Hospitalization rates for asthma in New York City are highest in poor urban neighborhoods, although the reasons for this are unknown. We performed a small area analysis of asthma hospitalization rates in Boston, to determine whether this pattern of asthma hospitalization also obtained in a medium-sized city and to identify characteristics of neighborhoods with high hospitalization rates, including the relative use of inhaled anti-inflammatory medication. Zip codes were used to define 22 small areas within Boston. The number of asthma hospitalizations for residents of each area in 1992 was obtained from the Codman Research Group. Population and demographic characteristics of each area were obtained from the 1990 US Census. Estimates of inhaled asthma medications (β-agonists, steroids, and cromolyn) dispensed in each area in 1992 were obtained from IMS America. Asthma hospitalization rates for each of the six areas with the highest rates (5.3 to 9.8 per 1,000 persons) were significantly greater than the citywide average of 4.2 hospitalizations per thousand persons (p<0.001 for each comparison). Asthma hospitalization rate was positively correlated with poverty rate and with the proportion of nonwhite residents and inversely correlated with income and educational attainment. Asthma hospitalization rate was inversely correlated with the ratio of inhaled anti-inflammatory to β-agonist medication use ($r=-0.55$, p=0.008). We conclude that asthma hospitalization rates in Boston are highest in poor inner city neighborhoods, and that these high rates affect both genders and all age groups. Underuse of inhaled anti-inflammatory medication may be one of the many factors that contributes to this excess hospitalization. (CHEST 1995; 108:28-35)

**DRG=diagnosis-related group; HMO=health maintenance organization; ICD-9=International Classification of Diseases, 9th rev.; MDI=metered-dose inhaler**

**Key words:** asthma; epidemiology; medication; poverty; small-area analysis

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Asthma is one of the most important chronic illnesses in both children and adults, affecting approximately 12 million persons in the United States and resulting in approximately 500,000 hospitalizations annually at an estimated direct cost for emergency department and hospital care of $1.9 billion in 1990. Despite the development of effective asthma therapy in the past two decades, including inhaled anti-inflammatory medications, asthma morbidity and mortality are increasing. Analyzing data from the National Hospital Discharge Survey, Gergen and Weiss estimated that hospitalizations for asthma among US children aged 0 to 17 years increased by 4.5% per year between 1979 and 1987. During that period, asthma mortality among persons aged 5 to 34 years increased by 6.2% per year.

Asthma morbidity and mortality disproportionately affect minority populations in the United States. In the early to mid-1980s, the asthma mortality rate among black residents of the continental United States aged 5 to 34 years was three to five times as great as the rate among whites. The asthma hospitalization rate during this period was two to three times greater in nonwhite children than in white children. Small-area analyses of asthma hospitalization rates in New York City and asthma mortality rates in New York City and Chicago have demonstrated that asthma morbidity and mortality are concentrated in inner-city neighborhoods characterized by poverty and large minority populations. The causes of this excess morbidity and mortality in inner-city neighborhoods are not known, although possible explanations include a higher level of expo-
sure to agents that cause or exacerbate asthma and lack of access to or use of appropriate medical therapy, such as inhaled anti-inflammatory agents.

In the present study, we have analyzed asthma hospitalization in Boston, a medium-sized city (1990 population 562,705) in a metropolitan area not known to have a high asthma mortality rate. Although asthma mortality is not known to be high in Boston, the rate of hospitalization for asthma and bronchitis among persons aged 0 to 14 years was 4 times greater in Boston than in Rochester, NY, in 1982.\textsuperscript{8} Using the technique of small-area analysis, we compared rates of hospitalization for asthma in different neighborhoods within Boston and identified sociodemographic characteristics of areas with high rates of hospitalization for asthma. We also investigated the relationship between use of inhaled anti-inflammatory medications and asthma hospitalization rates.

\section*{Methods}

\subsection*{Small Areas}

Zip code boundaries were used to define 22 small areas within the city of Boston, Mass. Twenty of the small areas are composed of a single zip code. Six contiguous downtown zip code areas with small populations, which were homogeneous with respect to the race, percent Hispanic origin, income, and asthma hospitalization rates of their populations, were combined into a single small area. The Prudential Center, a large building with a small residential component, has its own zip code. This was combined with the demographically similar zip code area surrounding it. The mean (±SD) population of these 22 small areas was 25,578 (±9,258) persons. Zip code boundaries were also used to define an additional four small areas in suburbs contiguous to the city of Boston (Winthrop, Brookline, Quincy, and Milton).

\subsection*{Data}

The number of hospitalizations during calendar year 1992 for residents of each small area and the total state of Massachusetts were obtained from PANDORA, a product of the Codman Research Group (Lebanon, NH). The number of hospitalizations for which the principal diagnosis was asthma (International Classification of Diseases, Ninth Revision [ICD-9] code 493), as well as the diagnostic groupings bronchitis/asthma (Health Care Financing Administration Diagnosis Related Group [DRG] code 88) and COPD (DRG codes 96-98), were evaluated. These data are derived from hospital discharge data provided by the Massachusetts Health Data Consortium (for Massachusetts, Connecticut, and Rhode Island), the Vermont and New Hampshire Departments of Health, the Maine Health Care Finance Commission, New York SPARCS, and the VA Operations Division, and include hospitalizations of Massachusetts residents not only in Massachusetts, but also in New York and in all New England states. Hospitalizations are identified by zip code of residence, age, and gender. If an individual is hospitalized more than once, each episode is counted as an individual hospitalization. The number of such “multiple admissions” is not identified.

The 1990 US Census Summary Tape File 3B was the source of zip code level population estimates and demographic data, including the race, age, and gender distribution of the population, Hispanic origin, per capita income, population living in poverty, and educational attainment. This information was obtained for the state of Massachusetts from the 1990 US Census Summary Tape File 3A.

\section*{Asthma Medications}

The amount of inhaled asthma medication dispensed from pharmacies within each small area was provided by IMS America (Totowa, NJ), a company that tracks both retail and nonretail medication dispensing throughout the United States. These data represent dispensing of β-agonist and steroid metered-dose inhalers (MDIs), and cromolyn sulfate MDIs and unit-dose ampules for inhalation, from all identified medication outlets within the small area, excluding pharmacies located in hospitals and staff-model health maintenance organizations (HMOs), for the year 1992. The unit of measure for β-agonist and steroid inhalers was one MDI. The unit of measure for inhaled cromolyn sulfate was 200 inhalations for MDIs and 100 U for unit-dose ampules or capsules. For each small area, the ratio of the total number of units of anti-inflammatory medication (steroid plus cromolyn sulfate) to the total number of units of β-agonist dispensed was calculated.

\section*{Analysis}

All statistical analyses were performed using a specific system (SAS Statistical Analysis System; SAS Institute; Cary, NC). For descriptive comparisons and correlation with sociodemographic data, hospitalization rates were adjusted for age and gender by indirect standardization to the city of Boston.\textsuperscript{9} An age- and gender-stratified Mantel-Haenszel \( \chi^2 \) statistic was used to test for significant differences in asthma hospitalization rates between areas.\textsuperscript{10} Because multiple hospitalizations for a single individual will result in an overestimate of \( \chi^2 \) using this technique, \( \chi^2 \) values were divided by a “multiple admission factor” of 1.50, representing the ratio of the true variance in asthma hospitalization rates to that expected under a Poisson distribution, as suggested by Cain and Diehr.\textsuperscript{11} This multiple admission factor was derived from individual level data on asthma hospitalizations in 1992 that were available for 224 members of the Neighborhood Health Plan, a network model HMO in which 77% of the members reside in Boston.

Having found that asthma hospitalization rates varied significantly within the city of Boston, each small area within Boston was compared with the remainder of the city using an age- and gender-stratified Mantel-Haenszel \( \chi^2 \) statistic. A p value <0.002 was considered significant in the pairwise comparisons of each small area within Boston to the rest of the city, to provide an overall type I error rate of less than 5%.

We assessed whether diagnostic misclassification might be responsible for the observed differences in asthma hospitalization rates in two ways. We repeated the above analysis of asthma hospitalization rates, restricting the analysis to persons aged 5 to 34 years, in whom the diagnosis of asthma may be more accurate.\textsuperscript{12,13} We also compared small-area hospitalization rates for all obstructive respiratory diseases (the sum of DRGs 88 and 96-98) in all age groups.

Potential modification of the relationship between small-area residence and asthma hospitalization rate by gender and age was evaluated graphically. The relationship of adjusted asthma hospitalization rates in the 22 small areas to asthma medication use and sociodemographic characteristics of the small areas was assessed using the population-weighted product-moment correlation coefficient. For graphic analyses and descriptive presentation, the small areas were divided into three groups: those with annual asthma hospitalization rates per thousand population of <2.5 (group 1, population 194,775), 2.5 to 4.9 (group 2, population 200,382), and ≥5.0 (group 3, population 167,550).
RESULTS

The asthma hospitalization rate for the city of Boston in 1992 was 4.2/1,000 persons. This was twice the age- and gender-adjusted Massachusetts rate of 2.1/1,000 persons. Within the city of Boston, there was great variation in age- and gender-adjusted asthma hospitalization rates among the small areas, from a low of 0.7/1,000 persons in Kenmore to a high of 9.8/1,000 persons in Roxbury (Figs 1 and 2). The six areas with the highest asthma hospitalization rates (5.3 to 9.8/1,000 persons, group 3) were each significantly higher than the citywide rate (p<0.001 for each comparison). Small-area asthma hospitalization rates for persons aged 5 to 34 years were highly correlated with asthma hospitalization rates for persons of all ages (r=0.95, p<0.001).

The six areas with the highest hospitalization rates for asthma also had the highest hospitalization rates for all obstructive respiratory diseases combined. The rate difference between group 1 and group 2 areas for asthma hospitalization (1.9/1,000 persons, Fig 3) was similar to the rate difference between these groups

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**Figure 1.** Age- and gender-adjusted asthma hospitalization rates in Boston, by small area, 1992. The areas with the highest rates are concentrated in poor, inner-city neighborhoods. The "Roxbury" and "Dorchester" neighborhoods include small areas of Roxbury, Roxbury Crossing, Grove Hall, Uphams Corner, Fields Corner, and Codman Square.

**Figure 2.** Age- and gender-adjusted asthma hospitalization rates in Boston, by small area, 1992.

**Figure 3.** Age- and gender-adjusted hospitalization rates for asthma (ICD-493) and for all obstructive respiratory disorders (DRGs 85 and 96-98), 1992, for each of the three groups of small areas within Boston (as defined in text). The rate difference between areas for asthma is similar to that for all obstructive respiratory disorders, suggesting that diagnostic misclassification is not responsible for the excess asthma hospitalization observed in group 3.
for hospitalization for all obstructive diseases (2.5/1,000 persons). Likewise, the hospitalization rate differences between groups 1 and 3 were similar for asthma (5.0/1,000 persons) and for all obstructive diseases (5.5/1,000 persons).

The relationship between age and asthma hospitalization rate for each of the three groups of small areas is shown in Figure 4. In each group, the asthma hospitalization rate was highest in the 0- to 4-year age group, and declined progressively through ages 15 to 24 years, after which it increased again through age 55 to 64 years. There was no evidence of important modification by age of the relationship between small area of residence and asthma hospitalization rate. Hospitalization rates were higher in male than in female subjects below age 15 years, while they were higher in female than in male subjects above age 15 years. The relationship between small area of residence and asthma hospitalization rate was present in both genders.

Areas with higher asthma hospitalization rates had a larger proportion of black and Hispanic residents than areas with lower asthma hospitalization rates (Table 1). Asthma hospitalization rate in the 22 small areas was strongly correlated with the percentage of the population that was nonwhite (r=0.84, p<0.001) and with the percentage that was Hispanic (r=0.48, p=0.024). The population of areas with higher asthma hospitalization rates was also of lower socioeconomic status than that of areas with lower rates, whether assessed by income or educational attainment. Annual per capita income was highest in group 1, at $20,191, falling to $11,390 in group 3 (Table 1). While 15% of the population in groups 1 and 2 lived below the poverty line, 24% of the population in

<table>
<thead>
<tr>
<th>Table 1—Small-Area Characteristics, by Hospitalization Rate Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group No.</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td>Asthma hospitalizations per 1,000 persons, range*</td>
</tr>
<tr>
<td>Race, %</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Hispanic origin, %</td>
</tr>
<tr>
<td>Per capita income, $</td>
</tr>
<tr>
<td>Living in poverty, %</td>
</tr>
<tr>
<td>Educational attainment,¹ %</td>
</tr>
<tr>
<td>No high school diploma</td>
</tr>
<tr>
<td>High school diploma</td>
</tr>
<tr>
<td>Bachelor's degree</td>
</tr>
<tr>
<td>Ratio of inhaled anti-inflammatory to β-agonist medication dispensed</td>
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</table>

*Asthma hospitalization rates are adjusted for age and gender by indirect standardization to the city of Boston.

¹Educational attainment of persons aged 18 years and above.
Figure 5. Relationship between age- and gender-adjusted asthma hospitalization rate and the ratio of inhaled anti-inflammatory medication (steroid plus cromolyn) to inhaled β-agonist dispensed within each small area. Each point represents a single small area (closed squares=small areas within Boston; open squares=small areas in suburbs adjacent to Boston).

attainment of persons aged 18 years and over (Table 1). In group 1, 84% had completed high school and 39% held a bachelor’s degree, while in group 3, 67% had completed high school and 17% held a bachelor’s degree. The percentage of the population holding a bachelor’s degree was inversely correlated with asthma hospitalization rate ($r = -0.61$, $p = 0.003$).

Areas with high asthma hospitalization rates had a lower ratio of inhaled anti-inflammatory medication (steroid plus cromolyn) to inhaled β-agonist dispensing than did areas with low hospitalization rates. For each unit of inhaled β-agonist dispensed in group 1 areas, 0.49 units of inhaled anti-inflammatory medication was dispensed; in group 2 and 3 areas, these ratios were only 0.38 and 0.34, respectively (Table 1). There was a strong inverse correlation between small-area asthma hospitalization rate and the ratio of inhaled anti-inflammatory medication to inhaled β-agonist dispensed ($r = -0.55$, $p = 0.008$, Fig 5). This result was unaffected ($r = -0.56$, $p = 0.007$) by angular transformation of the medication dispensing data14 to normalize the distribution of ratios. Exclusion of the two small areas at the extremes of this distribution (Roxbury with 9.8 hospitalizations per 1,000 persons and medication ratio of 0.24; Kenmore with 0.7 hospitalizations per 1,000 persons and medication ratio of 0.82) had little effect on the magnitude of this correlation ($r = -0.49$, $p = 0.03$), suggesting that the observed association between medication use and asthma hospitalization rate is not driven by outlying “leverage points.”

Four suburban areas contiguous to the city of Boston, with a combined population of 186,647, were evaluated separately. The per capita income of these areas was $16,730 to $24,682, and only 3 to 9% of their populations lived in poverty. The racial composition of these areas was 86 to 95% white and only 1 to 4% Hispanic. The age- and gender-adjusted asthma hospitalization rates in these four areas in 1992 ranged from 1.3 to 1.7 hospitalizations per 1,000 persons. The ratio of inhaled anti-inflammatory medication to inhaled β-agonist dispensed in these combined areas was 0.54. These areas thus resemble, in sociodemographic characteristics, asthma medication dispensing, and asthma hospitalization rates, the group 1 areas within the city of Boston.

**Discussion**

We have demonstrated that the city of Boston had an asthma hospitalization rate in 1992 that was twice the statewide rate, and that among neighborhoods within Boston, there was a large variation in asthma hospitalization rates. Six small areas had age- and gender-adjusted rates that were significantly higher than the citywide rate. In those six areas combined, the rate of asthma hospitalization was 6.9/1,000 persons, 2.5 times the rate in the rest of Boston and 3.3 times the Massachusetts average. Asthma hospitalization rate in the 22 small areas was positively correlated with the percentage of minority residents, inversely correlated with socioeconomic status as determined by income or educational attainment, and inversely correlated with the ratio of inhaled anti-inflammatory to inhaled β-agonist medication dispensed.

The observed variation in asthma hospitalization rates is larger than would be expected by chance. Although the application of $\chi^2$ analysis under the assumption that each individual can be hospitalized only once will lead to overestimation of $\chi^2$, we have adjusted for this using a “multiple admission factor” estimated from a sample of asthmatics, most of whom reside in Boston. Moreover, the small-area asthma hospitalization rates for 1992 were highly correlated with the rates for 1990 ($r = 0.96$, $p < 0.001$). This further supports the conclusion that asthma hospitalization rates are elevated in these areas for reasons other than chance.

We have considered several potential flaws in our data, including inaccuracy of US Census population estimates, inaccuracy in patient reporting of home address, and diagnostic misclassification. Although
concern has been expressed that the US Census may underestimate the population of urban areas, a failure to count more than 45% of the inner-city population would be necessary to explain the observed difference in asthma hospitalization rate between the six areas with the highest asthma hospitalization rates and the overall city of Boston. Such a gross relative undercounting of these areas is implausible.

We have no independent verification of a patient’s reported place of residence. There is no reason to suspect, however, a differential misrepresentation of address across small areas in which hospitalized residents of more affluent areas report residence in less affluent inner-city areas.

The possibility that the observed differences in asthma hospitalization rate might result from differential diagnostic misclassification was addressed in two ways: by restricting the comparison of asthma hospitalization rates to persons aged 5 to 34 years, and by comparing the rates of hospitalization for a broader category of obstructive airways disease that includes asthma, acute and chronic bronchitis, bronchiolitis, tracheitis, bronchiectasis, and emphysema. This category includes those diagnoses that would most likely be confused with asthma. The same six areas with the highest rates of hospitalization for asthma also had the highest rates of hospitalization for these combined respiratory diagnoses. Moreover, the hospitalization rate differences among the three groups of small areas were similar for asthma and for the combined obstructive respiratory diagnoses. This finding suggests that the high rate of asthma hospitalization in the inner city was not due to differential diagnostic misclassification. This conclusion is supported by the finding that among persons aged 5 to 34 years in whom the diagnosis of asthma may be most accurate, the differences in asthma hospitalization rates between small areas were very similar to those observed in the entire population.

The areas with the highest asthma hospitalization rates are concentrated in Boston’s “inner city.” They are characterized by high rates of poverty, low per capita income, low educational attainment, and large black and Hispanic populations. This pattern of asthma hospitalization was observed in New York City in the early 1980s; the present study extends this finding to a second city in a much smaller metropolitan area. This is consistent with the higher asthma hospitalization and mortality rates of nonwhite children than of white children in the United States during the 1980s. High rates of asthma mortality have been reported in the inner city areas of New York City and Chicago. The smaller population of Boston, and the consequent small number of asthma deaths, precludes a meaningful comparison of asthma mortality rates among small areas in Boston.

The previous report of variation in asthma hospitalization rates within New York City considered persons aged 0 to 34 years. The present study extends these findings to persons of all ages, demonstrating that the excess asthma hospitalization in the inner city affects both genders and all age groups. However, asthma hospitalization rates were particularly striking among children below the age of 5 years. Combining the six areas with the highest rates (group 3), the asthma hospitalization rate for children below the age of 5 years was 15.2/1,000 persons for girls, and 25.2/1,000 persons for boys. We found that male subjects were hospitalized at a higher rate than female subjects below age 15 years, while female subjects were hospitalized at a higher rate than male subjects above age 20 years, a pattern that has been observed in other populations and that mirrors the prevalence of asthma in population studies.

The reasons for high rates of asthma hospitalization in these areas are not known. Multiple regression analyses using small-area hospitalization rate as the dependent variable and ecologic data, such as per capita income or racial composition of the population, as independent variables, have found that both low income and high percent black or Hispanic population within a small area are independent predictors of asthma hospitalization rate. Such analyses have a broad risk of ecologic bias, however, for which adequate control is not possible and should therefore be treated as exploratory exercises. It is unwise to impute relative magnitudes to the effects of the various ecologic variables, eg, by considering the proportion of variance in hospitalization rates explained by each variable in linear regression models. Moreover, it is unlikely that a variable such as poverty or race is per se responsible for increased asthma hospitalization. Rather, other correlates of residence in the inner city are likely to be causally related to asthma severity.

The correlates of inner-city residence that are likely to influence asthma severity and the rate of hospitalization for asthma fall into two broad categories: the level of exposure to environmental causes of asthma, and the pattern of utilization of outpatient health-care resources. Relevant environmental agents include both nonspecific irritants such as air pollution and tobacco smoke, and specific allergens such as dust mite and cockroach antigens, while access to care, medication costs, and health attitudes are likely to affect the utilization of outpatient health-care resources.

Cigarette smoking is associated with an increased prevalence of self-reported asthma in the US population. Exposure to environmental tobacco smoke more than doubles the risk of asthma in young children and increases the risk of hospitalization in
children with asthma. While the level of cigarette smoking has declined in the United States during the past decade, smoking prevalence remains relatively high, and knowledge about the adverse health effects of tobacco smoke relatively low, among the poor and less well-educated. Higher levels of smoking in the inner city are therefore likely to contribute to asthma morbidity in poor neighborhoods. Although air pollution has also been associated with reduced pulmonary function and with an increase in emergency department visits and hospitalizations for asthma, to our knowledge, there is no published evidence suggesting that ambient particulate air pollution levels are higher in inner-city areas than in more affluent communities nearby.

Sensitization to respirable allergens, including cockroach and dust mite allergens, is a recognized cause of emergency department visits for asthma. Exposure to cockroach antigens is greatest where there is substandard housing stock, as is common in the inner city. High rates of sensitization to cockroach allergens have been demonstrated in patients with asthma in several US cities, including Boston. The prevalence of sensitization is higher in asthmatics with low income and higher in urban than in suburban asthmatics. Exposure to dust mite allergen, which is associated with asthma in both case-control and prospective cohort studies, is also likely to be greater in inner-city areas, where human crowding, high indoor humidity due to leaking pipes and poor ventilation, and older carpeting, bedding, and upholstered furniture provide excellent conditions for mite proliferation.

Differences in utilization of health care resources are also likely to be an important cause of high rates of asthma hospitalization in the inner city. Asthma hospitalization is potentially preventable with appropriate outpatient management; however, there are multiple barriers to the effective use of outpatient asthma services among poor inner-city residents. These include financial barriers that may prevent asthmatics from purchasing medications or seeking care except during severe crises, and language and educational barriers that may impair the ability to understand medical advice and learn appropriate self-management skills. These factors may act together to reduce the use of all asthma medications; however, they might preferentially reduce the use of long-term anti-inflammatory medication, since inhaled anti-inflammatory medication provides no immediate symptomatic benefit, and the rationale for its use is therefore more difficult for patients to understand.

We have found a strong inverse association between the ratio of inhaled anti-inflammatory to inhaled β-agonist medication dispensed within small areas in Boston. This suggests that underuse of inhaled anti-inflammatory medication may indeed contribute to excess asthma morbidity in the inner city. Greater severity of illness in the inner city, as manifested in higher hospitalization rates, might lead to bias in drug prescribing patterns, because severe asthma is more likely to be treated with anti-inflammatory medication than is mild asthma. Such a bias would be in the opposite direction, however, from the observed association.

Several potential shortcomings of our analysis of medication use must be recognized. The data represent medication dispensed within the small area; however, not all asthmatics will purchase medication within the small area in which they live. Although we expect that such misclassification will be nondifferential, and hence bias toward a null result, no individual level data are available to allow us to confirm this. We have excluded from consideration medication dispensed from pharmacies located in hospitals and staff-model HMOs, which are likely to serve many persons from outside the neighborhood in which they are located. Because the amount of medication dispensed from these hospital and HMO pharmacies, and as free samples, is likely to differ across small areas, we have not analyzed the absolute amount of anti-inflammatory medication dispensed. Our interpretation of the data is based on the assumption that the medication dispensed from nonexcluded pharmacies, as a proportion of that dispensed from all pharmacies in a small area, does not differ between β-agonists and anti-inflammatory medications. Inhaled β-agonists, and to a lesser extent inhaled steroids, are also used in the treatment of nonasthmatic lung diseases, especially COPD; however, the rates of hospitalization for obstructive lung diseases other than asthma are similar across small areas. Therefore, the inclusion of medications dispensed for the treatment of these illnesses (in which the ratio of anti-inflammatory to β-agonist dispensed should be lower than it is for asthma) should not bias the results in the direction of the observed association.

In conclusion, we have demonstrated that there is a large and significant variation in asthma hospitalization rates within the city of Boston. Our results extend to a medium-sized city the observation that high rates of hospitalization for asthma are found primarily in poor inner-city neighborhoods with large minority populations, and demonstrate that this excess hospitalization affects both genders and all age groups. Although many factors are likely to be responsible for the high asthma hospitalization rates in these inner-city neighborhoods, the apparent underuse of inhaled anti-inflammatory medications relative to more affluent areas may be a contributing factor. These inner-city neighborhoods should be...
targeted for further research to elucidate the causes of excess asthma morbidity and for interventions designed to prevent and control asthma.

ACKNOWLEDGMENTS: The authors would like to thank Phyllis Sims, of the Planning Office, Department of Health and Hospitals, Boston, for her expert technical assistance in utilization of the PANDORA database, and Robert Witzburg, MD, and Arlene Correa Goldberg for providing data on multiple asthma admissions in the Neighborhood Health Plan population.

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