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ORIGINAL PAPER

Variables Associated with Emergency Department Utilization by Pediatric Patients with Asthma in a Federally Qualified Health Center

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Abstract
To study variables associated with Emergency Department (ED) utilization among pediatric patients with asthma in a Federally Qualified Health Center (FQHC). We analyzed Electronic Health Record (EHR) data in a retrospective cohort study of patients with asthma between ages 2 and 18 who received primary care at a FQHC. The primary outcome studied was a visit to the ED at Ann and Robert Lurie's Children's Hospital (LCH) for an acute visit related to asthma. Univariate analyses and a multiple logistic regression were performed to study the effect of demographic and clinical variables on ED utilization. Of the 286 patients in the initial EHR query, 200 were included in the final analysis. The median age of subjects in the study cohort was 8.73 years. Patients in the cohort with ED visits averaged 1.32 ED visits in the 15-month period of analysis. The multivariable logistic regression model demonstrated the significant predictors of ED utilization were (1) younger age (OR 0.977, 0.968–0.984, $P < 0.001$), (2) proximity of patient residence to the hospital when compared with their primary care medical home (OR 0.907, 95% CI 0.828–0.992, $P < 0.05$), and (3) absence of an asthma action plan (OR 0.079, 95% CI, 0.016–0.283, $P < 0.001$). Younger age, closer relative proximity of the patient's home to the hospital compared with the clinic, and absence of an asthma action plan were all identified as significant predictors of ED utilization. Sex, ethnicity, language, passive smoke exposure, and insurance status were not statistically significant predictors of ED utilization.

Keywords Asthma · Emergency Department · Action plan

Background

Asthma is the most common chronic disease of childhood, and a significant cause of Emergency Department (ED) utilization among children [1, 2]. Asthma is a chronic condition with acute, episodic exacerbations where preventive strategies may enhance symptom control and disease self-management. The Center for Disease Control and Prevention (CDC) estimated that in 2015, approximately 6.2 million children in the United States had a diagnosis of asthma, and in 2017, there were over 1.6 million ED visits where asthma was the primary diagnosis [1]. Several aspects of acute asthma care can be provided in primary care settings, rather than in the ED. Recent studies identify a need for improvement in efforts to reduce preventable asthma-related ED visits, in part by increasing our knowledge of variables associated with increased ED usage, particularly in populations experiencing disparities [3]. Improved knowledge of the factors associated with ED visits in pediatric patients with asthma may improve strategies to address modifiable risk factors.

Prior studies examining ED utilization have demonstrated higher ED usage associated with two demographic variables—younger age and worse asthma severity [4–7]. Some studies suggest females are more likely to return to the ED within 30 days of a previous visit, while males may be more

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likely to be seen in the ED for non-emergent reasons [4, 8]. Patient residential proximity to hospitals has been shown to be an important driver of adult ED utilization in patients with cardiovascular disease, but knowledge on the magnitude of this effect remains limited in pediatric populations [9].

Asthma education with families is a modifiable risk factor which has been shown to decrease the rates of ED utilization [10]. Asthma action plans (AAP) have been integrated in clinical care recommendations and are used widely in practice [11, 12]. However, some studies have shown that a written AAPs may not change the frequency of ED utilization for asthma in certain populations [13]. Additionally, the efficacy of an AAP in lower-income populations has not been extensively studied, despite literature suggesting that these populations have a higher prevalence of asthma and more frequently utilize ED services for acute care regardless of diagnosis [14, 15]. Another risk factor for an asthma exacerbation is second hand smoke exposure [16, 17]. Research shows passive exposure in a child's home impairs recovery after hospitalization for an asthma exacerbation, thus potentially contributing to increased ED visit frequency [18].

This study addresses gaps in knowledge about these associations between patient, system, and environmental variables with ED usage in children with asthma who receive primary care at a Federally Qualified Health Center (FQHC). In our study, we examined variables among two cohorts of patients receiving care at the same FQHC with a diagnosis of asthma: one group included patients who utilized the ED for an asthma exacerbation, and the other group included patients who were only seen at their location of primary care for asthma exacerbations. We then compared these two cohorts to identify variables that increased the likelihood of a child having an ED visit for acute asthma care. Our hypothesis was that the following variables would be correlated with higher ED utilization: (1) younger age, (2) absence of an AAP, (3) patient home address that is closer proximity to the hospital when compared with the clinic, (4) asthma severity, as demonstrated by the presence of an active controller medication, (5) history of second-hand smoke exposure.

Methods

Patient Recruitment

Our study involved retrospective data analysis of children receiving primary care at an FQHC in Chicago. Clinical data was extracted from an Electronic Health Record (EHR) via manual chart review of visits to the clinic and to the Ann and Robert Lurie Children's Hospital (LCH). The study population included patients between the ages of 2 and 18 years, and the retrospective analysis included data extracted from clinical encounters occurring over a 15-month period from May 2016 to August 2017. Patients were identified through a query for the diagnosis of asthma by ICD-10 lead code J45.X. Additional eligibility criteria included each patient having an office visit to the FQHC within the 15-month study period. Eighty-six patients who fit the criteria above were excluded either due to preexisting pulmonary conditions as listed in Appendix Table 1 or because they were not registered as a patient of the FQHC for a full year as of August 2017. We also excluded patients if they had documented clinical advice in the EHR, whether in-person or via telephone, to seek medication attention in the ED immediately before the patient presented to the LCH ED. Due to variations in documentation of asthma severity classification of intermittent or persistent asthma, we used the presence of a controller medication as listed in Appendix Table 2 as a variable to capture severity; this metric is supported by asthma management guidelines that recommend controller medications for children with an asthma classification that is higher severity than mild intermittent [19]. A total of 200 subjects were included in the study, with 100 patients in each study cohort—one cohort that utilized the ED at LCH during the timeframe of May 2016 to August 2017 for an acute visit, and one cohort that utilized the FQHC but did not utilize the ED at LCH in that same timeframe. The study was approved by the LCH Institutional Review Board as well as the FQHC's Research Evaluation Committee.

Data Collection

The following data elements were collected from the EHR to compare cohort characteristics: (1) age, (2) distance to the clinic identified as the medical home, (3) distance to LCH, (4) ethnicity, (5) sex, (6) active prescription for a controller medication as demonstrated in Appendix Table 2, (7) presence of an AAP in the EHR that had been updated within the past year, (8) insurance coverage, (9) second hand smoke exposure, (10) ED utilization within the timeframe of May 2016–August 2017. We also collected descriptive data elements regarding the time of ED visit to describe the proportion of ED visits that occurred after clinic hours. This was accomplished by comparing the time that the ED provider's encounter note was first opened with the operating hours of the primary care clinic, considering federally recognized holidays. Relative distance from the ED was calculated by subtracting the distance of the patient's residence to the clinic from the distance of the patient's residence to LCH.

Data Analysis

We defined our primary outcome as a visit to the ED for an asthma exacerbation. As a first step, we conducted univariate analyses using t-tests and Chi square tests, as demonstrated in Appendix Table 3. A multiple logistic regression was then performed to account for confounding variables and

further explore predictors of LCH ED visits, which is shown in Appendix Table 4. A LASSO regression was then completed, which demonstrated that the variables of secondhand smoke exposure and insurance status were non-significant and were candidates for removal. Thus, we did not include these variables in our final regression. Results of the final LASSO regression are shown in Appendix Table 5. All analyses were performed using RSTUDIO and R version 0.99.878.

Results

In our study, 60.5% of participants were male and 39.5% were female. 69% of patients were Hispanic, and 38% of patients identified Spanish as their primary language. Medicaid was the insurer of 96.5% of patients. Over half (51%) of ED visits occurred outside of operating business hours of the FQHC. In patients who had utilized the ED during the study period, 63% had been to the ED previously that year. The majority, 63.5%, of the study population were between the ages of 3 and 9 years of age. Less than 1% of the study population were between the ages of 2 and 3.

As summarized in Appendix Table 3, univariate analyses demonstrated significant differences between age, relative distance from LCH, sex, Hispanic ethnicity, presence of an active controller medication prescription, and presence of an asthma action plan amongst the two cohorts. Identifying Spanish as a primary language did not show a significant association with ED utilization.

The results of the final multiple regression are summarized in Appendix Table 5. The regression had a Nagalkerke Pseudo-R^2 value of .517. Older age (OR 0.977; 95% CI 0.968–0.984), location of the patient's residence being closer to the hospital when compared with the clinic (OR 0.907; 95% CI 0.828–0.992), absence of an asthma action plan (OR 0.079; 95% CI 0.016–0.283), and presence of an active prescription for a controller medication (OR 2.556; 95% CI 1.215–5.558) were all significantly associated with increased ED utilization at the 5% confidence level. Sex (OR 0.579; 95% CI 0.270–1.232) and Hispanic ethnicity (OR 1.927; 95% CI 0.778–4.870), despite being significant in the original univariate testing, were not significant predictors of ED utilization in the multiple regression once after controlling for other variables.

Discussion

In this study, we aimed to describe variables associated with increased ED utilization in pediatric patients who receive primary care services at an FQHC. Our study identified several variables that could impact the frequency of ED utilization in this study cohort. We examined the presence of an AAP among patients who use the same FQHC and association with ED utilization. Notably, studies across disparate health systems have previously indicated that poor education about asthma may impact the frequency and nature of utilization of ED services in patients with asthma [20]. A key finding of our study was that the presence of an AAP was significantly associated with fewer ED visits. This suggests that a written plan of symptom management may enhance asthma self-management and knowledge on asthma symptoms that warrant emergent care. Also, an asthma action plan may assist families in promoting better control of symptoms and preventing exacerbations by informing key steps in managing exacerbations before deterioration to a stage that requires an ED level of care [21]. Future studies are needed to understand how patients perceive and use AAPs provided by their primary care providers.

The finding that over half of visits occurred outside of office hours may highlight a potential role for expanded access through virtual visits or expanded office hours to address patient questions regarding acute illness and provided guidance on the criteria for seeking care in an ED. As younger age was associated with higher utilization, targeted education efforts for families with younger children who are diagnosed with asthma on the indications for ED utilization may enhance acute service utilization in the primary care setting.

Having a controller medication on the problem list was significantly correlated with higher ED use in the logistic regression; given that controller medications are prescribed to patients with higher asthma severity, this could be an indication that children with more severe asthma have higher utilization of the ED. Of note, the presence of a controller medication was not significant in the original univariate analysis; it was only significant when all other variables were considered in the logistic multiple regression.

Among patients with persistent asthma, there may be a role for education about the importance of consistent and correct use of controller medications in preventing asthma exacerbations. In clinical practice, there may also be a benefit to implementing processes for scheduled preventive visits for symptom surveillance in patients who have been prescribed a controller medication. Such visits for symptom surveillance are recommended by asthma guidelines to monitor symptoms and educate patients and caregivers [22]. Our study also revealed that several individuals utilized the ED multiple times for asthma-related care within the same calendar year. This finding demonstrates the potential benefit of more extensive asthma education for individuals who frequently utilize ED services.

In our study, the relative proximity of the family's residence to the ED at LCH, when compared with their primary care location, was correlated with higher ED utilization. Although household proximity is not a modifiable variable that can be impacted by the primary care team or clinic, patients who do live farther from the clinic might benefit from additional touch points or diversified outreach efforts to support asthma care such as use of asthma educators, health coaches, or

virtual visits for asthma education and symptom surveillance and identification of children with more severe asthma [23]. Although previous studies identified Hispanic ethnicity as a risk factor for asthma severity, in our cohort, Hispanic ethnicity was not identified as a significant factor in the multiple regression [24]. Future studies should include a larger cohort to better understand the association of demographic variables such as race/ethnicity and sex with ED utilization.

Limitations

Retrospective data capture from an EHR system presented limitations. It was not possible to identify dissemination of AAP in the variety of modes in which they exist; we were only able to identify AAP's captured digitally in the HER platform of the FQHC. We were not able to capture AAP's that may have been developed and disseminated outside of the clinic's EHR. Some clinicians provide AAP's in non-digitized formats outside of the EHR, and some patients may have had been connected to subspecialty services such as Allergists and Pulmonologists who provided them AAP's. This study did not evaluate the severity of asthma exacerbation as a variable predicting presentation to the ED. Since retrospective data was analyzed from clinical settings rather than research settings, the use of standardized documentation codes to identify asthma severity and control was limited. Additionally, a unifying measure of asthma severity was not identifiable among our study cohort; asthma severity classification by ICD codes were not included as a variable in the study due to differences in provider documentation practices and severity. We therefore could only use the presence of a controller as an additional analytic variable as one marker of severity. The same limitation was true for identifying asthma control. Future studies should could include asthma symptom control as well measures of patient adherence to controller medications. Lastly, we could only account for visits to the LCH ED. From past analyses done at this clinic, however, it has been established that the majority of pediatric patients within this FQHC system seek ED services at Lurie Children's Hospital. We were not able to capture ED visits that might have occurred at other hospitals due to lack of available data in the EHR. Future research should also include variables to capture social determinants; data on poverty, transportation, and stress may have provided insights regarding social variables that may be related to ED utilization in underserved pediatric populations.

Conclusion

This study uniquely identifies variables associated with ED utilization among patients who receive primary care at the same FQHC. Our study indicates that variables such as younger age and closer relative proximity of the patient's home to the hospital are associated with higher ED utilization in children with asthma. Documentation of an administered AAP was significantly associated with fewer ED visits in this population. Patients who are younger, live farther from clinic, and who have been prescribed a controller medication may require more frequent outreach than other patients with asthma. Further research including variables such as asthma control and asthma exacerbation severity are needed to better understand additional variables that may drive ED utilization in populations receiving care at FQHCs.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

See Tables 1, 2, 3, 4 and 5.

Table 1 Summary of exclusion criteria

Criteria (ICD-10 codes)
Large airway obstruction (T81.X)
Congenital defects of the lung or trachea (Q32. X, Q33.X)
Benign or malignant tumors of bronchus and lung (C7A.X, D3A.X)
Benign neoplasm of bronchus and lung (D14.3, D38.1)
Bronchiolitis (J21.X)
Cystic fibrosis (E84.X)
Bronchopulmonary dysplasia (P27.1)
Registration as EFHC patient for < 1 year
Age below 2 or above 18
Placed call to FQHC or visited FQHC on day of ED visit

Table 2 Summary of controller medications by drug class

Inhaled corticosteroids (ICS)
Beclomethasone propionate (QVAR)
Budesonide (Pulmicort Turbuhaler or Flexi haler, Pulmicort Respules)
Fluticasone propionate (Flovent HFA, Flovent Diskus)
ICS and long-acting beta agonist combinations
Fluticasone-salmeterol (Advair HFA, Advair Diskus)
Leukotriene antagonists
Montelukast (singulair)

Drugs are displayed as: generic name (trade name)

Table 3 Results of two tailed T-testing or Chi-square analysis for risk factors between the ED and Non-ED cohort

Variable	ED cohort	Non-ED cohort	Pr(>|z|)	
Age (months)[T]	75.48	134.1	< .001	***
Relative distance from LCH (miles)[T]	2.60	4.20	.010	**
Female sex (n)[C]	48	31	.013	**
Hispanic ethnicity (n)[C]	60	78	.006	**
Presence of an AAP (n)[C]	3	35	< .001	***
Presence of controller (n)[C]	56	43	.066	
Spanish primary language (n)[C]	42	34	.244	
Private insurance (n) [C]	3	5	0.241	

**Denotes significance at the 5% confidence level

***Denotes significance at the 1% confidence

[T]Denotes T-testing analysis for continuous variables

[C]Denotes Chi-Square analysis for categorical variables

Table 4 Results of multiple regression with all variables included

Variable	Coefficient	Pr(>|z|)	Odds ratio (2.5%–97.5%)	
(Intercept)	2.392	< .001	10.932 (3.495–37.496)	***
Age	− 0.025	< .001	0.975 (0.967–0.983)	***
Relative distance from LCH	− 0.010	0.033	0.904 (0.825–0.989)	**
Female sex	− 0.485	0.156	0.615 (0.284–1.324)	
Hispanic ethnicity	0.657	0.159	1.927 (0.778–4.870)	
Presence of an AAP	− 2.530	< .001	0.079 (0.016–0.291)	***
Presence of controller	0.950	0.015	2.585 (1.222–5.661)	**
Spanish-speaking	0.284	0.428	1.328 (0.546–3.256)	
Secondhand smoke	− 0.592	0.423	0.553(0.127–2.385)	
Private insurance	− 1.135	0.209	0.321(0.050–1.970)	

Odds ratios are displayed as the average and then a 2.5–97.5% confidence interval

**Denotes significance at the 5% confidence level

***Denotes significance at the 1% confidence

Table 5 Results of final Lasso Regression without secondhand smoke exposure and insurance status

Variable	Coefficient	Pr(>|z|)	Odds ratio (2.5%–97.5%)	
(Intercept)	2.183	<.001	8.869 (3.000–28.601)	***
Age	− 0.023	<.001	0.977 (0.968–0.984)	***
Relative distance from LCH	− 0.097	0.033	0.907 (0.828–0.992)	**
Female sex	− 0.547	0.156	0.579 (0.270–1.232)	
Hispanic ethnicity	0.656	0.159	1.927 (0.778–4.870)	
Presence of an AAP	− 2.542	< .001	0.079 (0.016–0.283)	***
Presence of controller	0.938	0.015	2.556 (1.215–5.558)	**
Spanish-speaking	0.352	0.428	1.422 (0.597–3.432)	

Odds ratios are displayed as the average and then a 2.5–97.5% confidence interval

**Denotes significance at the 5% confidence level

***Denotes significance at the 1% confidence

References

1. Control CfD. Most recent asthma data. 2017.
2. Pearson, W. S., Goates, S. A., Harrykissoon, S. D., & Miller, S. A. (2014). State-based Medicaid costs for pediatric asthma emergency department visits. *Preventing Chronic Disease, 11*, E108. https://doi.org/10.5888/pcd11.140139.
3. Soril, L. J., Leggett, L. E., Lorenzetti, D. L., Noseworthy, T. W., & Clement, F. M. (2015). Reducing frequent visits to the emergency

department: A systematic review of interventions. *PLoS ONE, 10*(4), e0123660. https://doi.org/10.1371/journal.pone.0123660.
4. Nath, J. B., & Hsia, R. Y. (2015). Children's emergency department use for asthma, 2001–2010. *Academic Pediatrics, 15*(2), 225–230. https://doi.org/10.1016/j.acap.2014.10.011.
5. Dondi, A., Calamelli, E., Piccinno, V., et al. (2017) Acute asthma in the pediatric emergency department: Infections are the main triggers of exacerbations. *BioMed Research International, 2017*, 9687061. https://doi.org/10.1155/2017/9687061.
6. Hasegawa, K., Sullivan, A. F., Tovar Hirashima, E., et al. (2014) A multicenter observational study of US adults with acute asthma: Who are the frequent users of the emergency department? *The Journal of Allergy and Clinical Immunology. In Practice, 2*(6), 733–740. https://doi.org/10.1016/j.jaip.2014.06.012.
7. Adams, R. J., Smith, B. J., & Ruffin, R. E. (2000). Factors associated with hospital admissions and repeat emergency department visits for adults with asthma. *Thorax, 55*(7), 566–573.
8. Rosychuk, R. J., Ospina, M., Zhang, J., Leigh, R., Cave, A., & Rowe, B. H. (2017) Sex differences in outcomes after discharge from Alberta emergency departments for asthma: A large population-based study. *The Journal of Asthma: Official Journal of the Association for the Care of Asthma. 2017*, 1–9. https://doi.org/10.1080/02770903.2017.1373805.
9. Bergeron, P., Courteau, J., & Vanasse, A. (2015). Proximity and emergency department use: Multilevel analysis using administrative data from patients with cardiovascular risk factors. *Canadian Family Physician Medecin de Famille Canadien, 61*(8), e391–e397.
10. Williams, K. W., Word, C., Streck, M. R., & Titus, M. O. (2013). Parental education on asthma severity in the emergency department and primary care follow-up rates. *Clinical Pediatrics, 52*(7), 612–619. https://doi.org/10.1177/0009922813479163.
11. Khan, R., Maharaj, R., Seerattan, N., & Babwah, F. (2014). Effectiveness of personalized written asthma action plans in the management of children with partly controlled asthma in Trinidad: A randomized controlled trial. *Journal of Tropical Pediatrics, 60*(1), 17–26. https://doi.org/10.1093/tropej/fmt063.
12. Gibson, P. G., & Powell, H. (2004). Written action plans for asthma: An evidence-based review of the key components. *Thorax, 59*(2), 94–99.
13. Sheares, B. J., Mellins, R. B., Dimango, E., et al. (2015) Do patients of subspecialist physicians benefit from written asthma action plans? *American Journal of Respiratory and Critical Care Medicine, 191*(12), 1374–1383. https://doi.org/10.1164/rccm.201407-1338OC.
14. Akinbami, L. J., Moorman, J. E., Simon, A. E., & Schoendorf, K. C. (2014). Trends in racial disparities for asthma outcomes among children 0 to 17 years, 2001–2010. *The Journal of Allergy and Clinical Immunology, 134*(3), 547 – 53.e5. https://doi.org/10.1016/j.jaci.2014.05.037.
15. Akinbami, L. J., Simon, A. E., & Rossen, L. M. (2016) Changing trends in asthma prevalence among children. *Pediatrics*. https://doi.org/10.1542/peds.2015-2354.
16. Strickland, M. J., Klein, M., Flanders, W. D., et al. (2014). Modification of the effect of ambient air pollution on pediatric asthma emergency visits: Susceptible subpopulations. *Epidemiology (Cambridge, Mass.), 25*(6), 843–850. https://doi.org/10.1097/ede.0000000000000170.
17. Chilmonczyk, B. A., Salmun, L. M., Megathlin, K. N., et al. (1993). Association between exposure to environmental tobacco smoke and exacerbations of asthma in children. *The New England journal of medicine, 328*(23), 1665–1669. https://doi.org/10.1056/nejm199306103282303.
18. Abulhosn, R. S., Morray, B. H., Llewellyn, C. E., & Redding, G. J. (1997). Passive smoke exposure impairs recovery after hospitalization for acute asthma. *Archives of Pediatrics & Adolescent Medicine, 151*(2), 135–139.
19. Expert Panel Report 3 (EPR-3). (2007). Guidelines for the diagnosis and management of asthma-summary report 2007. *The Journal of Allergy and Clinical Immunology, 120*(5 Suppl), S94–S138. https://doi.org/10.1016/j.jaci.2007.09.043.
20. Al-Muhsen, S., Horanieh, N., Dulgom, S., et al. (2015). Poor asthma education and medication compliance are associated with increased emergency department visits by asthmatic children. *Annals of Thoracic Medicine, 10*(2), 123–131. https://doi.org/10.4103/1817-1737.150735.
21. Kuhn, L., Reeves, K., Taylor, Y., et al. (2015). Planning for action: The impact of an asthma action plan decision support tool integrated into an electronic health record (EHR) at a large health care system. *Journal of the American Board of Family Medicine: JABFM, 28*(3), 382–393. https://doi.org/10.3122/jabfm.2015.03.140248.
22. Lee, M. G., Cross, K. J., Yang, W. Y., Sutton, B. S., & Jiroutek, M. R. (2016). Frequency of asthma education in primary care in the years 2007–2010. *The Journal of Asthma: Official Journal of the Association for the Care of Asthma, 53*(2), 220–226. https://doi.org/10.3109/02770903.2015.1087024.
23. Campbell, J. D., Brooks, M., Hosokawa, P., Robinson, J., Song, L., & Krieger, J. (2015). Community health worker home visits for medicaid-enrolled children with asthma: Effects on asthma outcomes and costs. *American Journal of Public Health, 105*(11), 2366–2372. https://doi.org/10.2105/ajph.2015.302685.
24. Keet, C. A., McCormack, M. C., Pollack, C. E., Peng, R. D., McGowan, E., & Matsui, E. C. (2015). Neighborhood poverty, urban residence, race/ethnicity, and asthma: Rethinking the inner-city asthma epidemic. *The Journal of Allergy and Clinical Immunology, 135*(3), 655–662. https://doi.org/10.1016/j.jaci.2014.11.022.