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ORIGINAL RESEARCH

Emergency Medical Services

Examination of disparities in prehospital encounters for pediatric asthma exacerbations

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Abstract

Introduction: There are disparities in multiple aspects of pediatric asthma care; however, prehospital care disparities are largely undescribed. This study's objective was to examine racial and geographic disparities in emergency medical services (EMS) medication administration to pediatric patients with asthma.

Methods: This is a substudy of the Early Administration of Steroids in the Ambulance Setting: An Observational Design Trial, which includes data from pediatric asthma patients ages 2–18 years. We examined rates of EMS administration of systemic corticosteroids and inhaled bronchodilators by patient race. We geocoded EMS scene addresses, characterized the locations' neighborhood-based conditions and resources

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Prior presentations: Portions of this study were submitted for and presented as an abstract at the National Association of EMS Physicians 2023 annual conference.

Clinical trials registration: Early Administration of Steroids in the Ambulance Setting: An Observational Design Trial (EASI AS ODT, ClinicalTrials.gov NCT03962894).

relevant to children using the Child Opportunity Index (COI) 2.0, and analyzed associations between EMS scene address COI with medications administered by EMS.

Results: A total of 765 patients had available racial data and 825 had scene addresses that were geocoded to a COI. EMS administered at least 1 bronchodilator to 84.7% (n = 492) of non-White patients and 83.2% of White patients (n = 153), P = 0.6. EMS administered a systemic corticosteroid to 19.4% (n = 113) of non-White patients and 20.1% (n = 37) of White patients, P = 0.8. There was a significant difference in bronchodilator administration between COI categories of low/very low versus moderate/high/very high (85.0%, n = 485 vs. 75.9%, n = 192, respectively, P = 0.003).

Conclusions: There were no racial differences in EMS administration of medications to pediatric asthma patients. However, there were significantly higher rates of EMS bronchodilator administration for encounters in low/very low COIs. That latter finding may reflect inequities in asthma exacerbation severity for patients living in disadvantaged areas.

KEYWORDS
asthma, Child Opportunity Index, emergency medical services, health disparities, pediatric

1 | INTRODUCTION

1.1 | Background

Pediatric asthma is a major public health issue in the United States, affecting over 4 million children, nearly half (42%) of whom experience at least 1 asthma exacerbation per year.[1] Unfortunately, there are racial and ethnic disparities in asthma incidence, exacerbations, emergency department (ED) visits, and hospitalizations.[2] Specifically, Black and Hispanic children are at increased risk for developing asthma and experiencing asthma-related ED or urgent health care visits compared to non-Hispanic White children.[3,4] Black children also experience higher mortality rates from asthma, with over twice as many asthma deaths in 2020 as White children.[5] Additionally, there are socioeconomic and geographic disparities in pediatric asthma incidence and exacerbations.[6] Living in a disadvantaged neighborhood, an area with a history of redlining, and areas with a high air pollution burden have all been associated with increased ED visits for pediatric asthma and poor asthma outcomes for children.[6–9] Furthermore, rural areas have higher rates of hospitalization for pediatric asthma.[10]

1.2 | Importance

Emergency medical services (EMS) are an important component of the emergency care continuum for children with asthma. Of the approximately 1 million pediatric patients treated every year by EMS,[11,12] asthma exacerbations account for ~15% of those encounters,[13] and albuterol is the most frequently administered prehospital medication by EMS to children.[13] For children with an asthma exacerbation first treated by EMS clinicians, there exists an opportunity for early administration of inhaled bronchodilators and systemic corticosteroids before ED arrival, and the National Model EMS Clinical Guidelines for asthma recommend EMS administration of both of those medications.[14]

1.3 | Goals of this investigation

Prior prehospital-specific research has revealed racial and ethnic disparities in the EMS administration of medications for other non-asthma conditions. In a retrospective analysis of the National Emergency Services Information System (NEMSIS) for painful conditions, Black patients were less likely to receive pain medication from EMS than other racial groups.[15] Yet it is not known if disparities exist in the prehospital incidence and management of children with acute asthma exacerbations. Therefore, the objective of this study was to examine racial, ethnic, and geographic (ie, community resources and conditions relevant to children) disparities in the prehospital incidence of and EMS medication administration to pediatric asthma patients experiencing an acute asthma exacerbation.

2 | METHODS

2.1 | Study design and setting

This is a substudy of the Early Administration of Steroids in the Ambulance Setting: An Observational Design Trial (EASI AS ODT, ClinicalTrials.gov NCT03962894), whose methods have been published previously.[16] EASI AS ODT is an observational, non-randomized, stepped wedge trial examining whether EMS administration of systemic corticosteroids to pediatric asthma patients decreases hospital

admissions. EASI AS ODT included data from 7 EMS agencies serving different urbanicities and populations from 2013–2022 (see Table 1 for agency and population characteristics). The EASI AS ODT study was approved by the University of Florida Institutional Review Board.

2.2 | Selection of subjects and interventions

EASI AS ODT and this substudy include 2 years of data from each EMS agency: 1 year before and 1 year after each agency adopted an oral systemic corticosteroid option in their standard operating protocols for the prehospital treatment of pediatric asthma exacerbations. Before that adoption of an oral systemic corticosteroid, all agencies in the study had intravenous systemic corticosteroids included in their protocols. Agencies provided data from the prehospital electronic patient care record and linked ED outcomes (ie, patient disposition). We included encounters for patients ages 2–18 years who had EMS documentation of wheezing and/or an asthma exacerbation and/or an ED diagnosis of an asthma exacerbation. We excluded cardiac arrests, respiratory arrests, and intubations as they follow different EMS protocols with prioritization of different medications. We also excluded interfacility transfers, patients who were not transported to an ED, and patients for whom ED outcomes could not be ascertained.

2.3 | Outcomes and measurements

In this analysis, we examined the associations between patient race, ethnicity, and EMS scene address characteristics with the patient's asthma exacerbation severity and EMS administration of inhaled bronchodilators and systemic corticosteroids. We also examined the incidence of prehospital encounters by race as compared to the baseline population demographic data. We extracted patient race and ethnicity as recorded by the EMS clinician or in the linked ED data (ie, clinician-reported race or ethnicity, not patient-reported race or ethnicity). We divided race into 2 categories: White and non-White. We included any inhaled beta-2-agonist for inhaled bronchodilators and included oral, intramuscular, and intravenous systemic corticosteroids (eg, prednisone and its oral derivatives, methylprednisolone, and dexamethasone). Both inhaled bronchodilators and systemic corticosteroids were included in all 7 EMS agencies' standard operating protocols for the treatment of pediatric asthma exacerbations.

The Bottom Line

In this study of 841 children with asthma encountered by 7 emergency medical services agencies, 85% of children in disadvantaged areas received prehospital bronchodilators compared to 76% of those in less disadvantaged areas. These results highlight an important inequity in disease severity and the importance of considering social determinants of health in medicine.

We used the 2015 Child Opportunity Index 2.0 (COI v 2.0) to characterize the EMS scene address in a manner salient for the examination of disparities.[17] The COI, developed by diversitydatakids.org in collaboration with the Kirwan Institute, defines "opportunity" as "neighborhood-based conditions and resources conducive to healthy child development."[18] The COI is a composite index that ranks census tracts within metropolitan areas on a 5-point ordinal scale from very low to very high, with very high signifying greater opportunity. The COI includes 29 indicators from 3 domains: (1) education, (2) health and environment, and (3) social and economic. We chose the COI over other geographic-based composite indices of neighborhood quality given its inclusion of indicators relevant to pediatric patients (eg, education). Additionally, in a prior study of 1 Ohio metropolitan area, the COI was associated with population-level asthma morbidity.[19]

There is no widely validated or adopted prehospital-specific pediatric asthma severity score. Therefore, to assess the severity of asthma exacerbations, we used a score we previously developed for a statewide study of EMS treatment of pediatric patients with asthma.[20] That score was further adapted for this study's available data and divides patients into mild, moderate, and severe/critical categories

TABLE 1 Participating EMS agency characteristics.

Agency location	EMS or fire-EMS	Urbanicity	Population served[2]	Population under 18 years of age[b]	Persons in poverty[b]	Non-White race[b]	Hispanic or Latino ethnicity[b]
Houston, TX	Fire-EMS	Urban/suburban	4,780,913	26%	16%	31%	44%
Cincinnati, OH[a]	Both	Urban/suburban	825,037	23%	16%	33%	4%
Nassau County, FL	Fire-EMS	Suburban/rural	97,899	20%	10%	10%	5%
Lee County, FL	EMS	Urban/suburban	822,453	17%	12%	14%	24%
Walton County, FL	Fire-EMS	Rural	83,304	21%	12%	10%	7%
Leon County, FL	EMS	Urban/suburban	297,369	19%	16%	39%	7%
Sarasota County, FL	Fire-EMS	Urban/suburban	462,286	14%	9%	9%	10%

Abbreviation: EMS, emergency medical services.

[a]Cincinnati, Ohio data represents a collection of agencies that follow a regional protocol.

[b]Per 2020 US Census.

TABLE 2 Prehospital pediatric asthma exacerbation severity scoring[20].

	Mild	Moderate	Severe/critical
Respiratory rate (breaths per minute)			
2–5 years	10–29	30–40	>40 or <10
6–11 years	10–24	25–35	>35 or <10
12–18 years	10–19	20–30	>30 or <10
Pulse oximetry	>95%	90%–95%	<90%

Note: If either respiratory rate or pulse oximetry are missing, then the other measure is used to score. If respiratory rate and pulse oximetry place the patient in different categories, the higher severity category is assigned.

based on age-adjusted respiratory rate[21] and pulse oximetry readings (see Table 2 for severity score parameters).

2.4 | Statistical and geospatial analyses

For descriptive analyses, we calculated frequencies and percentages for categorical data and median and interquartile range for continuous data, as most continuous data was non-normally distributed. We treated the severity score and the COI ranking as an ordinal variable. Due to the relatively small number of patients from Nassau County, Florida and Walton County, Florida, and their similar urbanicities (ie, rural), we combined those 2 agencies' data into a "rural" agency. For univariate analyses of categorical data, we applied the chi-square test or Fisher exact test when any expected or actual cell count was <5. For univariate analyses of continuous data, we applied the Wilcoxon Rank Sum test for 2-sample comparisons and the Kruskal–Wallis rank sum test for variables with 3 or more levels. For missing data (eg, race, ethnicity) we did not perform any imputation, as it was unknown if data were missing at random.

We geocoded patients based on scene address location using ArcGIS Pro 3.1 software (Redlands, CA: Environmental Systems Research Institute, Inc., 2023) and a 2020 HERE street network data set.[22] To make demographic comparisons between patients and the underlying population within COI category groupings, we joined demographic characteristics from the patient data set, tract-level 2015 American Community Survey (ACS) 5-year estimate data set,[23] and the COI[24] to 2010 census tracts[25] based on spatial location or Census geographic identifier. We then calculated summary statistics for both the patient and population demographic variables within groups based on the COI rankings.

We created maps to visualize the spatial patterns of patient characteristics in relation to COI within each agency study area. For the patient characteristics layers, EMS scene locations were aggregated into visual clusters and symbolized based on size and color. Symbols sizes show the number of scene locations occurring within a cluster, with larger symbols representing a greater number of patient scene locations. Symbol color represents the magnitude of summary statistics of patient characteristics that were calculated for each cluster. The patient characteristics layers were overlaid on top of COI census tracts, which were symbolized according to COI rankings.

3 | RESULTS

3.1 | Characteristics of study participants

After excluding 30 patients for missing outcomes (25 from Leon County, 2 from Sarasota County, and 3 from Lee County), 841 patients met final inclusion criteria and 59% were male, 62.7% were African American or Black, and 13.0% were Hispanic or Latino, with a median age of 8 years (Table 3). Over 80% of patients were of mild or moderate severity. EMS administered at least 1 bronchodilator in 82.3% of encounters, administering a systemic corticosteroid in only 20.9% of encounters. A total of 825 patients were geocoded (98.1%); the remainder of patients could not be geocoded due to missing or erroneous address information. Over half (51.1%) of EMS scene addresses were in census tracts with a very low COI ranking. There were statistically significant differences in all the analyzed baseline characteristics by EMS agency, except for male sex (Table 3). Of note, ethnicity was missing for 44.7% of encounters, precluding further analyses by ethnicity.

3.2 | Main results

With regard to medication administration, there was no significant difference in EMS administration of bronchodilators or systemic corticosteroids to White versus non-White race patients (Table 4). There was also no statistically significant difference in the administration of either medication by race when accounting for the patient's asthma exacerbation severity (Table S1). There was a statistically significant difference in bronchodilator administration between COI categories of low/very low versus moderate/high/very high (85.0% vs. 75.9%, respectively, $P = 0.003$, Table 4), with a higher proportion of bronchodilators administered to patients with scene encounters in a low or very low COI. There was no significant difference in systemic corticosteroid administration by COI (Table 4). When asthma exacerbation severity categories were analyzed separately, there was also a statistically significant difference in bronchodilator administration for moderate severity patients ($P = 0.002$), with 87% of patients in a low or very low COI receiving at least 1 inhaled bronchodilator, compared to 72% in moderate, high, or very high COIs ($P = 0.002$).

3.3 | Geospatial results

When looking at the incidence of EMS encounters for pediatric asthma exacerbations by race, there was a proportionally higher number of EMS encounters with patients of non-White race in low or very low COIs overall (Table 5, 83.7%, $n = 449$ non-White patients vs. 16.2%, $n = 87$ White patients). Additionally, the proportion of study patients overall of non-White race involved in EMS scene encounters in low or very low COIs was much higher than the baseline non-White population <18 years of age in those COIs (83.7% study sample vs. 57% baseline per 2015 ACS, $P < 0.001$). Mapping EMS

TABLE 3 Pediatric asthma patient and EMS encounter characteristics.

	Overall *N* = 841	Cincinnati, OH *N* = 271	Houston, TX *N* = 268	Lee County, FL *N* = 137	Leon County, FL *N* = 99	Sarasota County, FL *N* = 46	Rural counties, FL *N* = 20	*P* value
Male % (*n*)	59.0% (496)	58.0% (157)	61.2% (164)	54.7% (75)	62.6% (62)	50.0% (23)	75.0% (15)	0.30
Race % (*n*)								<0.001
African-American or Black	62.7% (527)	75.6% (205)	67.2% (180)	36.5% (50)	79.8% (79)	19.6% (9)	20.0% (4) 70.0	
White	21.8% (184)	18.8% (51) 5.5%	17.5% (47)	32.1% (44)	14.1% (14)	30.4% (14)	(14) 5.0	
Other	6.4% (54)		11.2% (30)	5.1% (7)	0.1% (1)	0		
Ethnicity % (*n*)								<0.001
Hispanic or Latino	13.0% (109)	2.2% (6)	25.0% (67)	22.6% (31)	2.0% (2)	6.5% (3)	0% (0)	
Non-Hispanic or Latino	42.3% (356)	97.8% (265)	32.5% (87)	2.9% (4)	0% (0)	0% (0)	0% (0)	
Age in years, median (IQR)	8 (5–12)	8 (5–12)	7 (4–11)	8 (4–12)	7 (4–11)	9.5 (6–15)	5.5 (4–9)	0.008
Asthma exacerbation severity								<0.001
Mild	39.7% (334)	49.8% (135)	41.4% (111)	29.9% (41)	30.3% (30)	30.4% (14)	15.0% (3)	
Moderate	40.7% (342)	37.6% (102)	40.7% (109)	37.2% (51)	46.5% (46)	47.8% (22)	60.0% (12)	
Severe/critical	16.8% (142)	9.6% (26)	14.2% (38)	31.4% (43)	21.2% (21)	21.7% (10)	20.0% (4)	
EMS medication administration								
>/ = 1 bronchodilator	82.3% (692)	86.0% (233)	84.3% (226)	75.2% (103)	86.9% (86)	65.2% (30)	70.0% (14)	<0.001
Any systemic corticosteroid	20.9% (176)	5.2% (14)	26.8% (72)	24.8% (34)	31.3% (31)	47.8% (22)	15.0% (3)	<0.001
Childhood Opportunity Index								<0.001
Very low	51.1% (430)	52.0% (141)	57.8% (155)	48.9% (67)	49.4% (49)	19.6% (9)	45.0% (9)	
Low	16.9% (142)	21.7% (59)	19.4% (52)	6.6% (9)	16.2% (16)	8.7% (4)	10.0% (2)	
Moderate	13.7% (115)	14.0% (38)	9.0% (24)	21.2% (29)	8.2% (8)	23.9% (11)	25.0% (5)	
High	9.8% (82)	5.3% (14)	7.8% (21)	15.3% (21)	10.1% (10)	26.0% (12)	20.0% (4)	
Very high	6.8% (56)	4.2% (11)X	5.6% (15)	3.8% (5)	15.1% (15)	21.7% (10)	0% (0)	

Note: Some variables contain missing data when counts do not add up to site or overall *N*. Overall, for gender *N* = 2 (<1%) missing, for race *N* = 76 (9%) missing, for ethnicity *N* = 376 (44.7%) missing, for asthma exacerbation severity *N* = 2%) 23 (2.7%) missing, and for Childhood Opportunity Index *N* = 16 (2%) missing.
Abbreviations: EMS, emergency medical services; IQR, interquartile range.

TABLE 4 EMS medication administration by race and Childhood Opportunity Index.

	Race *N* = 765			COI *N* = 825		
EMS medication administration	Non-White	White	*P* value	COI low/very low	COI moderate/ high/very high	*P* value
>/ = 1 Bronchodilator			0.6			0.003
No	15.3% (89)	16.8% (31)		15.2% (87)	24.1% (61)	
Yes	84.7% (492)	83.2% (153)		85.0% (485)	75.9% (192)	
Systemic corticosteroid			0.8			0.5
No	80.6% (468)	80.0% (147)		79.5% (455)	77.5% (196)	
Yes	19.4% (113)	20.1% (37)		20.5% (117)	22.5% (57)	

Abbreviations: COI, Childhood Opportunity Index; EMS, emergency medical services.

TABLE 5 EMS encounter incidence by race and COI.

	Study sample overall ($N = 825$)	Study sample low/very low COI ($N = 572$)	Study sample moderate/high/very high COI ($N = 253$)	*P* value[a]
Race				<0.001
Non-White	572 (76.0%)	449 (83.7%)	123 (56.9%)	
White	180 (23.9%)	87 (16.2%)	93 (43.1%)	
Missing	73	36	37	

Abbreviations: COI, Childhood Opportunity Index; EMS, emergency medical services.
[a]Fisher exact test.

encounter incidence by asthma exacerbation severity and scene address COI revealed that more severe and frequent encounters were located mostly in low or very low COI areas across all 7 sites (Figure 1 A–G).

4 | LIMITATIONS

This study has limitations that merit consideration. Race and ethnicity were recorded by EMS or ED clinicians and are not patient reported. The a priori asthma severity score used may not fully capture asthma exacerbation severity, as it does not include subjective assessments of work of breathing, wheezing, and so forth. We intentionally chose the COI as a measure of opportunity for this pediatric-specific study, as its composite score includes elements salient to childhood development (eg, education). However, there are other geographic-based composite scores that represent opportunity, which may or may not have similar values for the studied areas as the COI. This study did not analyze ethnicity due to a large number of missing values, and it could not be judged whether missingness was or was not random. One reason that ethnicity data may be frequently missing is that ethnicity data is merged with race in the NEMSIS version 3.4.0 a combined variable, and NEMSIS is a national EMS data standard followed by most EMS agencies.[26] We geocoded the EMS encounter scene address, which is not necessarily the same as the patient's home address, and there may be differences in COI between the two. However, a previous study by our team found that nearly two thirds of scene addresses were either homes or schools, indicating that the COI is likely to be representative of the patient's home living environment.[20] Additionally, we found a low rate of systemic corticosteroid use, which may limit the comparison of differences in its administration rate by race. Further to this, different education and training among the 7 participating EMS agencies may have contributed to differences in medication administration rates.

5 | DISCUSSION

In this study of disparities in prehospital incidence and EMS medication administration for pediatric patients with asthma exacerbations, we found no significant racial differences in medication administration. However, we did find significantly higher rates of bronchodilator administration in EMS encounters with scene addresses in low and very low COI areas. Additionally, we found population-based disparities in the incidence of prehospital asthma encounters, specifically a high proportion of non-White patient encounters in low and very low COIs when compared to the study population overall, and when compared to those areas' baseline non-White pediatric population per the 2015 ACS.

In the United States, the burden of asthma is disproportionately endured by racial and ethnic minority groups and the economically disadvantaged.[1] To date, there have been no known prior studies examining EMS disparities in care for pediatric patients with asthma exacerbations. Our study found no significant difference in the EMS administration of bronchodilators or systemic corticosteroids to White and non-White race children. In addition, there was no statistically significant difference in the administration of bronchodilators or systemic corticosteroids by race when accounting for the asthma exacerbation severity. That finding is limited only to race, however, as data for ethnicity were not able to be analyzed, given 44.7% of encounters had missing ethnicity data.

Future studies intentionally incorporating ethnicity are therefore warranted, given that multiple prior prehospital pain studies have found EMS disparities in care when analyzing both race and ethnicity, particularly with regard to medication administration.[14,15,27] In a prospective study evaluating the impact of race and ethnicity on prehospital opioid administration for injured children across a diverse network of EMS agencies and hospitals, results suggested the possibility that Black and Hispanic patients were less likely to receive opioid medications compared with White patients.[15] However, those findings were not statistically significant due to smaller numbers and wide conference intervals. A study evaluating disparities in prehospital nontraumatic pain management found that Black patients were less likely than White patients to receive pain medications and receive pain medication within 20 min; however, Hispanic patients were more likely to receive pain medications.[27]

This study identified significantly higher rates of EMS administration of bronchodilators for children with acute asthma exacerbations in a low or very low COI area compared to a moderate or high COI area. However, the study found no significant difference in systemic corticosteroid administration by COI. When accounting for asthma exacerbation severity, there was a statistically significant difference

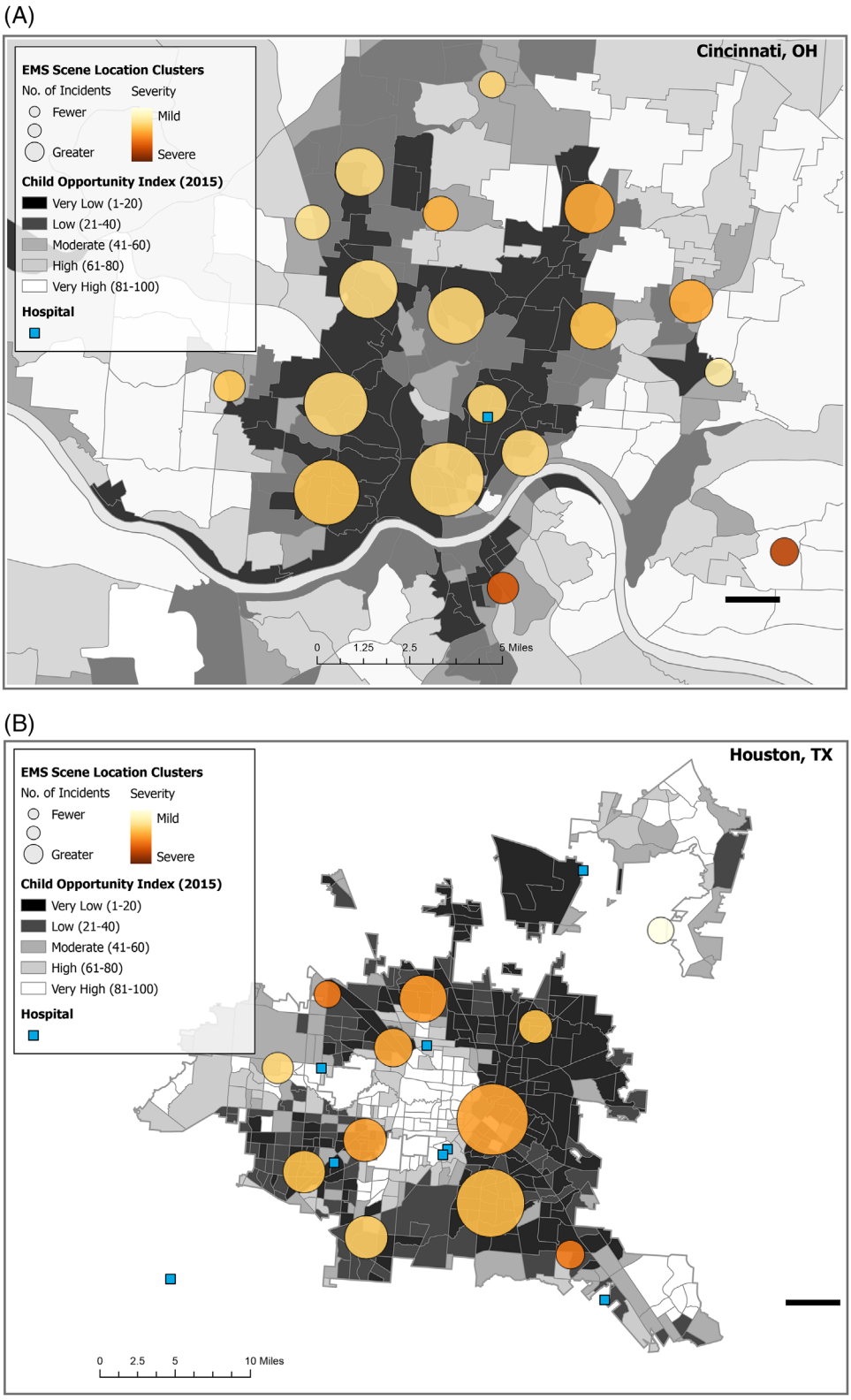
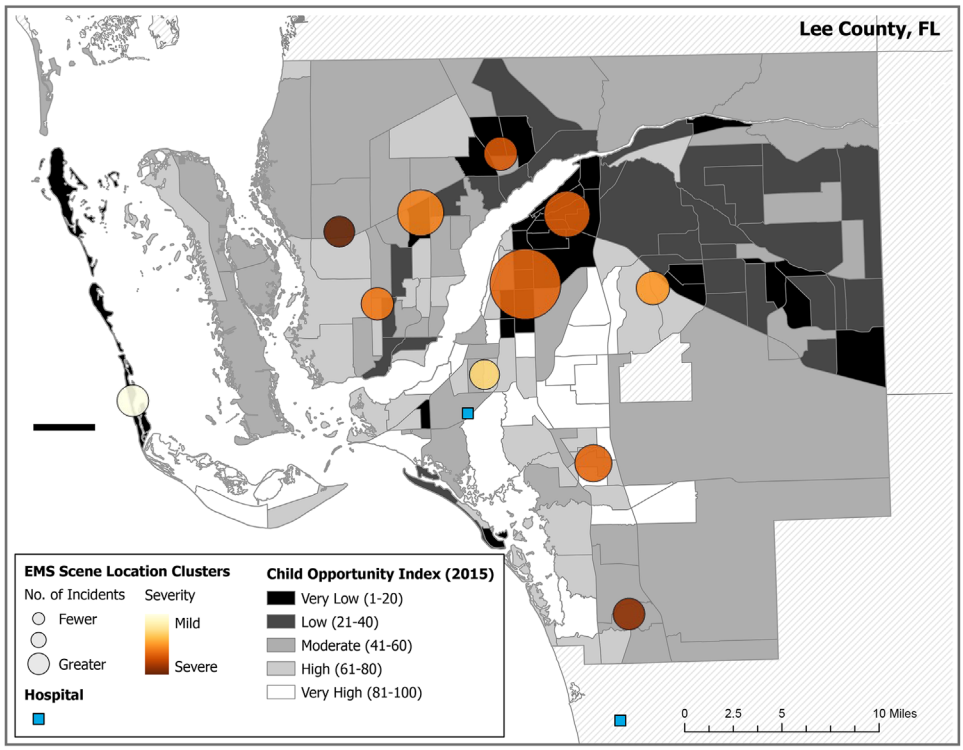


FIGURE 1 EMS encounter incidence, asthma exacerbation severity, and scene address COI maps (A) Cincinnati, OH. (B) Houston, TX. (C) Lee County, FL. (D) Leon County, FL. (E) Sarasota County, FL. (F) Nassau County, FL. (G) Walton County, FL. Abbreviations: COI, Child Opportunity Index; EMS, emergency medical services.

(C)



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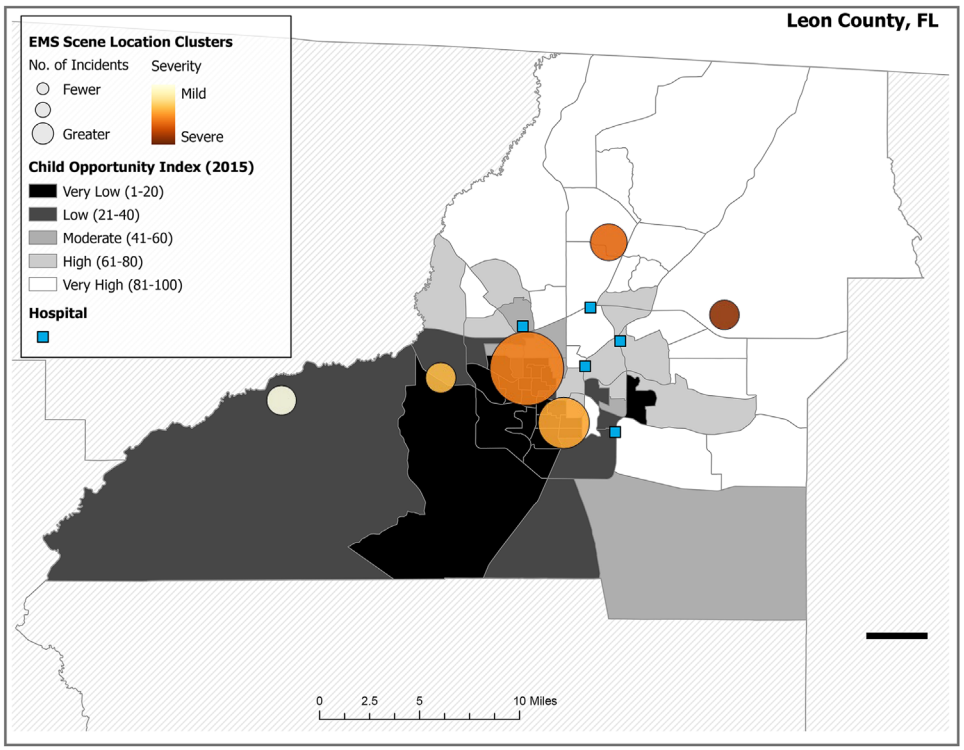

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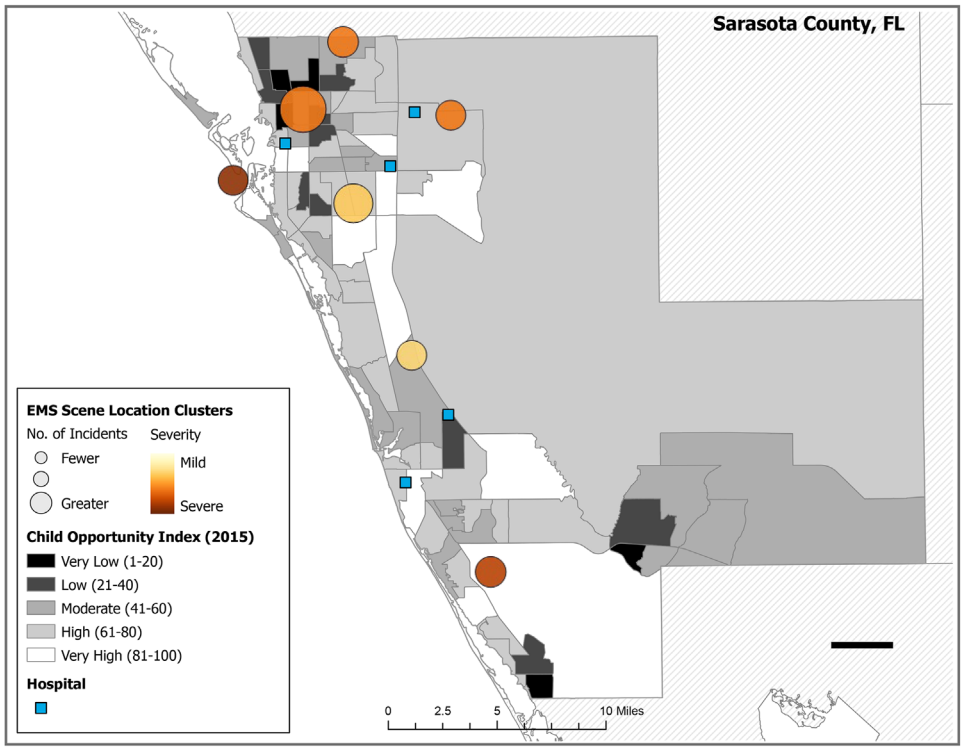

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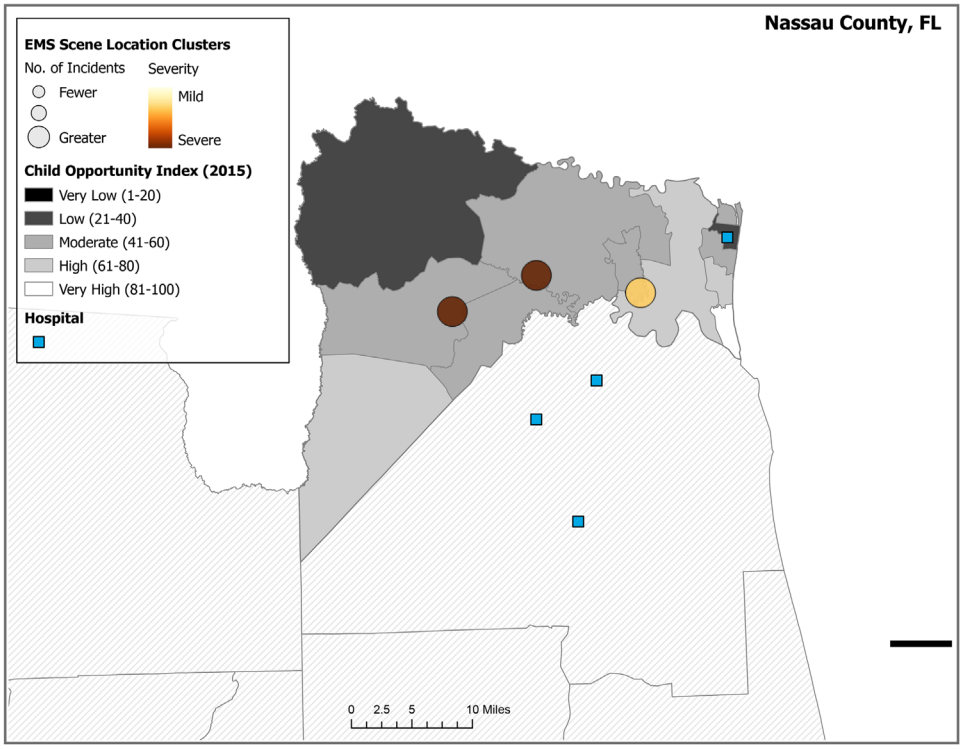

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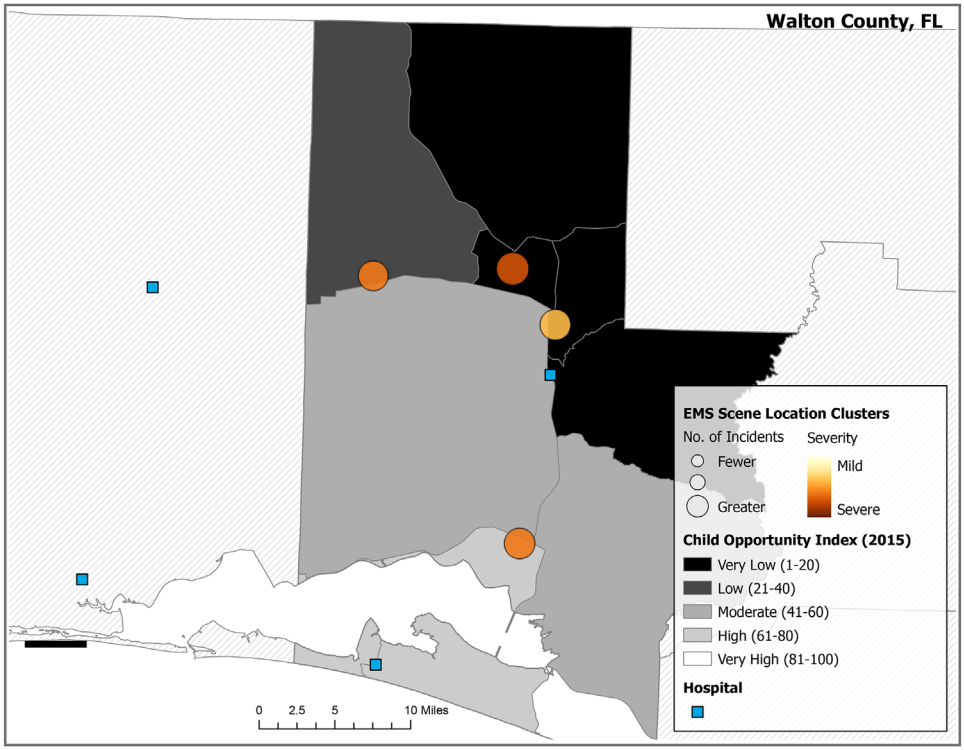

FIGURE 1 Continued

in bronchodilator administration by EMS for patients with moderate severity exacerbations, with 87% in a low or very low COI receiving at least 1 bronchodilator compared to 72% in a moderate, high, or very high COIs. Numerous potential reasons for increased bronchodilator administration for patients in areas of lower COI exist, including lack of available bronchodilators for treatment at home, EMS clinician concern for lack of prior treatments or access to care, and/or further distance from destination hospitals. EMS protocols for agencies in this study specify that bronchodilators should be given for an asthma exacerbation, and after each agency changed their protocols to include oral systemic corticosteroids, systemic corticosteroids should also have been administered to all pediatric patients with asthma exacerbations. However, overall compliance with EMS protocols is rarely 100%, and thus non-protocol factors such as those may play a role in administering medications. Additionally, the data analyzed contain a year where systemic corticosteroids were not mandated in protocols for all pediatric patients with asthma, which may also explain the low systemic corticosteroid administration rate.

Other reasons for differences in management by COI include baseline health disparities present in lower COI areas, resulting in more frequent exacerbations and contact with EMS, reinforcing prehospital clinicians' administration of fast-acting bronchodilators. This is supported by our findings of increased proportions of EMS encounters for non-White patients in low or very low COI areas compared to the baseline population of non-White children in those areas. Prior studies have shown COI is independently associated with population-level asthma hospitalization and use rates, specifically that very low-COI census tracts experience higher asthma morbidity compared with very high-COI tracts.[19] EMS clinicians have frequent experience and first-hand knowledge of the areas they service, and those facts may influence prehospital management toward more interventions in areas of lower COI. Furthermore, after adjusting for poverty rate, diesel exhaust particle emissions, and pollution levels, the risk ratio for residents of historically redlined areas of having an asthma-related ED visit was almost 40% higher than for those from areas less likely to be redlined.[28] Given those environmental and structural disparities that manifest in different COIs, the COI could be used as a tool to inform EMS education and clinical management, in tandem with informing public health efforts toward primary preventative asthma care.

In conclusion, in the 7 EMS agencies included in this study, there was no difference in the administration of EMS therapies regarding race for children with asthma. However, this study found a significant difference in the EMS administration of bronchodilators to children with asthma based on EMS scene encounter COI, with a higher proportion being administered during encounters in a very low or low COI. Additionally, there was a significantly higher incidence of asthma exacerbations in non-White patients in areas of low/very low COI. Those results suggest that baseline inequities exist in the incidence and frequency of asthma exacerbations treated by EMS in patients of non-White race living in disadvantaged areas, and future public health, primary care, and/or community paramedicine initiatives could assist those children and families with achieving improved asthma control.

AUTHOR CONTRIBUTIONS

Lauren Riney: Study design and conceptualization, data acquisition, and interpretation, manuscript drafting, and critical editing of manuscript; Sam Palmer: Study design and conceptualization, data analysis and interpretation, critical editing of manuscript; Erik Finlay,: Study design and conceptualization, data analysis and interpretation, critical editing of manuscript; Andrew Bertrand: Data acquisition and analysis, critical editing of manuscript; Shannon Burcham: Data acquisition, critical editing of manuscript; Phyllis Hendry: Study design and conceptualization, data interpretation, critical editing of manuscript; Manish Shah: Data acquisition, critical editing of manuscript; Kathryn Kothari: Data acquisition, critical editing of manuscript; David W. Ashby: Data acquisition, critical editing of manuscript; Daniel Ostermayer: Data acquisition, critical editing of manuscript; Olga Semenova: Data acquisition, critical editing of manuscript; Benjamin N. Abo: Data acquisition, critical editing of manuscript; Benjamin Abes: Data acquisition, critical editing of manuscript; Nichole Shimko: Data acquisition, critical editing of manuscript; Emily Myers: Data acquisition, critical editing of manuscript; Marshall Frank: Data acquisition, critical editing of manuscript; Tim Turner: Data acquisition, critical editing of manuscript; Mac Kemp: Data acquisition, critical editing of manuscript; Kim Landry: Data acquisition, critical editing of manuscript; Greg Roland: Data acquisition, critical editing of manuscript; Jennifer N. Fishe: Study design and conceptualization, acquisition of funding, data acquisition, analysis, and interpretation, secondary drafting of manuscript and revisions, critical editing of manuscript.

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CONFLICT OF INTEREST STATEMENT

No authors have conflicts of interest or financial disclosures.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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