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Neighborhood Environmental Vulnerability and Pediatric Asthma Morbidity in US Metropolitan Areas

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Abstract

Background: Research suggests demographic, economic, residential, and health-related factors influence vulnerability to environmental exposures. Greater environmental vulnerability may exacerbate environmentally-related health outcomes. We developed a neighborhood environmental vulnerability index (NEVI) to operationalize environmental vulnerability on a neighborhood-level.

Objective: We explored the relationship between NEVI and pediatric asthma emergency department (ED) visits (2014-2019) in three US metropolitan areas: Los Angeles (LA) County, California (CA); Fulton County, Georgia (GA); and New York City (NYC), New York (NY).

Methods: We performed separate linear regression analyses examining the association between overall NEVI score and domain-specific NEVI scores (demographic, economic, residential, health status) with pediatric asthma ED visits (per 10,000) across each area.

Results: Linear regression analyses suggest that higher overall and domain-specific NEVI scores were associated with higher annual pediatric asthma ED visits. Adjusted R-squared values suggest that overall NEVI scores explained at least 40% of the variance in pediatric asthma ED visits. Overall NEVI scores explained more of the variance in pediatric asthma ED visits in Fulton

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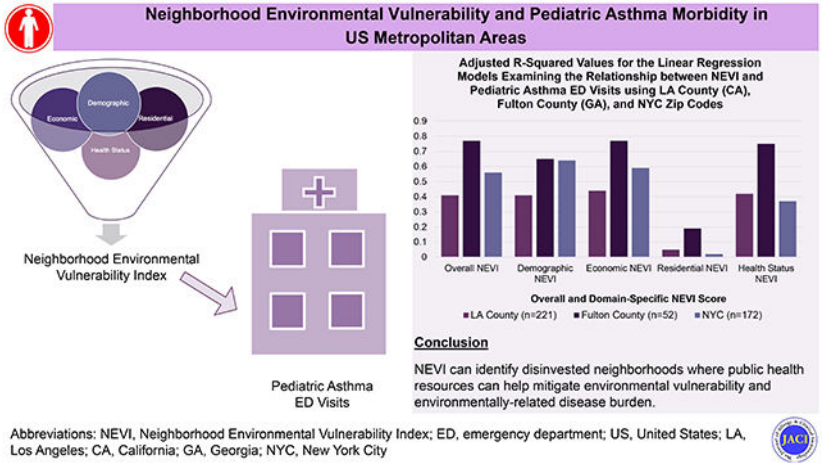
County. NEVI scores for the demographic, economic, and health status domains explained more of the variance in pediatric asthma ED visits in each area, compared to the NEVI score for the residential domain.

Conclusion: Greater neighborhood environmental vulnerability was associated with greater pediatric asthma ED visits in each area. The relationship differed in effect size and variance explained across the areas. Future studies can use NEVI to identify populations in need of greater resources to mitigate the severity of environmentally-related outcomes, such as pediatric asthma.

Graphical Abstract



Capsule Summary

Greater vulnerability to environmental exposures, measured via a neighborhood environmental vulnerability index (NEVI), is associated with greater pediatric asthma morbidity. NEVI can identify disinvested neighborhoods where resources may be needed to mitigate environmental vulnerability and disease burden.

Keywords

pediatric asthma; environmental vulnerability; neighborhood; racial disparities

Introduction

Asthma is a common chronic disease among children[1-3] and the third most common cause of hospitalization among children under the age of 15 years.[4] Pediatric asthma is the second highest cause of pediatric healthcare expenditures as direct costs of pediatric asthma were nearly $6 billion in 2013, driven by asthma-related emergency department (ED) visits and hospital admissions.[4, 5] Epidemiological data demonstrate racial and ethnic disparities in US pediatric asthma health outcomes.[6-8] Studies suggest that Black and Hispanic children have higher incidence and earlier onset of pediatric asthma compared to White children.[9] Furthermore, Black and Hispanic children have higher rates of asthma-related ED and inpatient visits compared to White children.[10, 11] The racial, ethnic, and geographic

disparities in pediatric asthma morbidities may be driven by differential vulnerability to environmental exposures.[1, 12, 13 14]

Accordingly, there is a public health need to understand drivers of ED use among children with asthma to reduce racial, ethnic, and geographic disparities in pediatric asthma outcomes. Populations' differential vulnerability to environmental exposures may stem from systemic racism, defined as the implicit and explicit systems that sustain barriers to health and wellness for communities of color.[15] Systemic racism may underlie why communities of color have greater susceptibility to environmental exposures,[15-17] as systemic racism has influenced historical policies, such as residential redlining where the US federal government discouraged insuring housing loans to individuals who resided in predominantly Black neighborhoods.[18-22] This contributed to a disinvestment in predominantly Black communities, concentrating poverty and reducing their options for housing mobility.[23-25] Communities in disinvested neighborhoods are exposed to a range of adverse factors,[18-22, 26-28] including overcrowding in residential units,[29] greater population density,[30, 31] greater urbanization,[12, 32] and lower socioeconomic levels,[33, 34] which contribute to greater vulnerability to environmental exposures. Greater vulnerability to environmental exposures may then be associated with a higher burden of pediatric asthma morbidity, such as higher pediatric asthma ED visits.

Therefore, we developed the neighborhood environmental vulnerability index (NEVI) to gauge a population's susceptibility to the influence of environmental exposures in four domains pertaining to demographics, economic indicators, residential characteristics, and health characteristics.[35] The NEVI captures built and social environmental features independent of air pollution and allergens that are known triggers of asthma morbidity and ED utilization.[35] In creating the NEVI, we used a multi-model approach to identify how a combination of these factors may altogether define the vulnerability of populations to environmental exposures,[36, 37] and thereby, contribute to higher pediatric asthma morbidity.[38-40] Given that populations are exposed to a combination of adverse factors that likely occur together especially in the context of disinvested neighborhoods, it is more logical to look at the combination of social and structural factors that influence environmentally-related health outcomes.

Our study objective was to examine the relationship between neighborhood environmental vulnerability (measured via NEVI) and pediatric asthma morbidity for three metropolitan areas: 1) Los Angeles (LA) County, California (CA); 2) Fulton County, Georgia (GA), and 3) New York City (NYC), New York (NY). We measured pediatric asthma morbidity via ED visits, as pediatric asthma can generally be managed in an outpatient setting via controlling exposures to factors that trigger exacerbations, adequate pharmacological management, continual monitoring of disease, and patient education in healthcare. Therefore, frequent pediatric asthma ED visits can highlight shortcomings in effective management for vulnerable populations in certain areas.[41-43]

We chose to study LA County (CA), Fulton County (GA), and NYC as these three metropolitan areas encompass populations that are upwards of 1 million to 10 million people and have a varied distribution of neighborhood vulnerability levels, which may contribute

to a better understanding of the NEVI's utility in explaining pediatric asthma ED visit rates. Additionally, these regions comprise some of the most racially and ethnically diverse US populations with White, Black, Asian, and Hispanic representation.[44-46] Using these three metropolitan areas can allow for better generalizability of the findings regarding the relationship between NEVI and pediatric asthma ED visits.

We hypothesized that higher overall NEVI score, meaning greater environmental vulnerability, would be associated with higher pediatric asthma ED visits. Disinvested neighborhoods are exposed to adverse factors that may increase their vulnerability to environmental exposures, which may be associated with greater exacerbations of environmentally-related diseases, such as pediatric asthma. We also hypothesized that the economic NEVI score, which includes many socioeconomic variables, would have the strongest relationship with pediatric asthma ED visits, in comparison to the demographic, residential, and health NEVI scores, as the literature suggests low education, unemployment, and low socioeconomic status are strongly associated with increased vulnerability to adverse environmental exposures.[47-49]

Methods

Data Sources

Features for the NEVI were prepared using publicly available data from the 2015-2019 U.S. Census American Community Survey (ACS) 5-year estimates and the 2020 data release from the Centers for Disease Control and Prevention (CDC) PLACES Project. The US Census ACS provides social and economic data across states, cities, counties, census tracts, and block groups. The PLACES project generates model-based, population-level analyses and community health indices for all counties, places, census tracts, and ZIP Code Tabulation Areas (ZCTAs) across the US.[50]

Annual average pediatric asthma ED visit data was retrieved at the zip code level from the following sources: 1) California Department of Public Health for LA County;[51] 2) Georgia Department of Public Health for Fulton County;[52] and 3) New York State Department of Health for NYC.[53]

Study Population

We limited the data to zip codes that had both NEVI and pediatric asthma ED visit data. We included 221 zip codes in LA County (>77% of LA County zip codes),[51] 52 zip codes in Fulton County (>62% of Fulton County zip codes),[52] and 172 zip codes in NYC (>95% of NYC zip codes).[53] In collating the NEVI data by zip code, we excluded census tracts that had a population of less than 20 or had a population greater than 20 but had missing data for at least one of the NEVI features of interest.[54]

Measures

Exposure: Neighborhood Environmental Vulnerability Index (NEVI) Score by Zip Code—Development of the NEVI was first reported by Uong et al.[54] We adapted the methodology as outlined in their study.[54] The NEVI was calculated using 54 features

organized into four domains: 1) demographics, 2) economic indicators, 3) residential characteristics, and 4) health status. Within each domain, we summarized the selected features (Supplemental Table 1).[35] A higher NEVI score suggests a higher level of neighborhood vulnerability to environmental exposures. The NEVI is standardized to each individual area, which indicates that a 0.30 NEVI score in an NYC zip code will not suggest the same level of vulnerability to environmental exposures as a 0.30 NEVI score in a Fulton County zip code. We intentionally did not standardize NEVI to the combined data across the three metropolitan areas, as a NEVI standardized to each individual metropolitan area has more potential utility. For example, a NEVI standardized to Fulton County can help researchers identify disinvested neighborhoods in Fulton County that may need more resources to mitigate environmental vulnerability, compared to other neighborhoods in Fulton County.

Outcome: Pediatric Asthma ED Visits—Pediatric asthma ED visit data were obtained by zip code based on available participant age and calendar year ranges. For LA County (CA), pediatric asthma ED visit data were obtained for children (age 0-17 years) in 2019.[51] For Fulton County (GA), pediatric asthma ED visit data were obtained for children (0-19 years) averaged over the years 2014-2018. For NYC, pediatric asthma ED visit data were obtained for children (0-17 years) averaged over the years 2017-2019.

Descriptive and Statistical Analyses

We examined descriptive statistics, including the mean, median, standard deviation, interquartile range, minimum, and maximum, for the overall NEVI scores, NEVI domain-specific scores, and pediatric asthma ED visits per 10,000 in LA County, Fulton County, and NYC. For each of the three areas, we constructed five separate linear regression models examining the relationships between the NEVI scores and pediatric asthma ED visits (per 10,000). Each linear regression model was composed of only one explanatory variable, which included either the overall NEVI score or one of the four domain-specific NEVI scores (demographic NEVI score, economic NEVI score, residential NEVI score, or health status NEVI score).

For each model, we produced the standardized beta coefficient, corresponding 95% confidence interval, and the adjusted R-squared value. We plotted a heatmap of the adjusted R-squared values across the 15 linear regression models, with the x-axis designating the region and the y-axis designating the NEVI score used as the explanatory variable in the model.

Lastly, we explored how NEVI scores related to characteristics of specific areas within LA County, Fulton County, and NYC to understand how social and demographic context may be related to NEVI scores. We implemented our analyses using the R (version 4.1.2) statistical software program.[55]

Results

Summary Statistics

Table 1 provides the summary statistics for overall NEVI scores, NEVI domain-specific scores, and pediatric asthma ED visits across LA County, Fulton County, and NYC. Fulton County exhibited the largest range in overall NEVI scores (0.15-0.53) compared to that of LA County and NYC. NYC had the highest average pediatric asthma ED visits (155.78 per 10,000) and LA County had the lowest average pediatric asthma ED visits (70.59 per 10,000).

Linear Regression Estimates

Table 2 identifies the linear regression estimates corresponding to the relationship between NEVI score (overall and domain-specific) and pediatric asthma ED visits for LA County, Fulton County, and NYC. Across each area, we found that a 0.1 increase in NEVI score, indicating greater environmental vulnerability, corresponded with greater pediatric asthma ED visits. The magnitude of beta coefficients is not directly comparable across the three areas as NEVIs are calculated within each area separately and each area has a different magnitude of pediatric asthma ED visits. However, in examining the relationship between NEVI and pediatric asthma ED visits, the demographic NEVI score consistently produced the beta coefficient of the greatest magnitude while the residential NEVI score consistently produced the beta coefficient with the lowest magnitude across all three metropolitan areas.

Adjusted R-Squared Values

We presented a heatmap to plot the distribution of the adjusted R-squared values by model and region (Figure 1). Higher adjusted R-squared values suggest that the model explained higher variance of the outcome. Overall NEVI scores explained at least 40% of the variance in pediatric asthma ED visits across LA County, Fulton County, and NYC. The residential NEVI score explained the least variance in pediatric asthma ED visits across each area. Overall and domain-specific NEVI scores explained more of the variance in pediatric asthma ED utilization in Fulton County, when compared to the variance that the NEVI scores explained for LA County or NYC. Overall, we found that Fulton County exhibited the highest adjusted R-squared values corresponding to linear regression models that either included the overall NEVI score, or a domain-specific NEVI score.

Location-Specific Results

In exploratory analyses, we examined location-specific findings among the three metropolitan areas. In Fulton County, the city of East Point, GA yielded an overall NEVI score of 0.40 and the fourth highest pediatric asthma ED visit rate in Fulton County (209.3 per 10,000), while Milton, GA yielded a lower overall NEVI score of 0.19 and the lowest pediatric asthma ED visit rate in Fulton County (28.1 per 10,000). In NYC, the Upper East Side yielded an overall NEVI score of 0.27, and the second lowest pediatric asthma ED visit rate in NYC (20.2 per 10,000), while Harlem yielded an overall NEVI score of 0.38, and the highest pediatric asthma ED visit rate in NYC (597.2 per 10,000). In LA County, we found an inverse association between NEVI and pediatric asthma ED visit rates in Antelope

Valley (Northeastern LA County), as the pediatric asthma ED visit rate was relatively high (163.7 per 10,000), while the overall NEVI score (0.32) was average. As the NEVI scores are not standardized across cities, each metropolitan area's scores are comparable only to themselves for better local contextualization.

Discussion

We found that greater neighborhood-level vulnerability to environmental exposures is associated with greater pediatric asthma morbidity within each of the three US metropolitan areas, including LA County, Fulton County, and NYC, as higher overall and domain-specific NEVI scores were associated with greater pediatric asthma ED visit rates. This suggests that NEVI may have utility in capturing the built and social environment characteristics to operationalize neighborhood-level vulnerability to environmental exposures, and thereby, can help identify neighborhoods with greater burden of environmentally-related health outcomes, such as pediatric asthma morbidity. Thus, NEVI can be used to identify neighborhoods in need of greater public health resources to help mitigate vulnerability to environmental exposures, and the burden of environmentally-related health outcomes in the future.

We found that overall and domain-specific NEVI scores explained more of the variance in pediatric asthma ED visits in Fulton County than in LA County and NYC. Thus, the overall and domain-specific NEVI scores had better predictive power in determining pediatric asthma ED visits in Fulton County than in LA or NYC, as the NEVI scores explained more of the variation in pediatric asthma ED visit rates in Fulton County than in LA County or NYC. In addition, we found that the economic, demographic, and health status domain-specific NEVI scores explained more of the variance in pediatric asthma ED visits, than the residential domain-specific NEVI score, for these three metropolitan areas. This finding may suggest that the economic, demographic, and health status domain-specific NEVI scores may better characterize vulnerability to environmental exposures, and better explain variation in morbidity of environmentally-related outcomes.

The NEVI tool encompasses multiple strengths as it comprises of an overall index score, and four domain-specific scores, pertaining to demographics, economic indicators, residential characteristics, and health status characteristics. In contrast, other indices that measure social vulnerability, such as the Area Deprivation Index, Community Needs Index, and Distressed Communities Index cannot be stratified into smaller subdomains.[56] Although the Social Vulnerability Index (SVI) can be stratified into smaller domains, the SVI is not informed by the health characteristics of a neighborhood, such as health outcomes, health behaviors, and health insurance access.[56] Health characteristics is an important domain to consider given that studies suggest that neighborhood-level health outcomes can influence the health of an individual.[57] Therefore, in using NEVI, we can implement a holistic approach in assessing neighborhood environmental vulnerability, and ascertain how different domains may be most strongly related with environmentally-related outcomes.

In developing NEVI, we intentionally excluded racial or ethnic origin from our contributory features as we hypothesized that race is not itself a contributory factor to vulnerability

to environmental exposures; rather, systemic policies affecting demographic, economic, residential and health vulnerabilities disproportionately impact US racial minorities.[39] In delving deeper into the local context of our findings, we found evidence that NEVI may be distributed along racial lines. For example, the city of East Point in Fulton County with a relatively high NEVI score and high pediatric asthma ED visit rate, is predominantly Black in terms of demographic make-up (77.75% as of 2020) and Milton, with a relatively low NEVI score and low pediatric asthma ED visit rate, is predominantly White (73.23% as at 2020). We found similar patterns in NYC, with the Upper East Side, with a relatively low NEVI score and low pediatric asthma ED visit rate, having a predominantly White population (72.5% as of 2020), in contrast to Harlem, with a relatively higher NEVI score and high pediatric asthma ED visit rate, having a predominantly Black population (54.3% as of 2020).[58] Therefore, our study demonstrates the overall and domain-specific impacts of systemic racism on children's health in three different city environments. Different NEVI domains allow these inequities to be targeted based on the infrastructural, economic, political origins of these disparities, that are locally specific.

We also found higher pediatric asthma ED visit rates in Antelope Valley (LA County, CA) than one would expect based on its NEVI score, as the pediatric asthma ED visit rate was relatively high while the overall NEVI score was average. We further found that the percent of children seeking asthma-related care in an ED setting in Antelope Valley is 65% higher than the national average.[59] Antelope Valley is a rural area with high particulate matter pollution; thus, it may not have the typical urban characteristics that would drive the NEVI score to be higher, but it does have higher environmental exposures. It is possible that the low residential NEVI score (0.20) may contribute to a lower overall NEVI score, highlighting that the residential NEVI score may not have strong utility in operationalizing neighborhood environmental vulnerability in rural contexts. In contrast, the health status NEVI score, which operationalizes neighborhood environmental vulnerability driven by health behaviors, outcomes, prevention practices, and access, was the highest NEVI domain score (0.47) and better characterized the high pediatric asthma ED visit rate in Antelope Valley. This suggests that there is also value in looking at domain-specific NEVI scores when gauging the population's environmental vulnerability.

Overall, our findings suggested that a composite measure of neighborhood environmental vulnerability and domain-specific measures of neighborhood environmental vulnerability were associated with pediatric asthma ED visits across LA County, Fulton County, and NYC. These findings are consistent with existing literature that demonstrates the impact of factors across multiple domains on pediatric asthma incidence and severity.[40, 60-63] Studies have found that residential characteristics, such as household crowding and poor housing quality, are associated with higher pediatric asthma incidence. [64, 65] Similarly, studies identified low socioeconomic status to be associated with increased severity of pediatric asthma outcomes.[66-68] This association is important to consider given that deleterious domain characteristics, such as poor housing quality and low socioeconomic status, occur together and cluster in racial and ethnic minority communities, as a result of place-specific, structurally racist policies. [18-25] Therefore, we must consider vulnerability to environmental exposures on a neighborhood-level using a composite index, such as the overall NEVI score

or a domain-specific NEVI score that can identify groups of characteristics, specific to a given population, that impact vulnerability.

The strengths of the study include that we consistently measured NEVI and pediatric asthma outcomes by zip code unit across LA County, Fulton County, and NYC. We additionally used three major US metropolitan areas to identify the relationship between NEVI and pediatric asthma ED visits. The study limitations include the use of zip codes, which is a larger geographical unit than a census tract, and census tracts may offer more spatial granularity in studying neighborhood-level environmental vulnerability. However, pediatric asthma ED visits were not available by census tracts for all three areas that we studied. Another limitation included that each area had different data coverage, as NEVI and pediatric asthma data was available for 95% of the NYC zip codes, 77% of the LA County zip codes, and 62% of the Fulton County zip codes. Excess coverage from one area over another may mean that our findings may better characterize NYC and LA County, in comparison to Fulton County. An additional limitation is the inability to compare NEVI scores across the different metropolitan areas as the NEVI scores are standardized to each individual metropolitan area. While this allows us to capture differences in environmental vulnerability within an individual metropolitan area, NEVI scores standardized to nationwide data would allow comparability of NEVI scores across different geographical areas.

Future study directions include examining the relationship between NEVI and pediatric asthma outcomes within additional US metropolitan areas. Examining more cities may allow for more geographical heterogeneity, which may allow us to identify unique clusters of NEVI patterns across the US. Future studies can continue to assess the utility of the residential NEVI score and overall NEVI score in explaining pediatric asthma ED visits in other contexts, such as when NEVI is measured on a census tract level or in suburban and community environments. We can additionally explore the development of a residential NEVI domain score index that is more appropriate for rural communities. In regards to policy research, it is important to understand how specific policies contribute to the observed race/ethnicity-based health disparities evident in our study findings.

Conclusion

We found that greater neighborhood-level vulnerability to environmental exposures is associated with greater pediatric asthma morbidity across three US metropolitan areas: LA County, Fulton County, and NYC. Our findings suggest that NEVI can be used to identify the social and structural drivers contributing to environmentally-related diseases, and can help identify neighborhoods in need of greater resources to help mitigate their vulnerability to environmental exposures. NEVI can then help reduce the incidence of environmentally-related diseases in neighborhoods with a high vulnerability to environmental exposures, which may be comprised of minoritized and marginalized communities due to systemic racism. This is important as there is a current growing interest in studying racism at levels higher than interpersonal levels and researchers are grappling with measuring racism at community levels. The NEVI tool may provide an opportunity to advance thinking around this topic.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

NEVI	Neighborhood Environmental Vulnerability Index
ED	Emergency Department
LA	Los Angeles
GA	Georgia
NYC	New York City

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Key Messages

- We previously developed a neighborhood environmental vulnerability index (NEVI) to integrate built environment and social factors on a neighborhood-level to operationalize vulnerability to environmental exposures.
- We found that greater neighborhood environmental vulnerability, measured via the NEVI tool, is associated with greater annual pediatric asthma emergency department (ED) visits and explains at least 40% of the variance of pediatric asthma ED visits in three US metropolitan areas: Los Angeles County (California), Fulton County (Georgia), and New York City (New York).
- Given that vulnerability to environmental exposures are often clustered in US neighborhoods of minoritized and marginalized populations that have experienced disinvestment due to historical redlining and systemic racism, the NEVI tool provides an opportunity to disentangle contributors to racial health disparities, and identify neighborhoods in need of resources to mitigate environmentally-related disease disparities.

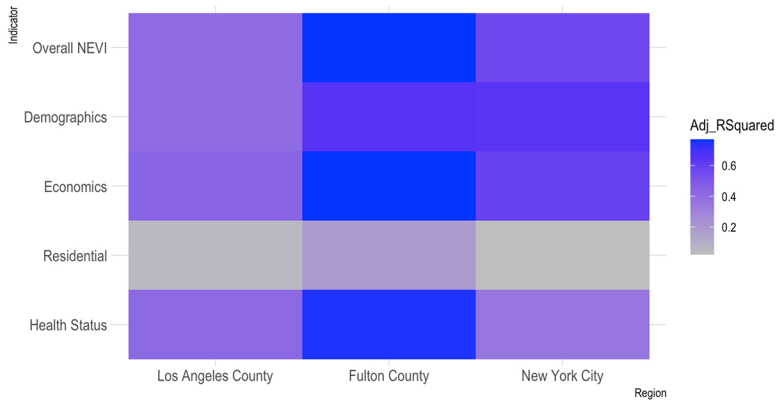

Figure 1. Heatmap of the Variance Explained (Adjusted R-Squared Values) Using the Linear Regression Models Examining the Relationship between NEVI and Pediatric Asthma ED Visits (per 10,000)[1]

[1] Adjusted R-squared values are plotted by metropolitan area (Los Angeles County, Fulton County, New York City) on the x-axis and by the individual explanatory variable included in the linear regression model (e.g., overall NEVI score, type of domain-specific NEVI score) on the y-axis

Acronyms: NEVI = Neighborhood Environmental Vulnerability Index; ED = emergency department

Table 1.

Summary Statistics Across Overall NEVI and NEVI Domain-Specific Scores, and Annual Rates of Pediatric Asthma[1] ED visits (per 10,000) using LA County (CA), Fulton County (GA), and NYC Zip Codes

LOS ANGELES COUNTY						
	Mean	**SD**	**Median**	**IQR**	**Min.**	**Max**
Overall NEVI	0.30	0.07	0.29	0.25–0.34	0.18	0.47
Domain-Scores						
Demographic	0.30	0.04	0.30	0.28-0.33	0.21	0.44
Economic	0.27	0.08	0.26	0.21-0.32	0.13	0.46
Residential	0.23	0.06	0.22	0.19-0.25	0.09	0.43
Health Status	0.39	0.12	0.39	0.30-0.48	0.17	0.69
Rates of Pediatric Asthma ED Visits (per 10,000)	70.59	32.60	67.70	47.20-83.90	15.60	178.20
FULTON COUNTY (GA)						
	Mean	**SD**	**Median**	**IQR**	**Min.**	**Max**
Overall NEVI	0.32	0.10	0.30	0.23–0.40	0.15	0.53
Domain-Scores						
Demographic	0.36	0.09	0.37	0.28-0.43	0.19	0.53
Economic	0.29	0.12	0.26	0.19-0.39	0.13	0.54
Residential	0.25	0.10	0.25	0.18-0.30	0.11	0.53
Health Status	0.36	0.17	0.35	0.21-0.49	0.10	0.71
Rates of Pediatric Asthma ED Visits (per 10,000)	109.59	67.06	91.96	49.95-159.00	23.93	293.37
NEW YORK CITY						
	Mean	**SD**	**Median**	**IQR**	**Min.**	**Max**
Overall NEVI	0.33	0.07	0.32	0.28–0.38	0.21	0.50
Domain-Scores						
Demographic	0.28	0.06	0.27	0.24-0.32	0.17	0.46
Economic	0.36	0.10	0.35	0.30-0.42	0.19	0.60
Residential	0.33	0.07	0.34	0.27-0.38	0.13	0.51
Health Status	0.36	0.12	0.36	0.29-0.44	0.13	0.64
Rates of Pediatric Asthma ED Visits (per 10,000)	155.78	120.64	134.65	53.77-205.30	17.40	597.20

[1] Pediatric Asthma ED Visits pertain to those between 0 to 19 years of age

Acronyms: NEVI = Neighborhood Environmental Vulnerability Index (higher NEVI score means higher vulnerability to environmental exposures), LA = Los Angeles, CA = California, GA = Georgia, NYC = New York City, ED = emergency department, SD = standard deviation, IQR = interquartile range

Table 2.

Linear Regression Estimates Regarding the Relationship between NEVI (Overall & Domain-Specific) and Annual Rates of Pediatric Asthma[1] ED Visits (per 10,000) using LA County (CA), Fulton County (GA), and NYC Zip Codes[2]

LOS ANGELES COUNTY (CA)		
Pediatric Asthma ED Visit Rate (per 10,000)	**Beta Coefficient (95% CI)[3]**	**Adjusted Model R-Squared[4]**
Model 1: Overall NEVI	31.87 (26.78, 36.96)	0.41
Model 2: Demographic NEVI	51.48 (43.35, 59.60)	0.41
Model 3: Economic NEVI	28.07 (23.85, 32.29)	0.44
Model 4: Residential NEVI	13.53 (6.26, 20.80)	0.05
Model 5: Health Status NEVI	18.04 (15.23, 20.85)	0.42
FULTON COUNTY (GA)		
Pediatric Asthma ED Visit Rate (per 10,000)	**Beta Coefficient (95% CI)**	**Adjusted Model R-Squared**
Model 1: Overall NEVI	56.25 (47.56, 64.94)	0.77
Model 2: Demographic NEVI	60.39 (47.85, 72.92)	0.65
Model 3: Economic NEVI	48.22 (40.87, 55.56)	0.77
Model 4: Residential NEVI	32.20 (14.37, 50.03)	0.19
Model 5: Health Status NEVI	35.23 (29.57, 40.89)	0.75
NEW YORK CITY		
Pediatric Asthma ED Visit Rate (per 10,000)	**Beta Coefficient (95% CI)**	**Adjusted Model R-Squared**
Model 1: Overall NEVI	134.47 (116.56, 152.39)	0.56
Model 2: Demographic NEVI	161.05 (142.76, 179.34)	0.64
Model 3: Economic NEVI	97.42 (85.10, 109.73)	0.59
Model 4: Residential NEVI	29.36 (3.45, 55.26)	0.02
Model 5: Health Status NEVI	63.36 (50.72, 76.00)	0.37

[1] Pediatric Asthma ED Visits pertain to those between 0 to 19 years of age

[2] Results correspond to a 0.1 increase in NEVI and domain-specific NEVI indicators

[3] All standardized beta coefficients are significant with p-values <0.05

[4] All R-coefficients of determination are significant with p-values <0.05

Acronyms: NEVI = Neighborhood Environmental Vulnerability Index, LA = Los Angeles, CA = California, GA = Georgia, NYC = New York City, ED = emergency department, SD = standard deviation, IQR = interquartile range