Neighborhood poverty, urban residence, race/ethnicity, and asthma: Rethinking the inner-city asthma epidemic

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Background: Although it is thought that inner-city areas have a high burden of asthma, the prevalence of asthma in inner cities across the United States is not known.
Objective: We sought to estimate the prevalence of current asthma in US children living in inner-city and non–inner-city areas and to examine whether urban residence, poverty, or race/ethnicity are the main drivers of asthma disparities.
Methods: The National Health Interview Survey 2009-2011 was linked by census tract to data from the US Census and the National Center for Health Statistics. Multivariate logistic regression models adjusted for sex; age; race/ethnicity; residence in an urban, suburban, medium metro, or small metro/rural area; poverty; and birth outside the United States, with current asthma and asthma morbidity as outcome variables. Inner-city areas were defined as urban areas with 20% or more of households at below the poverty line.
Results: We included 23,065 children living in 5,853 census tracts. The prevalence of current asthma was 12.9% in inner-city and 10.6% in non–inner-city areas, but this difference was not significant after adjusting for race/ethnicity, region, age, and sex. In fully adjusted models black race, Puerto Rican ethnicity, and lower household income but not residence in poor or urban areas were independent risk factors for current asthma. Household poverty increased the risk of asthma among non-Hispanics and Puerto Ricans but not among other Hispanics. Associations with asthma morbidity were very similar to those with prevalent asthma.
Conclusions: Although the prevalence of asthma is high in some inner-city areas, this is largely explained by demographic factors and not by living in an urban neighborhood. (J Allergy Clin Immunol 2015;135:655-62.)

Key words: *Inner-city asthma, childhood asthma, urban/rural, neighborhood, race/ethnicity*

The idea that certain features of life in poor urban areas promote asthma dates back to more than a half century ago, when researchers began to describe an "inner-city asthma epidemic" of high asthma prevalence and morbidity in poor areas of large cities.[1-8] Research focusing on the inner city, which was typically defined as census tracts in large metro center areas with at least 20% of households at below the poverty line,[9] has led to significant advances in our understanding of what causes asthma and how to treat it,[10] but the prevalence of asthma in inner-city areas across the United States is not known nor is it known how it compares with prevalence in other types of communities. Studies of asthma prevalence in the inner city have generally focused on individual urban communities and have not separated demographic features of inner-city areas from their metropolitan status.[5,11-19] Nationally representative studies have also had several limitations, including the fact that much of the work on the relative contribution of metropolitan status to asthma disparities overall was done decades ago, used measures of metropolitan status that are not consistent with National Institutes of Health definitions of the inner city, and rarely looked at the independent contributions of poverty, metropolitan status, and race/ethnicity.[3,6,20] Despite our significant and ongoing national commitment to combating inner-city asthma, we do not actually know the prevalence of asthma in inner cities across the United States, whether it is in fact greater than that found in other areas, and, if there are differences, whether race/ethnicity, poverty, or residence in an urban area explain them.

Thus our primary objectives were to (1) estimate childhood asthma prevalence for inner-city and non–inner-city areas in the United States and (2) disentangle the effects of urban residence, neighborhood-level poverty, race/ethnicity, and household poverty on asthma prevalence. Understanding whether asthma disparities seen in various geographic areas are primarily a result of environmental exposures concentrated in the inner city or are instead related to sociodemographic features of the inhabitants of these neighborhoods is key to advancing an efficient and effective national research and public health agenda.

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Abbreviations used
CDC: Centers for Disease Control and Prevention
NCHS: National Center for Health Statistics
NHIS: National Health Interview Survey
OR: Odds ratio

METHODS

Data were drawn from the National Health Interview Survey (NHIS) 2009-2011. The NHIS is a survey conducted annually by the National Center for Health Statistics (NCHS), which is part of the Centers for Disease Control and Prevention (CDC). It has a multistate probability design that covers all 50 states and the District of Columbia and is intended to be representative of the civilian noninstitutionalized population living in the United States. Black, Asian, and Hispanic populations are oversampled to increase precision of estimates in certain subgroups. Data collection is done in person using a computer-assisted personal interviewing mode. The overall response rate for the child section of these surveys ranged from 71% to 75%.[21-23] Because asthma is not reliably diagnosed in young children, the sample population was limited to children aged 6 to 17 years.

To evaluate the effect of geographic variables on asthma outcomes, we linked participants' census tracts, as classified by the 2000 Census, to 2 additional data sets: the 2006 NCHS Urban-Rural Classification Scheme for Counties and the 2000 US Census. The 2006 NCHS Urban-Rural Classification scheme divides counties into 6 categories based on population density and other measures of urbanization: (1) large metro, central; (2) large metro, fringe; (3) medium metro; (4) small metro; (5) micropolitan; and (6) noncore. Generally, "large metro, central" is considered the urban core, whereas "large metro, fringe" is thought to be equivalent to "suburban."[24] Because there were relatively few people residing in small metro, micropolitan, and noncore areas, these categories were combined and classified as small metro/rural areas. The 2000 Census provided the percentage of households living at below the federally defined poverty level in each census tract. This was generally treated as a continuous variable in our analyses, although in some analyses we defined inner-city neighborhoods as census tracts located in large metro central areas with 20% or more of households at below the poverty line.[9] *Household income* was defined as household income divided by the federally defined poverty level.

Ever asthma was defined by a yes answer to the following question: "Has a doctor or other health professional EVER told you that [name] had asthma?" Other questions that defined asthma were as follows: "Does [name] still have asthma?," which was used for current asthma. "During the past 12 months, has [name] had an episode of asthma or an asthma attack?," which was used for an asthma episode. "During the past 12 months, did [name] have to visit an emergency room or urgent care center because of [his/her] asthma?," which was for an asthma emergency department visit.

Race/ethnicity was by self-report and recoded in the NHIS data in the following categories: Hispanic, non-Hispanic white (called "white" here), non-Hispanic black (called "black" here), non-Hispanic Asian (called "Asian" here), and all other race/ethnicities, a group comprising less than 1% of the total population. Because it has been previously reported that Puerto Rican Hispanics have different asthma risk than other Hispanics,[25] we created a separate race/ethnicity category for those of Puerto Rican heritage. Hereafter, "Hispanic" refers to non-Puerto Rican Hispanics.

Although multilevel modeling is often used in analyses of the association between neighborhood factors and disease, multilevel modeling typically requires at least 25 subjects per group (in this case census tract),[26] and in this analysis there were an average of only 4 subjects per census tract. Thus, for this analysis, standard survey methods were used with sample weights and strata provided in the survey. This accounts for the complex survey design, correctly adjusts the variances for clustering within a sampling unit, and does not require a minimum number of subjects per group. For analyses of individual-level income, the CDC provides multiply imputed data for subjects missing income data. These data are generated by the CDC by using sequential regression multivariate imputation implemented with the module IMPUTE with IVEware (www.isr.umich.edu/src/smp/ive)[27] and were analyzed with the MI ESTIMATE commands in Stata, which accounts for the imputation uncertainty using the methods of Rubin.[28] Three logistic regression models for prediction of current asthma, asthma episodes, and emergency department visits in the past year were generated: crude bivariate analyses; multivariate models adjusted for age, sex, race/ethnicity, region of residence, neighborhood-level poverty, and urban/rural status; and multivariate models additionally adjusted for household income. To determine whether race/ethnicity or metropolitan residence modified the relationship between poverty and asthma, we also investigated interactions between these factors and constructed stratified models. Model diagnostics included the Pearson goodness-of-fit test, visual examination of the data, and sensitivity analyses excluding very large values. Individual- and neighborhood-level poverty were examined for collinearity, and because the collinearity was not strong (variance inflation factor of 1.2), both variables were included in some models. Because we identified differences in the relationship between current asthma and both neighborhood- and individual-level poverty between Hispanics and non-Hispanics, we stratified these analyses into (1) Hispanics and (2) all others, including Puerto Ricans. Our analyses confirmed that children of Puerto Rican heritage were more similar to non-Hispanic populations than Hispanics in the relationship between asthma and poverty (data not shown), supporting this method of stratification. Sensitivity analyses of the main model were done, including the following variables: (1) whether the child had a well-child visit in the past year and (2) whether the child had at any point been uninsured in the past year. A significance level of .05 was used. All analyses were done with Stata 13/SE software (StataCorp, College Station, Tex). Because census tract information is not available in the public NHIS data set, these analyses were conducted at the Research Data Center with approval from the NCHS Research Ethics Review Board. Data collection for the NHIS was approved by the NCHS Research Ethics Review Board.

RESULTS

Population characteristics

Twenty-three thousand sixty-five subjects aged 6 to 17 years living in 5,853 different census tracts were included in this analysis. Because the sample was derived from a population-based survey and was weighted to reflect the noninstitutionalized US population, the demographics of the analytic population matched those of children aged 6 to 17 years in the United States as a whole (Table I). On average, subjects resided in census tracts in which 12% of households lived at below the poverty line. Twenty-eight percent resided in urban census tracts, 16% resided in poor tracts (defined as ≥20% living at below the poverty line), and 7% resided in poor urban tracts (the inner city, Table I). The lifetime asthma prevalence was 16.3%, the current asthma prevalence was 10.7%, 5.9% reported an asthma episode, and 1.6% reported visiting the emergency department for asthma in the prior year.

Prevalence of asthma in urban poor (inner-city) and other poor areas

The overall prevalence of current asthma in inner-city neighborhoods in the United States was 12.9% (95% CI, 11.1% to 14.9%) compared with 10.6% (95% CI, 10.0% to 11.2%) in non–inner-city areas ($P = .01$), but this difference was no longer significant after adjusting for race/ethnicity, region, sex, and age (odds ratio [OR], 1.01; 95% CI, 0.84-1.21; $P = .90$). Approximately 8% of asthmatic children are estimated to live in inner-city areas compared with 7% of children overall (see Table E1 in this article's Online Repository at www.jacionline.org). The prevalence of asthma in inner-city neighborhoods was not constant throughout the United States and ranged from 7.9% (95% CI, 5.9% to 10.5%) in the West to 17.3% (95% CI, 13.2% to 22.4%) in the Northeast (Fig 1). In addition, poor