Family Medicine and Community Health

Comparison of associations of household-level and neighbourhood-level poverty markers with paediatric asthma care utilisation by race/ethnicity in an open cohort of community health centre patients

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ABSTRACT

Objective The objective of this research was to examine how different measurements of poverty (household-level and neighborhood-level) were associated with asthma care utilisation outcomes in a community health centre setting among Latino, non-Latino black and non-Latino white children.

Design, setting and participants We used 2012–2017 electronic health record data of an open cohort of children aged <18 years with asthma from the OCHIN, Inc. network. Independent variables included household-level and neighborhood-level poverty using income as a percent of federal poverty level (FPL). Covariate-adjusted generalised estimating equations logistic and negative binomial regression were used to model three outcomes: (1) ≥2 asthma visits/year, (2) albuterol prescription orders and (3) prescription of inhaled corticosteroids over the total study period.

Results The full sample (n=30 196) was 46% Latino, 26% non-Latino black, 31% aged 6–10 years at first clinic visit. Most patients had household FPL <100% (78%), yet more than half lived in a neighbourhood with >200% FPL (55%). Overall, neighbourhood poverty (<100% FPL) was associated with more asthma visits (covariate-adjusted OR 1.26, 95% CI 1.12 to 1.41), and living in a low-income neighbourhood (≥100% to <200% FPL) was associated with more albuterol prescriptions (covariate-adjusted rate ratio 1.07, 95% CI 1.02 to 1.13). When stratified by race/ethnicity, we saw differences in both directions in associations of household/neighbourhood income and care outcomes between groups.

Conclusions This study enhances understanding of measurements of race/ethnicity differences in asthma care utilisation by income, revealing different associations of living in low-income neighbourhoods and households for Latino, non-Latino white and non-Latino black children with asthma. This implies that markers of family and community poverty may both need to be considered when evaluating the association between economic status and healthcare utilisation. Tools to measure both kinds of poverty (family and community) may already exist within clinics, and can both be used to better tailor asthma care and reduce disparities in primary care safety net settings.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Poverty affects health outcomes, especially in chronic conditions such as asthma, and there are many ways to measure poverty.

WHAT THIS STUDY ADDS

⇒ When measures of household and neighbourhood poverty are combined in a primary care context (US community health centres), household poverty appears more influential on asthma care utilisation outcomes, however this varies by race/ethnicity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Data that are already collected at clinics, or easily linked to clinic data, can be used to tailor care to be more equitable by incorporating this social determinant of health into regular clinical care.

INTRODUCTION

Poverty is associated with poor health[1–3]; however, the association of poverty with the utilisation of healthcare is less clear. In some settings, low-income individuals have been shown to use, or have less access to, appropriate care,[4–6] and in other settings, the reverse has been found, especially when factors such as insurance, ethnicity and language are considered.[7–9]

Complicating our understanding of the relationship between poverty and healthcare utilisation is a consideration of how poverty is measured. Numerous studies have used

individual/household income as a relatively straightforward measure of economic status,[1 4 10 11] but increasing attention to neighbourhood social factors, including poverty/income at a neighbourhood level, suggests that these neighbourhood/community markers of poverty are also significantly associated with healthcare utilisation.[12–16] Moreover, neighbourhood-level socioeconomic factors can affect health regardless of individual circumstances.[12 17] Although some research has found that neighbourhood does not affect access to care overall, this may be due to increased utilisation of safety net clinic services rather than private medical care in low-income neighbourhoods.[18]

Healthcare providers, especially in federally funded primary care organisations, routinely collect household income data[19 20] and consider neighbourhood factors in determining risk, care patterns and best approaches to their patients and their communities.[21 22] Understanding whether or not household or community markers of poverty are more heavily associated with the use of specific healthcare services may be useful to clinics and organisations in serving patients with increased social risk, and in considering what information to gather about their patients and communities.

Asthma can be an expensive condition. The American Thoracic Society recently released a statement regarding the affordability of asthma medications in response to the continually increasing costs that low-income and even middle-income patients face when trying to obtain these necessary medications.[23 24] Neighborhood-level poverty has also been associated with asthma risk or diagnosis.[25 26] Compounding this even further, household-level and neighborhood-level poverty can affect the asthma care of children differently depending on race and ethnicity.[10 27]

In this study, we investigated whether household-level markers of poverty and/or neighborhood-level markers of poverty were differentially associated with care utilisation outcomes when combined with each other in the context of primary care, overall and by race/ethnicity, in a community health centre (CHC) setting. These important outcomes of asthma care utilisation include visits for asthma care and albuterol prescription among the full sample of children with asthma, and inhaled corticosteroid prescriptions in children with persistent asthma. Prescribing inhaled corticosteroids for persistent asthma is a longstanding, guideline-driven step in asthma treatment,[28] and there is evidence that Latinos underuse and are underprescribed inhaled corticosteroid medications.[29 30] The role of poverty in accessing this kind of asthma care in low-income Latino, non-Latino black and non-Latino white children can help provide better understanding of how clinicians and health system planners can use different types of measurements to reduce disparities in primary care settings. The study sample includes patients who received care at CHCs, where patients have generally lower income and are able to receive care regardless of their ability to pay,[8 31 32] thus we hypothesise that neighborhood-level poverty will have more impact than household-level poverty, when examined together in the same model, on asthma care utilisation outcomes. Additionally, we hypothesise that there will be differences in race/ethnicity groups.

METHODS

Data source and patient inclusion criteria

Our study used OCHIN, Inc. (not an acronym, formerly Oregon Community Health Information network until other states joined) data on children with asthma from 13 states (Oregon (32%), California (26%), Ohio (15%), Massachusetts (11%), Indiana (5%); else: Alaska, Georgia, Minnesota, Montana, North Carolina, Texas, Washington and Wisconsin). The OCHIN network includes >1000 CHCs in 45 US states as of April 2023, and data are available to those who partner with OCHIN for research. Patients receiving care at these clinics sign a consent form that they will allow their data to be used for research purposes. OCHIN provides Epic electronic health record (EHR) to all member CHCs and are able to use these data for research. Inclusion criteria was age <18 years, ≥1 geocoded address in the EHR, ≥1 ambulatory visit in study clinics between 1 January 2012 and 31 December 2017, and ≥1 documentation of household income. A diagnosis of asthma (irrespective of the number of visits) was identified in this population as having ≥1 International Classification of Disease (ICD)-9 code of 493* or ICD-10 code of J45* captured by encounter or problem list diagnosis during the study period. In the subsample of patients with persistent asthma, we identified persistent asthma using ICD-10 codes J45.30-32, J45.40-42, J45.50-52. See study participant inclusion in online supplemental figure 1.

Primary outcome variables

The three dependent variables were clinical measures that reflect the utilisation of care for asthma management and control. The first outcome was asthma care visits (ie, binary indicator of having ≥2 visits per year for asthma care,[28] defined as two visits coded for asthma or one coded for asthma plus one coded as a visit for primary care, as many children get asthma care at primary care visits). A minimum of two visits per year for asthma management is recommended by the National Asthma Education and Prevention Programme's Expert Panel,[28] and this outcome was chosen to determine whether the minimum standard of care was met with regard to utilisation—once the minimum is met, the number of additional visits needed differ by child based on individual care needs, which is why this is operationalised as a binary outcome. The second outcome was number of albuterol prescription orders. Albuterol is a short-acting bronchodilator medication used to relieve acute asthma symptoms.[33] The third and final outcome was prescription of inhaled corticosteroids among children with persistent asthma. Inhaled corticosteroids are long-term controller medications, used as first-line treatment in patients with

persistent asthma.[33] Prescriptions were based on medication orders in the EHR, and medications were identified by National Drug Codes, reviewed and cleaned by analysts and reviewed again for final categorisation by a practising clinician.

Independent variables

The main independent variables were race/ethnicity, household income and neighbourhood income. Self-reported race/ethnicity was categorised as Latino, non-Latino black and non-Latino white. While we use Latino/a because it is often preferred in our study population, the actual ethnicity information collected by clinics is Hispanic and non-Hispanic white. CHCs are mandated to collect this information, therefore missing race/ethnicity data are low.[19] Income as a per cent of federal poverty level (FPL) at the household level (household FPL), and income as a per cent of FPL at the census tract-level (neighbourhood FPL) were considered. Household FPL was collected at clinic visits. We then summarised the variable to three groups based on FPL at the majority of visits: (1) <100% household FPL, (2) ≥100% to <200% household FPL and (3) ≥200% household FPL at the majority of visits. If there were ties, the lower FPL category was chosen, as we assume risk to be higher if poverty is greater.[20] Although household FPL was a continuous variable, we categorised it to match the categories that are reported for the neighbourhood FPL variable which came from the American Community Survey (ACS) 2012–2016 estimates. The variables collected from the ACS represent (1) per cent of census tract at poverty level (<100% FPL) and (2) per cent of census tract at low-income level (<200% FPL, but ≥100% FPL). We linked the patient address data from the EHR to the census tract-level ACS data, using the address with the longest duration if multiple addresses were recorded for a patient (when a patient moves, they report the new addresses to the clinic and the time between addresses can be estimated). The neighbourhood FPL variable had three categories: (1) poverty: <100% neighbourhood FPL (≥50% of the census tract had FPL <100%), (2) low-income: ≥100% to <200% neighbourhood FPL (≥50% of the census tract had FPL <200%, but ≥100%), (3) ≥200% neighbourhood FPL (≥50% of the census tract had FPL ≥200%). These categories are consistent with Health Resources & Services Administration guidelines for provision of discounted care at CHCs.[34]

Confounders

Potential confounders included in our regression models included age in years at first visit (categorised: <3, 3–5, 6–10, 11–17), sex (male/female), insurance type across study visits (never insured, some private insurance, some public insurance, mixture of public and private insurance), maximum documented asthma severity (mild or moderate/severe) and body mass index (BMI) across study visits (never overweight/obese (patients were always <85th percentile for age and sex), sometimes overweight/obese (patients has a BMI ≥85th percentile for age and sex at least one time), always overweight/obese (patients always had a BMI ≥85th percentile for age and sex). BMI was included because obesity can affect asthma control and medication efficacy.[35 36] The albuterol and inhaled steroid models also included visits per year (<2, 2–5, 5–10, >10). Although we report patient-preferred language descriptively, we did not include it in modelling, as it was too closely correlated with ethnicity in this sample. Also described is the 2010 rural-urban commuting area code for each patient's primary clinic (urban/rural), which was not included in the models due to lack of variation (>98% of clinics had urban designation).

Statistical analysis

All analyses were performed at the patient level. We conducted descriptive statistics to examine patient characteristics. We then estimated unadjusted outcome prevalence and rates overall and by race/ethnicity groups. Next, we considered two analytic approaches. First, we estimated the association between household and neighbourhood poverty with our asthma study outcomes using generalised estimating equations (GEE) regression models. Then, we ran stratified analyses by race/ethnicity groups to examine effect modification in the associations between poverty and asthma study outcomes. For odds of having ≥2 visits for asthma and odds of ever having had an inhaled steroid prescription (in the subsample with persistent asthma), we used GEE logistic regression, fitted with a compound symmetry correlation structure and empirical sandwich variance estimator to obtain adjusted ORs and their corresponding 95% CIs, while accounting for clustering of patients within the patients' primary clinics. The rates of albuterol, in the overall sample, and inhaled corticosteroids among the subsample of children with persistent asthma, were analysed using GEE-negative binomial regression to obtain adjusted rate ratios (RR), also clustering by primary clinic. All models were adjusted for confounders listed above. The analytic dataset was created using RStudio V.1.3.1056, and analyses were performed using Stata V.15 and two-sided testing with set 5% type I error.

Patient and public involvement

The OCHIN Patient Engagement Panel reviews studies using OCHIN patient data.

RESULTS

Sample characteristics

Table 1 shows the characteristics of our total patient sample of children with asthma (n=30 196). The children in this sample were Latino (46%), non-Latino black (26%) and non-Latino white (28%). The most common age category at first visit was 6–10 years (31%). More children were male (56%), with 2–5 (41%) or <2 primary care clinic visits per year (34%). Most of the sample used public insurance (84%) and more than half had mild

Table 1 Characteristics of paediatric patients with asthma, overall and by race/ethnicity (n=30 196)

	Overall N=**30 196** N (%)	Latino N=**13 905** N (%)	Non-Latino black N=**7860** N (%)	Non-Latino white N=**8431** N (%)
Age category at first visit (years)				
<3	6930 (23.0)	3820 (27.5)	1514 (19.3)	1596 (18.9)
3–5	5915 (19.6)	3013 (21.7)	1461 (18.6)	1441 (17.1)
6–10	9390 (31.1)	4290 (30.9)	2480 (31.6)	2620 (31.1)
11–17	7961 (26.3)	2782 (20.0)	2405 (30.6)	2774 (32.9)
Sex				
Male	16 925 (56.1)	7923 (57.0)	4396 (55.9)	4606 (54.6)
Female	13 271 (44.0)	5982 (43.0)	3464 (44.1)	3825 (45.4)
Insurance type				
Never insured	817 (2.7)	277 (2.0)	258 (3.3)	282 (3.3)
Some private	1702 (5.6)	327 (2.4)	462 (5.9)	913 (10.8)
Some public	25 422 (84.2)	12 430 (89.4)	6708 (85.3)	6284 (74.5)
Some private and public	2255 (7.5)	871 (6.3)	432 (5.5)	952 (11.3)
Visits per year				
<2	10 317 (34.2)	3718 (26.7)	3472 (44.2)	3127 (37.1)
2 up to 5	12 519 (41.5)	6135 (44.1)	2913 (37.1)	3471 (41.2)
5 up to 10	5544 (18.4)	3135 (22.5)	1067 (13.6)	1342 (15.9)
>10	1816 (6.0)	917 (6.6)	408 (5.2)	491 (5.8)
Maximum documented asthma severity				
Intermittent	10 319 (34.2)	4791 (34.5)	2962 (37.7)	2566 (30.4)
Mild	4408 (14.6)	2081 (15.0)	1438 (18.3)	889 (10.5)
Moderate or severe	2738 (9.1)	1232 (8.9)	803 (10.2)	703 (8.3)
Not documented	12 731 (42.2)	5801 (41.7)	2657 (33.8)	4273 (50.7)
Body mass index				
Never overweight/obese	11 947 (39.6)	4809 (34.6)	3450 (43.9)	3688 (43.7)
Sometimes overweight/obese	8471 (28.1)	4399 (31.6)	1814 (23.1)	2258 (26.8)
Always overweight/obese	9778 (32.4)	4697 (33.8)	2596 (33.0)	2485 (29.5)
Albuterol prescribed ever within study period				
Yes	26 436 (87.6)	12 621 (90.8)	6715 (85.4)	7100 (84.2)
Primary language				
English	21 136 (70.0)	4845 (34.8)	7860 (100.0)	8431 (100.0)
Spanish	9060 (30.0)	9060 (65.2)	0 (0.0)	0 (0.0)
2010 RUCA designation of patients' primary clinics				
Urban	29 735 (98.5)	13 806 (99.3)	7846 (99.8)	8083 (95.9)
Rural	461 (1.5)	99 (0.7)	14 (0.2)	348 (4.1)
Household FPL				
Under 100%	23 624 (78.2)	10 852 (78.0)	6944 (88.3)	5828 (69.1)
≥100% to <200%	4984 (16.5)	2664 (19.2)	694 (8.8)	1626 (19.3)
200% or higher	1588 (5.3)	389 (2.8)	222 (2.8)	977 (11.6)
Neighbourhood FPL				
Under 100%	1668 (5.5)	290 (2.1)	1248 (15.9)	130 (1.5)
≥100% to <200%	12 040 (39.9)	6413 (46.1)	3529 (44.9)	2098 (24.9)
200% or higher	16 488 (54.6)	7202 (51.8)	3083 (39.2)	6203 (73.6)

FPL, federal poverty level; RUCA, rural-urban commuting area.

Table 2 Unadjusted asthma care outcomes, overall and stratified by race/ethnicity

Total sample	Overall (n=30 196)	Latino (n=13 905)	Non-Latino black (n=7860)	Non-Latino white (n=8431)
Prevalence of having had ≥2 asthma visits per year (n, %)	10 090 (33.4%)	4975 (35.8%)	3030 (38.6%)	2085 (24.7%)
Rate of albuterol prescriptions per year (rate, 95% CI)	1.05 (1.04 to 1.05)	1.14 (1.13 to 1.15)	1.12 (1.11 to 1.13)	0.82 (0.81 to 0.83)
Sample with persistent asthma	Overall (n=6665)	Latino (n=3087)	Non-Latino black (n=2103)	Non-Latino white (n=1475)
Rate of inhaled corticosteroid prescriptions per year (rate, 95% CI)	0.85 (0.84 to 0.86)	0.90 (0.88 to 0.92)	0.91 (0.89 to 0.94)	0.66 (0.64 to 0.68)
Prevalence of ever having had inhaled corticosteroid (n, %)	5397 (81.0%)	2598 (84.2%)	1653 (78.6%)	1146 (77.7%)

persistent asthma (61.7%). Most patients had a household income of <100% FPL (78%), however, more than half lived in a neighbourhood with ≥200% FPL (55%). Characteristics by household and neighbourhood income group are shown in online supplemental tables 1 and 2. Characteristics for the sample with EHR-documented persistent asthma (n=6665) were similar to the full study sample and are shown in online supplemental table 3.

Unadjusted outcomes

Unadjusted outcome data are shown in table 2. Non-Latino white patients had the lowest unadjusted prevalence and rates of all outcomes. Latino and non-Latino black patients had similar prevalence/rates.

Adjusted outcomes—overall sample

Figure 1 and online supplemental table 4 show that among children with asthma, children living in poor neighbourhoods (FPL <100%) had 26% higher odds of having ≥2 visits for asthma (OR 1.26, 95% CI 1.12 to 1.41). Those living in low-income neighbourhoods (FPL ≥100 to <200%) had more albuterol orders (RR 1.07, 95% CI 1.02 to 1.13). Household income was not significantly associated with asthma visits or albuterol orders.

Adjusted outcomes—subsample with persistent asthma

Among the subsample of children with persistent asthma, those living in low-income areas (FPL ≥100 to <200%) had more inhaled steroid orders than those in high-income areas (>200% FPL) (RR 1.10, 95% CI 1.03 to 1.17). Household FPL showed no significant association with asthma care outcomes (figure 1 and online supplemental table 2).

Adjusted odds of having ≥2 asthma visits by race/ethnicity

Table 3 and online supplemental figure 2 show that in race/ethnicity stratified models, Latino children living in

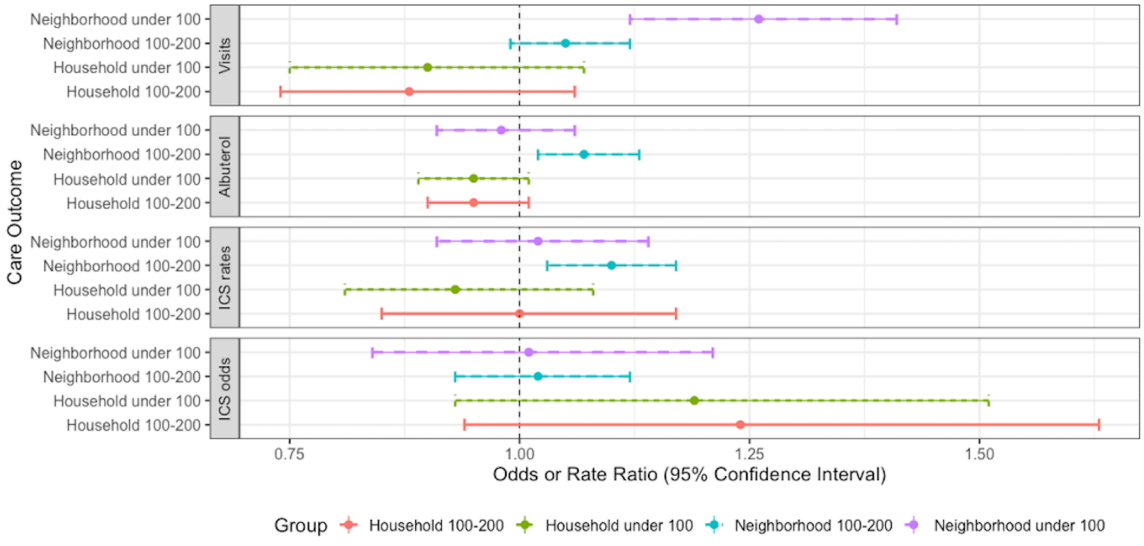

Figure 1 Overall associations of asthma care outcomes by neighbourhood and household income (reference group ≥200% federal poverty level (FPL)). Y-axis labels are defined as: 'under 100'=income as per cent of FPL <100%; '100–200'=income as per cent of FPL between 100% and 200%. The reference group was ≥200% FPL. Outcomes included 'visits'=ORs of having ≥2 asthma visits per year; 'albuterol'=rate ratios of albuterol prescriptions per year; 'ICS rates'=rate ratios of inhaled corticosteroids in children with persistent asthma. 'ICS odds'=and ORs of inhaled corticosteroids in children with persistent asthma. Generalised estimating equations logistic and negative binomial models adjusted for age at first visit, race/ethnicity, sex, insurance, body mass index, asthma severity.

Table 3 Adjusted asthma care outcomes estimated from GEE logistic and negative binomial models, stratified by race/ethnicity

	Latino (n=13 905)	Non-Latino black (n=7860)	Non-Latino white (n=8431)
Odds of having at least two asthma visits per year	**OR (95% CI)**		
Household FPL categories			
Under 100%	0.79 (0.62 to 1.00)	1.19 (0.91 to 1.55)	0.84 (0.63 to 1.13)
≥100% to <200%	**0.73 (0.56 to 0.94)**	**1.29 (1.02 to 1.62)**	0.88 (0.67 to 1.15)
200% or higher (ref.)	--	--	--
Neighbourhood FPL categories			
Under 100%	1.26 (0.96 to 1.66)	**1.22 (1.06 to 1.39)**	**2.02 (1.52 to 2.68)**
≥100% to <200%	1.01 (0.93 to 1.10)	1.07 (0.96 to 1.19)	**1.15 (1.03 to 1.28)**
200% or higher (ref.)	--	--	--
Albuterol prescription per year	**RR (95% CI)**		
Household FPL categories			
Under 100%	0.96 (0.87 to 1.08)	0.96 (0.84 to 1.11)	**0.91 (0.84 to 0.99)**
≥100% to <200%	0.96 (0.87 to 1.06)	0.98 (0.87 to 1.12)	0.93 (0.86 to 1.01)
200% or higher (ref.)	--	--	--
Neighbourhood FPL categories			
Under 100%	0.95 (0.82 to 1.10)	0.94 (0.85 to 1.04)	1.10 (0.92 to 1.33)
≥100% to <200%	**1.09 (1.01 to 1.17)**	0.99 (0.93 to 1.06)	**1.11 (1.05 to 1.18)**
200% or higher (ref.)	--	--	--

GEE logistic and negative binomial models adjusted for age at first visit, sex, insurance, body mass index, asthma severity and visits per year in the albuterol model.
Boldface indicates statistical significance.
FPL, federal poverty level; GEE, generalised estimating equations; RR, rate ratio.

low-income households (≥100 to <200% FPL) had lower odds of having ≥2 asthma visits compared with Latino children in a household with >200% FPL (OR 0.73, 95% CI 0.56 to 0.94). Neighbourhood FPL did not affect odds of having ≥2 asthma visits for Latino children.

For non-Latino black children, those in low-income households (≥100 to <200% FPL) had 29% higher odds of having ≥2 asthma visits per year compared with non-Latino black children in a household with >200% FPL (OR 1.29, 95% CI 1.02 to 1.62). Non-Latino black children in neighbourhoods with the most poverty (<100% FPL) had 22% greater odds of having ≥2 asthma visits per year compared with non-Latino black children in neighbourhoods with >200% FPL (OR 1.22, 95% CI 1.06 to 1.39).

Household FPL did not affect visits for non-Latino white children, however, non-Latino white children living in areas with poverty (<100% FPL), and those in low-income areas (≥100 to <200% FPL) had greater odds of asthma visits compared with those living in high-income areas (table 3 and online supplemental figure 2).

Adjusted rates of albuterol prescription by race/ethnicity

Table 3 and online supplemental figure 3 show that Latino children living in low-income neighbourhoods (≥100% to <200% FPL) had 9% greater rate of albuterol prescription than those living in neighbourhoods with >200% FPL (adjusted RR 1.09, 95% CI 1.01 to 1.17). Household FPL did not influence albuterol prescription among Latino children. Neither household nor neighbourhood FPL affected albuterol use in non-Latino black children.

For non-Latino white children, those in a household with the most poverty (<100% FPL) had lower rates of albuterol prescription compared with non-Latino white children in households with >200% FPL (RR 0.91, 95% CI 0.84 to 0.99). Non-Latino white children in low-income neighbourhoods (≥100 to <200% FPL) had higher rates of albuterol prescription than non-Latino white children in neighbourhoods with >200% FPL (RR 1.11, 95% CI 1.05 to 1.18).

Rates/Odds of corticosteroid prescription among children with persistent asthma by race/ethnicity

Among the sample with persistent asthma, the rate of corticosteroid prescription was greater for non-Latino white children living in poor (<100% FPL) and low-income (≥100% to <200% FPL) neighbourhoods than those in >200% FPL neighbourhoods (<100% FPL RR 1.25, 95% CI 1.02 to 1.53; ≥100% to <200% FPL RR 1.20, 95% CI 1.06 to 1.36). All other groups had comparable

Table 4 Adjusted asthma care outcomes in children with persistent asthma estimated from GEE logistic and negative binomial models, stratified by race/ethnicity

	Latino (n=3087)	Non-Latino black (n=2103)	Non-Latino white (n=1475)
Inhaled corticosteroids per year	**RR (95% CI)**		
Household FPL categories			
Under 100%	1.05 (0.88 to 1.25)	0.76 (0.62 to 0.94)	0.89 (0.71 to 1.12)
≥100% to <200%	1.10 (0.94 to 1.30)	0.78 (0.62 to 0.98)	1.04 (0.79 to 1.37)
200% or higher (ref.)	--	--	--
Neighbourhood FPL categories			
Under 100%	1.13 (0.92 to 1.39)	0.96 (0.84 to 1.10)	**1.25 (1.02 to 1.53)**
≥100% to <200%	1.09 (0.99 to 1.20)	1.04 (0.96 to 1.13)	**1.20 (1.06 to 1.36)**
200% or higher (ref.)	--	--	--
Inhaled corticosteroid ever	**OR (95% CI)**		
Household FPL categories			
Under 100%	1.11 (0.74 to 1.67)	0.94 (0.52 to 1.70)	1.26 (0.82 to 1.93)
≥100% to <200%	1.06 (0.69 to 1.65)	1.18 (0.56 to 2.48)	1.38 (0.88 to 2.18)
200% or higher (ref.)	--	--	--
Neighbourhood FPL categories			
Under 100%	0.74 (0.49 to 1.11)	1.16 (0.91 to 1.48)	**2.13 (1.01 to 4.51)**
≥100% to <200%	0.89 (0.77 to 1.03)	1.18 (0.99 to 1.51)	1.14 (0.86 to 1.50)
200% or higher (ref.)	--	--	--

GEE-negative binomial and logistic models adjusted for age at first visit, sex, insurance, body mass index, asthma severity and visits per year. Boldface indicates statistical significance.
FPL, federal poverty level; GEE, generalised estimating equations; RR, rate ratio.

rates of albuterol prescription. Non-Latino white children with persistent asthma living in poor neighbourhoods (<100% FPL) also had higher odds of ever having an inhaled corticosteroid prescription compared with those in >200% FPL neighbourhoods (OR 2.13, 95% CI 1.01 to 4.51). All other groups had comparable odds of inhaled corticosteroid prescription (table 4).

DISCUSSION

This study enhances our understanding of racial and ethnic variation in asthma care utilisation by neighbourhood and household income, revealing potentially different effects of living in low-income neighbourhoods and households for Latino, non-Latino white and non-Latino black children with asthma. To our knowledge, this is the first study to use EHR data from a safety net population to explore the potentially differential effects of household and neighbourhood poverty on asthma care utilisation measures across racial and ethnic groups. Our findings that associations differ across neighbourhood and household poverty levels are important to those hoping to combat disparities among populations with asthma in primary care safety net settings.

In our study, we did not find evidence of a relationship between individual-level income and asthma utilisation. This is a crucial finding, as CHCs may be playing a critical role in neighbourhoods to support families of low-income to use services that may not be accessible otherwise. Indeed, the structure of CHCs is such that individuals and families can access care regardless of the ability to pay, and this structure may allow access to basic primary care services in children with asthma. However, this is a narrow group of services and study population, so this should be repeated in other populations/health conditions to assess whether this finding holds true more widely. CHC population income strata also do not contain large numbers of middle-class and upper-class patients, so investigating these associations across the entire income spectrum would be an important next step.

In the overall sample, neighbourhood poverty was associated with several of our outcomes, with low-income neighbourhoods being associated with more service utilisation in visits, albuterol prescriptions and inhaled corticosteroid rates. Although our results might suggest that individual income differences might be mitigated somewhat in CHCs, neighbourhood economic differences seem to persist. While this pattern again needs to be replicated in other demographics and clinical areas, it does underscore the importance of community factors in service utilisation, and suggests that clinics (especially CHCs, which serve geographically distinct areas) should understand the neighbourhood factors in the areas from

which their patients come, as these may be associated with the use of clinic services.

In the analyses stratified by race/ethnicity, household income held some associations with service use, but more frequent significant associations still occurred with neighbourhood poverty levels. Interpreting why specific service findings occur in a given population is challenging, but the general pattern of neighbourhood poverty level being associated with service utilisation is again repeated in the stratified sample. Our findings are consistent with claims data that find differing trends in asthma among different race/ethnicity groups.[27]

Our use of EHR data to examine asthma care utilisation may be less subjective to some recall biases than patient-reported data. Our findings also align with others that have shown that patient-level and community-level factors do not always match,[37] adding to a body of literature that can inform the use of social risk data to tailor care at a population level. However, these findings also suggest that care should be taken not to use household or neighbourhood income as a direct proxy for the other in predicting population needs. In fact, our findings suggest that inclusion of both community and individual income variables be considered when examining the impact of economic status on healthcare utilisation. Community health centres, because of their geographic location and community orientation, may be uniquely positioned to understand, intervene and develop programmes and models of care to meet neighbourhood/community needs. This has been demonstrated in the literature in varied settings.[38 39] Our findings add to these ideas by investigating the type of data (especially around poverty/income) that may be most associated with utilisation in a given group. In an age of abundant population health tools, we still fail to (1) identify how variation in utilisation of our services by socioeconomic status/demographic/area deprivation changes care seeking and clinic use and (2) address this variation with changes in the way we deliver services. These findings have implications for both.

LIMITATIONS

Our sample entirely comprised CHC patients, many of whom live in low-income households, limiting generalisability to patients at other clinics. This does not limit its relevance, as CHCs serve a disproportionate share of patients with asthma, with an emphasis on vulnerable populations with worse asthma outcomes.[20 40] While study findings may not be generalisable to the full US population, it will be for the >30 million patients seeking care at CHCs[41] and with implications for millions more living in areas with similar disparities not perceiving access to or seeking primary care for their asthma and other primary care amenable conditions. Next, in complex models such as these with multiple covariates and groups, it was not possible to run models with interactions between neighbourhood and household income, due to insufficient power due to low sample size in some groups. Next steps can include larger studies to ensure adequate sample sizes for certain categories that were lacking in this paper (eg, household income >200%). Additionally, while household income should be recorded at every visit in CHCs, it is up to clinics on how often to record this information[34] and sometimes household income data were missing (8194 patients had no income information reported). The sample with no income information had a higher percentage of private insurance than the sample with income reported. Anecdotally, we know that if patients are using private insurance and/or the clinics know that the patient does not need to use the sliding fee discount programme (FPL <200% qualifies for discounted care[34]), income may not be asked at every visit. More exploration into collection of income data would be an interesting future step. In order to include everyone who could be treated for asthma, we included all patients with at least one asthma diagnosis code. As asthma diagnosis can be a complex process, we understand that this could bias towards less treatment (in cases where the child was not ultimately diagnosed with asthma), in real-world clinical care, one diagnosis code can be enough for treatment.

CONCLUSIONS

We sought to examine whether measurements of household or neighbourhood income in a combined context were influential to asthma care utilisation among a cohort of paediatric patients with asthma seen in CHCs. While we found some increased care measures associated with more neighbourhood poverty, these findings were not the same in all race/ethnic groups. More uniform deployment and use of decision support tools that allow population health management can allow clinical teams to measure and adapt plans for neighbourhood poverty. This implies that markers of family and community poverty may both need to be considered when evaluating the association between economic status and healthcare utilisation. Tools to measure both kinds of poverty (family and community) may already exist within primary care safety net settings, and clinics will need to know what type of data is most useful in order to best care for their communities. While the different measures of poverty should not be used as proxies for each other, since neighbourhood data had more of an impact, it shows the importance of environment, and both measures should be used to better tailor asthma care and reduce disparities that may exist for different people even when living in the same or similar places.

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