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Predictors of Asthma Self-Management Education among Children and Adults—2006–2007 Behavioral Risk Factor Surveillance System Asthma Call-back Survey

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Background. Patient self-management, besides expert care, is necessary to improve health outcomes among persons with asthma. Our objective was to describe the characteristics of persons with asthma likely to receive asthma self-management education. *Methods.* The 2006 and 2007 Behavioral Risk Factor Surveillance System (BRFSS) Child and Adult Asthma Call-back Survey (ACBS) data were analyzed. Binary and multinomial response logistic regression models were used to examine the association between asthma self-management education and explanatory variables. *Results.* Of the 31,278 persons who ever had asthma, 3953 of the children (75.8%) and 19,723 of the adults (72.8%) were classified as having active asthma. For both children and adults, the three most commonly reported asthma education components were being taught how to use an inhaler (78.6% and 89.8%, respectively); being taught what to do during an asthma episode (86.3% and 74.6%); and to recognize early signs or symptoms of an asthma episode (82.0% and 64.4%). Children and adults who reported routine care visits, hospitalization, and asthma episodes in the past 12 months because of asthma were more likely to report several asthma education components and higher asthma education scores. Children aged 12–17 years were more likely to report having instruction in peak flow meter use (1.3; 1.1–1.6) and inhaler use (1.3; 1.2–1.4), whereas older adults (aged 54–64 years or 65+ years), adults who were not high school (HS) graduates, and smokers were less likely to report having asthma management education than the corresponding comparison groups. *Conclusions.* Having a routine care visit, being hospitalized, and having an asthma episode were significantly associated with reporting multiple asthma education components, whereas being an older adult, having less than a HS degree, and being a smoker were associated with reporting fewer asthma education components. Asthma control programs should continue to monitor asthma self-management education and promote asthma education to all persons with asthma, especially for older adults, persons with less education, and smokers.

Keywords active asthma, adults, asthma, asthma education, asthma episodes/attacks, children, self-management

INTRODUCTION

Asthma is a chronic respiratory disease characterized by episodic and reversible airflow obstruction and airway hyperresponsiveness (1). In the United States, 24.4 million adults aged ≥18 years and 9.6 million children aged ≤17 years are affected with asthma during their lifetime (2). Asthma is responsible for an estimated 500,000 hospitalizations, 4000 deaths, and 1.8 million emergency department (ED) visits a year (1). However, most of the adverse health outcomes caused by asthma could be prevented by effective asthma management.

Patient self-management, besides expert care, is necessary to improve asthma signs and symptoms and reduce related morbidity and mortality (3, 4). Asthma self-management education is one of the four key components of asthma control and management. It provides people with asthma and their caregivers with the knowledge and skills to understand the disease and its treatment. It teaches them to take medications appropriately, recognize early signs and symptoms of asthma episodes, seek medical care as appropriate, and identify and avoid environmental asthma allergens and irritants (3). Previous studies assessed the effects of various components of self-management education on asthma-related health outcomes in clinics, EDs, hospitals, pharmacies, doctor's offices, schools, and community settings. These studies showed that asthma self-management education was effective in reducing urgent care visits, hospitalizations, and asthma-related healthcare costs. Education also improved health status, quality of life, and medication adherence for both adults and children (5–10). Despite the extensive research examining the effectiveness of asthma self-management education, a limited number of studies examined which components of asthma education were provided, to whom, and how often.

There is limited research focused on prevalence estimates of the various components of asthma education and the characteristics of persons with asthma who are likely to receive asthma education (11, 12). A 2003 Centers for Disease Control and Prevention (CDC) publication reported population-based prevalence estimates of various components of asthma education by sex, age group, race/ethnicity, and health insurance status (11) and Shah et al. (12) identified the characteristics of healthcare providers and persons with asthma receiving asthma education.

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Additionally, Healthy People 2010 objectives 24–6 and 24–7 include initial and targeted population-based prevalence estimates for some of the asthma education components (13).

Although the characteristics of children and adults with asthma who were more likely to receive various components of asthma education were previously studied (11, 12), the characteristics of those who were more likely to receive multiple components of asthma education have not been examined. It is important to characterize the receipt of multiple components of asthma education among children and adults with asthma because a multifaceted approach is recommended to improve knowledge and self-management skills for effective asthma management and control (3). Therefore, this article examines asthma health outcomes, healthcare access and use, and sociodemographic characteristics of children and adults with active asthma who were likely to receive multiple components of asthma education.

METHODS

Survey Data Description

The Behavioral Risk Factor Surveillance System (BRFSS) survey is a state-based, ongoing, random-digit-dialed telephone survey of civilian, noninstitutionalized adults aged $\geq$18 years residing in the United States. Since 1984, BRFSS has been collecting data on risk behaviors and the use of preventative health practices that affect health status (14). The BRFSS Asthma Call-back Survey (ACBS) is a survey that has been implemented as a follow-up survey to the BRFSS survey since 2005. The BRFSS survey contains a Random Child Selection module and the Child Asthma Prevalence module, which were used in participating states to identify households with a child who had asthma to administer the Child ACBS.

The BRFSS survey respondents (i.e., adults or children) with an affirmative response to the question "Have you {has the child} ever been told by a doctor, nurse, or other health professional that you {the child} had asthma?" were asked to participate in the adult or child ACBS within 2 weeks to provide more information about their or the child's asthma. Only one adult or one child per household could participate in the ACBS, which obtains in-depth information about asthma symptoms and episodes/attacks, self-management education, healthcare utilization and access, medication use, comorbidities, and environmental allergens and irritants (15). An adult family member served as a proxy respondent for children. A sampling weight was assigned to each survey respondent in the ACBS sample to adjust for selection probabilities and estimates of the age–sex–race distribution of adults and children in the participating state each year. More information on weight calculation can be found in the 2006–2008 ACBS Summary Data Quality Report at http://www.cdc.gov/brfss/acbs/2007/2007.htm. The median ACBS response rates for adults were 50.6% in 2006 and 54.3% in 2007; the median response rates for children (via adult proxies) were 49.1% in 2006 and 51.5% in 2007.

Respondents were considered to have "active asthma" if they reported, during the previous 12 months, any of the following: having talked to a doctor or other health professionals about asthma, taken any asthma medications, or experienced asthma symptoms (16, 17).

A total of 31,278 persons (26,047 adults and 5231 children) were in the combined 2006 and 2007 BRFSS ACBS from the District of Columbia and 34 states (Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, Utah, Vermont, Washington, Wisconsin, West Virginia) (15). Of the 31,278 persons who ever had asthma, 3953 (75.8%) children and 19,723 (72.8%) adults were classified as having active asthma and were included in this analysis.

Statistical Analysis

Demographic characteristics (e.g., age, sex, race/ethnicity, and education) of survey respondents who met the definition of active asthma were defined as shown in Table 1. Asthma health outcome measures (e.g., "asthma episode" [one or more asthma episodes in the past 12 months] and asthma control status) and healthcare access and use were assessed for both adult and child populations with active asthma. For adults, health risk factors such as obesity, smoking status, and comorbid conditions (e.g., physician-diagnosed chronic obstructive pulmonary disease [COPD], emphysema, chronic bronchitis, and depression) were included in the analysis. Following the guidelines in the National Asthma Education and Prevention Program (NAEPP) Expert Panel Report 3, we classified asthma control as well controlled, not well controlled, and very poorly controlled by using three parameters: daytime symptoms, nighttime symptoms, and use of short-acting β_2-agonists (3, 16).

For adults, body mass index (BMI) was categorized as obese (30.0 kg/m^2 and above) and not obese (less than 30.0 kg/m^2), and smoking status was classified as current smoker (adults who smoked at least 100 cigarettes in their lifetime and currently smoke, either once in a while or everyday) and nonsmoker (persons who do not currently smoke). For children, data for smoking status and comorbid conditions were not collected and the BMI was not calculated. The use of BMI to screen for overweight and obesity in children aged 0–2 years is not recommended and for children aged 2–19 years, the interpretation of BMI varies by age and sex (18).

Healthcare access and use was determined by the following measures: health insurance (had any type of health insurance), routine care visit (saw a doctor for a routine asthma care), urgent care visit (had urgent care visit in the past 12 months because of an asthma episode/attack), ED visit (visited an ED in the past 12 months because of their asthma), hospitalization (stayed overnight in a hospital

because of their asthma during the past 12 months), and cost as a barrier (being unable to see a primary care physician or specialist for asthma care or unable to buy medication for asthma in the past 12 months).

Responses to seven questions were used to assess respondents' asthma education status: taught episode signs (Has a doctor or other health professional ever taught you how to recognize early signs or symptoms of an asthma episode?), taught episode response (Has a doctor or other health professional ever taught you how to respond to episodes of asthma?), taught peak flow meter (PFM) use (Has a doctor or other health professional ever taught you how to use a PFM to adjust your daily medications?), given an action plan (Has a doctor or other health professional ever given you an asthma management plan?), asthma management course (Have you ever taken a course or class on how to manage asthma yourself?), taught inhaler use (Did a doctor or other health professional show you how to use the inhaler?), and environment control advice (Has a doctor or other health professional ever advised you to change things in your home, school, or work to improve your asthma?). An asthma self-management education score with eight levels was created by counting the number of "yes" responses to the seven asthma education questions (from "yes" to all seven to "no" to all seven).

All analyses were conducted using SAS callable SUDAAN (v. 10.0) (v. 9.2, SAS Institute Inc., Cary, NC, USA.) to account for the complex survey design. Data from the states that participated in both years were reweighted to account for the differences in sample size in each year. Statistical significance was determined as $p < .05$ by a nondirectional z-test. Relative standard error (RSE = standard error/prevalence estimate) was used as a measure of an estimate's reliability (RSE of <0.30 indicates a "reliable" estimate) (19).

A multivariate (binary response) logistic regression model was used to determine the association between each component of asthma education and the explanatory factors. A multivariate (multinomial response) logistic regression model (proportional odds model) was used to assess the association between the asthma education score and the explanatory factors. The explanatory factors for all regression models were sociodemographic factors (e.g., age, sex, race/ethnicity for both children and adults, and education for adults only), asthma health outcomes (e.g., asthma episode and asthma control level), healthcare access and use (e.g., health insurance, cost as a barrier, routine care visit, ED visit, and hospitalization in the past 12 months), and health risk factors for adults only (e.g., obesity, smoking, COPD, and depression). The explanatory variables for the models shown in Tables 3 and 4 were selected using a backward selection process. All variables were included in the initial models. The least significant variable was removed and the model was refit until the resulting regression coefficients for all remaining explanatory variables were significant (p-values less than .05). The nonmodifiable variables (age, sex, and race) were kept in the models regardless of statistical significance status because of their importance in considering asthma self-management education (20, 21). As seen in Table 5, all explanatory variables were included in the proportional odds model to estimate the cumulative odds of asthma scores (sum of reported asthma education components).

Results

Children

Among the 3953 children with active asthma, 58.8% were boys, 51.2% were aged 0–4 years, and 59.6% were non-Hispanic White. About half (53.7%) reported an asthma episode in the past 12 months, 20.5% had not-well-controlled asthma, and 13.8% had very poorly controlled asthma. Almost all children had health insurance (96.8%), 73.8% reported a routine care visit, 35.1% an urgent care visit, 17.6% an ED visit, and 3.3% a hospitalization. Reporting cost as a barrier for care among children was lower (8.3%) than adults (17.0%). Reporting cost as a barrier was 3.5% for a primary care physician visit, 1.8% for a specialist visit, and 6.0% for buying medicine for their asthma during the past year (Table 1).

A majority of children with active asthma had at least one (98.0%) and approximately 80% had three or more of the seven asthma education components. The three most commonly reported asthma education components were being taught inhaler use (78.6%); being taught episode response (86.3%); and being taught episode signs and symptoms (82.0%). More than one-third of children were given an action plan (42.6%) and being taught PFM use (42.6%) (Table 2).

The results from the multivariate logistic regression analyses for children are presented in Tables 3 and 5. Sex, race and ethnicity, and health insurance status of children were not associated with any of the education components. Episode signs and symptoms instruction was associated with a routine care visit (adjusted risk ratio (ARR) = 1.2; 95% confidence interval (CI) = 1.1–1.3) and episode response instruction was associated with being hospitalized (1.1; 1.1–1.2). Children aged 12–17 years were 1.3 times (1.1–1.6) and children who reported a routine care visit were 1.3 times (1.1–1.5) more likely to report having PFM instruction than children aged 0–4 years or those who did not have a routine care visit, respectively. Having an action plan was associated with a routine care visit (1.4; 1.2–1.7) and an ED visit (1.3; 1.1–1.6). Having taken an asthma management course was associated with being hospitalized (2.4; 1.4–4.3). Instruction in inhaler use was associated with being aged 12–17 years (1.3; 1.2–1.4) and with having cost as a barrier for care (i.e., being unable to see a primary care physician or specialist for asthma care or unable to buy medication for asthma in the past 12 months) (1.2; 1.1–1.2). Children with not-well-controlled asthma were 1.4 times (1.2–1.6) more likely to report being given advice on environment control than children with well-controlled asthma (Table 3). Children who reported

TABLE 1.—Characteristics of Asthma Call-back Survey (ACBS) respondents with active asthma in participating states—2006–2007 ACBS data for children and adults.

Characteristics	Children (≤17 years) (n = 3953)		Adults (≥18 years) (n = 19,723)	
	Sample size[a]	Weighted % (95% CI)	Sample size[a]	Weighted % (95% CI)
Sex				
Male	2303	58.8 (55.7–61.8)	5174	37.8 (35.9–39.8)
Female	1630	41.2 (38.2–44.3)	14,549	62.2 (60.2–64.1)
Age group (years)				
0–4	1921	51.2 (48.6–53.8)	NA	NA
5–11	881	25.1 (22.7–27.7)	NA	NA
12–17	1018	23.7 (21.2–26.4)	NA	NA
18–34	NA	NA	2481	32.3 (30.3–34.4)
35–44	NA	NA	2895	18.5 (17.2–19.9)
45–54	NA	NA	4472	19.0 (17.8–20.2)
55–64	NA	NA	4808	15.2 (14.3–16.2)
65+	NA	NA	4995	15.0 (14.1–15.9)
Race and ethnicity				
White, non-Hispanic	2677	59.6 (56.2–62.9)	16,301	75.3 (73.5–77.1)
Black, non-Hispanic	360	12.6 (10.4–15.3)	948	6.7 (5.9–7.6)
Hispanic	411	17.3 (14.8–20.2)	862	10.6 (9.1–12.4)
Other	406	10.5 (8.4–13.1)	1424	7.3 (6.4–8.4)
Education	NA	NA		
Not high school (HS) graduate	NA	NA	1841	9.9 (8.9–11.0)
HS graduate or attended college or technical school	NA	NA	11,195	55.3 (53.5–57.1)
College graduate or more	NA	NA	6626	34.8 (33.1–36.5)
Health risk factors				
Obesity	NA	NA	7502	36.8 (35.0–38.6)
Current smoker	NA	NA	3803	20.3 (18.9–21.8)
COPD[b]	NA	NA	7817	33.7 (32.0–35.4)
Depression	NA	NA	7545	35.3 (33.6–37.1)
Asthma control levels				
Well controlled	2695	65.7 (62.5–68.8)	9289	50.7 (48.8–52.5)
Not well controlled	767	20.5 (18.0–23.2)	5037	26.4 (24.8–28.0)
Very poorly controlled	491	13.8 (11.6–16.4)	5397	22.9 (21.6–24.4)
Asthma episodes in past year	2031	53.7 (50.4–56.9)	9902	50.9 (49.1–52.8)
Healthcare access and use				
Health insurance	3784	96.8 (95.8–97.6)	17,883	86.7 (85.1–88.1)
Routine care visits	2720	73.8 (71.0–76.4)	10,898	52.5 (50.6–54.3)
ED visits	585	17.6 (15.3–20.2)	2208	11.2 (10.2–12.3)
Urgent care visits	1172	35.1 (31.9–38.5)	4661	23.0 (21.7–24.4)
Hospitalization	116	3.3 (2.3–4.8)	743	3.0 (2.6–3.5)
Cost as a barrier	332	8.3 (6.9–10.1)	3075	17.0 (15.7–18.4)
Medication cost	240	6.0 (4.7–7.5)	2525	14.2 (12.9–15.5)
Primary care physician visit cost	146	3.5 (2.7–4.6)	1617	9.6 (8.6–10.7)
Specialist visit cost	88	1.8 (1.2–2.7)	838	5.3 (4.5–6.2)

Notes: Denominator of the estimates represents those who were classified as having active asthma. NA, not applicable; ED, emergency department; COPD, chronic obstructive pulmonary disease.
[a]Unweighted numerator count.
[b]Reported having COPD, emphysema, or chronic bronchitis.

having multiple education components were associated with an asthma episode (Adjusted odds ratio (AOR) = 1.5; 95% CI = 1.1–2.0) and a routine care visit (1.7; 1.3–2.3) (Table 5).

Adults

Among the 19,723 adults with active asthma, 62.2% were female, 32.3% were aged 18–34 years, 75.3% were non-Hispanic White, and approximately 10% were not high school (HS) graduates. About one-fifth were current smokers (20.3%), 36.8% were obese, 33.7% were with COPD (reported having physician-diagnosed emphysema, chronic bronchitis, or COPD), while 35.3% reported having physician-diagnosed depression (Table 1).

About half (50.9%) reported an asthma episode in the past 12 months, 26.4% had not-well-controlled asthma, and 22.9% had very poorly controlled asthma. A majority (86.7%) of adults reported having health insurance, 52.5% reported a routine care visit, 23.0% an urgent care visit, 11.2% an ED visit, and 3.0% a hospitalization. Among adults overall 17.0% reported cost as a barrier for care. Reporting cost as a barrier was 5.3% for a specialist visit, 9.6% for a primary care physician visit, and 14.2% for buying asthma medicine during the past year (Table 1).

The majority (95.2%) of adults with active asthma had at least one of the seven asthma education components and approximately 71% of adults had three or more. The three most commonly reported asthma education components

TABLE 2.—Asthma self-management education among Asthma Call-back Survey (ACBS) respondents with active asthma in participating states—2006–2007 ACBS data for children and adults.

Components of asthma self-management education	Children (≤17 years) (n = 3953)		Adults (≥18 years) (n = 19,723)	
	Sample size[a]	Weighted % (95% CI)	Sample size[a]	Weighted % (95% CI)
Taught to recognize early signs and symptoms of an asthma episode	3171	82.0 (79.4–84.5)	12,052	64.4 (62.6–66.2)
Taught to respond to an asthma episode appropriately	3330	86.3 (83.9–88.4)	14,300	74.6 (73.0–76.3)
Taught how to use a peak flow meter (PFM)	1734	42.6 (39.4–45.8)	8274	43.5 (41.6–45.3)
Given an action plan	1615	42.6 (39.4–45.9)	4937	26.8 (25.3–28.5)
Taken a course on how to manage asthma	516	13.6 (11.5–16.0)	1787	9.2 (8.3–10.2)
Taught how to use an inhaler	3253	78.6 (75.6–81.3)	17,817	89.8 (88.5–90.9)
Given advice on environment control	1700	44.7 (41.6–47.9)	7823	43.2 (41.4–45.1)
Asthma education score				
Seven	175	3.9 (3.0–5.0)	531	3.2 (2.6–3.9)
Six	561	15.3 (13.1–17.8)	1997	10.1 (9.1–11.3)
Five	795	19.3 (16.9–21.8)	3171	18.0 (16.5–19.5)
Four	799	18.1 (15.9–20.6)	3836	20.1 (18.6–21.6)
Three	780	23.2 (20.4–26.3)	3912	19.2 (17.8–20.6)
Two	472	10.6 (9.0–12.5)	2884	12.6 (11.6–13.8)
One	273	7.6 (5.8–9.9)	2588	12.1 (10.9–13.3)
None	98	2.0 (1.4–2.9)	804	4.8 (3.9–5.8)

Notes: Denominator of the estimates represents those who were classified as having active asthma.
[a]Unweighted numerator count.

TABLE 3.—The association between components of asthma self-management education and the characteristics of children (aged ≤17 years) with active asthma in participating states—2006–2007 Child Asthma Call-back Survey (ACBS).

	Components of asthma self-management education as dependent variables						
	Taught to recognize signs of an episode	Taught to respond to an asthma episode	Taught how to use a peak flow meter (PFM)	Given an action plan	Taken asthma management course	Taught how to use an inhaler	Given advice on environment control
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Characteristics	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)
Sex							
Boys	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Girls	1.0 (1.0–1.1)	1.0 (0.9–1.1)	0.9 (0.8–1.1)	1.0 (0.9–1.2)	1.0 (0.7–1.5)	1.1 (1.0–1.2)	1.0 (0.8–1.1)
Age group (years)							
0–4	Referent	Referent	Referent	Referent	Referent	Referent	Referent
5–11	1.0 (0.9–1.1)	1.1 (1.0–1.1)	1.0 (0.9–1.2)	1.0 (0.9–1.2)	1.0 (0.7–1.6)	1.1 (1.0–1.2)	1.0 (0.9–1.2)
12–17	1.0 (0.9–1.1)	1.0 (1.0–1.1)	1.3 (1.1–1.6)	1.0 (0.8–1.2)	1.1 (0.8–1.7)	1.3 (1.2–1.4)	0.9 (0.8–1.1)
Race/ethnicity							
White, non-Hispanic	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Black, non-Hispanic	1.0 (0.9–1.1)	1.0 (0.9–1.1)	1.3 (1.0–1.6)	1.0 (0.8–1.3)	1.3 (0.8–2.2)	0.8 (0.7–1.0)	0.9 (0.7–1.1)
Hispanic	1.0 (0.9–1.0)	0.9 (0.9–1.0)	1.1 (0.9–1.4)	0.9 (0.7–1.2)	1.2 (0.7–2.0)	1.0 (0.9–1.1)	0.9 (0.8–1.2)
Other	0.9 (0.8–1.1)	1.0 (0.9–1.1)	1.2 (0.9–1.6)	1.2 (0.9–1.6)	1.6 (0.9–2.7)	1.0 (0.9–1.1)	1.0 (0.8–1.3)
Asthma control levels	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]
Well controlled							Referent
Not well controlled							1.4 (1.2–1.6)
Very poorly controlled							1.1 (0.9–1.4)
Asthma episode in the past 12 months (Y/N)	—[b]	1.1 (1.0–1.2)	1.2 (1.0–1.4)	—[b]	—[b]	1.1 (1.0–1.2)	—[b]
Routine care visit (Y/N)	1.2 (1.1–1.3)	1.1 (1.0–1.2)	1.3 (1.1–1.5)	1.4 (1.2–1.7)	1.6 (1.0–2.4)	—[b]	—[b]
Emergency department (ED) visit (Y/N)	—[b]	—[b]	—[b]	1.3 (1.1–1.6)	—[b]	—[b]	—[b]
Hospitalization (Y/N)	—[b]	1.1 (1.1–1.2)	—[b]	—[b]	2.4 (1.4–4.3)	—[b]	—[b]
Cost as a barrier (Y/N)	—[b]	—[b]	—[b]	—[b]	—[b]	1.2 (1.1–1.2)	—[b]

Notes: "No" category is the reference group for all "Y/N" variables.
[a]Adjusted risk ratio (ARR) in a logistic regression model with a binary (0/1) dependent variable.
[b]Not included in models because of nonsignificant association with the dependent variable.

included being taught inhaler use (89.8%); being taught episode response (74.6%); and being taught episode signs and symptoms (64.4%). About one-fourth (26.8%) of adults with active asthma reported being given an action plan, 43.5% reported being taught PFM use, and 43.2% reported being given advice on environment control (Table 2).

The results from the multivariate logistic regression analyses for adults are presented in Tables 4 and 5. Each explanatory factor was associated with one or more of the education components except for obesity and cost as a barrier for care, which were not a predictor for any education component.

For instruction in asthma episode signs and symptoms, the prevalence rate ratios were lower for adults aged 65+ years (0.8; 0.7–0.9) than for adults aged 18–34 years and for adults with less formal education (not a HS graduate) (0.8; 0.7–0.9) than for those with a college degree or more. However, for instruction in asthma episode signs and symptoms, the ratios were higher (1.2; 1.1–1.3) for other-race adults than whites and higher (1.4; 1.3–1.5) for those who reported a routine care visit than for those who did not (Table 4).

For instruction in episode response, the prevalence rate ratios were lower for adults aged 65+ years (0.8; 0.8–0.9) than for adults aged 18–34 years and for adults who were not HS graduates (0.8; 0.7–0.9) than for those with a college degree or more. Adults who reported having an asthma episode (1.2; 1.1–1.2), those with health insurance (1.1; 1.1–1.3), and those who reported a routine care visit

TABLE 4.—The association between components of asthma self-management education and the characteristics of adults (aged ≥18 years) with active asthma in participating states—2006–2007 Adult Asthma Call-back Survey (ACBS).

	Components of asthma self-management education as dependent variables						
	Taught to recognize signs of an episode	Taught to respond to an asthma episode	Taught how to use a peak flow meter (PFM)	Given an action plan	Taken asthma management course	Taught how to use an inhaler	Given advice on environment control
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Characteristics	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)	ARR[a] (95% CIs)
Sex							
Male	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Female	1.1 (1.0–1.1)	1.0 (1.0–1.1)	1.0 (1.0–1.1)	1.2 (1.0–1.4)	1.2 (0.9–1.5)	1.0 (1.0–1.1)	1.1 (1.0–1.2)
Age group (years)							
18–34	Referent	Referent	Referent	Referent	Referent	Referent	Referent
35–44	1.0 (1.0–1.1)	1.0 (1.0–1.1)	0.9 (0.8–1.0)	1.1 (0.9–1.3)	1.1 (0.8–1.6)	1.0 (0.9–1.0)	0.9 (0.8–1.0)
45–54	1.0 (1.0–1.1)	1.0 (0.9–1.0)	1.0 (0.9–1.1)	1.1 (0.9–1.3)	1.6 (1.1–2.2)	1.0 (1.0–1.0)	0.9 (0.8–1.0)
55–64	0.9 (0.9–1.0)	0.9 (0.9–1.0)	0.9 (0.8–1.0)	1.0 (0.8–1.2)	1.5 (1.1–2.1)	1.0 (0.9–1.0)	0.8 (0.7–0.9)
65+	0.8 (0.7–0.9)	0.8 (0.8–0.9)	0.9 (0.8–1.0)	0.8 (0.7–1.0)	1.5 (1.0–2.0)	1.0 (0.9–1.0)	0.5 (0.5–0.6)
Race/ethnicity							
White, non-Hispanic	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Black, non-Hispanic	1.1 (1.0–1.2)	1.0 (0.9–1.1)	1.3 (1.1–1.4)	1.2 (1.0–1.4)	1.2 (0.9–1.7)	1.0 (0.9–1.0)	0.9 (0.7–1.0)
Hispanic	1.1 (0.9–1.2)	1.0 (0.9–1.1)	1.1 (0.9–1.4)	1.2 (0.9–1.5)	1.3 (0.9–1.9)	1.0 (1.0–1.1)	0.9 (0.8–1.2)
Other	1.2 (1.1–1.3)	1.1 (1.0–1.1)	1.0 (0.8–1.2)	1.3 (1.0–1.6)	1.6 (1.1–2.4)	1.0 (1.0–1.1)	1.1 (0.9–1.3)
Education			—[b]	—[b]	—[b]		
Not high school (HS) graduate	0.8 (0.7–0.9)	0.8 (0.7–0.9)				0.9 (0.8–1.0)	0.7 (0.5–0.8)
HS graduate/attended college/technical school	0.9 (0.9–1.0)	0.9 (0.9–1.0)				1.0 (1.0–1.0)	0.9 (0.8–1.0)
College graduate or more	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Asthma control levels	—[b]	—[b]	—[b]	—[b]		—[b]	—[b]
Well controlled					Referent		
Not well controlled					1.1 (0.9–1.5)		
Very poorly controlled					1.5 (1.2–1.9)		
Asthma episode in the past 12 months (Y/N)	—[b]	1.2 (1.1–1.2)	1.1 (1.1–1.3)	1.3 (1.2–1.5)	1.4 (1.1–1.7)	1.1 (1.0–1.1)	1.1 (1.0–1.3)
Current smoker (Y/N)	0.9 (0.9–1.0)	0.9 (0.9–1.0)	0.8 (0.7–0.9)	—[b]	—[b]	1.0 (0.9–1.0)	—[b]
COPD[c] (Y/N)	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]	1.2 (1.1–1.3)
Depression (Y/N)	—[b]	—[b]	—[b]	—[b]	—[b]	1.0 (1.0–1.1)	1.1 (1.0–1.2)
Healthcare access and use							
Health insurance (Y/N)	—[b]	1.1 (1.1–1.3)	—[b]	—[b]	—[b]	—[b]	—[b]
Routine care visit (Y/N)	1.4 (1.3–1.5)	1.2 (1.2–1.3)	1.5 (1.4–1.7)	1.8 (1.6–2.0)	1.4 (1.1–1.8)	1.1 (1.1–1.1)	1.3 (1.2–1.4)
ED visit (Y/N)	—[b]	—[b]	—[b]	—[b]	1.5 (1.1–1.9)	—[b]	—[b]
Hospitalization (Y/N)	—[b]	—[b]	1.4 (1.2–1.6)	1.4 (1.2–1.7)	—[b]	—[b]	—[b]

Notes: "No" category is the reference group for all "Y/N" variables. ED, emergency department; COPD, chronic obstructive pulmonary disease.
[a]Adjusted risk ratio (ARR) in a logistic regression model with a binary (0/1) dependent variable.
[b]Not included in models because of nonsignificant association with the dependent variable.
[c]Reported having COPD (emphysema or chronic bronchitis).

TABLE 5.—The association between asthma self-management education score and the characteristics of children and adults with active asthma in participating states—2006–2007 Asthma Call-back Survey (ACBS).

Characteristics	Asthma self-management education score as dependent variable	
	Children (≤17 years) AOR[a] (95% CIs)	Adults (≥18 years AOR[a] (95% CIs)
Sex		
Male	Referent	Referent
Female	1.0 (0.8–1.3)	1.2 (1.1–1.5)
Age group (years)		
0–4	Referent	NA
5–11	1.2 (0.9–1.6)	NA
12–17	1.4 (1.0–1.9)	NA
18–34	NA	Referent
35–44	NA	0.9 (0.7–1.1)
45–54	NA	1.0 (0.8–1.3)
55–64	NA	0.7 (0.6–0.9)
65+	NA	0.4 (0.4–0.6)
Race/ethnicity		
White, non-Hispanic	Referent	Referent
Black, non-Hispanic	0.9 (0.6–1.3)	1.2 (1.0–1.5)
Hispanic	0.9 (0.7–1.3)	1.2 (0.8–1.8)
Other	1.2 (0.7–2.0)	1.5 (1.1–2.0)
Education	NA	
Not high school (HS) graduate	NA	0.5 (0.4–0.7)
HS graduate/attended college/technical school	NA	0.9 (0.8–1.0)
College graduate or more	NA	Referent
Asthma control levels		
Well controlled	Referent	Referent
Not well controlled	1.3 (0.9–1.7)	1.0 (0.8–1.1)
Very poorly controlled	0.9 (0.6–1.3)	1.0 (0.8–1.3)
Asthma episode in the past 12 months (Y/N)	1.5 (1.1–2.0)	1.5 (1.3–1.8)
Current smoker (Y/N)	NA	0.7 (0.6–0.8)
COPD[c] (Y/N)	NA	1.3 (1.0–1.5)
Depression (Y/N)	NA	1.0 (0.8–1.1)
Healthcare access and use		
Health insurance (Y/N)	1.3 (0.7–2.6)	1.6 (1.2–2.0)
Routine care visit (Y/N)	1.7 (1.3–2.3)	2.5 (2.2–2.9)
ED visit (Y/N)	1.2 (0.9–1.6)	1.0 (0.8–1.2)
Hospitalization (Y/N)	1.3 (0.6–2.8)	1.7 (1.2–2.5)
Cost as a barrier (Y/N)	1.4 (1.0–2.2)	1.3 (1.0–1.6)

Notes: "No" category is the reference group for all "Y/N" variables. ED, emergency department; COPD, chronic obstructive pulmonary disease; NA, not applicable.
[a]Adjusted odds ratio (AOR) in a logistic regression model with a multinomial dependent variable (proportional odds model), which indicates "odds" of reporting multiple education components.
[b]Not included in models because of nonsignificant association with the dependent variable.
[c]Reported having COPD (emphysema or chronic bronchitis).

(1.2; 1.2–1.3) were more likely to report having instruction in episode response than the corresponding reference groups (Table 4).

PFM instruction was less likely for smokers (0.8; 0.7–0.9) and more likely for Blacks (1.3; 1.1–1.4), adults who reported having asthma episodes (1.1; 1.1–1.3), a routine care visit (1.5; 1.4–1.7), or being hospitalized (1.4; 1.2–1.6) (Table 4).

Adults who reported an asthma episode (1.3; 1.2–1.5), a routine care visit (1.8; 1.6–2.0), or being hospitalized (1.4; 1.2–1.7) were more likely to be given an action plan compared with those who did not (Table 4).

Having taken an asthma management course was associated with several characteristics of survey respondents, whereas instruction in inhaler use was associated only with having a routine care visit (1.1; 1.1–1.1). Being older (aged 45–54 years: 1.6; 1.1–2.2 and aged 55–64 years: 1.5; 1.1–2.1) and being a member of other race (1.6; 1.1–2.4); having very poorly controlled asthma (1.5; 1.2–1.9); an asthma episode (1.4; 1.1–1.7); a routine care visit (1.4; 1.1–1.8); or ED visits (1.5; 1.1–1.9) were associated with taking an asthma management course (Table 4).

The prevalence rate ratios for advice on environment control were lower for older adults aged 55–64 years and 65+ years than for adults aged 18–34 years (0.8; 0.7–0.9 and 0.5; 0.5–0.6, respectively) and lower for adults who were not HS graduates (0.7; 0.5–0.8) than for those with college degrees or more, whereas the odds were higher for adults having COPD (1.2; 1.1–1.3) and reporting a routine care visit (1.3; 1.2–1.4) than corresponding rate ratios for adults who did not (Table 4).

Several personal characteristics of adults were associated with the asthma education score (number of reported asthma education components). Older adults (aged 55–64 years: AOR = 0.7; 95% CI = 0.6–0.9 and aged 65+ years: 0.4; 0.4–0.6), adults who did not graduate from HS (0.5; 0.4–0.7), and those who were smokers (0.7; 0.6–0.8) were less likely to report multiple asthma education components compared with those who did not have each characteristic. Adults who were female (1.2; 1.1–1.5), those reporting an asthma episode (1.5; 1.3–1.8), having health insurance (1.6; 1.2–2.0), reporting a routine visit (2.5; 2.2–2.9), and those who were hospitalized (1.7; 1.2–2.5) in past year were more likely to report multiple asthma education components compared with those who did not have those characteristics (Table 5).

Discussion

The majority of children and adults with active asthma had at least one asthma education component. For both children and adults, the most commonly reported asthma education components were being taught how to use an inhaler, taught to respond to an asthma episode, and taught to recognize early signs and symptoms of an asthma episode. The most comprehensive but least commonly reported education event was having taken a formal asthma management course. Demographic characteristics and healthcare access and use were associated with asthma education status for both children and adults with active asthma. These findings were comparable with the findings from a recent CDC report (11).

Our findings indicate that more children (97%) and adults (87%) with active asthma had health insurance compared with the general US population (89.0% and 80.4%, respectively) (22). Healthcare access and use was higher and cost was less of a barrier for medical care for children than for adults with active asthma. Children are primarily covered under their parent's health insurance or the State Children's Health Insurance Program that provides healthcare coverage to low-income children, which could explain why cost was not as much of a barrier for medical care for children as it was for adults.

Similar to the previous CDC report (11) findings, a majority of children with active asthma or their caregivers received multiple asthma education components. As anticipated, older children were taught skills to take asthma medicines correctly (e.g., how to use an inhaler) and to monitor their symptoms (e.g., taught how to use a PFM), which would result in improving self-management of their asthma. Children and adults who had at least one asthma episode in the past 12 months also received education on asthma management. Although the temporal sequence of events was not known because of the cross-sectional nature of data, we can speculate that persons who have had asthma episodes may have sought medical care and were provided asthma management education. There is a rich body of research in asthma self-management education and its effectiveness. The most recent evidence-based guidelines on asthma self-management education and its effectiveness come from "The Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma." The Expert Panel Report 3 was developed by the NAEPP expert panel and the National Heart, Lung, and Blood Institute of the National Institutes of Health. The report provides up-to-date information on four essential components of asthma care, including assessment and monitoring, patient education, pharmacologic treatment, and control of environmental factors and comorbid conditions that can affect asthma (3). Consistent with the NAEPP expert panel recommendations, hospitalization and especially routine care visits for asthma were associated with receiving several asthma education components and with a higher asthma education score for both children and adults. NAEPP recommends that key asthma education messages need to be taught and reinforced at every opportunity during clinic visits, ED visits, pharmacy visits, and in community centers and schools (3).

Nearly half of adults' asthma was poorly controlled. Aging-associated decline in lung functions and coexisting respiratory conditions such as COPD (i.e., chronic bronchitis or emphysema) could explain these findings (23, 24). In addition, smoking and having less formal education were associated with poor health outcome among adults with asthma (25, 26). Despite poor health outcomes, some adults with active asthma reported receiving fewer asthma education components, especially older adults (aged 55–64 years and 65+ years), adults with less formal education, and smokers. Asthma education is an important part of asthma control and management and although it can improve quality of life among all persons with asthma, the persons who need it most (due to other health issues) are receiving it the least (3, 4). Improving asthma management through additional patient and provider training should result in better asthma-related health outcomes for persons in those groups.

The findings in this article are subject to at least three limitations. First, as a cross-sectional study, the observed associations do not imply causality and the temporal sequence of events was not known. Second, the findings cannot be generalized to populations in states that did not participate in the ACBS. Finally, because an adult family member served as a proxy respondent for children, responses may have been affected by inaccurate recall due to the proxy adult respondent's relationship to the child such as lack of knowledge about the child's health outcomes and child's asthma education status and the proxy respondent's social desirability to be a good provider.

Conclusion

This study provides the prevalence of asthma self-management education among children and adults with active asthma in ACBS participating states and identifies the characteristics of those likely to receive asthma self-management education. Being a female or a member of "other" race and having one or more asthma episodes in

the past 12 months, healthcare access and use, especially having routine care visits in the past 12 months, were significantly associated with the receipt of multiple components of asthma education among children and adults with active asthma. Alternatively, being an older adult, having less formal education, and smoking were associated with reporting fewer components of asthma education. The observed associations were based on asthma education that was "ever been taught or given." The current survey does not have information on quality, duration, or mode of asthma education and how well these instructions were followed. Therefore, further studies might be beneficial to assess asthma education modes that are most effective in asthma management and control. All persons with asthma could benefit from asthma self-management education that provides persons with the skills necessary to control asthma and improve health outcomes. Asthma control programs should continue to monitor asthma self-management education and assist healthcare providers in their efforts to provide asthma self-management education according to NAEPP guidelines to all persons with asthma, especially older adults, those with less education, and smokers. In addition, they should promote support services that take into account population-specific characteristics (e.g., clinical preventive services, culturally tailored asthma education, programs to improve the literacy, and smoking sensation programs).

Declaration of Interest

The authors declare no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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