RESEARCH ARTICLE

Neighborhood Deprivation and Childhood Asthma Outcomes, Accounting for Insurance Coverage

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ABSTRACT

OBJECTIVES: Collecting social determinants data is challenging. We assigned patients a neighborhood-level social determinant measure, the area of deprivation index (ADI), by using census data. We then assessed the association between neighborhood deprivation and asthma hospitalization outcomes and tested the influence of insurance coverage.

METHODS: A retrospective cohort study of children 2 to 17 years old admitted for asthma at 8 hospitals. An administrative database was used to collect patient data, including hospitalization outcomes and neighborhood deprivation status (ADI scores), which were grouped into quintiles (ADI 1, the least deprived neighborhoods; ADI 5, the most deprived neighborhoods). We used multivariable models, adjusting for covariates, to assess the associations and added a neighborhood deprivation status and insurance coverage interaction term.

RESULTS: A total of 2270 children (median age 5 years; 40.6% girls) were admitted for asthma. We noted that higher ADI quintiles were associated with greater length of stay, higher cost, and more asthma readmissions ($P < .05$ for most quintiles). Having public insurance was independently associated with greater length of stay (β: 1.171; 95% confidence interval [CI]: 1.117–1.228; $P < .001$), higher cost (β: 1.147; 95% CI: 1.093–1.203; $P < .001$), and higher readmission odds (odds ratio: 1.81; 95% CI: 1.46–2.24; $P < .001$). There was a significant deprivation–insurance effect modification, with public insurance associated with worse outcomes and private insurance with better outcomes across ADI quintiles ($P < .05$ for most combinations).

CONCLUSIONS: Neighborhood-level ADI measure is associated with asthma hospitalization outcomes. However, insurance coverage modifies this relationship and needs to be considered when using the ADI to identify and address health care disparities.

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www.hospitalpediatrics.org
DOI:https://doi.org/10.1542/hpeds.2017-0032

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HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

Drs Knighton, Stone, and Nkoy conceptualized and designed the study, participated in data collection, analysis, and interpretation of results, and drafted the initial manuscript; Drs Fassl, Johnson, Maloney, and Savitz participated in the study concept, design, and interpretation of the data, and critically review of the manuscript; and all authors approved the final manuscript as submitted.

Despite advances in diagnosis and treatment, studies have reported persistent disparity gaps in asthma care and outcomes in both adults and children with lower socioeconomic status, particularly those with lower education, lower income, public insurance coverage, and of disadvantaged racial and/or ethnic groups.[1–4] Disparities are associated with poorer asthma control, more frequent exacerbations, and higher emergency department and hospital admission and/or readmission rates.[4,5]

Eliminating health disparities is 1 of the Healthy People 2010 improvement goals and is a key recommendation in the National Academy of Medicine (formerly the Institute of Medicine) 2001 report "Crossing the Quality Chasm."[6] Despite a decade of effort and some improvements, health disparities in general and particularly for children with asthma remain.[7] A barrier to addressing health disparities is a difficulty collecting patient-level socioeconomic characteristics (eg, sex, race, ethnicity, education, income, poverty, housing, etc), which are known as social determinants of health.[8,9]

The assessment of social determinants is time consuming and intrusive for frontline staff and patients.[10] Besides basic demographics (age, sex, race, and ethnicity), most health care organizations do not routinely collect social determinant data, limiting their ability to compare performance and identify and address health care disparities. An improved collection of social determinants may guide effective interventions to reduce disparities in vulnerable populations.

Alternative measures at the neighborhood level that use readily available census variables[11,12] offer an opportunity for health care organizations to obtain social determinant data. Previous studies have reported associations between neighborhood-level measures and health behaviors, mortality, and health disparities.[13–16] Yet, the use of neighborhood measures as a proxy for patient-level social determinants in the health care setting, particularly for children with asthma, is not widespread.

Intermountain Healthcare has implemented in the organization's electronic medical record (EMR) system a measure of neighborhood-level social determinants, the area of deprivation index (ADI),[17] by using Singh's ADI approach.[18] The ADI, also called a measure of neighborhood deprivation or neighborhood wealth,[18,19] includes 17 US census block group variables related to education, employment, income and/or poverty, and housing and reflects the average socioeconomic characteristics of individuals within a neighborhood.[20,21] Within the Intermountain Healthcare EMR, each patient is automatically assigned an ADI score on the basis of his or her geocoded address (the address is converted into geographic coordinates, including latitude and longitude) for use at the point of care and to support health care planning, research, and quality-improvement activities.

Previous studies have shown that private insurance patients have better clinical outcomes.[22,23] Yet, the influence of insurance coverage on health care outcomes within deprived and advantaged neighborhoods has not been studied in children with asthma. The objective of this study was to investigate the value of the ADI by testing its association with the outcomes of children who are hospitalized with asthma. We also sought to assess the independent association of insurance coverage on outcomes and test if insurance coverage modifies the relationship between neighborhood deprivation and asthma outcomes.

METHODS

Setting

Our study included 8 hospitals in Utah participating in a previous quality-improvement study[24] involving all children age 2 to 17 years who were hospitalized for asthma. The intervention involved the implementation of a standardized asthma care process model and an assessment of its impact. These hospitals are operated by Intermountain Healthcare, a regional, not-for-profit, integrated health care delivery system with 22 hospitals and 185 clinics and urgent care facilities located in Utah and southeastern Idaho.[25] Intermountain Healthcare provides health care services to ~1 680 000 patients, including 60% of Utah's residents and 95% of Utah's children.[26] Participating hospitals included Primary Children's Hospital, a 289-bed, freestanding, academic, tertiary-care children's hospital affiliated with the Department of Pediatrics at the University of Utah and located in Salt Lake City, and 7 community hospitals located throughout Utah, including the following: American Fork Hospital in American Fork, Dixie Regional Medical Center in St George, Logan Regional Hospital in Logan, McKay-Dee Hospital in Ogden, Riverton Hospital in Riverton, Utah Valley Hospital in Provo, and Cedar City Hospital in Cedar City. Overall, the 8 hospitals provide inpatient care to ~700 children with asthma each year and serve urban (Primary Children's Hospital, Riverton Hospital, McKay-Dee Hospital, and Utah Valley Hospital) and rural (American Fork Hospital, Dixie Regional Medical Center, Cedar City Hospital, and Logan Regional Hospital) populations. The Intermountain privacy board and the University of Utah institutional review board approved the study.

Study Design and Population

This was a retrospective cohort study of children 2 to 17 years old who were discharged from 1 of 8 Intermountain hospitals between January 1, 2010, and June 30, 2015, with a primary *International Classification of Diseases, Ninth Revision* diagnostic code 493 for asthma.

Patient Identification and Data Collection

The enterprise data warehouse (EDW), an integrated database linking administrative and clinical data from Intermountain hospitals and clinics,[27] was used to identify patients and collect data. Data collected included the following: patient demographics (age, sex, and race), ADI score, insurance (public, private, or self-pay), and severity of illness (SOI), which was divided into 4 levels (1, low severity; 4, high severity) by using All Patient Refined Diagnosis Related Groups.[28] Within the EDW, ADIs are generated as raw scores based on

2013 US census block group data and categorized into quintiles (1, lower neighborhood deprivation; 5, greater neighborhood deprivation) of equal proportions (not at the patient level) and then assigned to patients given the most recent address on record, which is a method used in European census reporting statistics.[17–19]

Outcome variables, also collected by using the EDW, included hospital length of stay (LOS) in hours, variable hospitalization costs, and asthma-related 6-month readmission, which is defined as any emergency department revisit or hospital readmission for asthma as the primary diagnosis at any of 22 Intermountain hospitals within 6 months of a hospital discharge, as was used in a previous study.[24] Variable cost data were derived from the Intermountain Healthcare internal costing system, which provides actual direct costs (not charges) associated with services (eg, costs of supplies and drugs, salaries of nurses and technicians, etc) rendered during each hospitalization.

Data Analysis

Descriptive analyses were used to describe the study population, and regression analyses were used to assess the univariate relationship of the ADI or insurance status, independently and combined, with child asthma outcomes. Specifically, we used multiple linear regressions analysis to assess the impact on hospital LOS and costs after natural log transformation to account for skewing, and we used multiple logistic regression analysis to determine the impact on readmissions and then introduced the ADI quintile and/or insurance coverage interaction term. Multivariable analyses were adjusted for age, race and/or ethnicity, sex, and disease severity using All Patient Refined Diagnosis Related Groups SOI scores.

RESULTS

There were 2351 patients (3003 encounters) discharged from the 8 Intermountain hospitals between January 2010 and June 2015 with a primary *International Classification of Diseases, Ninth Revision* diagnostic code of 493 for asthma. One hundred twenty-three (4.1%) encounters without insurance coverage (self-pay) were excluded, leaving 2880 encounters (2270 patients) with either private (1761 encounters) or public insurance (1119 encounters) and ADI quintile assignments (Fig 1). Of the 1119 encounters with public insurance, 90.5% ($n = 1013$) were for patients with Medicaid, and 9.5% ($n = 106$) were for patients covered under the Children's Health Insurance Program. The overall median age of the study population was 5 years (interquartile range [IQR] 3–8), and 40.0% (908 of 2270) of encounters were for female patients.

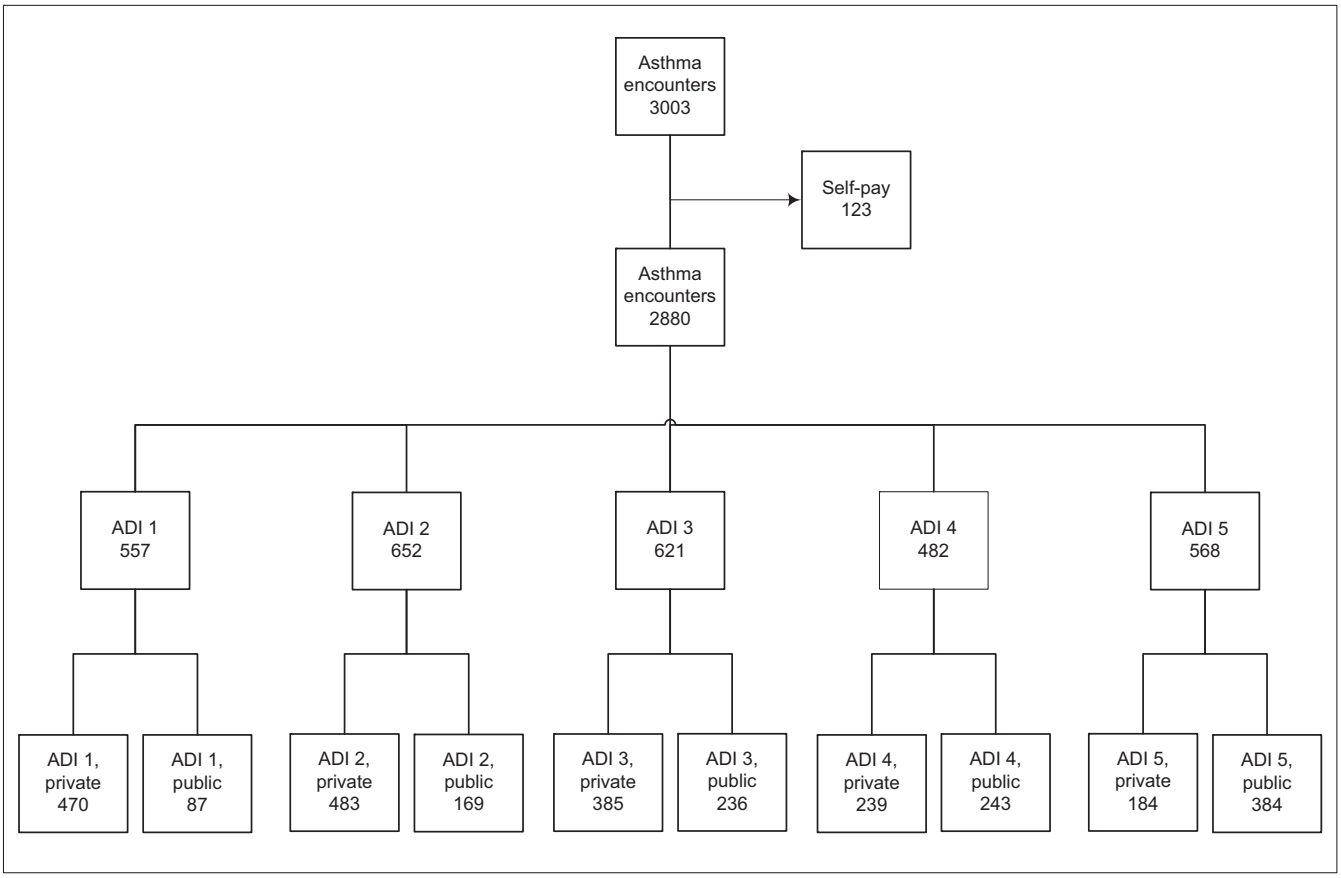

FIGURE 1 Consort diagram.

We found no difference in sex and SOI distributions (Table 1) based on neighborhood deprivation status (ADI quintiles) but significant differences in age ($P = .026$), distribution of race and/or ethnicity ($P < .001$), and insurance coverage ($P < .001$). White children (in ADI 1, 87.3% and ADI 2, 84.1%) were more likely to live in advantaged neighborhoods compared with minority children (ADI 1, 12.7% and ADI 2, 15.9%), whereas the disadvantaged neighborhoods had a mix of white (ADI 3, 62.7% and ADI 4, 53.9%) and minority (ADI 3, 37.3% and ADI 4, 46.1%) children. Patients of Hispanic ethnicity are the largest minority population in Utah, representing 16% of the population. In the advantaged neighborhoods (ADI 1and ADI 2), the majority (84.4% and 74.1%) of patients had private compared with public insurance (15.6% and 25.9%). Of patients living in disadvantaged neighborhoods (ADI 3 and ADI 4), 50.4% and 67.6% had public insurance compared with 49.6% and 32.4% with private insurance, respectively. On the basis of insurance coverage (private versus public), there were no differences in age, sex, and SOI distributions among groups, but there were significant differences ($P < .001$) in racial and/or ethnic distributions.

In univariate analysis (Table 2, top 2 sections), we noted that LOS, costs, and readmission rates were significantly different ($P < .001$) across ADI quintiles. Specifically, as neighborhood deprivation increases from low- to high-ADI quintiles, LOS, costs, and readmission rates also tend to increase, with patients living in the least deprived neighborhoods (ADI1) having the best outcomes and those living in the most deprived neighborhoods (ADI5) having worse outcomes. Patients with public (compared with private) insurance also had greater LOS, higher costs, and higher readmission rates ($P < .001$). In the combined groupings of neighborhood deprivation and insurance coverage (Table 2, bottom section), patients with public (compared with private) insurance had consistently greater LOS, higher costs, and more readmissions within each ADI quintile–insurance combination; however, across quintiles, the relationship was less consistent (eg, LOS, cost, and readmissions did not progressively increase with increasing ADI quintile in patients with public insurance).

After controlling for age, race and/or ethnicity, sex, and disease severity, we found that overall ADI scores were positively associated with increased LOS (β: 1.04; $P < .001$), costs (β: 1.03, $P < .001$), and readmissions (odds ratio [OR]: 1.15; 95% confidence interval [CI]: 1.06–1.24). Also, we found that higher neighborhood deprivation quintiles (ADIs 3–5) were independently associated ($P < .05$ for most quintile) with greater LOS, higher costs, and greater 6-month odds of readmission by using ADI quintile 1 (the most advantaged) as the reference group (Table 3, top 2 sections). Furthermore, we found that public insurance recipients had significantly longer LOS (β: 1.171; $P < .001$), higher costs (β: 1.147; $P < .001$), and higher odds of readmission (OR: 1.81; 95% CI: 1.46–2.24; $P < .001$) by using private insurance as the reference group (Table 3, middle section).

After adding an ADI quintile–insurance coverage interaction term, we found that insurance coverage modifies the relationship between neighborhood deprivation and asthma hospitalization outcomes (Table 3, bottom section). Within quintiles, patients with public insurance had consistently greater ($P < .05$ for most combinations) LOS, higher costs, and higher odds of readmission, whereas patients with private insurance had shorter LOS, lower costs, and smaller readmission odds by using patients living in the least deprived

TABLE 1 Demographics by Study Grouping

	Neighborhood Deprivation Status						Insurance Coverage Type		
	ADI 1	ADI 2	ADI 3	ADI 4	ADI 5	*P*	Public	Private	*P*
No. encounters	557	652	621	482	568		1119	1761	
Age, y, median (IQR)	4 (3–7)	5 (3–8)	5 (3–8)	5 (3–8)	5 (3–8)	.026	5 (3–8)	5 (3–8)	.639
Female sex, *n* (%)	241 (43.3)	280 (42.9)	235 (37.8)	191 (39.6)	222 (39.1)	.213	441 (39.4)	728 (41.3)	.304
Race, *n* (%)						<.001			<.001
White	486 (87.3)	548 (84.1)	453 (72.9)	302 (62.7)	306 (53.9)		643 (57.5)	1452 (82.5)	
Hispanic	9 (1.6)	10 (1.5)	36 (5.8)	24 (4.9)	63 (11.1)		106 (9.5)	36 (2.0)	
Other	28 (5.0)	36 (5.5)	59 (9.5)	73 (15.2)	80 (14.1)		136 (12.1)	140 (7.9)	
Unknown	34 (6.1)	58 (8.9)	73 (11.8)	83 (17.2)	119 (20.9)		234 (20.9)	133 (7.6)	
SOI[a], median (IQR)						.620			.453
1	366 (65.7)	405 (62.1)	376 (60.5)	293 (60.8)	366 (64.4)		684 (61.1)	1122 (63.7)	
2	144 (25.9)	190 (29.1)	182 (29.3)	143 (29.7)	150 (26.4)		324 (28.9)	485 (27.5)	
3	39 (7.0)	48 (7.4)	55 (8.9)	44 (9.1)	44 (7.8)		98 (8.8)	132 (7.5)	
4	8 (1.4)	9 (1.4)	8 (1.3)	2 (0.4)	8 (1.4)		13 (1.2)	22 (1.3)	
Public insurance, *n* (%)	87 (15.6)	169 (25.9)	236 (38.0)	243 (50.4)	384 (67.6)	<.001	—	—	—

—, not applicable.
[a] SOI 1, minor; 2, moderate; 3, major; 4, extreme.

TABLE 2 Outcomes by Study Grouping (Univariate, Unadjusted Analysis)

	LOS, h, Median (IQR)	Hospitalization Costs, Median (IQR)	6-mo Readmission, % (SD)
Neighborhood deprivation status			
ADI 1	38 (25–55)	1499 (1008–2264)	11.1 (31.5)
ADI 2	40 (27–55)	1585 (1099–2326)	12.0 (32.5)
ADI 3	42 (30–66)	1649 (1094–2770)	15.8 (36.5)
ADI 4	41 (28–63)	1631 (1051–2609)	12.7 (33.3)
ADI 5	43 (31–64)	1684 (1149–2789)	18.7 (39.0)
P	<.001	<.001	<.001
Insurance coverage type			
Public	43 (31–67)	1736 (1163–2829)	18.4 (38.8)
Private	39 (26–57)	1542 (1037–2311)	11.3 (31.7)
P	<.001	<.001	<.001
Combined groupings			
ADI 1, private	37 (25–55)	1441 (982–2238)	11.1 (31.4)
ADI 1, public	41 (27–54)	1832 (1231–2487)	11.5 (32.1)
ADI 2, private	38 (26–50)	1534 (1061–2192)	10.5 (30.7)
ADI 2, public	46 (32–73)	1867 (1198–3022)	15.9 (36.7)
ADI 3, private	41 (29–66)	1609 (1084–2691)	11.9 (32.5)
ADI 3, public	44 (31–66)	1734 (1128–2845)	22.0 (41.5)
ADI 4, private	41 (24–62)	1603 (999–2546)	10.5 (30.7)
ADI 4, public	42 (30–66)	1640 (1128–2727)	14.8 (35.6)
ADI 5, private	42 (28–58)	1567 (1084–2441)	13.6 (34.3)
ADI 5, public	43 (33–66)	1735 (1183–2950)	21.1 (40.8)

LOS and hospitalization costs were log transformed before analysis. ADI 1, least deprived; ADI 5, most deprived.

neighborhoods with private insurance (ADI quintile 1, private) as the reference group. However, across quintiles, the relationship was more complex, without consistent improvement or worsening outcomes as ADI increased in either public or privately insured patients.

Overall, patients who were living in the most deprived neighborhoods showed an 18% increase in LOS, 14% increase in costs, and 1.84 times–increased readmission odds compared with those in quintile 1 (Table 3, top section). Patients with public insurance had a 17% increase in LOS, ∼15% increase in costs, and 1.81 times–increased readmission odds compared with those with private insurance (Table 3, middle section). However, when patients living in most deprived neighborhoods had public insurance, they had an ∼25% increase in both LOS and costs, and 2.2-fold increased readmission odds compared with those living in least deprived neighborhoods with private insurance (Table 3, bottom section).

DISCUSSION

We found that the ADI was associated independently with asthma hospitalization outcomes. We specifically noted an association of higher ADI quintiles with increased LOS, costs, and readmission rates and lower ADI quintiles (lower neighborhood deprivation) with reduced LOS, costs, and readmission rates. Overall, the ADI may have value as a proxy for patient-level social determinants for children who are hospitalized with asthma, with potential for use in other health conditions for both children and adults.

Barriers to addressing health care disparities in health care settings include a difficulty collecting patient-level social determinant data because collection is time consuming and intrusive.[10] With increasing movement toward value-based purchasing and pay for performance in the United States, health care researchers and policy makers need easy ways of incorporating social determinant data. Easily computed and validated, neighborhood-level measures derived from readily available data offer an easy way to include social determinant data in health care systems if they can be shown to be comparable to patient-level social determinants. The ADI, which is generated from low-cost census data,[18] can be stored in an electronic format and assigned automatically to patients in the EMR on the basis of the patient address for use in point-of-care interventions and comparative analyses to support health care planning, research, and quality improvement.

Our findings are consistent with the few previous studies that used neighborhood-level social determinant measures to evaluate their impact on asthma outcomes in children. Using limited census variables, Liu and Pearlman[29] reported an association between disadvantaged neighborhoods and higher readmission rates in children with asthma. A nationwide study from Sweden also reported an association between disadvantaged neighborhoods and an increased risk of childhood asthma

TABLE 3 Comparisons by Study Grouping (Adjusted Analysis for Age, Sex, Race, and SOI)

	n	LOS, h, β-Coefficient (95% CI)	*P*	Hospitalization Costs, β-Coefficient (95% CI)	*P*	6-mo Readmission, OR (95% CI)	*P*
Neighborhood deprivation							
ADI 1	557	0.0 (reference)		0.0 (reference)		1.0 (reference)	
ADI 2	652	1.060 (0.989–1.135)	.102	1.043 (0.971–1.120)	.246	1.08 (0.76–1.54)	.673
ADI 3	621	1.179 (1.100–1.265)	<.001[a]	1.134 (1.055–1.219)	.001[a]	1.50 (1.07–2.11)	.020[a]
ADI 4	482	1.141 (1.059–1.230)	.001[a]	1.081 (1.001–1.168)	.046[a]	1.16 (0.79–1.69)	.435
ADI 5	568	1.181 (1.099–1.269)	<.001[a]	1.141 (1.060–1.230)	<.001[a]	1.84 (1.30–2.58)	.001[a]
Insurance coverage type							
Private	1761	0.0 (reference)		0.0 (reference)		1.0 (reference)	
Public	1119	1.171 (1.117–1.228)	<.001[a]	1.147 (1.093–1.203)	<.001[a]	1.81 (1.46–2.24)	<.001[a]
Combined groupings							
ADI 1, private	470	0.0 (reference)		0.0 (reference)		1.0 (reference)	
ADI 1, public	87	1.063 (0.925–1.220)	.388	1.161 (1.007–1.339)	.040[a]	1.03 (0.50–2.12)	.929
ADI 2, private	483	1.001 (0.928–1.081)	.970	1.011 (0.934–2.465)	.787	0.94 (0.62–1.41)	.759
ADI 2, public	169	1.294 (1.163–1.441)	<.001[a]	1.250 (1.120–1.395)	<.001[a]	1.55 (0.94–2.57)	.088
ADI 3, private	385	1.156 (1.065–1.255)	<.001[a]	1.141 (1.049–1.241)	.002[a]	1.09 (0.71–1.66)	.702
ADI 3, public	236	1.256 (1.142–1.383)	<.001[a]	1.200 (1.088–1.323)	<.001[a]	2.35 (1.54–3.59)	<.001[a]
ADI 4, private	239	1.085 (0.988–1.194)	.088	1.069 (0.970–1.178)	.176	0.95 (0.57–1.57)	.831
ADI 4, public	243	1.230 (1.120–1.353)	<.001[a]	1.151 (1.045–1.269)	.004[a]	1.43 (0.91–2.27)	.123
ADI 5, private	184	1.100 (0.992–1.220)	.071	1.064 (0.956–1.183)	.255	1.27 (0.76–2.12)	.360
ADI 5, public	384	1.247 (1.148–1.355)	<.001[a]	1.230 (1.129–1.339)	<.001[a]	2.21 (1.50–3.24)	<.001[a]

LOS and costs were log transformed before analysis. ADI 1, least deprived; ADI 5, most deprived.
[a] Statistically significant.

hospitalization independent of maternal-level sociodemographic characteristics.[30] Beck et al[31] used neighborhood-level measures in multiple studies and identified that children with asthma are likely to return to the hospital after discharge and that neighborhood toxic stressors affect asthma control.[32] Juhn et al developed and validated a housing-based socioeconomic status index called HOUSES to overcome the lack of socioeconomic measures and demonstrated its value in multiple studies.[33] More recently, Auger et al[34] reported a correlation between individual family characteristics and neighborhood factors in children who are hospitalized with asthma. Other non-asthma–related studies in adults also found an association between disadvantaged neighborhood variables and poor health and between increased hospitalization and mortality.[12,35] Yet, previous studies have been inconsistent in their selection of census-based variables, often including a limited number (<5) and varying combinations of variables and omitting many key variables previously reported to be associated with outcomes.[20,21,36] In our study, we used the ADI, which includes a comprehensive and standardized list of 17 key US census block group variables.[31] Despite being validated 2 decades ago,[18] ADI use in the US health care setting remains uncommon.[19] Intermountain Healthcare is currently using the ADI at the point of care to identify high-risk, first-time expectant mothers for referral to the Salt Lake County–based Nurse Family-Partnership program and to identify children with asthma from more deprived neighborhoods with previous asthma admissions for referral to home environmental assessment and/or remediation. We are not aware of its previous integration into an EMR or its use at the point of care.

As previously reported in the literature, we also found that insurance coverage was an independent predictor of asthma outcomes. We specifically noted that having private compared with public insurance was independently associated with better asthma outcomes. Our findings are consistent with previous studies in both children and adults that have demonstrated this relationship,[23,37,38] although a recent study has raised some uncertainty.[39] However, in our study, we explore this further by looking at the modifying effect of insurance coverage on the relationship between the ADI and asthma outcomes. Specifically, we found that the relationship between the ADI and asthma outcomes is modified by insurance coverage, although for odds of readmission, results were significant only for ADI 3, public and ADI 5, public, which is possibly due to limited power to detect differences because overall readmission rate was low at 14%. This suggests that having private insurance may have the potential to mitigate the negative effects of living in disadvantaged neighborhoods. The basis of this is likely multifactorial, including higher household income (despite neighborhoods) and better access to outpatient services and asthma medications, leading to improved asthma control and reduced asthma exacerbation frequency and severity.

Our study has several limitations. First, our study includes data from 2010 to 2015, but ADI calculation was based on 2013 census data (because the ADI is not updated yearly). The actual deprivation status of individual neighborhoods may have changed during the study period, and such change may affect our results. However, we believe changes, if any, are minimal because individual neighborhood deprivation status is unlikely to change in this time frame, and if patients move, it is likely they will move to neighborhoods of comparable deprivation status.[40]

Second, our study was not designed to uncover neighborhood or insurance coverage contextual factors associated with poorer asthma outcomes. Although we did not collect neighborhood contextual factors, we can speculate about factors explaining differences in outcomes based on insurance coverage, such as lower access to continuous care, because lower public insurance reimbursement to providers may contribute to outpatient clinics limiting or refusing publicly insured patients, thus hampering a child's ability to receive early and comprehensive care and increasing the risk of having poor asthma control and exacerbations.[41,42] Public insurance recipients are also often financially challenged and have limited education, both of which contribute to low adherence to treatment, and are more likely to live in environments with increased exposure to asthma triggers, making asthma exacerbations more common.[43] Overall, poor outcomes among patients with public insurance may highlight the unmet health care needs of recipients, including limited access to outpatient services and asthma medications.

A third problem with our study is a limitation of the generalizability of our findings beyond our study populations for the following reasons: (1) our study was conducted in Utah, a less diverse state with a high proportion of white children. Results could be different if the study was conducted in states with more racially and socioeconomically diverse populations; (2) because of the unique characteristics of US health care financing, our findings may not be applicable to other countries.

Fourth, we only measured readmissions to the Intermountain Healthcare system and may have missed readmissions at non-Intermountain facilities. The impact of this is unknown but is unlikely to change our results because Intermountain Healthcare covers the 95% of pediatric inpatient care occurring in Utah. Finally, we included SOI as a confounding factor in our regression analyses because we did not collect data on asthma chronic severity. SOI is an imperfect marker of illness severity at presentation because it reflects diagnosis codes and resource use after admission. If we had been able to include chronic severity data, results may have been different. Our results showing poor outcomes of patients living in the most deprived neighborhoods could be due to a disproportionate number of sicker children living in those neighborhoods.

Our future plans include a direct comparison of ADI and patient-level social determinants, defining other ADI-sensitive diseases, assessing the underlying mechanisms and neighborhood contextual factors responsible for the associations with health care outcomes, and defining potential point-of-care and community-based interventions to mitigate the negative effects of neighborhood deprivation and improve the outcomes of vulnerable patients.

CONCLUSIONS

The ADI, a neighborhood-level measure, exhibits associations with asthma hospitalization outcomes and may be a proxy of patient-level social determinants that can be used to support health care planning, research, quality improvement, and point-of-care interventions to reduce disparities. However, in childhood asthma, insurance coverage modifies the relationship between neighborhood characteristics and outcomes and needs to be considered when assessing the impact of neighborhood deprivation or implementing targeted interventions to address disparities in vulnerable patients.

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