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Documentation of asthma control and severity in pediatrics: analysis of national office-based visits

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ABSTRACT

Objective: To evaluate the extent of documentation of asthma control and severity and associated characteristics among pediatric asthma patients in office-based settings. **Methods:** This cross-sectional study utilized data from the 2012–2015 National Ambulatory Medical Care Survey (NAMCS). Patients aged 6–17 years with a diagnosis of asthma were included. Weighted descriptive analysis examined the extent of documentation and uncontrolled asthma; while logistic regression evaluated associated characteristics. **Results:** Overall, there were 2.47 million (95% confidence interval, 95% CI: 2.04–2.90) average annual visits with asthma as a primary diagnosis. Asthma control and severity was documented in only 36.1% and 33.8% of the visits, respectively. An established patient (odds ratio, OR = 3.81), Hispanic ethnicity (OR = 2.10), chronic sinusitis (OR = 5.59), and visits in the Northeast (OR = 2.12) and Midwest (OR = 2.25) regions had higher odds of documented asthma control status, whereas undocumented asthma severity (OR = 0.02), and visits in spring (OR = 0.34), had lower odds. Osteopathic doctors (OR = 0.18), visits in the Northeast region (OR = 0.23), chronic sinusitis (OR = 0.08), and undocumented asthma control status (OR = 0.03) had lower odds of documented asthma severity, whereas visits in spring (OR = 3.88) and autumn (OR = 3.32) had higher odds. Moderate/severe persistent asthma (OR = 15.35) had higher odds of uncontrolled asthma (as compared to intermittent asthma), while visits in the summer (OR = 0.14) had lower odds. **Conclusion:** The findings of this study suggest a critical need to increase the documentation of asthma severity and control to improve quality of asthma care in children.

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Introduction

Asthma is a prevalent, chronic disease affecting over 6.3 million (8.6%) children and adolescents in the United States [1]. About 60% of the children with asthma have persistent asthma and the remaining 40% have intermittent asthma. According to recent national estimates, 38.4% of asthmatic children have uncontrolled asthma, which contributes significantly to decreased quality of life and increased healthcare resource use. Poor asthma control results in oral steroid use, emergency department visits, and hospitalizations [2]. Poor asthma control in children also contributes significantly to the economic burden of asthma [3]. In 2013, the total cost of asthma was \$81.9

billion, which included costs incurred due to morbidity and absenteeism. During 2008–2013, asthma accounted for \$3 billion in losses due to missed school and work days, and \$50.3 billion in medical costs [4].

The National Heart, Lung, and Blood Institute (NHLBI) National Asthma Education and Prevention Program (NAEPP) Expert Panel Report focuses on asthma severity and control for disease management [5]. Asthma severity describes the underlying disease state, while asthma control is the patient's response to his or her current asthma management [6]. Asthma severity and control are distinct terms and it is important to note that patients with severe asthma can have good control, while patients with mild

asthma can have poor control. The goal of disease management is to achieve asthma control while minimizing medication side effects. The level of asthma control is particularly important to patients as it directly impacts patient's quality of life and related outcomes, while helping physicians in determining the needed treatment adjustments [7]. Therefore, regular follow-up and evaluation of asthma control is important in determining the efficacy of current treatment in reducing the frequency and intensity of symptoms and functional limitations [8,9]. Although clinical research and international guidelines provide clear recommendations on how to achieve asthma control, significant gaps exist between therapeutic goals and the level of asthma control in actual practice [10].

Studies suggest an association between provider documentation of asthma severity and prescription of recommended asthma controller medications as per by the NHLBI guidelines [11]. The goal of disease management is to achieve asthma control while minimizing medication side effects. However, there are challenges in adopting the recommended assessment and documentation of asthma severity and control into everyday clinical practice, resulting in a gap between guidelines and actual clinical management of asthma [12,13]. A national survey of pediatricians revealed that one fourth of respondents indicated a lack of familiarity with NHLBI guidelines for the prescription of asthma controller medications [13]. Limited reproducibility and the variable nature of asthma may also contribute to the wide variation in use of these assessments [10,14,15].

Documentation of asthma severity and control is critical to providing optimal pediatric care, however not many studies have examined the documentation and assessment of asthma severity and control in pediatric outpatient settings [6,16] as well as other primary care practices. Although uncontrolled asthma in adults has been studied extensively, limited data exists regarding uncontrolled asthma and its management in children and adolescents [9,11,17–20]. Little is known about the association between individual characteristics associated with the documentation of poorly controlled asthma in children. This study examined a nationally representative sample of office-based visits among children and adolescents with asthma. The objectives of this study were threefold: 1) to evaluate the extent of documentation of asthma control and severity; 2) to examine patient and provider characteristics associated with such documentation; and 3) to determine the characteristics associated with documentation of uncontrolled asthma. An understanding of the provider or patient

characteristics associated with the documentation of asthma severity and control can help to develop mechanisms to improve the quality of asthma care in children.

Materials and methods

Data source

The study used 2012–2015 National Ambulatory Medical Care Survey (NAMCS) data [21–24]. The uniqueness of NAMCS from 2012 onwards is the collection of additional information about asthma control, asthma severity, and asthma action plans, which were not available in NAMCS data in prior years [21–24]. The NAMCS is a national probability sample survey conducted annually by the National Center for Health Statistics (NCHS) of the Center for Disease Control and Prevention (CDC), which provides detailed information about the use of ambulatory resources and healthcare patterns in the office-based setting. The NAMCS employs a multistage probability survey design which involves probability samples of primary sampling units (PSUs), physician practices within PSUs and patient visit within practices. These are cross-sectional surveys where the final sampling unit is the physician-patient encounter or visit.

Only visits to the offices of non-federally employed physicians classified by the American Medical Association or the American Osteopathic Association as "office-based, patient care" are included in NAMCS. A systematic random sample of visits for a one week period at every selected clinic was used. During the one week period, physicians or their office staff completed a one page patient record form (PRF) about demographic, clinical, and treatment characteristics of each patient visit. In the NAMCS, diagnoses are recorded as per the ICD-9-CM with a maximum of three diagnoses per visit for 2012–2013 and up to five diagnoses for 2014–2015 [21–24]. The 2012–2015 NAMCS datasets were combined to examine the extent of documentation of asthma control and severity, and the characteristics associated with documentation and uncontrolled asthma among pediatric patients in office-based settings. This study was considered exempt by the Institutional Review Board for the protection of human subjects at the University of Houston.

Study design and sample population

This study included children (6–11 years of age) and adolescents (12–17 years of age) with a diagnosis of

asthma. Asthma was identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes of 493.XX [16]. The analyses included patient visits with a primary diagnosis of asthma (asthma visits) and those with any asthma diagnosis (asthma-related visits). The primary outcome variables for this study were documentation of asthma control and asthma severity as assessed by the physicians during office-based visits in 2012–2015 [21–24]. These variables were operationally defined based on the NAMCS documentation. Asthma control was operationally defined based on the NAMCS categorization of well-controlled, uncontrolled (if asthma was not well controlled or very poorly controlled), and other (if asthma control response was blank, none recorded, not applicable or other). Asthma severity was also operationally defined from intermittent to severe persistent. Asthma severity and control was considered undocumented if it was blank, or none recorded.

Statistical analysis

Descriptive analyses were used to examine the demographic, clinical, and provider characteristics of the visit. These variables were operationally defined based on the NAMCS documentation [21–24]. Patient characteristics included demographic variables (age, sex, race, and ethnicity), region, payment source (private insurance, Medicare and other), patient seen before status, season of visit, and tobacco use. Patient clinical characteristics included asthma severity, asthma control, allergic, and non-allergic comorbidities. Allergic comorbidities included chronic sinusitis (473.0–473.3, 473.8, 473.9), atopic dermatitis (690.12, 690.18, 691.8, 692.3–692.6, 692.70, 692.72, 692.74, 692.82–692.84, 692.89, 693.1, 693.8, 693.9, 698.4), allergic rhinitis (477.0–477.2, 477.8, 477.9), conjunctivitis (372.00–372.06, 372.10–372.15, 372.20–372.22), eczema (692.9), anaphylaxis (977.7, 989.5, 995.0, 995.60–995.69, 999.41, 999.49), angioedema (995.1), nasal polyps (471.0, 471.1, 471.18, 471.19), food allergy (995.7), and urticaria (708.0–708.5, 708.8, 708.9). Nonallergic comorbidities included psychiatric disorders (290.XX–419.XX), obesity (278.XX), and obstructive sleep apnea (327.23). Due to the small sample size for certain comorbidities, they were combined together. Provider characteristics included provider specialty, primary care physician, type of provider, solo versus group practice, type of doctor, and metropolitan statistical area. These variables were chosen based on previous literature involving pediatric

patients with asthma and availability of variables in 2012–2015 NAMCS [21–26].

Multivariable logistic regression analyses were performed among visits with asthma as a primary diagnosis by including patient demographic and clinical characteristics, as well as provider characteristics as independent variables. Two separate regression analyses were conducted by using the binary dependent variable of documentation of asthma severity and control (documented vs. not documented) to evaluate characteristics associated with documentation in pediatric office visits. Also, demographic, clinical, and provider characteristics associated with uncontrolled asthma (not well controlled/very poorly controlled vs. well controlled asthma) was evaluated among those with asthma control documentation in pediatric office visits. All statistical analyses were performed using SAS 9.3 (SAS Institute, Cary, NC) with a statistical significance level of 0.05. Both descriptive and multivariable analyses were adjusted for the complex survey design using cluster, strata and weight variables in the SAS statistical procedures. The NAMCS data was weighted using the PATWT variable in order to produce national level estimates (that describe the utilization of ambulatory medical care services in the United States); this increases the generalizability of the study findings and accounts for item non-response bias.

Results

There were 2.47 million (95% confidence interval (CI), 2.04–2.90) million average annual visits with asthma as the primary diagnosis; and 8.9 million (95% CI, 8.03–9.89) annual asthma-related visits during the study period. Table 1 outlines the characteristics of the study sample involving visits with asthma as a primary diagnosis. The majority of the asthma patients were male (59.3%), children aged 6–11 years (54.8%), white (73.6%) and non-Hispanic (79.5%). Sixty percent of visits were to pediatricians (60.1%). Most of these visits involved established patients (90.6%) from metropolitan statistical areas (95.7%). More than half of the patient visits involved patients seen by their primary care physician (63.9%). Over 16% of the pediatric asthma visits involved patients with allergic comorbidities. Asthma was reported as well controlled in 0.56 million (22.80%), uncontrolled in 0.26 million (10.65%), and not documented in 66.55% of the visits.

Table 2 shows the documentation of asthma severity and control for asthma as the primary diagnosis and any asthma-related visits. Over 60% of the office visits involving asthma as the primary diagnosis did

Table 1. Demographic characteristics of pediatric patients visits with asthma as a primary diagnosis.

Patient demographic	Unweighted frequency	Annual weighted frequency	Weighted percentage
Sex			
Female	335	1,004,784	40.72
Male	460	1,462,949	59.28
Age (years)			
6–11	467	1,351,891	54.78
12–17	328	1,115,842	45.22
Race			
White	624	1,815,985	73.59
Black/African American	111	512,199	20.75
Other ^a	60	139,549	5.66
Ethnicity			
Hispanic/Latino	132	507,034	20.55
Non-Hispanic/Latino	663	1,960,699	79.45
Region			
Northeast	156	518,879	21.03
Midwest	156	441,131	17.88
South	295	933,741	37.84
West	188	573,982	23.25
Payment sources			
Private Insurance	487	1,315,364	53.30
Medicaid	228	807,758	32.73
Other ^b	80	344,611	13.96
MSA			
Metropolitan Statistical Area	743	2,360,530	95.66
Non-Metropolitan Statistical Area	52	107,203	4.34
Primary Care Physician			
Yes	311	1,579,122	63.99
No	440	751,528	30.45
Unknown	44	137,083	5.56
Patient seen before			
Yes, established	683	2,234,588	90.55
No, new patient	112	233,145	9.45
Type of provider			
Physician	763	2,304,934	93.40
Other provider ^c	32	162,799	6.60
Physician Specialty			
General/Family Practice/Internal medicine	52	370,064	14.99
Pediatrics	343	1,482,370	60.08
Other ^d	400	615,299	24.93
Solo practice			
Yes	240	902,518	36.57
No	555	1,565,215	63.43
Type of doctor			
MD	775	2,377,777	96.35
DO	20	89,956	3.65
Tobacco use			
Never	156	459,353	18.61
Other ^e	639	2,008,380	81.39
Asthma control			
Well controlled	264	562,622	22.80
Uncontrolled ^f	88	262,742	10.65
Not applicable ^g	28	65,001	2.63
Other ^h	415	1,577,368	63.92
Asthma severity			
Intermittent	84	223,734	9.07
Mild persistent	148	299,698	12.14
Moderate persistent	92	182,881	7.41
Severe persistent	20	31,781	1.29
Not applicable ⁱ	31	96,177	3.9
Other ^j	420	1,633,463	66.19
Allergic comorbidities			
Chronic sinusitis	36	151,250	6.13
Atopic dermatitis	44	53,786	2.18
Other ^k	80	199,607	8.09
Nonallergic comorbidities ^l	16	47,035	1.91

^aIncludes the categories Asian, Native Hawaiian/other Pacific Islander, American Indian/Alaska Native, and those individuals indicating more than one race.

^bIncludes Medicare, worker's compensation, self-pay, no charge/charity, other, and unknown.

^cIncludes physician assistant, nurse practitioner, RN/LPN (Registered Nurse/Licensed Practical Nurse), mental health provider, other providers and no provider.

^dIncludes general surgery, obstetrics and gynecology, orthopedic surgery, cardiovascular diseases, urology, psychiatry, neurology, ophthalmology, otolaryngology, and all other.

^eIncludes former, current, blank, and unknown.

^fIncludes not well controlled and very poorly controlled.

^gIncludes not applicable, and other specify.

^hIncludes blank, and none recorded.

ⁱIncludes not applicable, and other specify.

^jIncludes blank, and none recorded.

^kIncludes allergic rhinitis, conjunctivitis, eczema, anaphylaxis, angioedema, nasal polyps, food allergy, and urticaria.

^lIncludes psychiatric disorders, obesity and obstructive sleep apnea.

Table 2. Documentation of asthma severity and control in pediatric asthma visits, 2012–2015.

	Asthma control ^a		Asthma severity ^b	
	Documented	Undocumented	Documented	Undocumented
Asthma as a primary diagnosis				
Unweighted frequency	380	415	375	420
Weighted frequency	890,365	1,577,368	834,271	1,633,463
Percent	36.08	63.92	33.81	66.19
Asthma-related visits				
Unweighted frequency	940	1456	972	1424
Weighted frequency	2,835,053	6,124,467	2,876,994	6,082,525
Percent	31.64	68.36	32.11	67.89

^aWas considered documented if (well controlled, not well controlled, very poorly controlled, other specify, and not applicable); Was considered undocumented if (blank or none recorded).

^bWas considered documented if (intermittent, mild persistent, moderate persistent, severe persistent, other specify, and not applicable); was considered undocumented if (blank or none recorded).

Table 3. Documentation of asthma severity and control by physician specialty in pediatric visits with asthma as a primary diagnosis, 2012.

Physician specialty	Asthma control ^a		Asthma severity ^b	
	Documented	Undocumented	Documented	Undocumented
General practitioner/Family practice/Internal medicine (N = 20) ^c				
Unweighted	7	13	8	12
Weighted	1,24,814	1,82,082	1,58,670	1,48,226
Percent	40.67	59.33	51.70	48.30
Pediatrics (N = 121)				
Unweighted	53	68	55	66
Weighted	9,37,256	10,88,441	10,18,550	10,07,148
Percent	46.27	53.73	50.28	49.72
Allergy (N = 257)				
Unweighted	156	101	152	105
Weighted	3,52,665	1,83,154	3,29,226	2,06,593
Percent	65.82	34.18	61.44	38.56
Pulmonology (N = 63)				
Unweighted	47	16	41	22
Weighted	1,68,235	51,111	1,33,249	86,097
Percent	76.70	23.30	60.75	39.25
Other ^c (N = 3)				
Unweighted	1	2	1	2
Weighted	5280	27,873	8737	24,415
Percent	15.92	84.08	26.35	73.65

Note: Breakdown by sub-specialty is not available from 2013 onwards.

^aWas considered documented if (well controlled, not well controlled, very poorly controlled, other specify, and not applicable); Was considered undocumented if (blank or none recorded).

^bWas considered documented if (intermittent, mild persistent, moderate persistent, severe persistent, other specify, and not applicable); Was considered undocumented if (blank or none recorded).

^cIncludes general surgery, obstetrics and gynecology, orthopedic surgery, cardiovascular diseases, urology, psychiatry, neurology, ophthalmology, otolaryngology, oncology, and all other.

not have documentation of asthma control (63.92%) or severity (66.19%). For any asthma-related visits, asthma control was not documented in 68.36% of visits and asthma severity was not documented in 67.89% visits. Table 3 shows the extent of documentation according to physician specialty in NAMCS 2012. For this analysis, only NAMCS 2012 was used because breakdown by asthma-related physician sub-specialty was not available from 2013 onwards. The percent of visits with documentation of asthma severity was highest for allergists (61.44%), followed by pulmonologists (60.75%), general practice/internal medicine/family practice physicians (51.70%), and pediatricians (50.28%). The percent of visits with documentation of asthma control was

highest for pulmonologists (76.70%), followed by allergists (65.82%), pediatricians (46.27%), and general practice/internal medicine/family practice physicians (40.67%).

Asthma-related services provided by physicians during visits for which asthma control was documented were also examined. These included asthma education, spirometry, and asthma action plan. There was a significant difference in asthma services provided for visits in which asthma control was documented compared to those for which asthma control was undocumented. More asthma services were provided for visits in which asthma control was documented; these included asthma education (32.42%; $p = 0.007$), spirometry (23.95%; $p < 0.0001$), and

asthma action plan (24.96%; $p=0.032$) (data not shown).

Table 4 shows the characteristics associated with documentation of asthma control and severity. An established patient (OR=3.81; 95% CI, 1.44–10.07), Hispanic ethnicity (OR=2.10; 95% CI, 1.08–4.09), chronic sinusitis (OR=5.59; 95% CI, 1.66–18.88), and visits in the northeast (OR=2.12; 95% CI, 0.77–5.85) and midwest (OR=2.25; 95% CI, 0.79–6.44) regions had higher odds of documentation of asthma control status, whereas undocumented asthma severity (OR=0.02; 95% CI, 0.01–0.06), and office visits during the spring season (OR=0.34; 95% CI, 0.13–0.89) had lower odds. As seen from Table 4, Osteopathic doctors (OR=0.18; 95% CI, 0.06–0.56), visits in the northeast region (OR=0.23; 95% CI, 0.09–0.63), having a diagnosis of chronic sinusitis (OR=0.08; 95% CI, 0.01–0.45), and undocumented asthma control status (OR=0.03; 95% CI, 0.01–0.06) were all associated with lower odds of documented asthma severity, whereas visits in spring (OR=3.88; 95% CI, 1.47–10.24) and autumn (OR=3.32; 95% CI, 1.24–8.89) seasons were associated with higher odds.

Table 5 shows the characteristics associated with uncontrolled asthma in pediatric visits with asthma as a primary diagnosis. Moderate or severe persistent asthma (OR=15.35; 95% CI, 2.60–90.79) was associated with higher odds of uncontrolled asthma; while visits in the summer (OR=0.14; 95% CI, 0.04–0.42) were associated with lower odds of uncontrolled asthma.

Discussion

This study used four years of nationally representative samples of ambulatory visits by pediatric patients with asthma to examine the extent of documentation of asthma severity and control, and to determine characteristics associated with uncontrolled asthma and documentation of asthma control. This study used up-to-date robust data with a specific focus on asthma control and severity. In the current national study, asthma severity or control was not documented in over 60% of pediatric asthma visits. These results are consistent with a previous study that assessed the documentation of asthma severity in pediatric outpatient clinics, which found that asthma severity was documented in only 34% of the visits [16]. Another study demonstrated significant variation between specialists and primary care physicians, with specialists demonstrating better adherence to NAEPP guidelines in terms of assessment and monitoring of asthma,

control of asthma characteristics, pharmacotherapy, and patient education [27]. The present study found that allergists and pulmonologists showed higher documentation of asthma severity and control, as compared to general practitioners, family practice physicians or internal medicine physicians.

This study also compared the asthma related services provided by physicians during visits for which asthma control was documented or undocumented. Compared to visits without documentation of asthma control, more asthma services (such as asthma education, spirometry, and asthma action plans) were provided for visits with documentation of asthma control. These results are similar to a study by Cabana et al. which looked at documentation of asthma severity. The study found an association between documentation of asthma severity and provision of asthma services including asthma education and asthma action plans. A greater percentage of asthma education (47%) and asthma action plans (22%) were observed for visits with documentation of asthma severity [16].

Very limited data exist regarding the characteristics associated with documentation of asthma severity and control. This study analyzed the patient and physician characteristics associated with the documentation of asthma severity and control, which to the authors' knowledge has not been done previously. The study found that providers are nearly four times more likely to document asthma control in established versus new patients. The study also found racial variation in the documentation of asthma control; documentation is two times higher among Hispanics than non-Hispanic patients. Providers are more likely to document asthma control in patients with chronic sinusitis. This may be attributed to the impact of chronic sinusitis on asthma symptomatology. The study also found regional variation in the documentation; documentation is two times higher among providers from the Northeast region than those from the West. The likelihood of documentation is significantly lower in those with undocumented asthma severity and in visits in the spring season. This suggests significant correlation between asthma control and severity documentation as providers following national asthma guidelines are likely to document both.

The study found variation in asthma severity documentation by medical training; osteopathic doctors are less likely to document asthma severity than MDs. Unlike asthma control documentation, documentation of severity was lower among providers from Northeast region than those from the West. The reasons for the differences in the documentation of severity are

Table 4. Characteristics associated with documentation of asthma control and severity in pediatric visits with asthma as a primary diagnosis.

Variable	Asthma control			Asthma severity		
	Adjusted odds ratio	95% Confidence Interval	<i>p</i>	Adjusted odds ratio	95% Confidence Interval	<i>p</i>
Sex						
Female	0.84	(0.45–1.55)	0.573	0.89	(0.52–1.51)	0.661
Male	Reference			Reference		
Age (years)						
12–17	0.70	(0.33–1.47)	0.344	1.27	(0.70–2.29)	0.435
6–11	Reference			Reference		
Race						
White	0.90	(0.32–2.59)	0.849	1.32	(0.46–3.81)	0.606
Black/African American	1.20	(0.35–4.11)	0.775	0.51	(0.15–1.72)	0.279
Other ^a	Reference			Reference		
Ethnicity						
Hispanic/Latino	2.10	(1.08–4.09)	0.029	0.51	(0.23–1.11)	0.088
Non-Hispanic/Latino	Reference			Reference		
Region						
Northeast	2.12	(0.77–5.85)	0.044	0.23	(0.09–0.63)	0.004
Midwest	2.25	(0.79–6.44)	0.045	0.75	(0.31–1.87)	0.541
South	1.68	(0.68–4.16)	0.552	0.67	(0.26–1.69)	0.392
West	Reference			Reference		
Payment sources						
Private Insurance	Reference			Reference		
Medicaid or CHIP	0.93	(0.46–1.89)	0.849	0.62	(0.33–1.14)	0.124
Other ^b	0.39	(0.14–1.13)	0.083	1.23	(0.49–3.08)	0.665
MSA						
Metropolitan Statistical Area	2.15	(0.58–7.96)	0.253	0.66	(0.21–2.08)	0.475
Non-Metropolitan Statistical Area	Reference			Reference		
Patient seen before						
Yes, established	3.81	(1.44–10.07)	0.007	0.83	(0.32–2.18)	0.707
No, new patient	Reference			Reference		
Tobacco use						
Not current	6.47	(0.95–44.20)	0.057	0.60	(0.12–3.14)	0.545
Current/former	Reference			Reference		
Other ^c	17.34	(2.12–141.62)	0.167	0.47	(0.07–3.06)	0.427
Asthma severity						
Intermittent	Reference					
Mild persistent	0.89	(0.28–2.77)	0.833			
Moderate/severe persistent	2.80	(0.79–10.33)	0.324			
Other ^d	0.02	(0.01–0.06)	<0.0001			
Asthma control						
Well controlled				Reference		
Uncontrolled				0.89	(0.37–2.13)	0.787
Other ^e				0.03	(0.01–0.06)	<0.0001
Season of visit						
Spring ^f	0.34	(0.13–0.89)	0.028	3.88	(1.47–10.24)	0.006
Summer ^g	1.16	(0.44–3.07)	0.755	2.27	(0.79–6.52)	0.127
Autumn ^h	0.56	(0.26–1.23)	0.151	3.32	(1.24–8.89)	0.017
Winter ⁱ	Reference			Reference		
Chronic sinusitis						
Yes	5.59	(1.66–18.88)	0.006	0.08	(0.01–0.45)	0.004
No	Reference			Reference		
Allergic rhinitis						
Yes	4.28	(0.54–33.92)	0.169	0.12	(0.01–1.60)	0.109
No	Reference			Reference		
Atopic dermatitis						
Yes	0.61	(0.15–2.50)	0.489	2.18	(0.69–6.90)	0.185
No	Reference			Reference		
Type of provider						
Physician	0.41	(0.08–1.97)	0.263	0.36	(0.07–1.83)	0.219
Other provider ^j	Reference			Reference		
Primary Care Physician						
Yes	0.55	(0.18–1.65)	0.286	1.50	(0.39–5.83)	0.556
No	Reference			Reference		
Unknown	0.10	(0.01–0.92)	0.107	1.01	(0.18–5.54)	0.992
Type of doctor						
MD	Reference			Reference		
DO	0.62	(0.19–2.10)	0.445	0.18	(0.06–0.56)	0.003
Solo practice						
Yes	0.84	(0.41–1.74)	0.645	0.93	(0.49–1.73)	0.809
No	Reference			Reference		

(Continued)

Table 4. Continued.

Variable	Asthma control			Asthma severity		
	Adjusted odds ratio	95% Confidence Interval	<i>p</i>	Adjusted odds ratio	95% Confidence Interval	<i>p</i>
Provider specialty						
General/Family Practice/Internal medicine	0.69	(0.17–2.79)	0.597	0.56	(0.13–2.47)	0.445
Pediatrics	0.38	(0.11–1.24)	0.108	1.17	(0.31–4.47)	0.821
Other ^k	Reference			Reference		

^aIncludes the categories Asian, Native Hawaiian/other Pacific Islander, American Indian/Alaska Native, and those individuals indicating more than one race.

^bIncludes Medicare, worker's compensation, self-pay, no charge/charity, other, and unknown.

^cIncludes blank and unknown.

^dIncludes blank, none recorded, not applicable, and other specify.

^eIncludes blank, none recorded, not applicable, and other specify.

^fIncludes March, April, May.

^gIncludes June, July, August.

^hIncludes September, October, November.

ⁱIncludes December, January, February.

^jIncludes physician assistant, nurse practitioner, RN/LPN, mental health provider, other providers, and no provider.

^kIncludes general surgery, obstetrics and gynecology, orthopedic surgery, cardiovascular diseases, urology, psychiatry, neurology, ophthalmology, otolaryngology, and all other.

unclear; but may be due to regional geographic variations in physician practice. This phenomenon has also been noted with physician prescribing patterns [28] and physician testing for asthma [29]. Similarly, providers are less likely to document asthma severity in patients with chronic sinusitis than those without this condition. This suggests that the comorbid chronic sinusitis may be associated with increase in the likelihood of asthma control documentation but decrease in the likelihood of severity documentation for patients not taking a controller medication. Consistent with asthma control documentation, the likelihood of documentation of severity is significantly lower in those with undocumented asthma control status. However, the likelihood of documentation of asthma severity was high in visits in spring and autumn seasons.

Previous studies have found the following characteristics to be associated with uncontrolled asthma: race [9], education [17] income level [9], asthma severity [18,19], poor adherence [19], lack of prescription of asthma controller medications [20], and infections [19]. Consistent with the previous literature, our study reported additional patient and provider characteristics are associated with uncontrolled asthma in pediatric patients. The results of multivariable logistic regression showed that moderate or severe persistent asthma patients were more likely to have uncontrolled asthma than those with intermittent asthma severity, which is in accordance with the NAEPP guidelines. In a previous study, a diagnosis of moderate/severe persistent asthma (as compared with mild persistent asthma) had greater odds (adjusted OR = 18.87, *p* = 0.012) of asthma being partly controlled/

uncontrolled [18]. Dalcin et al. and Desalu et al. reported that one of the characteristics associated with uncontrolled asthma included asthma severity [30,31]. Similar findings were observed in another study where patients with persistent asthma were more likely to have uncontrolled asthma [32].

The study found that visits in the summer were less likely to be associated with uncontrolled asthma than those in the winter season. Seasonal variation in asthma has been widely recognized. Previous studies have found that season is significantly associated with asthma control [33,34]. Lower HRQoL has been observed during autumn compared to summer [33]. In a study by Koster et al., there was a decline in asthma symptoms during the summer period and a peak occurred from autumn to spring. The prevalence of respiratory symptoms and medication use was also lower during summer [34]. These increased exacerbations could be a result of seasonal environmental characteristics such as aeroallergens or respiratory infections which are more prevalent during winter and autumn seasons as compared to summer [35].

Overall the study findings suggest that asthma severity is associated with uncontrolled asthma but assessment and documentation of asthma severity and control is not consistent with the NAEPP guideline recommendations. Assessment of asthma control can help the provider evaluate both the current status and future risk of exacerbations for patients. Although physicians may show awareness of national guidelines, additional work is needed to ensure proper adoption of guidelines. In spite of improvements in healthcare coverage and access to primary care, several previous studies have found that the overall quality of asthma

Table 5. Characteristics associated with uncontrolled asthma in pediatric visits with asthma as a primary diagnosis.

Variable	Adjusted odds ratio	95% Confidence Interval	p
Sex			
Female	1.57	(0.67–3.67)	0.295
Male	Reference		
Age (years)			
12–17	0.80	(0.35–1.85)	0.605
6–11	Reference		
Race			
White	1.00	(0.22–4.50)	0.999
Black/African American	3.50	(0.59–20.52)	0.165
Other ^a	Reference		
Ethnicity			
Hispanic/Latino	0.35	(0.08–1.50)	0.159
Non-Hispanic/Latino	Reference		
Region			
Northeast	0.33	(0.10–1.13)	0.078
Midwest	0.55	(0.16–1.91)	0.347
South	0.56	(0.18–1.75)	0.321
West	Reference		
Payment sources			
Private Insurance	Reference		
Medicaid or CHIP	0.92	(0.36–2.33)	0.855
Other ^b	1.69	(0.37–7.69)	0.495
MSA			
Metropolitan Statistical Area	1.52	(0.25–9.19)	0.649
Non-Metropolitan Statistical Area	Reference		
Patient seen before			
Yes, established	0.40	(0.12–1.32)	0.132
No, new patient	Reference		
Tobacco use			
Not current	0.10	(0.01–1.6)	0.093
Current/former	Reference		
Other ^c	0.12	(0.01–1.80)	0.126
Asthma severity			
Intermittent	Reference		
Mild persistent	5.30	(0.81–34.79)	0.083
Moderate/severe persistent	15.35	(2.60–90.79)	0.003
Other ^d	4.70	(0.89–24.66)	0.068
Season of visit			
Spring ^e	0.69	(0.23–2.11)	0.516
Summer ^f	0.14	(0.04–0.42)	0.001
Autumn ^g	0.44	(0.15–1.34)	0.151
Winter ^h	Reference		
Chronic sinusitis			
Yes	3.24	(0.51–20.37)	0.211
No	Reference		
Allergic rhinitis			
Yes	6.04	(0.74–49.37)	0.094
No	Reference		
Atopic dermatitis			
Yes	1.87	(0.56–6.25)	0.312
No	Reference		

^aIncludes the categories Asian, Native Hawaiian/other Pacific Islander, American Indian/Alaska Native, and those individuals indicating more than one race.

^bIncludes Medicare, worker's compensation, self-pay, no charge/charity, other, and unknown.

^cIncludes blank and unknown.

^dIncludes blank, none recorded, not applicable, and other specify.

^eIncludes March, April, May.

^fIncludes June, July, August.

^gIncludes September, October, November.

^hIncludes December, January, February.

care and management still falls short of recommendations by national guidelines [36,37]. Also, there is significant variation in quality of asthma care, adherence to guidelines, and services across physician groups

[38]. Therefore, concerted efforts are needed in the areas of physician awareness and, asthma education programs [39,40]. For instance, an organized disease management program increased adherence to NAEPP guidelines by primary care physicians in urban clinics [41]. Also, use of the Physician Asthma Care Education Program was effective in improving provider communication skills and asthma health care use [42]. In another study, a continuous quality improvement demonstration produced major improvements in asthma related care processes such as documentation of asthma severity, review of action plans, and health care service use [43]. Thus, interventions and strategies designed to promote awareness and target physician behavior may promote guideline awareness and adoption, and can improve the quality of care for asthma.

Strengths and limitations

The national survey data used in this study provide reliable information about physician office-based visits among children in the US population. The assignment of weights to produce national estimates, adjusts for survey and item non-response, and facilitates high generalizability of the study findings. Also, this study used robust up-to-date national data (2012–2015) which provided information on documentation of asthma severity and control. To the authors' knowledge, this was the first study to use multiyear national data to examine asthma control and severity documentation in children and adolescents in the age group of 6–17 years. However, the results of the study should be viewed by considering several limitations. The analyses focused on documentation of asthma severity and control by the providers in the NAMCS. It is possible that providers may have evaluated asthma severity and control but did not document it or did not report it in the NAMCS survey instrument. Also, the study findings are limited to physicians (MDs and DOs) and are not applicable to other provider types (such as nonphysician practitioners—physician assistants, nurse practitioners, and nurse midwives). This is because beginning 2012, only visits to office-based physicians were included on the NAMCS public data products and did not include a sample of community health centers, unlike previous years. Due to the cross-sectional nature of the study, it is not possible to follow patients longitudinally over the course of their disease with respect to documentation. The study findings are also limited to the years in which data was collected and restricted to the data

available in the national surveys. The patient and provider characteristics were restricted to those available in the data source and the relationships that were found significant can only be considered as associations and not causal relationships. The variables included in the multivariable models were limited to those available in the NAMCS. There were a limited number of patient visits in certain patient groups, which could explain the wide confidence intervals for such groups. The inherent disadvantages of survey data such as errors in data collection, analysis, or reporting, as well as sampling and non-sampling errors, should be considered as limitations.

Conclusion

Asthma severity or control was not documented in over 60% of pediatric asthma visits. In visits with documentation of asthma control status, asthma severity and summer season were associated with documentation of uncontrolled asthma. The recognition of these characteristics will help identify patients with the greatest impact on asthma control, and provide early intervention opportunities. Both patient and provider characteristics were associated with documentation of asthma severity and control. Overall the study findings suggest a critical need to increase documentation of asthma severity and control to improve the quality of asthma care in children. Increased outreach and provider education is needed to underscore the importance of documenting and managing asthma in children in accordance with NHLBI guidelines.

Disclosures

Rajender R. Aparasu, Sanika Rege are employees of University of Houston, TX, that received funding from Novartis Pharmaceuticals Corporation for the conduct of the study. Benjamin Ortiz, Abhishek Kavati are employees of Novartis Pharmaceuticals Corporation. Kevin Murphy has received consultancy and speaker fees and has participated in advisory boards for AstraZeneca, Boehringer Ingelheim, Genentech, Greer, Meda, Merck, Mylan, Novartis, and Teva. Michael Cabana has received consultancy and speaker fees and has participated in advisory boards for Genentech, Merck, Novartis, and ThermoFisher. Giselle Mosnaim has participated in scientific advisory boards and/or served as a consultant for Novartis, Boehringer Ingelheim, and Teva; own stock options in Electrocure; and receives research grant support from GlaxoSmithKline and Propeller Health.

Declaration of interest

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

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