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# Association of neighborhood crime with asthma and asthma morbidity among Mexican American children in Chicago, Illinois

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ABSTRACT

**Background:** There is increasing evidence that neighborhood-level factors, in addition to individual-level factors, may contribute directly or indirectly to childhood asthma by affecting environmental and lifestyle factors. Exposure to neighborhood crime and violence has been associated with poor health outcomes, especially among underserved and minority populations, and its effect on respiratory health is an area of active research.

**Objective:** To examine the association of residential neighborhood crime with asthma and asthma-related outcomes among Mexican American children.

**Methods:** This cross-sectional study was conducted with parents of 2,023 Mexican American children. We derived measures of neighborhood (census tract) violent, property, and drug abuse crime and used multilevel generalized estimating equations to test associations of neighborhood crime counts with respiratory conditions.

**Results:** In multiple regression models, a 1-SD increase in neighborhood property crimes significantly increased the odds of lifetime asthma, lifetime wheezing, lifetime emergency department (ED) visits attributable to asthma or wheezing, and lifetime hospitalization attributable to asthma or wheezing by 25%, 18%, 44%, and 62%, respectively. A 1-SD elevation in neighborhood violent crime was positively and significantly associated with 21% and 57% higher odds of lifetime wheezing and ED visits, respectively. We also observed 13% and 44% significantly increased odds of lifetime wheezing and ED visits, respectively, for a 1-SD increase in drug abuse crime. These findings were not explained or modified by individual- and neighborhood-level covariates.

**Conclusion:** Higher neighborhood crime was associated with greater odds of asthma and asthma morbidity in Mexican American children.



## Introduction

Asthma is a debilitating and costly chronic health condition that affects 14% of children in the United States.[1] The prevalence of asthma has continued to increase among US children from low socioeconomic backgrounds.[2,3] The origin of asthma remains elusive, but it is increasingly understood that biological vulnerability to asthma may be related to the adverse psychosocial and physical contexts in which children live.[4] There is accumulating evidence supporting an association between greater levels of community crime and increased risk of parent-reported[5,6] and physician-diagnosed asthma[7] and asthma symptoms,[8] as well as higher number of symptom-days[9] and symptom-nights.[10] Elevated neighborhood crime was also associated with increased

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asthma-related emergency department (ED) visits and hospitalizations[11] and lung function decline.[12] It has been proposed that individuals living in communities with violence experience pervasive stress and that stress-induced physiologic changes may either directly or through the interaction with other deleterious factors (eg, air pollution) increase susceptibility to asthma.[4,13] Consistent with this hypothesis, community violence has been linked to psychological distress in children with asthma and their caregivers.[9,14–16] Animal- and human-based studies have elucidated associations between exposure to chronic stress and aberrant immune responses associated with asthma.[9,13,17] In addition, neighborhood crime is related to well-established risk factors of respiratory morbidity, such as smoking[18] and inadequate health care use.[10] Furthermore, neighborhood violence has been suggested to contribute to the pervasive asthma-related health disparities that affect children.

Mexican American children are one of the largest, fastest-growing racial/ethnic groups in the United States.[19,20] Urban Mexican American children are underrepresented in research of the association between neighborhood crime and asthma, even though a disproportionate number of Hispanic children live in economically disadvantaged neighborhoods[21] with elevated levels of crime.[22,23] Mexican American children and adults have more favorable asthma-related outcomes compared with other ethnic groups in the United States.[24–27] Individual-, family-, and community-level acculturation-related factors, such as being born in Mexico[24,28] and less acculturated,[29] living in neighborhoods with high immigrant density,[28] and having parents born in Mexico,[25] are associated with lower prevalence of asthma among Mexican American children. In addition, distinct from black and Puerto Rican urban-dwelling children, the association between lower socioeconomic status (SES) and asthma in Mexican Americans is not clear, with some studies suggesting an inverse association of low SES with asthma in Mexican Americans.[30] It is possible that Mexican American children may have lower vulnerability to adverse psychosocial and physical contexts because of such individual-, family-, and community-level factors; however, no previous study has systematically examined this hypothesis. The aims of this study were to examine associations of neighborhood crime with the odds of asthma and asthma-related outcomes in Mexican American children and to assess whether these associations are explained or modified by individual- and neighborhood-level characteristics.

## Methods

### *Design and Sample*

This analysis is based on data collected as part of the Study of Asthma in Children of Mexican Descent (SACMD), a population-based, cross-sectional study that targeted parents of 2,851 students who participated in the Chicago Asthma School Study from January to May 2004.[31] In that period, the Chicago Asthma School Study screened 15 public schools in Chicago to identify students who had asthma and/or asthma-related symptoms. Parents of 9,895 students enrolled in these schools (74% response rate) completed a brief questionnaire. Of those, 6,896 students were of Mexican descent. Parents of all Mexico-born students (n = 1,366) and a random sample of US-born students of Mexican descent (n = 1,485) were invited to participate in the SACMD from August 2004 to April 2005. Data were obtained for 2,023 students: 1,824 via telephone interviews and 199 via parent-administered questionnaires (71% response rate). All study materials were available in English and Spanish; approximately 91% of respondents completed the questionnaire in Spanish. The study questionnaire contained questions on individual-level variables, including respiratory outcomes and covariates. The SACMD (protocol 2004-0400) was approved by the institutional review board of the University of Illinois at Chicago.

### *Definition of Variables*

#### *Outcome variables*

In this analysis, 5 outcome variables were considered. Lifetime physician-diagnosed asthma was defined by the question, “Has a doctor ever said that your child had asthma?”[32] Other questions on respiratory symptoms were similar to those of the standardized core questionnaire of the International Study of Asthma and Allergies in Childhood.[33] Lifetime wheezing was assessed by the question, “Has your child ever had wheezing or whistling in the chest at any time in the past?” Current wheeze refers to history of “wheezing or whistling in the chest in the last 12 months.” Lifetime ED visits attributable to asthma or wheezing was determined by the question, “Has your child ever been to the emergency room for asthma or wheezing?” Lifetime hospitalization attributable to asthma or wheezing was based on the parent’s answer to the question, “Has your child ever stayed in the hospital overnight for asthma or wheezing?”

#### *Neighborhood crime*

Using geographic information system software (ArcMap 10.2, ESRI, Redlands, California), we geocoded participants’ home addresses and defined each participant’s neighborhood as the census tract in which she/he resided using year 2000 US Census boundaries. On the basis of the year 2004 crime data published by the Chicago Police Department, we derived measures of neighborhood crimes for all crime and for 3 crime categories: violent crime (homicide, criminal sexual assault, robbery, aggravated assault, aggravated battery), property crime (burglary, theft, motor vehicle theft, arson), and drug abuse crime (narcotics, other narcotics offenses).[34] For each neighborhood, we summed and standardized the number of crime incidents ([number of crime incidents in each census tract−mean number of crime incidents in all census tracts in the study]/SD). Standardized exposure variables provide a unit-free interpretation of the effect of crime on respiratory outcomes and facilitate the comparison of the magnitude of point estimates.[35] Odds ratios represent the change in the odds of the outcome variables for each 1-SD increase in the number of crime incidents. This approach allowed us to assess how the odds of the outcome variables in a given neighborhood changes if this neighborhood experiences higher number of crime incidents than the mean number of crimes experienced by all the census tracts included in this analysis. We used neighborhood crime counts rather than incidence rates[36,37] because it has been argued that people are more likely to be aware of and influenced by crime incidents in their neighborhood than neighborhood per capita crime rates.[36,38] Nonetheless, we controlled for population density in our final logistic regression models.

#### *Neighborhood-level covariates*

Data on neighborhood-level covariates were based on the 2000 US Census. A composite index of neighborhood deprivation[39] was created using 6 census tract indicators: percentage of adults 25 years or older with less than a high school degree, percentage of unemployed males, percentage of households receiving public assistance, percentage of households with income below the federal poverty line, percentage of female-headed households with children, and median household income. To create the index, each of these 6 variables was standardized and summed, with the resulting composite variable restandardized to ensure a mean of 0 and an SD of 1.0. Several indicators of immigrant concentration and ethnic composition were also considered, including percentage of residents born in Mexico, percentage of residents who identify as white, percentage of residents who identify as black/African

American, and Mexican American concentration (the percentage of residents who identify as Mexican American). Population density was calculated as the number of people residing within a census tract divided by the area (square miles) of the census tract.

*Individual-level covariates*

Individual-level covariates collected through the SACMD questionnaire considered in this analysis included child age (1-7, 8-11, ≥12 years), sex, country of birth, daycare or preschool attendance, presence of a smoker at home when child was born, and having regular access to a physician or clinic. Family history of asthma or allergies refers to the history of these conditions in siblings and/or parents. Data on primary traffic arterials (roads characterized by multiple lanes and capable of accommodating large volumes of traffic at relatively high speeds over long distances) were obtained from the Illinois Department of Transportation.[40,41] On the basis of the participants' addresses, we defined proximity to traffic as living within 150 m of a primary traffic arterial.

*Statistical Analyses*

We used generalized estimating equation regression analysis to examine the bivariate associations of crime with the outcome variables and covariates, accounting for the clustering of participants by census tract. To examine whether associations of crime with outcome variables were explained by individual- and neighborhood-level covariates, the final models included 8 individual-level (age, sex, country of birth, regular access to a physician or clinic, daycare or preschool attendance, family history of asthma or allergies, presence of smoker at home when child was born, and living within 150 m of primary traffic arterial) and 4 neighborhood-level (population density, neighborhood deprivation, percentage of African American residents, and percentage of Mexican origin residents) covariates. These variables did not confound the examined associations but were included because they are important demographic variables and/or have been linked with the outcome variables in our study or in previous investigations.[42–44] A change of more than 10% in the estimate for the association of crime with the outcome variables was considered evidence of confounding.[45,46] We also examined interactions between crime exposure variables and country of birth, living within 150 m of primary arterials, family history of asthma or allergies, and neighborhood deprivation by adding the product terms to the models. A total of 31 students had missing data on at least 1 outcome variable, and 26 participants were excluded because they resided outside city boundaries. Descriptive analyses were based on data from 1,966 participants living in 155 census tracts who have complete data on the outcome variables; multiple regression models were based on data from 1,915 participants with complete data on all study outcomes and covariates. Because the number of missing observations for all covariates was less than 5%, no imputation was necessary.[47] All statistical analyses were performed with SAS statistical software, version 9.3 (SAS Institute Inc, Cary, North Carolina). $P < .05$ was considered statistically significant.

## Results

The proportions of children with lifetime physician diagnosis of asthma, lifetime wheezing, and current wheezing were 7.3%, 17.3%, and 6.4%, respectively. Approximately 4% of participants visited the ED, whereas 1.5% were hospitalized because of asthma or wheezing in their lifetime (Table 1). The mean age of participants was approximately 10 years (data not shown), almost half (45.5%) were born in Mexico, 15% had a smoker in the home at birth, 7.7% resided within 150 m of a primary arterial, and approximately 16% had a family history of asthma or allergies. There was great heterogeneity regarding the total number of crime incidents in the year 2004 for participants' neighborhoods. The mean (SD) total number of crimes reported for participants' neighborhoods was 526 (334) with significant variation (Table 1). An important number of participants with asthma came from neighborhoods with relatively high numbers of reported crime (eFig 1). Furthermore, across participant neighborhoods, 17.6% of families lived below the federal poverty line, with a mean median household income of US$36,000, approximately one-quarter of the residents were born in Mexico, and almost half identified as Mexican (Table 1).

**Table 1**
Characteristics of Participants and Participant Neighborhoods

| Outcome Variable | No./Total No. (%) or Mean (SD) |
|---|---|
| Lifetime asthma | 143/1,966 (7.3) |
| Lifetime wheezing | 341/1,966 (17.3) |
| Current wheezing | 125/1,966 (6.4) |
| Lifetime emergency department visits for asthma or wheezing | 85/1,966 (4.3) |
| Lifetime hospitalizations attributable to asthma or wheezing | 30/1,966 (1.5) |
| Individual-level covariates | |
| Age, y | |
| 1-7 | 453/1,966 (23.0) |
| 8-11 | 877/1,966 (44.6) |
| ≥12 | 636/1966 (32.4) |
| Live within 150 m of primary arterial (vs > 150 m) | 152/1,966 (7.7) |
| Family history of asthma or allergies | 304/1,963 (15.5) |
| Country of birth (United States vs Mexico) | 1,070/1,965 (54.5) |
| Daycare or preschool attendance | 972/1,957 (49.7) |
| Maternal smoking during pregnancy | 44/1,956 (2.3) |
| Smoker at home when child was born | 295/1,926 (15.3) |
| Sex (male/female) | 957/1,966 (48.7) |
| Regular access to physician or clinic | 1,586/1,962 (80.8) |
| Neighborhood-level covariates | |
| Total No. of crimes reported in census tract in 2004 | 525.71 (333.6) |
| No. of violent crimes reported in census tract in 2004 | 143.38 (99.4) |
| No. of property crimes reported in census tract in 2004 | 175.66 (133.0) |
| No. of drug abuse crimes reported in census tract in 2004 | 46.11 (60.7) |
| Adults >25 years old with less than high school education, % | 18.87 (6.3) |
| Unemployed males, % | 5.85 (3.5) |
| Households receiving public assistance, % | 6.62 (5.3) |
| Families with income below the poverty line, % | 17.55 (10.6) |
| Female-headed households with children ≤18 years old, % | 66.27 (12.1) |
| Median household income, US$ | 36,039 (9,455) |
| Foreign-born residents, % | 35.26 (14.2) |
| Residents born in Mexico, % | 24.82 (15.4) |
| Residents who identify as non-Hispanic white, % | 48.08 (18.5) |
| Residents who identify as African American, % | 11.43 (21.5) |
| Residents who identify as Mexican, % | 44.58 (24.4) |

Property crime, violent crime, and total crime were inversely and significantly associated with the percentage of residents of Mexican origin (Table 2). Property crime was inversely correlated with neighborhood deprivation, whereas violent crime, drug abuse crime, and total crime were each positively correlated with neighborhood deprivation (Table 2).

Table 3 gives the results of multiple generalized estimating equation regression analyses for the association of exposure to crime with respiratory outcomes. A 1-SD increase in the number of property crime was associated with a 25%, 18%, 44%, and 62% increase in the odds of lifetime asthma, lifetime wheezing, lifetime ED visits attributable to asthma or wheezing, and lifetime hospitalizations attributable to asthma or wheezing, respectively, after accounting for individual- and neighborhood-level covariates. In

**Table 2**
Pearson Correlation Coefficients for the Association of Crime Counts in 2004 with Neighborhood-Level Covariates

| Neighborhood-Level Covariate | Property Crime | Violent Crime | Narcotics Crime | Total Crime |
|---|---|---|---|---|
| Percentage of residents born in Mexico | −0.162[a] | −0.111 | −0.078 | −0.161[a] |
| Percentage of residents who identify as Mexican | −0.193[a] | −0.160[a] | −0.134 | −0.208[b] |
| Percentage of residents who identify as African American | 0.070 | 0.422[c] | 0.429[c] | 0.291[c] |
| Neighborhood deprivation | −0.232[b] | 0.231[b] | 0.446[c] | 0.044 |

[a] $P \leq .05$.
[b] $P \leq .01$.
[c] $P \leq .001$.

addition, a 1-SD increase in neighborhood violent crime was associated with 21% and 57% increased odds of lifetime wheezing and lifetime ED visits attributable to asthma or wheezing, respectively, in adjusted models. We also observed 13% and 44% increased odds of lifetime wheezing and lifetime ED visits attributable to asthma or wheezing, respectively, for a 1-SD increase in neighborhood drug abuse crime, after adjusting for individual- and neighborhood-level covariates. Finally, there was a positive association between the total number of neighborhood crime and lifetime asthma, lifetime wheezing, and lifetime ED visits attributable to asthma or wheezing in the fully adjusted models. In additional analyses (data not shown), the further adjustment for lifetime allergic symptoms (ie, sneezing, itchy-watery eyes, and runny nose) with seasonal changes and history of allergies to food or medication did not affect the observed associations of crime with respiratory outcomes. We found no statistically significant interaction of any of the crime variables with neighborhood deprivation, country of birth, proximity to primary arterials, and family history of asthma or allergies (data not shown).

## Discussion

In a sample of Mexican American children living in Chicago, we found that greater neighborhood property crime was significantly associated with increased odds of parent-reported asthma and asthma-related outcomes, including lifetime wheezing, asthma-related ED visits, and hospitalizations for asthma. Similarly, increased neighborhood violent crime was associated with increased odds of lifetime wheezing and asthma-related ED visits. Although the associations of neighborhood violent crime with asthma and asthma-related hospitalizations were not significant, they followed a similar trend. Increased levels of neighborhood drug abuse crime were associated with higher odds of lifetime wheezing and asthma-related ED visits. Total neighborhood crime had similar associations with lifetime physician-diagnosed asthma and lifetime wheezing. These associations were explained by neither individual-level variables (such as country of birth, family history of asthma of allergies, and presence of smoker at home at birth) nor neighborhood-level characteristics, including neighborhood deprivation and ethnic composition. Furthermore, country of birth, neighborhood deprivation, proximity to primary arterials, and family history of asthma or allergies did not modify the observed associations between crime and respiratory health. These results suggest that the influence of neighborhood crime on respiratory health of Mexican American children is direct, deleterious, and nondiscriminating with regard to environmental and family history.

Our study adds to the limited body of literature linking objective measures of neighborhood crime with increased risk of asthma and asthma morbidity. Gupta et al[5] found positive associations between neighborhood incidence of property crime, violent crime, and drug abuse violations and the odds of asthma in Chicago. However, after adjusting for race/ethnicity, only violent crime remained significantly associated with asthma.[5] However, the study by Gupta et al[5] included 42% Hispanic, 28% white, and 30% black participants, whereas our study included Mexican American children only. In addition, we considered the potential confounding effect of individual- and neighborhood-level covariates not assessed in the study by Gupta et al.[5] In another study, crime in 13 communities in southern California predicted incident asthma among predominantly white and Hispanic school-age children, after adjustment for traffic pollution and individual, household, and school characteristics.[48,49] Our results agree with those suggesting that exposure to crime may increase asthma symptoms and exacerbation. For example, Jeffrey et al[50] documented a positive association between community violence, measured as assault-related hospitalization rates, and asthma-related hospitalizations among children in Los Angeles County. In addition, in a cross-sectional study of 1,232 parents of Brazilian children 4 to 12 years of age, parent-reported community violence was significantly associated with increased risk of wheezing in the past 12 months.[8] Our findings add to existing evidence suggesting that neighborhood crime contributes to worsening asthma-related disparities that affect inner-city

**Table 3**
Adjusted Associations of Standardized Neighborhood Crime Counts with Respiratory Conditions

| Variable | aOR (95% CI) | | | | |
|---|---|---|---|---|---|
| | Lifetime Asthma | Lifetime Wheezing | Current Wheezing | Lifetime ED Visits | Lifetime Hospitalizations |
| Property crime | | | | | |
| Model 1[a] | 1.21[c] (1.06-1.38) | 1.16[c] (1.06-1.28) | 1.13 (0.92-1.37) | 1.26 (0.94-1.68) | 1.31 (0.97-1.77) |
| Model 2[b] | 1.25[c] (1.07-1.46) | 1.18[c] (1.06-1.32) | 1.10 (0.89-1.38) | 1.44[c] (1.05-1.96) | 1.62[c] (1.08-2.41) |
| Violent crime | | | | | |
| Model 1[a] | 1.11 (0.87-1.43) | 1.15 (1.00-1.32) | 1.21 (0.97-1.51) | 1.39[c] (1.03-1.88) | 1.28 (0.81-2.02) |
| Model 2[b] | 1.16 (0.90-1.49) | 1.21[c] (1.03-1.42) | 1.24 (0.98-1.58) | 1.57[c] (1.16-2.12) | 1.45 (0.89-2.37) |
| Narcotics crime | | | | | |
| Model 1[a] | 1.02 (0.89-1.18) | 1.03 (0.92-1.16) | 1.06 (0.94-1.20) | 1.20[c] (1.09-1.33) | 0.89 (0.60-1.30) |
| Model 2[b] | 1.08 (0.94-1.24) | 1.13[c] (1.01-1.26) | 1.12 (0.96-1.30) | 1.44[c] (1.17-1.78) | 1.02 (0.65-1.60) |
| Total crime | | | | | |
| Model 1[a] | 1.19 (0.99-1.42) | 1.16[c] (1.03-1.31) | 1.18 (0.96-1.45) | 1.32 (0.98-1.76) | 1.19 (0.79-1.79) |
| Model 2[b] | 1.23[c] (1.02-1.48) | 1.21[c] (1.06-1.37) | 1.19 (0.95-1.49) | 1.53[c] (1.11-2.09) | 1.42 (0.86-2.36) |

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; ED, emergency department.
[a] Model 1 is adjusted for population density, age, sex, country of birth, daycare or preschool attendance, having regular access to a physician or clinic, family history of asthma or allergies, presence of smoker at home when child was born, and living within 150 m of primary arterial.
[b] Model 2 is further adjusted for neighborhood deprivation, standardized percentage of residents who identify as African American, and standardized percentage of residents of Mexican origin.
[c] $P < .05$.

communities,[4] including Mexican Americans, a group that is thought to have lower burden of asthma compared with other ethnic groups.[2]

*Limitations*

Although our study makes important contributions to the literature, there are several caveats to our findings. Because the study was cross-sectional, we cannot establish a causal and temporal link between crime and lifetime asthma, wheezing, ED visits, and hospitalizations. However, our findings are consistent with those from prospective investigations linking exposure to stress, commonly associated with crime, and asthma,[51] and our results are consistent with some longitudinal studies examining the incidence rather than prevalence of asthma.[48] In addition, the individual-level outcomes and covariates examined in this study were collected in 2004 to 2005. Nonetheless, the crime data we examined in this analysis were for the year 2004, and the research questions examined in this investigation remain relevant. In addition, the study relied on parent-report of the individual-level data. However, we used standardized questions similar to those used in national[32] and international[33] surveys.

*Strengths*

This study has several strengths. This study examined asthma and respiratory outcomes in a unique population-based sample of Mexican American children, a traditionally underserved and understudied population. In addition, we obtained detailed data from a large number of families while achieving a high participation rate. Our previous research focused on individual-level environmental and lifestyle factors that may contribute to the worsening of the respiratory health profile or lead to the erosion of the initial protection Mexican Americans have when they arrive in the United States.[28,29] However, in the current study, we expanded that research and investigated how neighborhood crime and the interplay between neighborhood crime and individual-level variables affect the risk of asthma and asthma morbidity in a sample of Mexican American children, with more than 45% born in Mexico and almost 50% of those born in rural Mexico.

We found that higher neighborhood crime was associated with risk of asthma and asthma morbidity in Mexican American children. The findings suggest that multilevel, community health interventions are needed to address factors associated with the incidence of crime and asthma at the neighborhood level and subsequently reduce asthma disparities that affect children living in disadvantaged neighborhoods. Future research regarding such interventions could investigate the potential health-protective role of social capital and collective efficacy because these constructs operate across the individual-, family-, and neighborhood-level and may partially attenuate the association between asthma and violence.[7,52–54] In the spirit of building a culture of health for all, examining the underappreciated association between neighborhood crime and asthma outcomes shifts the intervention points to upstream factors that produce disparate incidence of crime at the neighborhood level.

## Supplementary Data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.anai.2016.09.429.

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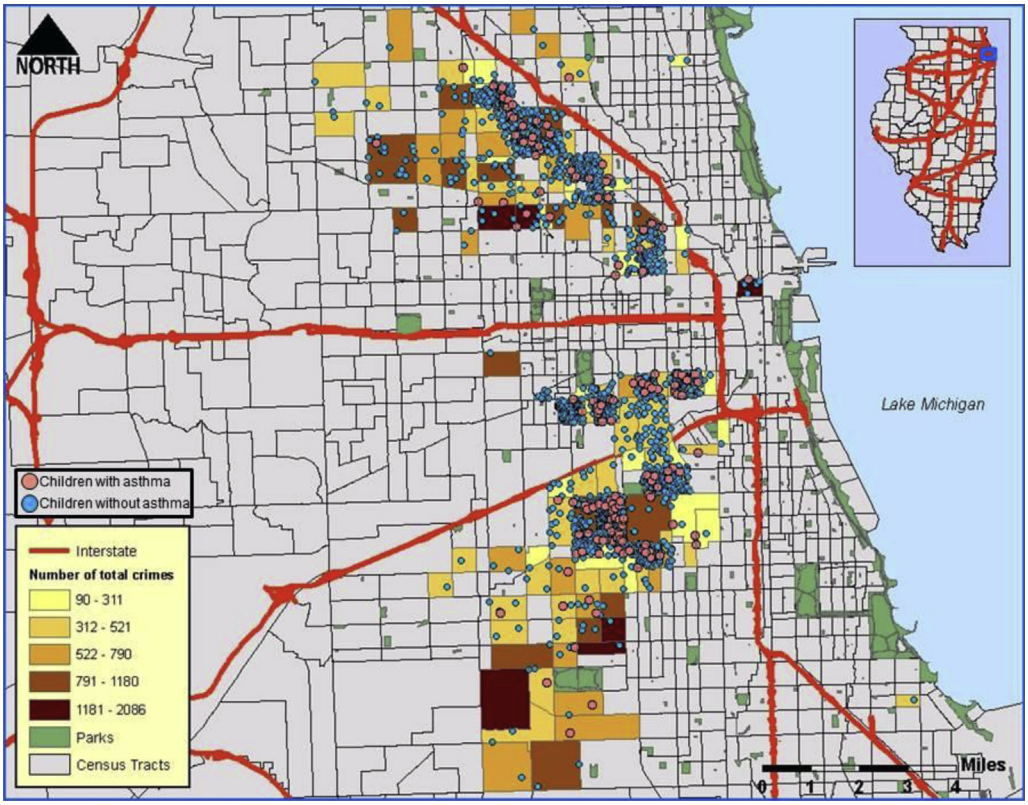


**eFigure 1.** Distribution of Mexican American participants with and without asthma in the study and number of total crimes reported for each census tract, 2004. The location of each participant address has been masked and randomly located within their census tract neighborhood for privacy reasons.