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Geographic Variation in Hospitalization for Lower Respiratory Tract Infections Across One County

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Abstract

IMPORTANCE—Bronchiolitis and pneumonia are leading causes of pediatric hospitalizations. Identifying geographic patterns in hospitalization rates across small geographic areas could be particularly relevant to targeted patient-level and population-level health care.

OBJECTIVE—To determine whether lower respiratory tract infection hospitalization rates varied geographically across a single county and whether such variability was associated with socioeconomic conditions.

DESIGN, SETTING, AND PARTICIPANTS—Cross-sectional, population-based study of children hospitalized at one institution for lower respiratory tract infections between January 1, 2010, and December 31, 2013. The setting was Cincinnati Children's Hospital Medical Center, a large, academic, stand-alone pediatric facility located in Hamilton County, Ohio. During the study period, 99.6% of in-county children hospitalized for lower respiratory tract infections were admitted to Cincinnati Children's Hospital Medical Center. Participants were children younger than 2 years who were hospitalized with bronchiolitis and children younger than 18 years who were hospitalized with pneumonia. Patients were identified using discharge diagnosis codes and then geocoded to their home census tract.

EXPOSURES—Primary exposures, linked to each geocoded patient, included census tract-level socioeconomic measures obtained from the 2008 to 2012 American Community Survey (eg, adult

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Study concept and design: All authors.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: All authors.

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educational attainment, unemployment, and poverty). Patient-level variables examined included demographics, presence of a complex chronic condition, length of stay, and cost.

MAIN OUTCOMES AND MEASURES—We calculated bronchiolitis and pneumonia hospitalization rates for Hamilton County and for each of 222 in-county census tracts.

Associations between hospitalization rate quintiles and underlying socioeconomic conditions were assessed using the Kruskal-Wallis test. Geographic clustering was assessed using the Getis-Ord G_i^* statistic.

RESULTS—There were 1495 bronchiolitis hospitalizations and 1231 pneumonia hospitalizations during the study period. The county rates were 17.5 (range across census tracts, 0–71.4) hospitalizations per 1000 children per year for bronchiolitis and 1.6 (range across census tracts, 0–4.3) hospitalizations per 1000 children per year for pneumonia. There was significant variation in the median hospitalization rates by census tract quintile for bronchiolitis (32.8, 20.8, 14.0, 10.4, and 5.1 per 1000) and for pneumonia (3.3, 2.1, 1.4, 0.9, and 0.3 per 1000). There were also significant, graded differences in socioeconomic measures by hospitalization rate quintile. Hot spots were localized to inner-city, impoverished neighborhoods.

CONCLUSIONS AND RELEVANCE—Bronchiolitis and pneumonia hospitalization rates varied considerably in ways that were related to underlying socioeconomic conditions. Clinical and public health interventions, targeted accordingly, could improve patient-level and population-level management of acute conditions at a reduced cost.

Bronchiolitis is the leading cause of lower respiratory tract infection (LRTI) in children younger than 2 years, with approximately 150 000 annual hospitalizations in the United States.^{1–5} Pneumonia is the most common serious bacterial infection in children and another leading cause of pediatric hospitalizations.^{6–8} For children’s hospitals, these conditions rank among the top 10 in cost and prevalence.⁸ Identifying factors that contribute to population-level hospitalization risk could highlight targets for intervention. Determining patterns in hospitalization rates across small geographic areas may be particularly relevant as hospitals seek to target interventions to those areas at highest risk.⁹

Numerous studies have shown linkages between socioeconomic status (SES) and disease prevalence and morbidity. For example, asthma-related hospitalization rates were found to vary considerably across Hamilton County, Ohio, neighborhoods, and area-level socioeconomic characteristics explained much of this variability.¹⁰ Given that other researchers have shown a link between individual-level socioeconomic deprivation and risk of pneumonia,^{11–13} it is plausible that analogous area-level characteristics could be relevant for acute pediatric LRTIs. For example, lower household income has been shown to be associated with higher costs of care for LRTIs.¹⁴ Other investigators have shown that adults from impoverished census tracts (demographically homogeneous areas of approximately 4000 people, defined by local municipalities and the US Census Bureau)¹⁵ are at increased risk for bacteremic pneumonia.¹⁶ In children, a correlation has been found between residence in impoverished or crowded neighborhoods and incidence of influenza-associated hospitalization.¹⁷

Although many researchers have identified associations between SES and infections, the relationship with hospitalizations is less clear. Therefore, we sought to determine whether

hospitalization rates for bronchiolitis and pneumonia varied geographically across a single county. In addition, we sought to determine whether hospitalization rates were associated with underlying area-level socioeconomic factors.

Methods

Study Design and Data Source

This was a cross-sectional, population-based study of children hospitalized for LRTI at Cincinnati Children's Hospital Medical Center (CCHMC) between January 1, 2010, and December 31, 2013. Clinical and demographic variables were extracted from the electronic medical record. Information regarding the presence of complex chronic conditions (CCCs), defined using representative *International Classification of Diseases, Ninth Revision (ICD-9)* codes,¹⁸ was obtained from data available within the Pediatric Health Information System (Children's Hospital Association, Overland Park, Kansas). Area-level socioeconomic variables were extracted from the US Census Bureau.¹⁵ The CCHMC Institutional Review Board approved this study. Informed consent was waived.

Study Population

The study included children younger than 2 years hospitalized with bronchiolitis and children younger than 18 years hospitalized with pneumonia. Patients were identified if they had an *ICD-9* discharge diagnosis code for bronchiolitis (code 466.11 or 466.19) or pneumonia (codes 480–486) in any diagnosis position. Children were excluded if they were in the custody of Hamilton County Children's Services because their home census tract could not be determined. The analysis was also limited to patients from Hamilton County to minimize hospitalizations lost to other institutions and to allow for a population-based sample.¹⁹ Hamilton County is home to CCHMC and includes Cincinnati and its suburbs. There are approximately 200 000 children younger than 18 years in Hamilton County.¹⁵

We verified CCHMC's in-county market share using data from the Ohio Hospital Association. All local hospitals, including those within Hamilton County, report self-validated discharge data to the Ohio Hospital Association, where they are aggregated and internally validated. The resulting database can be accessed and queried by member hospitals. Using this database, with assistance from the CCHMC Planning Department, we found that CCHMC hospitalized 99.6% of bronchiolitis cases and 99.6% of pediatric pneumonia cases from Hamilton County.

Outcome Measures

The primary outcome was census tract LRTI hospitalization rates. To calculate rates (one for bronchiolitis and one for pneumonia), the home address for each hospitalization event was geocoded (or mapped) and then linked to its census tract. Lower respiratory tract infection hospitalization rates were calculated for Hamilton County and for each of 222 in-county census tracts. The numerator was hospitalization events, and the denominator was the child population (younger than 2 years for bronchiolitis and younger than 18 years for pneumonia calculations) obtained from the 2010 US Census.¹⁵ These values were converted to rates,

measured per 1000 children per year, and averaged over the data collection period (2010–2013).

Covariates

Detailed ecological socioeconomic measures were obtained from the 2008 to 2012 American Community Survey.^{10,20–23} Census tract-level variables included the unemployment rate and the median rent, household income, and value of owner-occupied housing units, as well as percentages of the following: unoccupied housing units, persons below the poverty line, households living in rented homes, households that do not own a vehicle, adults (15 years or older) who have never married, and adults (25 years or older) with less than a 12th grade education.

Patient-level variables examined from the electronic medical record included insurance status, sex, age, race/ethnicity, diagnosis codes, and hospital length of stay (LOS). Reimbursement data provided information on the cost of the hospitalization. Using the Pediatric Health Information System data set, we also identified whether patients had a CCC (yes or no). Defined using a previously described classification scheme, CCCs represent diagnosis groupings expected to last longer than 12 months that involve either a single-organ system severe enough to require specialty care and hospitalization or multiple-organ systems.^{18,24}

Statistical and Spatial Analyses

Hospitalization rates were calculated, separately for bronchiolitis and pneumonia, for Hamilton County and each individual census tract. Census tracts were sorted in order of hospitalization rate and grouped into 5 quintiles, with 44 or 45 in each group. Quintiles were chosen, a priori, to aid in interpret-ability. Categorization was also thought to be potentially more actionable (eg, for future work aimed at risk stratification). Quintiles were compared with respect to the median hospitalization rates using the Kruskal-Wallis test. We then identified the distribution of each area-level socioeconomic variable within each hospitalization rate quintile. Differences between hospitalization rate quintiles with respect to the median of each SES variable, LOS, and cost were also assessed using the Kruskal-Wallis test.

Given our group's previous work highlighting area-level asthma inequalities¹⁰ and the potential relationship between asthma and LRTIs, we performed sensitivity analyses after excluding hospitalization events with a copresent *ICD-9* code for asthma (codes 493.XX). Given a potential interaction between SES and medical complexity, separate sensitivity analyses excluded those patients with a CCC.²⁵ For both of these sensitivity analyses, the same denominator was used as in the primary analysis because population numbers of children with asthma or CCCs were unavailable. The correlations of hospitalization rates before and after the exclusion of asthma and then CCCs were examined using Spearman rank correlation coefficients. Differences with respect to SES variables were also assessed using the Kruskal-Wallis test. Analyses were conducted using statistical software (SAS, version 9.3; SAS Institute Inc).

Cluster detection statistics were calculated to explore spatial patterns using the local Getis-Ord G_i^* statistic.²⁶ The G_i^* statistic compares the expected value of a variable across a local area (ie, one census tract) with the expected value of that variable across the entire study area (ie, all included census tracts) by calculating a standardized z score and associated P value. Here, the variable of interest was the hospitalization rate. The G_i^* statistic determined whether the observed spatial pattern was more pronounced than one would expect given an otherwise random distribution. Positive significant values indicate that a local area (ie, census tract) is a part of a hot spot, while negative significant values indicate that it is a part of a cold spot. We were interested in census tracts deemed hot (ie, higher hospitalization rates than would be expected if distribution was random) or cold (ie, lower hospitalization rate than would be expected if distribution was random) at a significance level of $P < .05$. Geocoding and spatial analyses were conducted using a software platform (ArcGIS; Esri).

Results

There were 1264 patients who contributed 1495 hospitalizations for bronchiolitis. Children hospitalized with bronchiolitis had a median age of 0.4 (interquartile range [IQR], 0.2–0.8) years (Table 1). There were 1017 patients who contributed 1231 hospitalizations for pneumonia. These children had a median age of 3.0 (IQR, 1.0–7.2) years. The median costs of a hospitalization were \$6599 (IQR, \$4700–\$10 255) for bronchiolitis and \$9997 (IQR, \$6035–\$23 496) for pneumonia.

The overall hospitalization rate for bronchiolitis was 17.5 (range across census tracts, 0–71.4) hospitalizations per 1000 children per year, while for pneumonia it was 1.6 (range across census tracts, 0–4.3) hospitalizations per 1000 children per year (Table 1). The median bronchiolitis hospitalization rates varied significantly, with 32.8, 20.8, 14.0, 10.4, and 5.1 per 1000 children within the highest to lowest neighborhood quintiles, respectively ($P < .001$). The highest quintile contributed 19.6% (4185 of 21 319) of county children but 38.1% (569 of 1495) of all bronchiolitis hospitalizations during the study period. The lowest quintile contributed 15.1% (3216 of 21 319) of county children and 4.5% (67 of 1495) of all bronchiolitis hospitalizations. A similar pattern was noted for pneumonia by highest to lowest neighborhood quintile, with 3.3, 2.1, 1.4, 0.9, and 0.3 hospitalizations per 1000 children ($P < .001$). Here, the highest quintile for pneumonia contributed 18.4% (34 857 of 189 640) of county children but 37.3% (459 of 1231) of all pneumonia hospitalizations during the study period, while the lowest quintile contributed 18.0% (34 209 of 189 640) of county children and 4.1% (50 of 1231) of pneumonia hospitalizations.

A total of 43 bronchiolitis-related and 347 pneumonia-related hospitalizations also had diagnosis codes present for asthma. There was significant correlation between hospitalization rates measured before and after the exclusion of children with asthma for bronchiolitis ($r = 0.99$, $P < .001$) and for pneumonia ($r = 0.85$, $P < .001$). Also, 157 children hospitalized with bronchiolitis and 281 children hospitalized with pneumonia had a CCC. There was significant correlation between census tract hospitalization rates measured before and after the exclusion of children with CCCs for bronchiolitis ($r = 0.95$, $P < .001$) and for pneumonia ($r = 0.85$, $P < .001$).

Significant differences were observed among quintiles with respect to area-level characteristics (Table 2). For example, the median annual household income within the highest hospitalization rate quintile for bronchiolitis was \$27 686. In contrast, the lowest quintile had a median annual household income of \$60 890, with household income related to each quintile in a graded fashion ($P < .001$). Similar graded relationships were noted for the other measures of SES ($P < .001$ for all). These relationships persisted after the exclusion of children with asthma and CCCs. For bronchiolitis, hospitalization rate quintile was not found to be significantly associated with LOS or with cost (eTable 1 in the Supplement).

Similar findings were noted for pneumonia, with significant differences among quintiles with respect to the same set of area-level measures (Table 3). Here, the median annual household income within the highest hospitalization rate quintile was \$31 424, whereas the value in the lowest quintile was \$61 250, with household income related to each quintile in a graded fashion ($P < .001$). Similar graded relationships were noted for the other measures ($P < .01$ for all). As with bronchiolitis, relationships persisted after the exclusion of children with asthma and CCCs. For pneumonia, there was no significant difference in the median LOS across quintiles (eTable 2 in the Supplement). However, a significant difference in cost was observed. This appeared to be driven by a lower median cost in the medium quintile. Cost data were similar across the other quintiles.

For bronchiolitis, higher hospitalization rates appeared to geographically cluster within Cincinnati's urban core compared with outlying suburbs (Figure 1A). This was confirmed using the G_i^* statistic (Figure 1B). Significant hot spots (ie, areas with higher hospitalization rates than would be expected if spatial distribution was random) were noted in high-poverty areas of the inner city, and significant cold spots (ie, areas with lower hospitalization rates than would otherwise have been expected) were noted in the more affluent northeastern suburbs ($P < .05$ for both). Similar patterns and clusters were noted for pneumonia (Figure 2A). Again, the inner city served as a hot spot and the eastern and northeastern suburbs as cold spots (Figure 2B) ($P < .05$ for all).

Discussion

This population-based analysis identified substantial variability in LRTI hospitalization rates across a single county. The highest census tract-level hospitalization quintile for bronchiolitis had a hospitalization rate 6 times that of the lowest quintile. The highest census tract-level hospitalization quintile for pneumonia had a hospitalization rate 11 times that of the lowest quintile. These inequalities were associated with underlying differences in multiple area-level socioeconomic measures. For example, the median household income within the highest hospitalization rate quintile for bronchiolitis approximated the federal poverty level for a family of 4. Moreover, significant geographic clustering was apparent, with LRTI hospitalization hot spots in the inner city and cold spots in outlying suburbs. This geospatial variability, and the strong associations between hospitalization rates and markers of SES, has substantial clinical and public health implications, suggesting small areas that could be targets for prevention and cost containment.

Geographic variability exists for multiple health conditions, particularly chronic diseases. Our group previously demonstrated that asthma hospitalization rates varied 18-fold across local neighborhoods.¹⁰ These findings parallel other results that illustrate relationships between asthma-related disparities and underlying social and environmental characteristics.²⁷ Other conditions thought to be sensitive to such factors (eg, lead poisoning, low birth weight, and sexually transmitted infections) have shown similar variability across small areas.^{22,23} These studies also identified geographic measures of SES most applicable to public health analyses, which are measures used as part of this study.²¹

To our knowledge, no previous US study has assessed LRTI hospitalization variability at geographic areas as small and homogeneous as census tracts. In Sweden, Jansson et al²⁸ reported 4-fold variability in bronchiolitis hospitalization risk for children younger than 1 year, across 10 residential areas of Malmö. A study²⁹ in the North of England found 6-fold variation in pneumonia hospitalization risk for children ages 0 to 14 years across 150 postcode districts in their region. In the United States, Gorton and Jones³⁰ assessed geographic variation in pneumonia hospitalizations across Pennsylvania counties. The statewide admission rate per year was 1.6 (range, 0.8–4.6) hospitalizations per 1000 children ages 2 months to 17 years. Although our findings are in close alignment, we were looking within a single county composed of 222 census tracts instead of within a single state composed of 67 counties. Our study highlighted variability that can exist within just one county. The highest pneumonia quintile in our study had a median hospitalization rate almost 18 times that of Pennsylvania (and 6 times that of the Pennsylvania county with the highest hospitalization rate).

Variability in LRTI hospitalization rates was significantly associated with underlying variability in area-level SES. This finding is consistent with previous studies assessing such relationships for other health outcomes. Locally, our group found that measures of poverty and housing quality were associated with a return to the hospital for children with asthma.^{20,31} Also, a recent study by Epstein et al³² showed that lower neighborhood income is associated with higher severity of illness on admission to the pediatric intensive care unit across diagnoses. Such findings are not surprising given the extensive literature on the influence of socioeconomic deprivation on a child's physical health.

A variety of mechanisms exist through which socioeconomic deprivation can effect health conditions such as LRTIs.^{33–36} Many posit that there is a biologic basis to an association between health and socioeconomic deprivation, a relationship that could extend to infectious diseases. For respiratory infections specifically, a link has been found with environmental exposures: children living in geographic areas with low SES may have increased pollutant and other environmental particle exposures associated with respiratory infections.³⁷ Exposure to adverse childhood events, or toxic stressors often rooted in poverty, may affect immune functioning, providing a physiological rationale by which morbidity of disease severity is experienced.³⁸ Low SES may also be associated with diminished access to primary preventive care,^{39,40} a consideration supported by our finding of the significant relationships between hospitalization rates and vehicle availability. Population density, generally higher in the urban core (hot spots in our analyses) than in outlying suburbs (our cold spots), may also provide a mechanism through which infectious diseases can spread.⁴¹

Associations we observed between area-level SES and area-level rates of hospitalization for acute infections highlight the potential benefit of identifying upstream targets for clinical and public health interventions.⁴² Therefore, determining which preventive strategies are most effective is relevant, particularly in this era of accountable care.⁴³ With documented variability in LRTI hospitalization rates across hospitals, counties, and now census tracts,^{30,44} the development, implementation, and evaluation of interventions targeted to the social determinants of health should be considered. For example, area-level or neighborhood-level hot spotting could be used to inform delivery of resources that promote hospitalization prevention.⁴⁵ Data systems could be more effectively integrated to highlight shared responsibilities for prevention by hospitals and by social agencies.⁹ Redesign of primary care services could increase access to care in ways that may help to interface with patients and families before illnesses reach the need for hospitalization.⁴⁶ Clearly, future studies are needed to better understand why children (and geographic areas) that experience poverty-related risks are at heightened risk for LRTI hospitalization and what interventions are best suited toward preventing hospitalizations in an equitable fashion.

There were limitations to this study. First, hospitalization rates for each census tract may vary with time. To stabilize estimates, we used multiple years' worth of data and aggregated census tracts into quintiles. Second, the cross-sectional design did not allow us to determine causation or directionality of association between hospitalization rates and census tract-level characteristics. Third, we were unable to directly measure the role of disease severity or underlying diagnoses in the hospitalization decision. Health care professionals may have a lower threshold to hospitalize a child of lower SES. It is also possible that medical history that varies by SES (eg, prematurity) may have influenced the hospitalization decision.²² Nevertheless, proxies of severity (LOS and cost) did not vary across hospitalization quintiles, and (similar to prior work³⁰) our results did not change after excluding children with asthma or CCCs. Fourth, we were not able to identify infections that may have occurred during a hospitalization. Still, we expect that any potential bias introduced would have been nondifferential. Fifth, we were unable to determine total LRTI prevalence across census tracts, specifically infections that did not require inpatient treatment. Therefore, higher hospitalization rates may have resulted from higher infection rates or lower rates of adequate outpatient treatment. Sixth, older patients and those living farther from CCHMC may have been hospitalized at other facilities. However, Ohio Hospital Association data suggest that, within our region, CCHMC cares for 99.6% of hospitalized children with LRTI. Seventh, our population was drawn from a single county and may not be generalizable to other regions.

Conclusions

Hospitalization rates for bronchiolitis and pneumonia showed substantial variation across census tracts within a single US county. This variability was significantly associated with underlying differences in census tract-level SES. Lower respiratory tract infection hospitalization hot spots were apparent in the urban core, with relative cold spots present in outlying, more affluent suburbs. Hospitalization has substantial consequences for children and families, in addition to its considerable cost. Clinical and public health interventions

should be targeted in ways that aim to “cool” areas at high risk of excessive hospital utilization, resulting in improved patient outcomes at decreased cost.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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At a Glance

- Our objective was to determine whether lower respiratory tract infection hospitalization rates varied geographically across a single county and whether such variability was associated with socioeconomic conditions.
- The hospitalization rate in Hamilton County, Ohio, calculated from hospitalization events at Cincinnati Children's Hospital Medical Center, for bronchiolitis was 17.5 hospitalizations per 1000 children per year, ranging from 0 to 71.4 per 1000 across all in-county census tracts. The county's hospitalization rate for pneumonia was 1.6 hospitalizations per 1000 children per year, ranging from 0 to 4.3 per 1000 across all in-county census tracts.
- There were significant, graded differences in socioeconomic measures by hospitalization rate quintile for both bronchiolitis and pneumonia. Hospitalization hot spots were localized to inner-city, impoverished neighborhoods.
- Clinical and public health interventions may be best targeted to those areas at high risk of excessive hospital utilization.

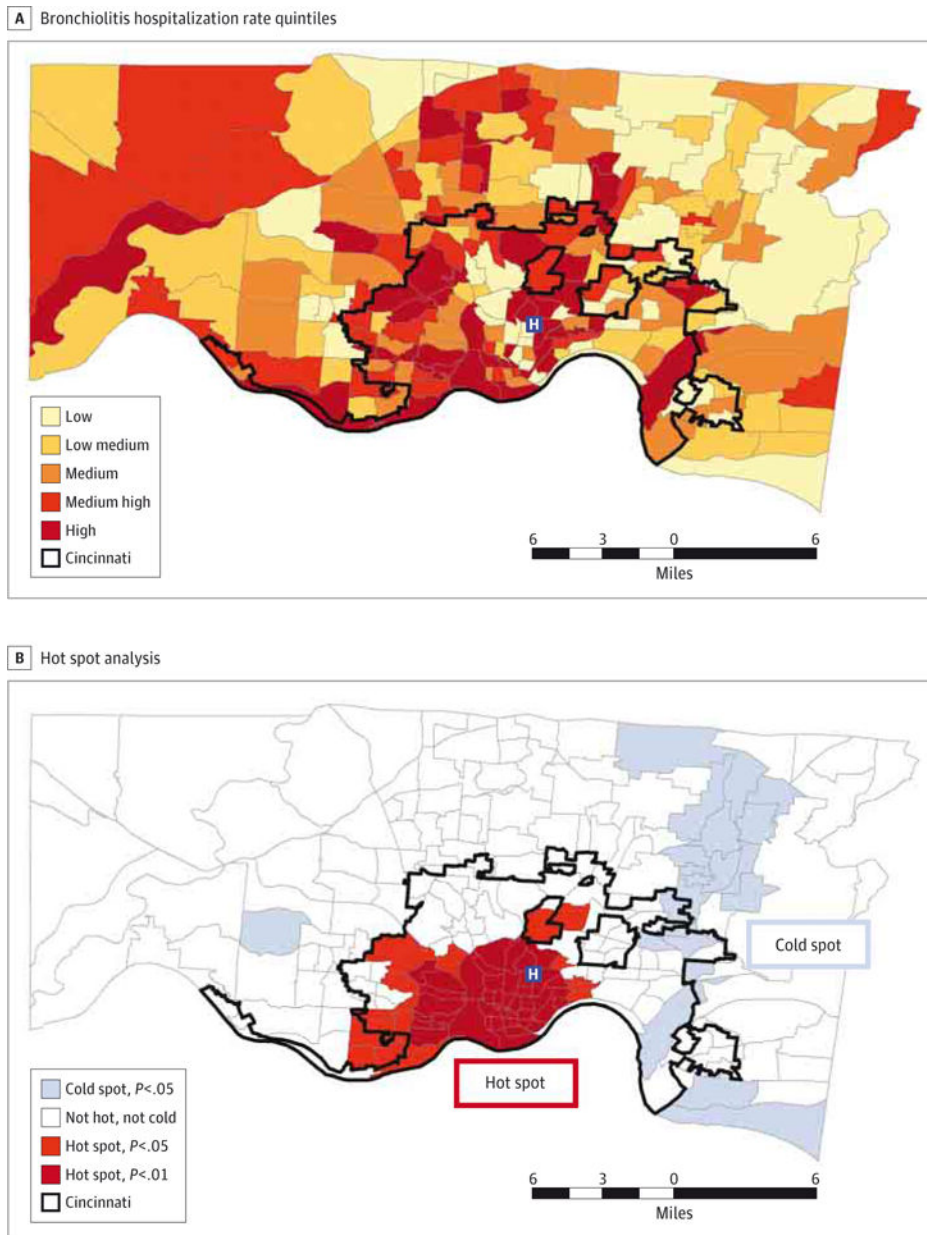


Figure 1. Map of Hamilton County, Ohio, Showing Bronchiolitis Hospitalization Rates
 A, Bronchiolitis hospitalization rates across Hamilton County census tracts, 2010–2013. B, Hot spot analysis for bronchiolitis hospitalization rates using the local Getis-Ord G_i^* statistic, 2010–2013. The *H* indicates the location of Cincinnati Children’s Hospital Medical Center.

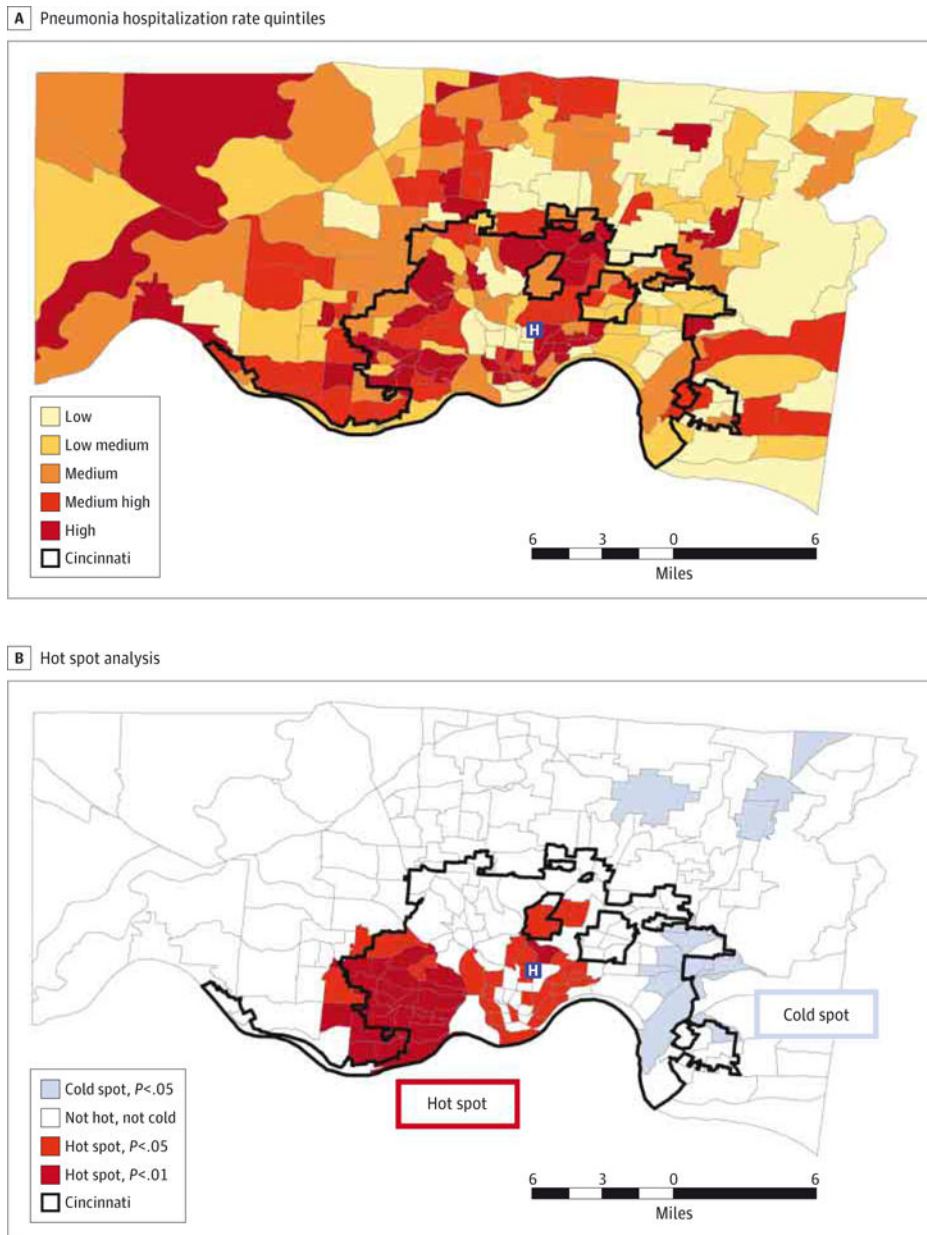


Figure 2. Map of Hamilton County, Ohio, Showing Pneumonia Hospitalization Rates
 A, Pneumonia hospitalization rates across Hamilton County census tracts, 2010–2013. B,
 Hot spot analysis for pneumonia hospitalization rates using the local Getis-Ord G_i^* statistic,
 2010–2013. The *H* indicates the location of Cincinnati Children’s Hospital Medical Center.

Table 1

Patient-Level Demographics and Area-Level Hospitalization Rate Characteristics in Hamilton County, Ohio

Variable	Bronchiolitis (n = 1264)	Pneumonia (n = 1017)
No. of events	1495	1231
Patient-Level Demographics		
Age, median (IQR), y	0.4 (0.2–0.8)	3.0 (1.0–7.2)
Male sex, No. (%)	713 (56.4)	544 (53.5)
Race/ethnicity, No. (%)		
Black or African American	600 (47.5)	455 (44.7)
White	526 (41.6)	458 (45.0)
Other	93 (7.4)	96 (9.4)
Refused or missing	45 (3.6)	8 (0.8)
Hispanic ethnicity, No. (%)	70 (5.5)	62 (6.1)
Insurance, No. (%)		(n = 1016)
Public	956 (75.6)	674 (66.3)
Private	298 (23.6)	333 (32.7)
Self-pay	10 (0.8)	9 (0.9)
Presence of a complex chronic condition, No. (%)	157 (12.4)	281 (27.6)
Length of stay, median (IQR), d ^a	2.7 (1.9–4.0)	3.0 (2.0–6.0)
Cost of hospitalization, median (IQR), \$ ^a	6599 (4700–10 255)	9997 (6035–23 496)
Area-Level Hospitalization Rate Characteristics		
Hamilton County hospitalization rate, No. per 1000 children	17.5	1.6
Hamilton County hospitalization rate by quintile, median No. per 1000 children ^b		
Low	5.1	0.3
Low medium	10.4	0.9
Medium	14.0	1.4
Medium high	20.8	2.1
High	32.8	3.3
Hamilton County hospitalization rate, excluding those with a complex chronic condition, No. per 1000 children	15.1	1.1
Hamilton County hospitalization rate by quintile, excluding those with a complex chronic condition, median No. per 1000 children ^b		
Low	3.7	0.0
Low medium	9.2	0.6
Medium	12.7	0.9
Medium high	18.4	1.4
High	28.2	2.3

Abbreviation: IQR, interquartile range.

^a Calculated for all events, not for individual patients.

^bUsing the Kruskal-Wallis test, $P < .001$ for bronchiolitis and pneumonia hospitalization rates across quintiles (including and excluding patients with a complex chronic condition).

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Table 2
 Median of Each Census Tract–Level Socioeconomic Characteristic, Obtained From the 2008–2012 American Community Survey, in Each of 5
 Bronchiolitis Hospitalization Rate Quintiles

Census Tract Variable	Bronchiolitis Hospitalization Rate Quintile					P Value ^a
	Low	Low Medium	Medium	Medium High	High	
Adults with less than a high school education, No./total No. (%)	6.2	7.8	10.9	13.1	12.1	<.001
Unemployment rate, No./total No. (%)	7.1	7.0	8.4	8.8	16.7	<.001
Annual household income, \$	60 890	55 306	50 017	38 715	27 686	<.001
Individuals below the poverty line, No./total No. (%)	9.8	8.9	12.8	17.5	35.4	<.001
Vacant homes, No./total No. (%)	9.7	7.4	11.5	11.3	22.5	<.001
Renter-occupied homes, No./total No. (%)	34.4	25.4	43.2	46.3	64.2	<.001
Households that do not own a vehicle, No./total No. (%)	7.1	4.3	9.0	13.4	20.5	<.001
Home value, \$	183 700	140 000	141 300	111 700	95 000	<.001
Median rent, \$	852	766	709	667	617	<.001
Never married, No./total No. (%)	35.0	31.1	35.5	36.8	48.4	<.001

^aUsing the Kruskal–Wallis test, remains significant at $P < .001$ during sensitivity analyses, first excluding those with asthma and then separately excluding those with complex chronic conditions.

Table 3
 Median of Each Census Tract–Level Socioeconomic Characteristic, Obtained From the 2008–2012 American Community Survey, in Each of 5 Pneumonia Hospitalization Rate Quintiles

Census Tract Variable	Pneumonia Hospitalization Rate Quintile					P Value ^a
	Low	Low Medium	Medium	Medium High	High	
Adults with less than a high school education, No./total No. (%)	6.0	10.0	11.4	13.9	18.0	<.001
Unemployment rate, No./total No. (%)	6.8	7.5	8.5	10.1	14.3	<.001
Annual household income, \$	61 250	50 096	44 707	43 402	31 424	<.001
Individuals below the poverty line, No./total No. (%)	7.7	13.3	15.5	18.0	31.9	<.001
Vacant homes, No./total No. (%)	8.1	10.2	9.8	12.9	21.2	<.001
Renter-occupied homes, No./total No. (%)	32.6	36.5	43.8	45.4	62.2	.001
Households that do not own a vehicle, No./total No. (%)	6.8	6.5	10.6	14.2	16.8	<.001
Home value, \$	180 000	143 500	122 700	120 000	106 300	<.001
Median rent, \$	859	780	665	697	635	<.001
Never married, No./total No. (%)	35.5	35.6	35.2	40.1	45.0	.009

^aUsing the Kruskal–Wallis test, remains significant at $P < .05$ during sensitivity analyses, first excluding those with asthma and then separately excluding those with complex chronic conditions.