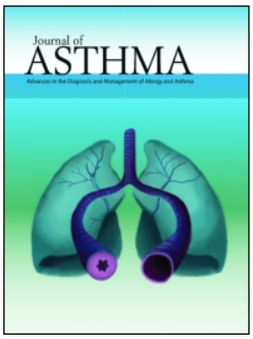

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The moderating role of housing quality on concentrated poverty and asthma-related emergency department visits among Hispanics/Latinos

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ABSTRACT

Background: Rates of asthma-related emergency department visits have been shown to vary significantly by place (i.e. neighborhood) and race/ethnicity. The moderating factors of asthmatic events among Hispanic/Latino-specific populations are known to a much lesser degree.

Objective: To assess the extent to which housing moderates the effect of poverty on Hispanic/Latino-specific asthma-related emergency department (ED) visits at an ecological level.

Methods: Using data from the Office of Statewide Health Planning and Development (OSHPD) and the 2016–2017 U.S. Census, a cross-sectional ecological analysis at the census tract-level was conducted. Crosswalk files from the U.S. Department of Housing and Urban Development were used to associate zip codes to census tracts. Negative binomial regression was used to estimate rate ratios.

Results: The effect of poverty on asthma-related ED visits was significantly moderated by the median year of housing structures built. The effect of mid-level poverty (RR = 1.57, 95% CI 1.27, 1.95) and high-level poverty (RR = 1.47, 95% CI 1.22, 1.78) in comparison to low-level poverty, was significantly greater among census tracts with housing built prior to 1965 in comparison to census tract with housing built between 1965 and 2020.

Conclusion: Communities with older housing structures tend to be associated with increased Hispanic/Latino ED visits apart from affluent communities.

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KEYWORDS
Asthma; Hispanic/Latino health; housing quality; concentrated poverty

Introduction

In California, the rate of Hispanic/Latino asthma-related emergency department (ED) visits is estimated to be 42.3 per 10,000 in the population compared to 30.3 per 10 000 among their white counterparts (1). In 2021, Hispanics/Latinos were the largest (and growing) racial/ethnic group in the state and composed 15.7 million individuals (2). Due to social and economic barriers, Hispanics/Latinos tend to initiate engagement with the healthcare system at the emergency department. Among children with asthma, one study found that 92% reported using a nonurgent care service in the past year and that Hispanics/Latinos were 57% less likely to have used such care in the same time frame (3). Moreover, Hispanics/Latinos with existing asthma were 49% more likely to have at least one ED visit compared to their counterparts. Given that Hispanics/Latinos have a higher rate of ED utilization than their white counterparts, and are the largest racial/ethnic group in California. Therefore, the health and well-being of this population has significant economic and healthcare policy implications.

The asthma disparities literature has seen a recent surge in studies highlighting social and environmental conditions as root causes of asthma (4) including chronic exposure to poor quality housing (5), racial/ethnic segregation (6), poverty (7), and air pollution (8). The emphasis being that historical policies coupled with discriminatory implementation practices have shaped economic, social, and health inequities at the community-level (5,9,10). Asthma-related ED visits have been shown to vary geographically among Hispanic/Latinos (7,11) and have been considered a health indicator of vulnerable populations due to poor neighborhood conditions (6,12). What is less known is how neighborhood-level housing age relates to poverty and asthma among this population.

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This study aims to gain a deeper understanding on how neighborhood-level housing age, poverty, and related community-level factors associate to asthma-related ED visits in a Hispanic/Latino-specific population. To the best of my knowledge, there has not been a Hispanic/Latino-specific ecological analysis investigating these factors in California. The objective of the study is twofold: (1) conduct an ecological analysis examining the extent to which the age of housing structures is associated with asthma-related ED visits among Hispanics/Latinos, and (2) to assess if the age of housing structures moderates the effect of poverty on asthma-related ED visits among Hispanics/Latinos. We hypothesize that communities with older housing and poverty will be associated with increased asthma-related emergency department visits.

Materials and methods

A cross-sectional ecological study design was implemented where the unit of analysis was the census tract. Secondary data were collected from various sources. The outcome of interest was the rate of asthma-related emergency department visits among Hispanics/Latinos/as in 2016–2017. Health data were collected from the Office of Statewide Planning and Development (OSHPD), to whom hospitals licensed in the state of California are required to report all emergency department visits. To access these data a research protocol was approved by the Committee for the Protection of Human Subjects Internal Review Board with the California Health and Human Services Agency. Analysis was completed on census tracts within the following fourteen California counties: Fresno, Kern, Kings, Madera, Merced, San Francisco, San Joaquin, San Luis Obispo, Santa Barbara, Santa Cruz, Sonoma, Stanislaus, Tulare, and Ventura.

Data from the U.S. Census' American Community Survey (2016–2020) 5-year estimates were used to estimate the number of Hispanic/Latino individuals, the percent of individuals living two times below the federal poverty level, linguistic isolation among Spanish-speaking populations, foreign-born individuals from a Hispanic/Latino country, and the median year of housing structures built per census tract.

Outcome variable

The outcome of interest was the census tract-level rate of Hispanic/Latino asthma-related emergency department (ED) visits. Asthma diagnoses were identified using the single-level Clinical Classifications Software (CCS) diagnosis category of 128. The numerator was the count of asthma-related ED visits. The denominator was the estimated number of Hispanics/Latinos in a census tract. In Poisson and negative binomial analyses, the natural log of the estimated number of Hispanics/Latinos in each census tract was entered into models, which allows exponentiated coefficients to be interpreted as rate ratios (13).

Health records from the OSHPD provide the patients' zip code of residence, meaning counts of ED visits can only be aggregated to the zip code-level—not the census tract. Therefore, an area apportionment method (14) was used to relate aggregated zip code-level data to census tract-level data using a crosswalk file from the U.S. Department of Housing and Urban Development (15).

Independent variables

Neighborhood housing age was measured as the median year of housing structures built in a census tract. The American Community Survey (2016–2020) 5-year estimates provides a definitive median year of the building structures across census tracts. Neighborhood housing age was treated dichotomously in analyses. A cut point for census tracts was made at the median year of 1964. Census tracts with a median year of 1964 and prior (27%) were recoded to one and census tracts with a median year between 1965 and 2020 were recoded to zero (reference group).

Poverty was measured as the percentage of individuals living two times below the federal poverty level from 2015 to 2019 in a census tract. Poverty was transformed by creating two cut points that split the variable into approximately three quantiles. The two cut points were 19.1% and 37.9% where low poverty ranged from 0% to 19%, mid poverty ranged from 19.1% to 37.8%, and high poverty ranged from 37.9% to 92%. The percent of foreign-born Hispanics/Latinos was the number of individuals born in Hispanic/Latin countries divided by the total populations residing in a census tract. The percent of Spanish-speaking linguistic isolation was the number of individuals with limited English-speaking from Spanish-speaking households divided by the total population residing in a census tract. Foreign-born Hispanics/Latinos and Spanish-speaking linguistic isolation were treated continuously in subsequent analyses.

Analytic techniques

A negative binomial regression was the primary multivariate statistical test used to estimate relationships at the census tract-level. Sensitivity analyses were

conducted by comparing ordinary least squares (transformed outcome to a rate), Poisson, and negative binomial regression. It was most appropriate to present results of the negative binomial due to the discrete nature of the outcome variable, overdispersion of the outcome, and residual plots did not suggest major biases. Negative binomial closely resembles model assumptions of a Poisson regression with the added benefit of accounting for excess zeros in the outcome variable as well as to model rate ratios by using the natural log of the population at risk (natural log of Hispanic/Latino population in each census tract). The robust variance-covariance matrix (VCE) option was used to estimate conservative standard errors and to protect against type II errors. Measures of socioeconomic status such as education and median household income were omitted in preliminary analyses due to high collinearity.

Results

Using the area apportionment crosswalk method, there were 1,069 census tracts that successfully merged the zip code-level OSHPD data to U.S. Census tracts. Among those, 67 (6%) outliers were dropped after examining residuals and observations with high leverage. There were 1,002 census tracts included in the ecological analysis. Within these census tracts, there were 32,308 asthma-related ED visits among Hispanics/Latinos from 2016 to 2017. The mean age was 21.6 years (SD = 19.3) where 48% ($n = 15,474$) were female and 52% ($n = 16,834$) were male.

Table 1 shows the descriptive statistics by county. The mean rate of asthma-related ED visits across census tracts was 4.9 (SD = 2.9) with a minimum of zero and a maximum of 15.2 per 1,000 in the population. Fresno County had the highest mean rate of asthma-related ED visits with 7.6 per 1,000 in the population and accounted for 16% ($n = 156$) of census tracts in the sample. Kings County had the second highest mean rate of 7.3 per 1,000 in the population and 2% ($n = 18$) of the census tracts in the sample. In contrast, Santa Cruz and San Luis Obispo Counties had lowest mean rates at 2.4 and 2.8 per 1,000 in the population, respectively.

Table 2 shows mean rates, standard deviations, and frequencies by neighborhood housing age and poverty. A two-way analysis of variance (ANOVA) on a sample of 1,002 census tracts showed an effect of neighborhood housing age and poverty on asthma-related ED visits. There was a significant interaction (i.e. moderation) effect of neighborhood housing age and poverty on asthma-related ED visits, $F(2,996) = 10.6$, $p < .001$. Tukey's test was used for postestimation pairwise comparison and showed that census tracts with a housing age prior to 1965 and of high poverty (mean = 6.4, SD = 3.0) were at significant greater risk for asthma-related ED visits than every other pairwise comparison, except when comparing census tracts to mid poverty with a median year of pre-1965. This analysis suggested that neighborhood housing age potentially modified the effect of poverty on asthma.

Table 3 shows the results of testing a Main Effects Model and a Moderation Model, respectively. An in-depth statistical model comparison between ordinary least squares (outcome was transformed to a continuous rate), Poisson, and negative binomial regression and the three competing statistical models did not change the results. Due to the discrete nature of the outcome variable, violation of the Poisson assumption that explanatory variables account for all variance in the outcome, and the added convenience of producing interpretable rate ratios, results from a negative binomial are shown in Table 3.

Table 1. Descriptive statistics of Hispanic/Latino asthma-related ED visits at the census tract-level by county, 2016–2017.

County	Mean rate/1,000	SD	*n*	%
Fresno	7.6	2.7	156	16%
Kings	7.3	2.6	18	2%
Merced	6.8	2.5	34	3%
Stanislaus	5.5	2.5	79	8%
Madera	5.4	2.4	10	1%
Kern	5.1	3.0	76	8%
San Joaquin	4.9	2.3	108	11%
Sonoma	4.4	2.6	74	7%
San Francisco	4.1	2.6	139	14%
Santa Barbara	3.9	2.1	64	6%
Ventura	3.7	2.0	128	13%
Tulare	3.3	2.4	52	5%
San Luis Obispo	2.8	1.3	30	3%
Santa Cruz	2.4	1.7	34	3%
Total Sample	4.9	2.9	1,002	100%

Table 2. Mean rate of asthma-related ED visits per 1,000 by poverty and year housing structure built, census tract-level ($n = 1,002$).

Year housing structure built	Poverty			
1965 and later	Low	Mid	High	Total
Mean	4.5	4.2	5.3	4.8
SD	2.6	2.6	2.9	2.7
n	180	252	296	728
Pre-1965				
Mean	3.7	5.5	6.4	5.3
SD	2.2	3.3	3.0	3.1
n	86	77	111	274
Total				
Mean	4.2	4.5	5.6	4.9
SD	2.5	2.8	2.9	2.9
n	266	329	407	1002

Note. The mean asthma rate of census tracts with housing structures built pre-1965 and of high poverty was significantly higher than all other pairwise comparisons by Tukey's post ANOVA statistical test (<0.001 in all comparisons).

Table 3. Results of negative binomial regression of Latino asthma ED visits ($n = 1{,}002$).

Variable	Main effects model			Moderation model		
	RR	Lower	Upper	RR	Lower	Upper
Moderation effects						
Housing structure built × poverty						
Pre-1965 × mid poverty	–	–	–	1.57***	1.27	1.95
Pre-1965 × high poverty	–	–	–	1.47***	1.22	1.78
Main effects						
Housing structure built						
1965–2020	REF			REF		
Pre-1965	1.10***	1.02	1.19	0.81**	0.69	0.95
Poverty						
Low	REF			REF		
Mid	1.13**	1.03	1.25	1.01	0.90	1.12
High	1.56***	1.40	1.73	1.41***	1.25	1.59
Covariates						
% Latino Foreign-born	0.98***	0.97	0.98	0.98***	0.97	0.98
% Linguistic isolation	1.05***	1.02	1.08	1.05***	1.02	1.08
_cons	0.01	0.01	0.01	0.01	0.01	0.01
ln(Hispanic Count)	1			1		

Note. ***<.001; **<.01; *<0.05.

In Table 3, the Main Effects Model shows that census tracts with a neighborhood housing age prior to 1965 had a greater risk of asthma-related ED visits compared to census tracts with a median housing age between 1965 and 2020 (RR = 1.10, 95% CI 1.02, 1.19). The Main Effects Model shows that mid and high poverty were associated with higher rates of asthma in comparison to census tracts of low poverty (RR = 1.13, 95% CI 1.03, 1.25; RR = 1.56, 95% CI 1.40, 1.73, respectively).

In Table 3, the results of the Moderation Model show that the effect of mid poverty (in comparison to low poverty) on the mean rate of asthma-related ED visits is 1.57 times greater in census tracts with a neighborhood housing age prior to 1965 compared to those with a neighborhood housing age between 1965 and 2020 (RR = 1.57, 95% CI 1.27, 1.95). In other words, mid poverty has a differentially higher effect in older census tracts than in newer census tracts. Similarly, the effect of high poverty on the mean rate of asthma-related ED visits is 1.47 times greater in census tracts with housing age prior to 1965 in comparison to those with a housing age between 1965 and 2020 (RR = 1.47, 95% CI 1.22, 1.78).

Figure 1 illustrates the moderation effect of poverty on asthma by housing quality. Census tracts of low poverty (affluent) and a housing age prior to 1965 tend to have the lowest rates of asthma-related ED visits (mean = 11.71, 95% CI 10.04, 13.38). Census tracts of low poverty (affluent) and a housing age between 1965 and 2020 have a predicted rate that is slightly higher (mean = 14.48, 95% CI 13.11, 15.85) suggesting that the difference between asthma rates between levels of housing age is negligible among affluent communities. Among census tracts with a housing age prior to 1965, the effects of mid poverty (RR = 1.57, 95% CI 1.27, 1.95) and high poverty (RR = 1.47, 95% CI 1.22, 1.78), in comparison to low poverty, tend to increase asthma-related ED visits linearly. Among census tracts with a housing age between 1965 and 2020, levels of poverty are not associated with similar increases in asthma-related ED visits.

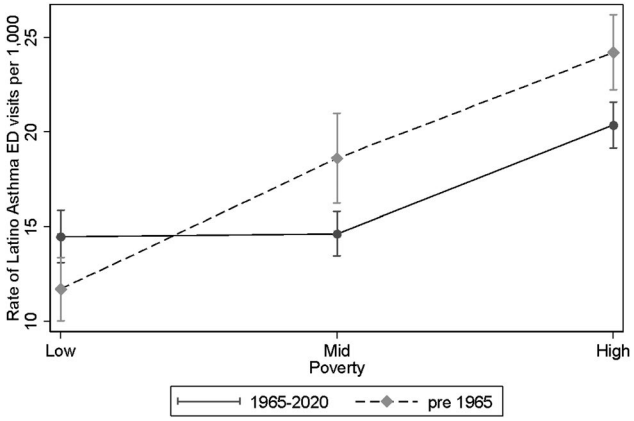

Figure 1. Predicted mean rate of asthma-related ED visits (moderation model) by poverty and neighborhood housing age, census tract-level, 2016–2017.

Discussion

The aim of this study was to examine the extent to which neighborhood housing age and poverty interact in association with Hispanic/Latino asthma-related emergency department (ED) visits, at the census tract-level. The primary finding of this study is that the effect of poverty on asthma-related ED visits is differentially higher in communities with older housing structures in comparison to communities with newer housing structures based on the median year of housing structures built in a census tract.

This study suggests that communities with older housing structures and increased levels of poverty have some of the highest rates of Hispanic/Latino asthma-related ED visits. This finding aligns with several Hispanic/Latino-based prospective cohort studies that share a similar region and population including the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), Genes-Environments and Admixture in Latino Americans (GALA) II, and Children's Health and Air Pollution Study (CHAPS). Hispanic/Latina mothers and children living in poor housing conditions tend to be more highly exposed to asthma triggers including cockroaches and rodents (16), mold and house dust (17,18), and poor indoor air quality. Furthermore, Hispanic/Latinos tend to live in poor urban communities or work in agriculture where asthma-inducing air pollution (19–21) and pesticides are present (22), respectively. In response to the evidence outlined earlier, there have been numerous interventions aimed at reducing in-home triggers with some success.

Place-based research has illustrated the connection between policies, environmental conditions, and health. Nardone et al. (10) conducted an in-depth ecological study investigating age-adjusted asthma ED visits in association to the redlining practices of the Home Owner's Loan Corporation (HOLC) and found a significant association. The authors suggest that historical redlining practices contribute to present-day asthma disparities. Another study found that HOLC redlining maps of the 1930s were strongly associated with modern day green space across the U.S. (23). In intraurban communities across the nation, present-day variation in air pollution and disparities in exposure to nitrogen dioxide (NO_2) and particulate matter (PM2.5) is strongly associated to redlining maps developed by HOLC, delineating favorable versus unfavorable neighborhoods and, to a lesser degree, race, and ethnicity (24). This suggests that housing policies are only one of many contributors to disparate environmental exposures across racial/ethnic groups. It should be noted that within California, there has been a substantial amount of work showing that black and brown communities are exposed to the highest degrees of cumulative environmental hazards (12) and that concentration of Hispanics/Latinos, in particular, demonstrate the highest exposure to cumulative pollution (24,25). In turn, cumulative exposure to environmental hazards has been shown to be associated with asthma-related health outcomes (6) including the joint effect of ambient air pollution and agricultural pesticide exposure (26,27). Bose et al. (28) concisely summarize the recent literature on redlining practices, air pollution, and asthma, and reorient the field to focus on structural racism as the direct drive of asthma health disparities rather than race as a risk factor for health inequities and a target for intervention.

This study adjusted for Hispanic/Latino foreign-born and linguistic isolation among Spanish-speaking concentrations within census tracts. Contrary to the growing literature on linguistic isolation, in fully adjusted models the effect of linguistic isolation was positively associated with asthma-related ED visits (RR = 1.05, 95% CI 1.02, 1.08). However, studies tend to find that linguistic isolation is associated with reduced rates of healthcare services due to language barriers. In a multilevel analysis of California, Alcala et al. (6) illustrate that zip code-level concentration of linguistic isolation is associated with reduced pediatric asthma-related hospitalizations. In a longitudinal study using electronic health records (EHR) across the U.S., researchers (29) show that among Hispanic/Latino children with at least one possible presenting symptom of asthma, Spanish-speaking Hispanic/Latino children were less likely to be diagnosed with asthma in comparison to English-speaking Hispanic/Latino children. The authors of that study suggest that disparities among Hispanic/Latino children depend on language access. The relationship between health services and Hispanic/Latino asthma-related conditions is complex; however, clinicians and policy makers should focus on the absolute number of diagnoses because the volume of cases is vital to children's health in the U.S. (29).

There is a large body of evidence suggesting that the so-called Hispanic/Latino Paradox is most prominent among Hispanics/Latinos of Mexican descent. In other words, Hispanics/Latinos of Mexican descent tend to have better health outcomes than other Hispanic/Latino subgroups and tend to demonstrate similar outcomes to their white counterparts. For example, Rosenbaum (30) illustrates that housing conditions only partially mediate the racial/ethnic disparities in asthma prevalence among households in New York City and that Black Americans and Puerto Ricans are at greater risk than other racial/ethnic groups after adjustment. In Chicago, Cagney et al. (31) found that asthma prevalence is highly dependent upon the concentration of foreign-born Hispanics/Latinos in a community.

This study does not stratify by Hispanic/Latino subgroups due to our assumption that most of the study population represent Mexican-origin Hispanic/Latinos. At the least, Puerto Ricans who have been

consistently shown to have a higher risk for asthma compared to individuals of Mexican descent do not compose a significant proportion of the studied population. Further research needs to be done on how healthcare access compares between these populations by language, uninsured rates, and rural living. Potentially, Hispanics/Latinos of Mexican descent have unique language barriers, higher uninsured rates, and more often live in rural settings with poor healthcare access in comparison to other Hispanics/Latinos. In this study, we focus on emergency department visits—as opposed to various other outcomes such as mortality or prevalence—on the premise that Hispanics/Latinos do demonstrate a higher rate of emergency department utilization than their white counterparts at the state-level (1) and that by analyzing a Hispanic/Latino-specific population a better understanding of the pathways toward asthma-related ED visits may be gained.

Differences in community socioeconomic and investment status of older, affluent housing were present in comparison to older, poor housing. We could not identify a census tract-level proxy for housing investments, so we compared housing costs that are associated with monthly owner costs for mortgages, deeds of trust, real estate taxes, insurance, utilities, and fuels. Table 4 shows mean values of census tract-level median housing costs by housing age and poverty. We found a significant interaction after conducting an ordinary least squares regression where old housing and mid-level poverty and old housing and high-poverty had significantly lower slopes than the effect of old housing in low-poverty communities ($b = -148.2$, 95% CI −291.4, −5.0; $b = -319.7$, 95% CI −453.1, −186.4), respectively. This may suggest that costs associated with older, affluent housing may protect against faulty roofing, floors, walls, and foundational structures that may contribute to asthma-related triggers such as dust mites, mold, and cockroaches. It is worth noting that affluent families can afford medical resources that those of low-income cannot. One recent study showed that Black and Latinx adults with moderate-to-severe asthma were randomly assigned to use a patient-activated, reliever-triggered inhaled glucocorticoid strategy plus usual care showed a lower rate of severe asthma exacerbations (32).

Table 4. Mean housing costs by poverty and year housing structure built, census tract-level.

	Poverty			
Housing structure built	Low	Mid	High	Total
1965-2020	$2,149	$1,626	$1,091	$1,538
Pre-1965	$2,460	$1,788	$1,082	$1,713
Total	$2,249	$1,664	$1,089	$1,586

Limitations

Although this study is cross-sectional, the use of neighborhood housing age in the analysis adds to the literature by attempting to capture historical housing policies and current health outcomes for Hispanics/Latinos. Furthermore, this study applies a novel area apportionment method developed by Din and Wilson (14) using geographic crosswalk files developed by the U.S. Department of Housing and Urban Development (15). Data collected from the American Community Survey for the present study has been shown to produce inconsistent estimates per year. However, this study used 5-year estimates which tend to normalize outliers and reduce differences between the American Community Survey and US Census (33).

Declaration of interest

The authors have no competing interests to declare that are relevant to the content of this article.

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