Social Determinants of Health and At-Risk Rates for Pediatric Asthma Morbidity

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abstract

BACKGROUND AND OBJECTIVES: Compared with population-based rates, at-risk rates (ARRs) account for underlying variations of asthma prevalence. When applied with geospatial analysis, ARRs may facilitate more accurate evaluations of the contribution of place-based social determinants of health (SDOH) to pediatric asthma morbidity. Our objectives were to calculate ARRs for pediatric asthma-related emergency department (ED) encounters and hospitalizations by census-tract in Washington, the District of Columbia (DC) and evaluate their associations with SDOH.

METHODS: This population-based, cross-sectional study identified children with asthma, 2 to 17 years old, living in DC, and included in the DC Pediatric Asthma Registry from January 2018 to December 2019. ED encounter and hospitalization ARRs (outcomes) were calculated for each DC census-tract. Five census-tract variables (exposures) were selected by using the Healthy People 2030 SDOH framework: educational attainment, vacant housing, violent crime, limited English proficiency, and families living in poverty.

RESULTS: During the study period, 4321 children had 7515 ED encounters; 1182 children had 1588 hospitalizations. ARRs varied 10-fold across census-tracts for both ED encounters (64–728 per 1000 children with asthma) and hospitalizations (20–240 per 1000 children with asthma). In adjusted analyses, decreased educational attainment was significantly associated with ARRs for ED encounters (estimate 12.1, 95% confidence interval [CI] 8.4 to 15.8, $P < .001$) and hospitalizations (estimate 1.2, 95% CI 0.2 to 2.2, $P = .016$). Violent crime was significantly associated with ARRs for ED encounters (estimate 35.3, 95% CI 10.2 to 60.4, $P = .006$).

CONCLUSION: Place-based interventions addressing SDOH may be an opportunity to reduce asthma morbidity among children with asthma.

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WHAT'S KNOWN ON THIS SUBJECT: Pediatric asthma morbidity, measured with population-based rates, is associated with adverse measures of social determinants of health. These results may be confounded as population-based rates do not account for underlying differences in asthma prevalence.

WHAT THIS STUDY ADDS: This study created census-tract at-risk rates at-risk rates for pediatric asthma morbidity in the DC census-tract and identified that 2 social determinants, decreased educational attainment and increased violent crime, were specifically associated with increased at-risk rates for pediatric asthma morbidity.

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Asthma remains a leading driver of pediatric unscheduled health care utilization across the United States, accounting for >760 000 emergency department (ED) encounters and 74 000 hospitalizations annually.[1,2] Asthma morbidity disproportionately impacts children who are Black, Hispanic, or experiencing socioeconomic barriers through a complex combination of adverse medical and psychosocial factors.[3–6]

Geospatial analysis can evaluate place-based contributors to these disparities by examining highly localized relationships between social determinants of health (SDOH) and asthma outcomes by defined geographic units (eg, census-tracts). Applying geospatial analyses using population-based rates (PBRs) may be suboptimal to study disparities, specifically for ED encounters and hospitalizations. PBRs divide asthma-related encounters by all children (with and without asthma) in a specific geographic area.[7] Previous work using PBRs revealed that adverse measures of adult educational attainment, poverty, housing, vehicle ownership, and crime at the census-tract level are associated with pediatric asthma morbidity.[8,9] These results may be confounded, however, by differences in asthma prevalence by census-tract.[10] Using at-risk rates (ARRs) are preferable as they divide asthma-related encounters only by children with asthma in a specific geographic area.[11,12]

ARRs have been used at the zip code level in Washington, the District of Columbia (DC) to characterize ED utilization and highlight the city's increased and maldistributed pediatric asthma morbidity.[4] ARRs for asthma-related ED encounters in 45% of DC zip codes supersede the national ARR for ED encounters.[4,13]ARRs, especially when applied at the census-tract level, may allow for a more accurate analysis of the contribution of SDOH to disparities in morbidity by restricting the rate denominator to only children at risk for asthma-related morbidity.[11] In turn, ARRs may better inform highly localized interventions addressing morbidity among children with asthma.

This study combines ARRs with geospatial analysis to determine associations between SDOH and pediatric asthma morbidity. To our knowledge, this is the first attempt to analyze associations between pediatric asthma morbidity and SDOH using ARRs, as previous studies have used PBRs.[12,14] Specifically, the aim of this study is to (1) calculate ARRs for census-tracts in DC for asthma-related ED encounters, hospitalizations, and critical care hospitalizations; and (2) evaluate their association with SDOH by DC census-tract. We hypothesized that census-tracts experiencing more adverse SDOH would have increased asthma morbidity.

METHODS

Overview

This cross-sectional study evaluated associations between SDOH and pediatric asthma morbidity by DC census-tract. It employed ARRs for pediatric asthma morbidity derived from the previously validated DC Pediatric Asthma Registry and SDOH data from the American Community Survey (ACS) and Open-Data DC (Supplemental Table 4).[4,15,16]

Study Population

By design, the DC Pediatric Asthma Registry has a standard look-back period of 24 months. We queried it to create a study population of DC residents aged 2 to 17 years old during 2018 and 2019 (extracted on December 31, 2019).[4] For this study population, we abstracted all ED, hospitalization, and critical care encounters over the same 24-month period (January 2018–December 2019) from the registry. Thus, the study population comprised the denominator of the ARRs, and encounters for this study population comprised the numerator of the ARRs. Children are excluded from the registry if they have significant respiratory comorbidities.[4] Children were excluded from the study if their residential DC address had no street listed or was not included in the DC Master Address Repository.

The Registry includes all children with asthma who have received care at Children's National Hospital (CNH), 1 of 2 CNH EDs, or a CNH-affiliated primary care center within the past 24 months by querying 3 electronic health records: Cerner (inpatient), eClinicalWorks (outpatient), and Greenway (affiliated outpatient).[4] Using the Behavioral Risk Factor Surveillance System, current asthma prevalence estimate for external validation, the registry globally captures >90% (>15 000) of children in DC with asthma.[4]

Census-Tract ARRs for Pediatric Asthma Morbidity (Outcome Variables)

We calculated ARRs for asthma-related ED encounters, hospitalizations, and critical care hospitalizations for each DC census-tract. ED encounters included children evaluated and discharged from the ED. Hospitalizations included observations, acute hospitalizations, and critical care hospitalizations. Critical care hospitalizations were analyzed as a subgroup of hospitalizations and included children in the critical care unit during the hospitalization.

Along with census-tracts, DC geography includes quadrants (Supplemental Fig 2).[16] We used census-tracts here because they reflect homogenous populations, are preferred for population-level analyses, and geographically align with SDOH data from the ACS.[15,17,18] Residential addresses associated with each encounter were geocoded to census-tract and summed by type (ED encounter, hospitalization, critical care hospitalization) to create census-tract morbidity outcome counts. As of December 31, 2019, current street addresses for each child in the Registry were geocoded and mapped to census-tract to calculate the number of children in each census-tract with asthma. For each census-tract, morbidity outcome counts were divided by the tract's pediatric asthma population to create ARRs.

Census-Tract SDOH (Exposure Variables)

We first identified potential SDOH to analyze on the basis of previously published associations with asthma morbidity using PBRs.[9,19] We then narrowed them to actionable and relevant SDOH for DC from a health care system programming and community policymaking perspective. We did this by selecting 5 census-tract SDOH variables that reflected the Healthy People (HP) 2030 framework's 5 SDOH domains (Supplemental Fig 3): Education, Healthcare, Community, Environment, and Economy.[20] Educational attainment less than high school graduate represented Education's "High school graduation" determinant. It was also a proxy for Healthcare's "Health Literacy" determinant because decreased educational attainment correlates to lower health literacy.[21,22] The percentage of adults with limited English proficiency (LEP) represented the Education domain determinant, "Language and Literacy." Adults with LEP were also a proxy for Healthcare's, "Access to Care" because LEP caregivers of children with asthma experience linguistic and navigational barriers to accessing health care.[23,24] Violent crime represented Environment's, "Crime and Violence." Because exposure to violence is associated with decreased perceived social support, violent crime was a proxy for Community's, "Social Cohesion."[25] The percentage of vacant nonvacation homes represented the Environment determinant, "Quality of Housing." The percentage of households in poverty represented the Economy domain determinant, "Poverty."

We obtained our SDOH variables from the Environmental Systems Research Institute's shapefiles, which contain 2015 to 2019 5-year estimates of census-tract percentages of variables abstracted from the ACS.[15,26] Census-tract violent crime counts were created from 2018 to 2019 data from Open Data DC and divided by the census-tract total population to create rates.[16]

Covariates

Population-level measures were created for each census-tract by determining mean age (years) and percentages of male children, publicly insured children, and children with a controller medication prescription with data derived from the registry.[4] Controller medication prescription was selected to reflect asthma severity. This binary (yes/no) variable identified patients prescribed ≥1 controller medication in the last 12 months that included: inhaled steroids, leukotriene receptor antagonists, mast cell stabilizers, biologic immunomodulators, theophylline, combined inhaled steroid/long-acting β agonist, and combined inhaled steroid/long-acting β agonist/long-acting muscarinic antagonist.[4]

Although children of Black race or Hispanic ethnicity experience disproportionate asthma morbidity, these disparities have been explained by the socioeconomic, environmental, and access measures of hardship and neighborhood opportunity.[27–29] This study directly evaluated measures of adverse social and environmental neighborhood conditions, for which race and ethnicity typically serve as proxy measures, so we excluded race and ethnicity as covariates.[30]

Analysis

Descriptive statistics included means and frequencies for covariates at the patient level, stratified by outcome.

Spatial Analysis of Pediatric Asthma Morbidity With ARRs

Census-tracts with asthma populations in the lowest 10th percentile (<12 children) were removed from the analysis to reduce the potential for artificially high or low rates. Crude ARRs were smoothed with spatial Empirical Bayes by using the queen's contiguity which borrows strength from census-tracts sharing corners or sides to correct denominator variance.[31]

Relationship Between Pediatric Asthma Morbidity and SDOH

Simple linear regression (SLR) evaluated census-tract level associations between SDOH and asthma outcomes. Multivariable linear regression models (MLR) were then constructed for each outcome. If any 2 variables had a Pearson correlation coefficient ≥0.7, 1 variable was removed from the MLR. An apriori P value of ≤.05 established statistical significance.

The DC Master Address Repository (Desktop Version 5.1; Washington, DC) geocoded street addresses. ArcMap (Version 10.8; Redlands, CA) and Geoda software conducted spatial analyses.[32] Microsoft Excel (Version 2008) and R Core Team, 2017 (Version 3.6.2)[33–35] conducted statistical analyses. CNH's Institutional Review Board approved this study.

RESULTS

Study Population

Eighteen of 179 DC census-tracts (10%) had asthma populations lower than the 10th percentile and were removed from the analysis. This step removed 106 children with 27 ED encounters, 9 hospitalizations, and no critical care hospitalizations.

The remaining study population included 15 492 children with asthma: 4300 children (27.8% of the total population) with 7488 ED encounters (Table 1); 1176 children (7.6% of the total population) with 1579 hospitalizations (Table 1); and 179 children (15.2% of the total hospitalized and 1.1% of the total population) with 223 critical care hospitalizations (Supplemental Table 5). During the study period, 1611 patients (37.5% of all patients with ED encounters) had >1 ED encounter, and 242 patients (20.6% of all patients with hospitalizations) had >1 hospitalization.

The population of children per eligible census-tract with asthma (Supplemental Fig 4) ranged from 12 to 368 children with a mean of 96 (±74) and a median of 73 (interquartile range 39–128). Additionally, children with and without utilization were similarly represented throughout DC (Supplemental Table 6).

Pediatric Asthma Morbidity

Figure 1 depicts encounter counts overlying ARRs for each outcome by DC census-tract measured as encounters per 1000 children with asthma. ARRs for ED encounters ranged from 64 to 728 with a mean of 414 (±149). ARRs for hospitalizations ranged from 20 to 240 with a mean of 95 (±31). ARRs for critical care hospitalizations ranged from 0 to 76 with a mean of 14 (±1).

Association Between Pediatric Asthma Morbidity and SDOH

Poverty and public insurance were the only variables excluded from the MLR because of correlations with educational attainment (0.7). Educational attainment remained in the MLR because it had stronger univariate associations with our outcomes of interest.

ED Encounters

In SLR (Table 2), vacancy (coefficient 8.6, 95% CI 4.4 to 12.9), poverty (coefficient 6.9, 95% CI 5.4–8.3), violent crime (coefficient 78, 95% CI 55.7 to 100.2), and decreased educational attainment (coefficient 14.3, 95% CI 11.3 to 17) were positively associated with increased ARRs ($P < .001$). Thus, a 1% increase in vacancy lead to an increase of 8.6 ED encounters per 1000 children with asthma. In MLR (Table 3), decreased educational attainment (coefficient 12.1, 95% CI 8.4 to 15.8, $P < .001$) and increased violent crime (coefficient 35.3, 95% CI 10.2 to 60.4, $P = .006$) remained positively associated with increased ARRs (Supplemental Fig 5). Controller medication prescription was also positively associated with increased ARRs (coefficient 3.8, 95% CI 1.3 to 6.4, $P = .004$).

Hospitalizations

In SLR (Table 2), decreased educational attainment (coefficient 1.6, 95% CI 0.9 to 2.4, $P < .001$), poverty (coefficient 0.5, 95% CI 0.1 to 0.9, $P = .009$), and adults with LEP (coefficient 1, 95% CI 0.3 to 1.7, $P = .005$) were positively associated with increased ARRs. In MLR (Table 3) decreased educational attainment remained positively associated with increased ARRs (coefficient 1.2, 95% CI 0.2 to 2.2, $P = .016$; Supplemental Fig 5A).

Critical Care Hospitalizations

There were no significant associations with ARRs.

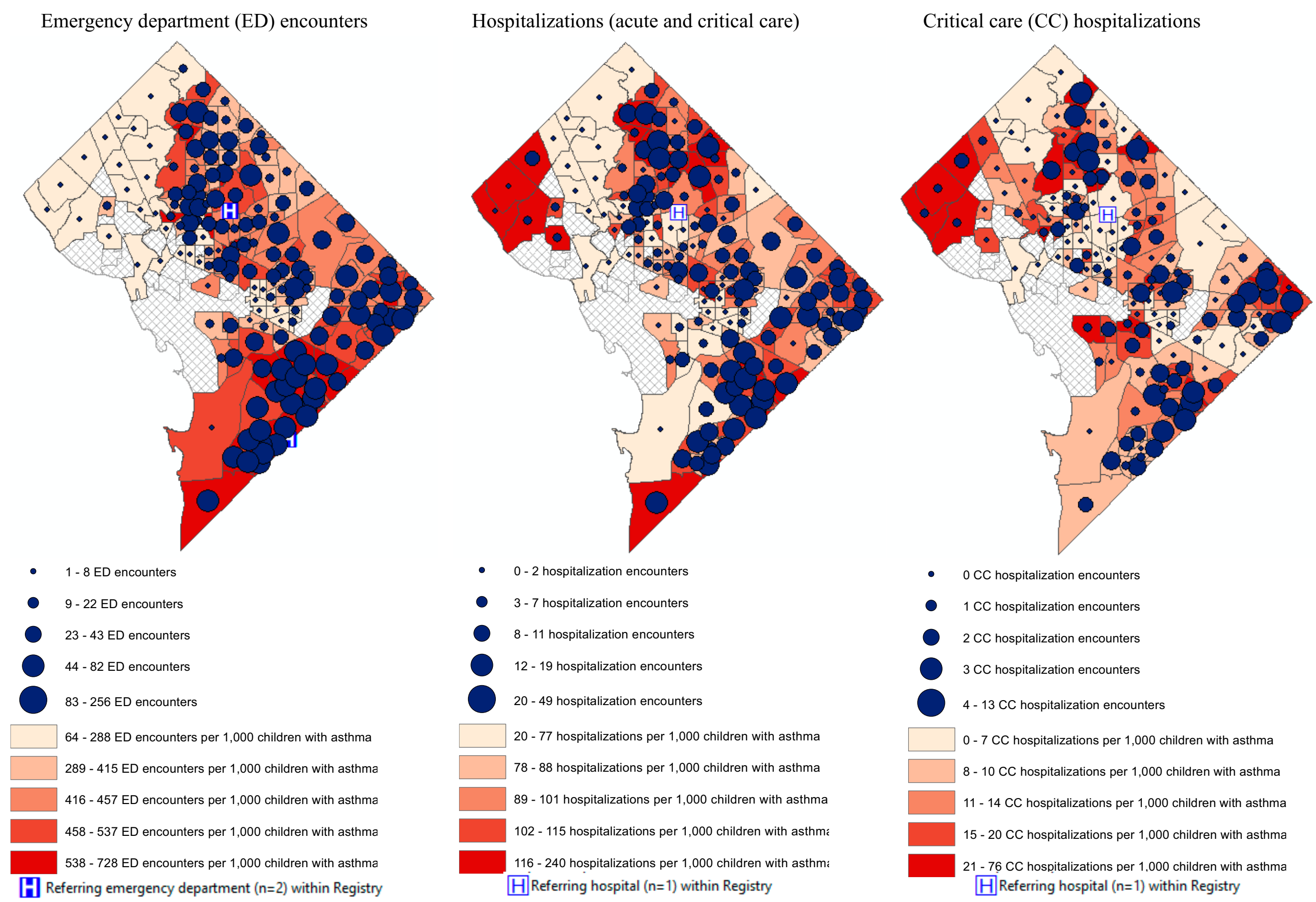
DISCUSSION

This study is the first to create and analyze ARRs for pediatric asthma

TABLE 1 Demographic and Clinical Characteristics of the Study Population[a]

Variable	Patients With ED Encounters, n = 4300	Patients With Hospitalizations, n = 1176
Age, y		
Median (IQR)	8 (6–12)	8 (5–11)
Sex, n (%)		
Male	2546 (59.2)	672 (57.1)
Controller medication prescription,[b] n (%)		
Yes	2408 (56)	922 (78.4)
Insurance, n (%)		
Public	3146 (73.2)	813 (69.1)
Private	389 (9)	164 (14)
Other	765 (17.8)	199 (16.9)
Encounters		
Total number	7488	1579
Mean (SD) per patient	1.7 (1.4)	1.3 (1)
Range per patient	1–20	1–17
Patients with >1 encounter, n (%)	1611 (37.5)	242 (20.6)

IQR, interquartile range; SD, standard deviation.
[a] As of December 31, 2019.
[b] Controller medication prescription refers to all patients prescribed ≥1 asthma controller medication (eg, inhaled corticosteroid, leukotriene receptor antagonist, or biologic) in the past 12 months.



[a] Census-tracts with gray hashmarks had pediatric asthma populations that were less than the 10th percentile and were removed from analysis

FIGURE 1
Counts of asthma-related encounters overlying at-risk rates by outcome among census-tracts in Washington, DC, 2018 to 2019.[a]

morbidity by census-tract in our urban setting and identified a >10-fold difference between the highest and lowest ARRs for ED encounters and hospitalizations. By combining ARRs, geospatial analysis, and actionable SDOH developed through the lens of the HP 2030 SDOH framework, we support our hypothesis that adverse SDOHs are significantly associated with ARRs for pediatric asthma morbidity. Specifically, decreased educational attainment was significantly associated with increased ARRs for both ED encounters and hospitalizations, and increased violent crime was significantly associated with increased ARRs for ED encounters. Previous literature examined asthma-related morbidity using census-tract and zip code PBRs, and local work calculated zip code level ARRs for ED encounters.[4,9,12,14] Our work moves geospatial analysis forward by identifying ARRs for asthma-specific encounters, ranging from ED to hospitalization (including critical care encounters), and characterizing their relationship with census-tract SDOH.

We unexpectedly identified a difference in the spatial distribution of ARRs for ED encounters and hospitalizations. The highest quintile ARRs for ED encounters were concentrated in Southwest (SW) and Southeast (SE) DC census-tracts, which are socio-economically underresourced neighborhoods.[36] In contrast, the highest quintile ARRs for hospitalizations were primarily located in Northwest (NW) DC, a socio-economically advantaged neighborhood.[36] This difference is likely multifactorial. First, fewer patients are captured by the Registry in NW DC, and NW DC has a smaller pediatric asthma population compared with SE DC. Thus, when we calculated ARRs and divided hospitalization encounters by the pediatric asthma population, NW DC census-tracts with smaller pediatric asthma populations had ARRs comparable to SE DC census-tracts with much larger pediatric asthma populations. It is possible that for NW DC, the registry captures more children on the basis of their hospital use rather than their ED or primary care use which would result in the NW DC

TABLE 2 Simple Linear Regression Results for Pediatric Asthma Morbidity ARRs by Outcome

Predictors	ED ARRs Coefficient (95% CI)	ED ARRs *P*	Hospitalization ARRs (Acute and Critical) Coefficient (95% CI)	Hospitalization ARRs (Acute and Critical) *P*	Critical Care Hospitalization ARRs Coefficient (95% CI)	Critical Care Hospitalization ARRs *P*
Educational attainment <HS, %[a]	14.3 (11.3 to 17)	<.001[b]	1.6 (0.9 to 2.4)	<.001[b]	−0.1 (−0.4 to 0.2)	.44
Adults with LEP, %	1.1 (−2.3 to 4.4)	.54	1 (0.3 to 1.7)	.005[b]	0.3 (−0.02 to 0.5)	.07
Housing vacancy, %	8.6 (4.4 to 12.9)	<.001[b]	0.3 (−6.2 to 1.2)	.51	−0.1 (−0.5 to 0.3)	.59
Violent crime, %	78 (55.7 to 100.2)	<.001[b]	4.5 (−0.8 to 9.7)	.09	−1.0 (−3.1 to 1.1)	.34
Poverty, %	6.9 (5.4 to 8.3)	<.001[b]	0.5 (0.1 to 0.9)	.009[b]	−0.1 (−0.2 to 0.1)	.44
Age, y	−8.4 (−10.7 to 24)	.61	−4.1 (−10.8 to 2.6)	.23	−0.3 (−3 to 2.3)	.81
Male sex	−0.04 (−3.5 to 3.4)	>.99	0.1 (−0.6 to 0.9)	.7	0.3 (−0.01 to 0.6)	.06
Controller medication prescription	4.6 (1.3 to 7.9)	.007[b]	0.7 (0.02 to 1.4)	.04[b]	0.2 (−0.04 to 0.5)	.09
Public insurance	4.9 (4.2 to 5.5)	<.001[b]	0.5 (0.3 to 0.7)	<.001[b]	−0.01 (−0.1 to 0.1)	.74

HS, high school.
[a] An increase of 1 percent, 1 year, or presence of male sex/controller medication prescription/public insurance, leads to the coefficient change in pediatric asthma morbidity. For example, a 1% increase of adults with educational attainment less than high school leads to a 14.3 increase in ED encounters per 1000 children with asthma (ED ARR).
[b] Indicates statistical significance.

TABLE 3 Multiple Linear Regression Models for Pediatric Asthma Morbidity ARRs by Outcome

Predictors	ED ARRs Coefficient	ED ARRs 95% CI	ED ARRs *P*	Hospitalization ARRs Coefficient	Hospitalization ARRs 95% CI	Hospitalization ARRs *P*
Educational attainment <HS, %[a]	12.1	8.4 to 15.8	<.001[b]	1.2	0.2 to 2.2	.016[b]
Adults with LEP, %	−1.9	−5.1 to 1.3	.24	0.6	−0.2 to 1.5	.15
Housing vacancy, %	2.7	−1.1 to 6.5	.17	0.2	−0.9 to 1.2	.76
Violent crime, %	35.3	10.2 to 60.4	.006[b]	2	−4.7 to 8.6	.56
Age, y	−22.1	−46.2 to 2	.07	−5.7	−12.1 to 0.8	.08
Male sex	−0.8	−3.5 to 1.8	.53	−0.02	−0.7 to 0.7	.96
Controller medication prescription	3.8	1.3 to 6.4	.004[b]	0.5	−0.2 to 1.2	.15

HS, high school.
[a] An increase of 1 percent, 1 year, or presence of male sex/controller medication prescription/public insurance, leads to the coefficient change in pediatric asthma morbidity. For example, a 1% increase of adults with educational attainment less than high school leads to a 1.2 increase in hospitalizations per 1000 children with asthma (hospitalization ARR).
[b] Indicates statistical significance.

population being biased with higher morbidity. Second, our findings that the highest ARRs for ED encounters were in SE and SW DC may reflect quadrant-related differences in primary care access and utilization. Although ED utilization is a marker for asthma-related morbidity, it also reflects decreased access to primary and/or specialist care.[37] Previous work reveals that spatial access to primary care is far lower in the SE quadrant of DC than in the NW quadrant.[38] It is possible that children living in SE and SW DC may be more likely to use the ED as their source of primary care compared with children in NW DC. ED utilization's connection to health care access may also explain stronger associations with SDOH compared with hospitalizations and warrant additional exploration.

PBRs can be created from more readily available data compared with the infrastructure needed to create ARRs. However, PBRs imprecisely estimate asthma morbidity and SDOH associations as they do not account for local variations in asthma prevalence. Our study's findings support the benefit of using ARRs to specifically evaluate which SDOHs are associated with pediatric asthma morbidity rather than asthma prevalence. For example, previous work using PBRs found significant associations between decreased educational attainment and increased asthma-related health care utilization.[9,12,39] Our findings with ARRs suggest decreased educational attainment may be a key driver of asthma morbidity among children with asthma, not just among all children. Conversely, increased housing vacancy was not significantly associated with asthma-related outcomes in our study, but, in previous literature, has significant associations with PBRs for asthma-related health care utilization.[9,12] Housing vacancy may be associated with asthma prevalence rather than morbidity.

We identified decreased educational attainment and increased violent crime as 2 SDOH associated with pediatric asthma morbidity. Complex interactions are likely involved, including with structural racism, which produces uneven access to all 5 SDOHs evaluated in this study.[40,41] Our study only evaluated 5 measures of SDOH and decreased educational attainment highly correlated with increased poverty and public health insurance (which were removed from the MLR because of collinearity). In addition, decreased educational attainment is associated with decreased health literacy.[21] Violent crime reflects toxic stress.[42] We did not study these additional factors and cannot comment on their potential contribution to pediatric asthma morbidity. Despite these limitations, our findings still provide insight into potential population-level interventions to improve place-based pediatric asthma morbidity. Decreased educational attainment may be improved by expanding community colleges for adults and high-quality early childhood education programs for children.[43,44] Early childhood education also correlates to decreased all-cause ED encounters and health care costs.[44] Community violence may be improved through community investment.[45–48] City-wide efforts can reduce income inequality which predicts community violence and expand access to mental health services which protects against it.[49]

As adverse SDOHs are interrelated, we advocate that population-level interventions apply a holistic, community-engaged approach to prioritizing and addressing SDOH associations. Interventions can focus on DC census-tracts with elevated ARRs for pediatric asthma morbidity. Past interventions using geospatial analysis and community engagement are effective and interventions addressing social factors are associated with reduced ED encounters and hospitalizations among children with asthma.[50] One hospital-community collaboration reduced all-cause hospitalization days in high morbidity neighborhoods by addressing chronic disease management, hospital-to-home transitions, and social risks.[51] Another asthma-specific intervention incorporated community health workers, asthma education, and environmental remediation and reduced health care utilization in zip codes with the highest asthma morbidity.[52] These population-level interventions importantly reduce disproportionate asthma morbidity among children without burdening individual families.[4,53,54]

This study had limitations. First, although CNH provides >90% of hospital and ED-based care for children 2 to 17 years living in DC,[55] it is possible that children with less severe asthma who do not use a CNH ED or hospital and who are cared for by a primary care office outside of the CNH network would not be captured by the Registry nor our study population (at-risk rate denominator).[4] Second, the cross-sectional design made it impossible to evaluate causality related to SDOH. Third, the limited number of critical care hospitalizations during the study period may explain their lack of significant associations with SDOH. Fourth, we could not account for asthma severity but did use controller medication prescription as a proxy for persistent asthma.[56] Fifth, this study examined 5 SDOHs that partially represent 5 HP domains. Structural racism, and other place-based factors such as primary care and specialist access, transportation, ambient air pollution, and allergen levels that represent other facets of the HP domains, were not studied here but are important. For example, spatial access to primary care varies greatly and is lower in SE DC compared with NW DC.[38] Future analysis is necessary using a Public Health Critical Race Framework to evaluate causal and correlational pathways that result in racialized inequities in SDOH and population health outcomes among children with asthma.[40] Finally, our findings could be biased by ecological fallacy when aggregate data does not accurately reflect individuals living in that area.[57] Although individual and neighborhood-level SDOHs are typically aligned, ecological fallacy can still occur.[58]

CONCLUSIONS

We found that ARRs for pediatric asthma morbidity varied among DC census-tracts and were associated with SDOH. This foundational information may be useful to inform highly localized interventions addressing SDOH and evaluate their impact on place-based morbidity among children with asthma living in Washington, DC.

ABBREVIATIONS

ACS: American Community Survey
ARR: at-risk rates
CI: confidence interval
CNH: Children's National Hospital
ED: emergency department
HP: Healthy People
LEP: limited English proficiency
MLR: multivariable linear regression
NW: northwest
PBR: population-based rates
SDOH: social determinants of health
SE: southeast
SLR: simple linear regression
SW: southwest

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