

Hospitalization to emergency department visit ratio for pediatric asthma: A population-based study

Olusegun Owotomo, MD, PhD, MPH^{a,b}, and
Stephen J. Teach, MD, MPH^{a,b}



Clinical Implications

Among children and adolescents (aged 2–17 years) with asthma in the District of Columbia, lack of specialty care, suboptimal adherence to guideline-based therapy, and Black race were associated with potentially preventable emergency department utilization.

Asthma is a leading cause of pediatric emergency department (ED) visits and hospitalizations in the United States.¹ Frequent ED visits for less-severe asthma exacerbations that do not result in hospitalizations may be preventable with specialty and guideline-based care. ED utilization for asthma is typically reported as the number of ED visits during a given period.^{2,3} This study developed a novel hospitalization-to-emergency department visit ratio (HE ratio) to identify patient-level characteristics associated with potentially preventable ED utilization for pediatric asthma. Specifically, we determined the asthma care-related and demographic factors associated with low HE ratios among children and adolescents with asthma in the District of Columbia (DC). Low HE ratios suggest a pattern of frequent ED visits for less-severe asthma exacerbations that respond to ED treatment and do not result in hospitalizations. We hypothesized that low HE ratios would be associated with lack of specialist care from an allergist or pulmonologist.

Data for patients aged 2 to 17 years with 2 or more ED visits for asthma over a 24-month period (January 1, 2018, to December 31, 2019) were extracted from the population-based DC Pediatric Asthma Registry.⁴ The HE ratio for each participant was derived by dividing the number of asthma-related ED visits that resulted in hospitalizations in the prior 24 months by the number of asthma-related ED visits that resulted in discharge home in the same period. We categorized each participant's HE ratio into low (0), moderate (0.01–0.5), or high (>0.51). Specialist contact in the prior 24 months was dichotomized into no specialist contact and at least 1 visit to an allergist or pulmonologist. Other asthma care-related factors included the number of visits to primary care providers (PCPs) in the prior 24 months, the controller-to-asthma prescription medication (CAM) prescription ratio as utilized in prior studies,^{5,6} asthma severity (intermittent or persistent), and

sociodemographic factors (age, sex, race and ethnicity, and insurance status).

Using multivariable logistic regression models, we estimated the unadjusted and adjusted odds ratio (AOR) for the association between HE ratio (low vs high HE ratio and low vs moderate HE ratio) and each independent variable. All analysis was conducted using IBM SPSS version 27. Given our use of deidentified data from the Registry, this study was determined to be exempt from review by the Institutional Review Board of Children's National Hospital.

The study sample consisted of 1,298 individuals (9.2% of all participants in the Registry; [Figure E1](#); available in this article's Online Repository at www.jaci-inpractice.org). Sample demographic and asthma care-related characteristics are reported in [Table 1](#). The complete unadjusted and adjusted models appear in [Table E1](#) (available in this article's Online Repository at www.jaci-inpractice.org). As depicted in [Figure 1](#), the adjusted odds of having a low versus high HE ratio were significantly higher among those who had no specialist contact than those with specialist contact (AOR 2.21; 95% CI 1.27–3.85; $P < .01$). The same was true for low versus moderate HE ratio (AOR 1.84; 95% CI 1.37–2.47; $P < .001$). Similarly, the adjusted odds of having a low versus high HE ratio were significantly higher among those with low versus high CAM ratio (AOR 6.26; 95% CI 3.54–11.07; $P < .001$). The same was true for low versus moderate HE ratio (AOR 1.90; 95% CI 1.31–2.75; $P < .001$). Also, the adjusted odds of having a low HE ratio compared with a moderate or high HE ratio were higher among those who had intermittent asthma than those with persistent asthma (AOR 1.47; 95% CI 1.07–2.03; $P < .05$; AOR 3.92; 95% CI 1.77–8.69; $P < .001$, respectively). Compared with White participants, Black participants had over 5 times higher adjusted odds of a low versus a high HE ratio (AOR 5.55; 95% CI 1.23–25.08; $P < .05$). Finally, the adjusted odds of having a low HE ratio than a moderate or high HE ratio was higher among older children than those aged 2 to 5 years. Of note, insurance type and frequency of PCP visits were not significantly associated with the HE ratio in both unadjusted and adjusted models. The interaction effects between specialist contact and asthma severity, specialist contact and CAM ratio, and asthma severity and CAM ratio on HE ratio did not reach statistical significance.

In summary, we found that in a sample of largely Black DC youth with asthma aged 2 to 17 years, the majority (70.9%) had an HE ratio of 0 (2 or more ED visits that never resulted in hospital admission). Consistent with our primary hypothesis, lack of specialist care was associated with lower HE ratios (a marker for potentially preventable ED utilization for asthma). Low CAM ratio, Black race, intermittent asthma, and older age were also associated with potentially preventable

TABLE I. Demographic and asthma care–related characteristics of total study sample (n = 1,298)

Demographic and asthma care-related factors	Frequency	%
Sex		
Male	776	59.8
Female	522	40.2
Age, y (mean = 6.7 ± 3.6 y)		
2–5	589	45.4
6–9	424	32.7
10–13	200	15.4
14–17	85	6.5
Race and ethnicity		
Black	1,104	85.1
White	24	1.8
Hispanic/Latino	65	5.0
Other	105	8.1
Health insurance		
Private	58	4.5
Public	860	66.3
Multiple payers	351	27.0
Self-pay/others	29	2.2
ED visits resulting in discharge home		
2	629	48.5
3	304	23.4
4	147	11.3
5	83	6.4
≥6	135	10.4
ED visits resulting in hospitalizations		
0	930	70.9
1	243	18.6
2	82	6.6
3	29	2.2
≥4	21	1.7
HE ratio		
Low HE ratio (0)	920	70.9
Moderate HE ratio (0.01–0.5)	295	22.7
High HE ratio (>0.51)	83	6.3
Primary care visits (in prior 24 mo)		
Low PCP contact (<2 visits)	109	8.4
Moderate PCP contact (2 visits)	117	9.0
High PCP contact (>2 visits)	1,072	82.6
Specialist care visit (in prior 24 mo)		
No specialist contact	724	55.8
Specialist contact	574	44.2
Asthma classification		
Intermittent	410	31.6
Persistent*	888	68.4
CAM ratio		
Low CAM ratio (<0.5)	1071	82.5
High CAM ratio (0.5–1)	227	17.5

ICD-10, International Classification of Diseases, 10th Revision.

*Based on the DC Pediatric Asthma Registry's definition⁴ of meeting 1 or more of the following criteria during the prior 24 mo: 1 or more asthma-related hospitalizations; prescription of an asthma controller medication; or an ICD-10 code for persistent asthma.

asthma-related ED utilization. We found no significant association between the HE ratio and the frequency of PCP visits.

Higher frequency of potentially preventable ED visits among children with intermittent asthma may stem from barriers to accessing longitudinal asthma care, low rates of short-acting beta agonists, low parental asthma education, and limited access to resources for environmental control of asthma.^{7,8} In addition, Black children have worse clinical outcomes from asthma and remain disproportionately impacted by poor access to comprehensive asthma care including specialist care.⁷⁻⁹

Effective strategies to reduce preventable ED utilization among children and adolescents with asthma may include educating health care providers on guideline recommendations for referral to specialists, optimizing the process for specialist referrals, eliminating potential barriers to specialist care, and improving rates of controller medication use among children with persistent asthma.⁷

This study was limited by its retrospective design that does not permit causal inferences. However, our findings are generalizable to the overall population of DC children and adolescents with asthma who made 2 or more asthma-related ED visits during the study period. Also, our findings related to intermittent asthma should be interpreted contextually. The participants with intermittent asthma in our study made 2 or more ED visits for asthma within the 2-year study period. This population had no International Classification of Diseases, 10th Revision (ICD-10) code for persistent asthma, was not on controller medications, and had no asthma-related hospitalizations. However, the frequency of their ED visits suggests they possibly had mild persistent asthma and would have benefited from specialist care.

In conclusion, lack of care by an allergist or pulmonologist, suboptimal adherence to guideline-based therapy, and Black race are associated with potentially preventable ED utilization for pediatric asthma. Improving access to asthma care specialists, increasing adherence to guideline-based asthma therapy, and focusing on Black children and adolescents may be effective strategies to reduce preventable ED visits for pediatric asthma.

^aChildren's National Hospital, Washington, DC

^bDepartment of Pediatrics, George Washington University School of Medicine and Health Sciences, Washington, DC

Supported by grants from DC Health and EJF Philanthropies, Inc.

Conflicts of interest: S. J. Teach reports royalties from UpToDate; research support from the National Institutes of Health/National Institute of Allergy and Infectious Diseases (NIH/NIAID), NIH/NHLBI (National Heart, Lung, and Blood Institute), NIH/NICHD (National Institute of Child Health and Human Development), DC Health and EJF Philanthropies, Inc.; and research support from Novartis. The rest of the authors declare that they have no relevant conflicts of interest.

Received for publication January 21, 2022; revised April 28, 2022; accepted for publication April 29, 2022.

Available online May 11, 2022.

Corresponding author: Stephen J. Teach, MD, MPH, Children's National Hospital, 111 Michigan Ave. NW, Washington, DC 20010. E-mail: steach@childrensnational.org.

2213-2198

© 2022 American Academy of Allergy, Asthma & Immunology

<https://doi.org/10.1016/j.jaip.2022.04.038>

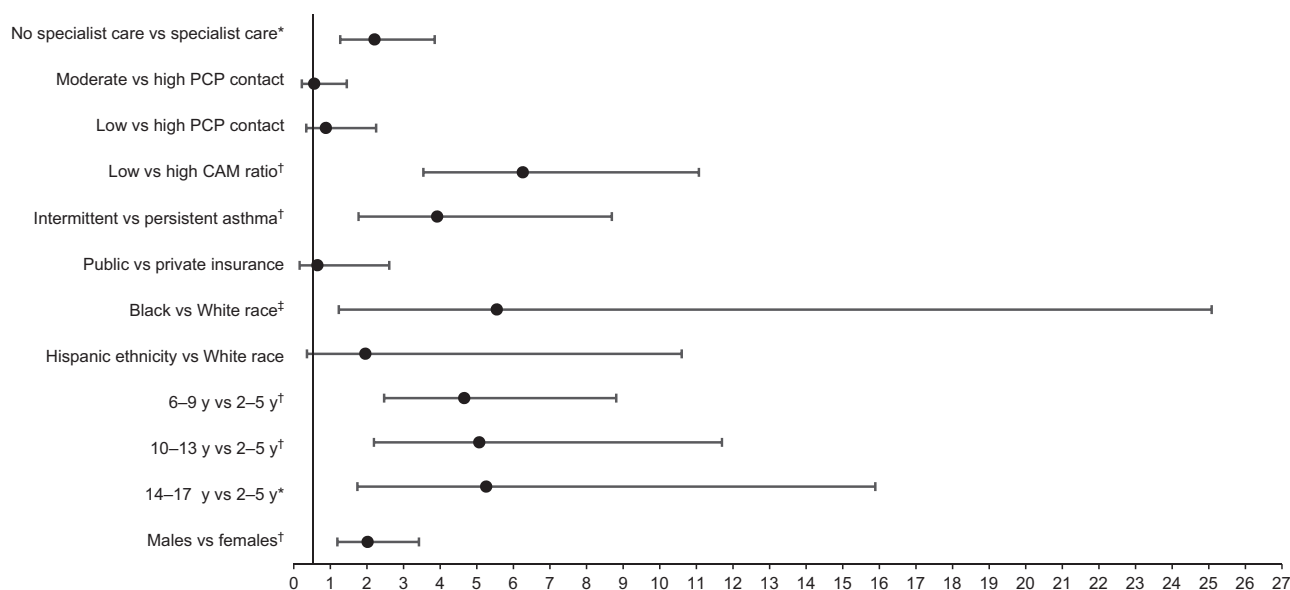
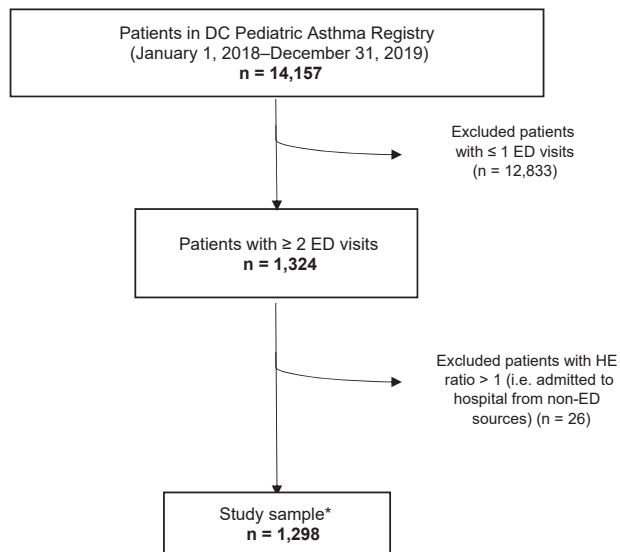


FIGURE 1. Adjusted odds ratios for associations between demographic and asthma care factors and low vs high HE ratio. Lack of specialist care, low CAM ratio, intermittent asthma, male sex, older (ages 5–17 y), and Black race were significantly associated with low HE ratio. * $P < .01$; † $P < .001$; ‡ $P < .05$.

REFERENCES

1. K.W. McDermott, C.S. Stocks, W.J. Freeman. Overview of Pediatric Emergency Department Visits, 2015: Statistical Brief #242. 2018. Agency for Healthcare Research and Quality, Rockville, MD. Accessed January 17, 2022. <https://www.hcup-us.ahrq.gov/reports/statbriefs/sb242-Pediatric-ED-Visits-2015.pdf>
2. Shechter J, Roy A, Naureckas S, Estabrook C, Mohanty N. Variables associated with emergency department utilization by pediatric patients with asthma in a federally qualified health center. *J Community Health* 2019;44: 948-53.
3. Rust G, Zhang S, Reynolds J. Inhaled corticosteroid adherence and emergency department utilization among Medicaid-enrolled children with asthma. *J Asthma* 2013;50:769-75.
4. Shelef DQ, Badolato GM, Badh R, Owotomo O, Kachroo N, Weissman M, et al. Creation and validation of a citywide pediatric asthma registry for the District of Columbia. *J Asthma* 2022;59:901-9.
5. Vernachio L, Trudell EK, Muto JM. Correlation of care process measures with childhood asthma exacerbations. *Pediatrics* 2013;131:e136-43.
6. Schatz M, Zeiger RS, Vollmer WM, Mosen D, Mendoza G, Apter AJ, et al. The controller-to-total asthma medication ratio is associated with patient-centered as well as utilization outcomes. *Chest* 2006;130:43-50.
7. National Heart, Lung, and Blood Institute. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma—Full Report 2007. Accessed January 20, 2022. https://www.nhlbi.nih.gov/sites/default/files/media/docs/EPR-3_Asthma_Full_Report_2007.pdf
8. Cloutier MM, Teach SJ, Lemanske RF Jr, Blake KV. The 2020 Focused Updates to the NIH Asthma Management Guidelines: Key Points for Pediatricians. *Pediatrics* 2021;147:e2021050286.
9. Guilbert T, Zeiger RS, Haselkorn T, Iqbal A, Alvarez C, Mink DR, et al. Racial disparities in asthma-related health outcomes in children with severe/difficult-to-treat asthma. *J Allergy Clin Immunol Pract* 2019;7:568-77.

ONLINE REPOSITORY



Footnote: Bold values represent number of patients.

FIGURE E1. Study population as drawn from the DC Pediatric Asthma Registry.⁴ *Study sample represents patients with asthma aged 2–17 y who had 2 or more emergency department (ED) visits that resulted in either hospital admission or home discharge from January 1, 2018, to December 31, 2019.

TABLE E1. Univariate and multivariable regression models of demographic and asthma care factors associated with HE ratio

Demographic and asthma care-related factors	Low vs moderate HE		Low vs high HE	
	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)
Specialist care visits				
Specialist contact	Reference	Reference	Reference	Reference
No specialist contact	1.86 (1.42–2.42)*	1.84 (1.37–2.47)*	3.20 (1.98–5.16)*	2.21 (1.27–3.85)†
Primary care visits				
High PCP contact	Reference	Reference	Reference	Reference
Moderate PCP contact	1.38 (0.85–2.25)	0.87 (0.52–1.45)	1.11 (0.49–2.49)	0.56 (0.22–1.45)
Low PCP contact	1.59 (0.94–2.70)	1.32 (0.76–2.29)	1.37 (0.58–3.25)	0.88 (0.34–2.25)
Asthma classification				
Persistent	Reference	Reference	Reference	Reference
Intermittent	1.65 (1.23–2.22)*	1.47 (1.07–2.03)‡	5.12 (2.44–10.76)*	3.92 (1.77–8.69)*
CAM ratio				
High CAM ratio	Reference	Reference	Reference	Reference
Low CAM ratio	1.98 (1.42–2.76)*	1.90 (1.31–2.75)*	6.41 (3.99–10.30)*	6.26 (3.54–11.07)*
Sex				
Female	Reference	Reference	Reference	Reference
Male	1.02 (0.78–1.33)	1.10 (0.83–1.46)	1.18 (0.75–1.86)	2.02 (1.19–3.42)*
Age group, y				
2–5	Reference	Reference	Reference	Reference
6–9	1.96 (1.44–2.67)*	2.43 (1.74–3.38)*	2.53 (1.45–4.41)†	4.66 (2.47–8.81)*
10–13	1.89 (1.26–2.82)†	2.59 (1.68–3.97)*	2.67 (1.24–5.76)†	5.07 (2.19–11.70)*
14–17	1.96 (1.08–3.53)‡	2.94 (1.59–5.48)*	1.79 (0.69–4.66)	5.26 (1.74–15.89)†
Race and ethnicity				
White	Reference	Reference	Reference	Reference
Black	1.20 (0.42–3.41)	1.64 (0.47–5.75)	5.78 (2.12–15.72)†	5.55 (1.23–25.08)‡
Hispanic	0.99 (0.30–3.21)	1.33 (0.34–5.28)	2.36 (0.69–8.08)	1.96 (0.36–10.60)
Insurance status				
Private	Reference	Reference	Reference	Reference
Public	0.67 (0.32–1.40)	0.63 (0.26–1.54)	1.72 (0.70–4.24)	0.65 (0.16–2.61)

AOR, Adjusted odds ratio; CAM ratio, controller-to–asthma prescription medication ratio; HE, hospitalization-to–emergency department visit ratio; OR, odds ratio.

* $P < .001$.† $P < .01$.‡ $P < .05$.