2.8 (0.1)
Former smoker	73.7 (1.8)	61.8 (1.7)	40.9 (1.6)	37.9 (1.8)	28.0 (1.5)	8.4 (0.7)	2.5 (0.1)
Lifetime non-smoker	79.8 (1.0)	68.6 (1.3)	47.5 (1.4)	40.9 (1.4)	30.4 (1.3)	10.6 (1.1)	2.8 (0.05)
Years since asthma onset							
<1	59.6 (5.1)	45.2 (4.9)	18.8 (3.2)	29.9 (4.5)	18.7 (3.5)	— <sup>a</sup>	1.7 (0.1)
1–5	67.1 (3.8)	55.3 (3.6)	31.2 (2.9)	37.3 (3.8)	22.2 (2.4)	4.8 (1.0)	2.2 (0.1)
>5	78.0 (0.8)	67.6 (1.0)	47.8 (1.0)	40.2 (1.0)	29.8 (1.0)	10.0 (0.7)	2.7 (0.03)

<sup>a</sup> Estimates based on fewer than 50 respondents or for which the relative standard error is greater than 30% are not shown.