Race, Income, Urbanicity, and Asthma Hospitalization in California*

A Small Area Analysis

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**Study objectives:** To explicate the interrelationship between asthma hospitalization and race/ethnicity and income.

**Design:** Small area ecologic analysis using census and administrative data.

**Setting and participants:** All asthma hospitalizations in California were identified using the 1993 California Hospital Discharge file. Small area analyses of Los Angeles (LA) were compared with published rates in New York City (NYC).

**Results:** In 1993, the age-adjusted asthma hospitalization rate in California for nonelderly blacks was 42.5/10,000—approximately four times higher than other populations. Black rates remained fourfold higher after stratification by age, income, and urbanicity. Multivariate analyses suggest that the association between black race and asthma hospitalization is independent of income. Regardless of race, children and persons living in poverty were at increased risk for asthma hospitalization. Urbanicity was not a predictor for asthma hospitalization. Overall, asthma hospitalization rates in NYC were 2.8 times higher compared with rates in LA; while rates were similar among blacks (60 vs 40/10,000, respectively), Puerto Rican Hispanics in NYC had dramatically higher rates compared with Mexican Hispanics in LA (63 vs 14/10,000, respectively).

**Conclusions:** After controlling for socioeconomic status, notable differences in asthma hospitalization by race and ethnicity persist. The reasons for the significantly elevated risk of asthma morbidity among blacks remain unclear.

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**Key words:** Asian; asthma; black; California; ethnicity; hospitalization; income; Los Angeles; Mexican-American; race; small area analysis

During the last two decades, asthma-related hospitalizations have increased steadily, especially among children and young adults.† The Centers for Disease Control and Prevention reported that from 1980 to 1993, asthma hospitalization increased by 28% from 16.8 to 21.4/10,000 persons ≤24 years.‡ The trend of increasing asthma morbidity exists despite major advancements in the pharmacologic treatment of asthma and increased prescription of anti-inflammatory medications by physicians in the past two decades. Nationally, 14 million persons suffered from asthma in 1993 to 1994, resulting in nearly 500,000 hospitalizations, 13.7 million ambulatory care visits, and more than $6.2 billion in direct medical expenditures and indirect costs.¶

It has been well established that the increasing trend in asthma hospitalizations has not occurred uniformly across all patient groups.¶ Ethnic minorities of low socioeconomic status are disproportionately represented in the trends of increasing asthma prevalence and adverse clinical sequelae. Elevated levels of asthma morbidity among blacks and Hispanic Puerto Rican children and young adults residing in poor neighborhoods have been found nationally and in New York City and Boston.¶· It has been implicated in this trend of increasing asthma morbidity include limited health-care access, inadequate health insurance, lack of recognition of asthma severity by patient or physician, psychosocial dysfunction of patient and family, overuse or inappropriate use of asthma medications, and exposure to indoor and outdoor environmental agents.¶··

Although numerous studies have demonstrated
that the concentration of asthma morbidity is found in impoverished urban neighborhoods and among minority populations, scant research has examined the differential risk of asthma hospitalization among and between minority populations residing in areas of similar socioeconomic status. To extend the previous research and address this epidemiologic gap, this study uses small area analyses to characterize, for the first time (to our knowledge), asthma hospitalizations in California in 1993. California was selected because of the occurrence of a disproportionate number of asthma deaths\(^\text{13}\) and because nearly half of the population is composed of minority groups. The three objectives of this study are as follows: (1) evaluate the relationship between race/ethnicity and income in the small area variation in asthma hospitalizations in California; (2) determine the role of urbanicity (ie, the degree that an area is urbanized) in contributing to asthma hospitalization; and (3) examine bicoastal (ie, east coast-west coast) differences in asthma hospitalization rates by comparing rates of hospitalization in Los Angeles with published rates in New York City.

**MATERIALS AND METHODS**

**Definition of Population at Risk**

Since the nonelderly population comprises 93% of the asthma population nationwide,\(^\text{15}\) this asthma hospitalization analysis was restricted to California residents \(\leq 64\) years. Information on hospitalizations was obtained from the 1993 California Hospital Discharge file, maintained by the California Office of Statewide Health Planning and Development. This data set represents all of the 3.7 million discharges from acute care nonfederal general hospitals in California in 1993. Information used from this file includes patient age, sex, race/ethnicity (white, black, Hispanic, Asian, Native American/Eskimo, other, and unknown), residence zip code, hospital length of stay in days, source of admission, source of payment, and principal diagnosis. All hospital discharges for California residents in calendar year 1993 with a three-digit International Classification of Diseases, Ninth Revision–Clinical Modification (ICD-9-CM) primary medical diagnosis code of 493, asthma, were selected.

Information on area population characteristics by three-digit zip code in California (eg, each area’s population by age, sex, and race/ethnicity, median household income, percentage of the population that were black, Hispanic, and Asian, and urbanicity) was derived from the 1990 US Bureau of the Census Summary Tape File 3B. Data from the 1990 US Bureau of the Census Summary Tape File 3B was matched to the three-digit zip code of the residence of each inpatient reported in the 1993 California Hospital Discharge file. Information on median household income was obtained from the 1990 US Bureau of the Census data because patient-level income data were not available in the 1993 California Hospital Discharge file. The number of persons \(\leq 65\) years residing in the three-digit zip code areas ranged from 35,939 (which includes portions of Sacramento, El Dorado, and Placer counties) to 2.1 million (which includes a portion of Los Angeles county). A three-digit zip code area was classified as rural if \(\geq 20\%\) of its population resided in rural farm or nonfarm areas; otherwise, the three-digit zip code area was classified as urban.

**Statistical Analysis**

Using bivariate and multivariate techniques, this study examined differences in asthma hospitalizations among and between different racial/ethnic, sex, age, and income groups statewide and in Los Angeles. Statewide, rates of hospitalization for asthma were examined by age group (<5 years, 5 to 19 years, 20 to 34 years, and 35 to 64 years), gender, and race/ethnicity (white, black, Hispanic, and Asian). Rates of asthma hospitalization by race/ethnicity group were age adjusted using the entire California statewide population as the reference group. A small area analysis of the rates of asthma hospitalization in California as a whole and in Los Angeles was conducted using three-digit zip code areas. To explicate the relationship between asthma morbidity and socioeconomic status, the rate of hospitalization was calculated for the three-digit zip code areas within each median household income quartile for California overall and for Los Angeles. Mantel’s adjusted test of trend was used to examine if the risk of asthma hospitalization declined with increasing income.\(^\text{16}\)

Using a statistical procedure (SAS general linear models), multiple ordinary linear regression models were used to determine the extent to which median household income, race/ethnicity, and urbanicity explained geographic variations in asthma hospitalization rates statewide.\(^\text{17}\) The dependent variable was the three-digit zip code area hospitalization rates for persons in each of the four age groups. The independent variables were area-level measures of median household income, percentage of the population that were black, Hispanic, and Asian, and urbanicity. A separate model that included an interaction term for race (percentage of the population black) and median household income was also estimated for each age category. Log transformations were applied to normalize the dependent and independent variables.

Finally, an analysis of bicoastal differences in asthma hospitalization rates was conducted by comparing rates of hospitalization in Los Angeles (derived in this analysis) to published rates obtained from an earlier study of asthma hospitalization rates in New York City.\(^\text{8}\) In this New York City analysis, Carr et al\(^\text{8}\) calculated asthma rates of hospitalization among New York City residents aged 0 to 34 years by dividing the number of hospital discharges from data obtained from the New York State Department of Health by the total number of New York City residents (overall and by age, gender, and race/ethnicity) from data obtained from the 1980 US Bureau of the Census Summary Tape File 3B.

**RESULTS**

**Statewide Analysis**

In 1993, there were a total of 35,800 hospitalizations for asthma among individuals 0 through 64 years of age in California (Table 1). Approximately half (56.4%) of all asthma hospitalizations in California were among blacks, Hispanics, and Asians. The age-adjusted asthma hospitalization rate for blacks 0 to 64 years was 42.5/10,000, nearly four times as high compared with the age-adjusted rates for Hispanics (13.0/10,000), whites (10.3/10,000), and Asians (9.4/10,000). For blacks and Hispanics, the principal
source of payment for asthma hospitalizations was Medicaid, while private insurance paid for most asthma hospitalizations for whites and Asians. For each racial/ethnic group, the main route of asthma inpatient admission was via the emergency department.

Blacks of all ages and Hispanic and Asian young children were found to have elevated rates of asthma hospitalization in California compared with same-age whites. Blacks in each of the four age groups were hospitalized for asthma 4.6 to 6.0 times more frequently than whites, 2.5 to 3.8 times more frequently than Hispanics, and 2.7 to 7.3 times more frequently than Asians. Moreover, Hispanic and Asian children <5 years were at nearly twice the risk of asthma hospitalization than their white counterparts. Among the older age groups, differences in asthma hospitalization rates among whites, Hispanics, and Asians were minimal.

Small Area Analysis

Across the state’s 57 three-digit zip code areas, asthma hospitalizations varied nearly 10-fold, from 4.0/10,000 in Santa Barbara to 39.3/10,000 in Oakland (Fig 1). In Los Angeles, rates varied fourfold, from 6.2/10,000 to 24.3/10,000. The descriptive relationship between asthma hospitalization in California and age, race, and income is presented in Table 2. In each of the four age groups, regardless of race, asthma hospitalization rates were approximately 1.5 times higher for persons residing in the poorest areas (with median household incomes of <$35,000) compared with persons residing in the wealthiest areas (with median household incomes ≥$35,000). The association between asthma hospitalization rates and area income levels was examined by conducting a test for trend analysis. Within each race/ethnicity group, the risk of asthma hospitalization significantly decreased with increasing median household income ($<0.01 for each race/ethnicity-age group). However, in each income-age strata, blacks consistently exhibited the highest asthma rates of hospitalization compared with the other race/ethnic groups. For example, black children <5 years in every income strata were hospitalized 1.9 to 6.4 times more frequently than whites, Hispanics, and Asians.

Finally, there was little difference in the asthma rates of hospitalization based on an area’s urbanicity status (data not shown). Notably, blacks were dramatically more likely to be hospitalized for asthma whether they resided in an urban area or in a rural area compared with the other racial/ethnic cohorts. For example, urban vs rural asthma hospitalization rates for blacks were as follows: 109.2 vs 86.7/10,000 for children ≤5 years; 45.1 vs 44.6/10,000 for children 5 to 19 years; 18.3 vs 18.0/10,000 for adults 20 to 34 years; and 31.3 vs 37.9/10,000 for adults 35 to 64 years of age, respectively.
Results of the multivariate regression model shown in Table 3 adjust for the potential confounding effects of race/ethnicity, income, and urbanicity on asthma hospitalization rates in California. Overall, the age-specific models explained 32 to 58% of the total variation in asthma hospitalization rates statewide. In general, only two ecologic predictors, median household income and the percentage of the population that was black, were significant in explaining the geographic variation in asthma hospitalization rates across California within each age group. For the youngest age group, an area's asthma hospitalization rate increased by 3.6% and 1.6% with an associated 10% increase in the proportion of black
Table 2—Rates of Asthma Hospitalizations by Race, Age, and Income Level in California in 1993

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Median Household Income by Quartiles*</th>
<th>Rates per 10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>&lt;5 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>20.77</td>
<td>131.96</td>
</tr>
<tr>
<td>Q2</td>
<td>20.74</td>
<td>101.22</td>
</tr>
<tr>
<td>Q3</td>
<td>20.54</td>
<td>97.54</td>
</tr>
<tr>
<td>Q4</td>
<td>20.75</td>
<td>81.73</td>
</tr>
<tr>
<td>5-19 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>8.37</td>
<td>50.90</td>
</tr>
<tr>
<td>Q2</td>
<td>9.83</td>
<td>43.44</td>
</tr>
<tr>
<td>Q3</td>
<td>7.00</td>
<td>43.46</td>
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<tr>
<td>Q4</td>
<td>6.74</td>
<td>35.57</td>
</tr>
<tr>
<td>20-34 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>4.65</td>
<td>19.42</td>
</tr>
<tr>
<td>Q2</td>
<td>5.00</td>
<td>21.19</td>
</tr>
<tr>
<td>Q3</td>
<td>4.03</td>
<td>13.99</td>
</tr>
<tr>
<td>Q4</td>
<td>4.28</td>
<td>14.81</td>
</tr>
<tr>
<td>35-64 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>9.85</td>
<td>42.91</td>
</tr>
<tr>
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<td>25.42</td>
</tr>
<tr>
<td>Q4</td>
<td>7.62</td>
<td>30.55</td>
</tr>
</tbody>
</table>

*Median household income by quartiles is defined as follows: Q1 = $23,703 to $29,844; Q2 = $30,046 to $34,536; Q3 = $34,707 to $40,906; Q4 = $42,918 to $49,508.

and Asian residents, respectively. The percentage of the population that was Hispanic and the urbanicity status of an area were not found to be significant predictors in any of the age-specific models. Finally, in each age-specific model, the addition of an interaction term for median household income and percent black was not significant, suggesting that the influence of black race on asthma hospitalization rates is independent of income.

Bicoastal Comparison

Using published data for New York City, a bicoastal comparison of asthma hospitalization rates was conducted. Among persons aged 0 to 34 years, New York City residents were hospitalized for asthma 2.8 times more frequently than their Los Angeles counterparts. The average asthma hospitalization rate among New York City residents was 39/10,000 (95% confidence interval, 21 to 115/10,000) between 1982 and 1986. By comparison, the average rate of asthma hospitalization among Los Angeles residents 0 to 34 years reported in this study was 14/10,000 in 1993. New York City children <5 years were hospitalized 2.3 times more frequently than their Los Angeles counterparts (102 vs 44/10,000, respectively). Important differences were found when comparing bicoastal asthma rates of hospitalization by race/ethnicity. Asthma hospitalization rates among black residents of Los Angeles and New York City were similar: 60 vs 40/10,000, respectively. In contrast, asthma hospitalization rates were 4.5 times higher among Hispanics in New York City (primarily of Puerto Rican origin) vs Hispanics in Los Angeles (primarily of Mexican-American origin) (63 vs 14/10,000, respectively). It appears that the higher rates among Puerto Ricans contributed most significantly to the increased rate of asthma hospitalization found in New York City.

Discussion

Asthma, a multifactorial disease associated with familial, infectious, allergic, socioeconomic, psychosocial, and environmental factors, is one of the leading chronic diseases that afflicts children and young adults in the United States. The frequency and length of stay of asthma hospitalizations in California in 1993 were consistent with nationwide rates. The annual rate of asthma hospitalization in California was 13.4/10,000 compared with 17.0/10,000 in the United States. The average length of stay for an asthma hospitalization was 3.3 days in California compared with 3.9 days nationwide. Finally, asthma hospitalizations comprised 1.4% of all hospitalizations in California and 1.5% of all hospitalizations nationwide.

The National Heart Lung and Blood Institute of the National Institutes of Health has stated that "failure to characterize the differences in disease characteristics, occurrence, and causes across minority groups and to address the reasons may have significant detrimental public health, social, and economic consequences." This study extends the previous research in this area by examining asthma hospitalization across different age and race/ethnic groups, levels of income, and urbanicity. We conclude that across all age and income groups, and whether residing in urban or rural areas, blacks were at dramatically higher risk of being hospitalized for asthma. While there is no known biological reason for the prevalence of asthma to be greater among blacks compared with other racial/ethnic groups, being black may be a surrogate for unmeasured discrimination, lower quality of care, and limited health-care access, even in systems where access should not be a variable. For example, Peterson et al found that in the Department of Veterans Affairs health-care system, blacks received fewer cardiac procedures after myocardial infarction compared with whites. Lozano et al demonstrated that among the Washington Medicaid population, black asthmatic children were less likely to have an office visit...
for asthma, suggesting that barriers other than insurance may exist for treatment of minority children with chronic illnesses.20

The provider of care and differences in medical practice styles (private physician, community health center, etc) can affect the type of care received. Finkelstein et al21 found significant differences in the quality of asthma primary care for black and Hispanic vs white young children with asthma in Boston. However, after adjustment for primary-care practice type, the effect of race disappeared, suggesting that the variations in the quality of asthma primary care may be associated with differences in the type of provider. Minorities and the poor tend to receive treatment at facilities that do not practice "state of the art" asthma care. Perrin et al22 found differences in the asthma hospital admission rates among children in Rochester, Boston, and New Haven and, in a follow-up study, Homer et al13 found large variations in the preventive care received for asthma among children in these three cities. Socioeconomic status, a tranquil predictor of asthma morbidity, is a surrogate for limited health-care access. Wissow et al23 reported that black children in Maryland were at increased risk of hospitalization for asthma. In contrast to our findings, Wissow et al23 found that the increased risk was related to poverty rather than to race. Haas et al24 also reported that socioeconomic status partially explains the differences in the quality of care received by asthma patients of both lower and higher socioeconomic status.

This study is unique in examining asthma rates of hospitalization among Asians. Notably, Asian children <5 years were at slightly higher risk of asthma hospitalization than white children regardless of the socioeconomic strata examined. In the only study (to our knowledge) to delineate asthma mortality of Asians, Schenker et al.25 found similar rates of asthma mortality among nonelderly Asians and whites from 1960 to 1989 residing in California, where the population is largely composed of persons of Filipino, Chinese, and Japanese descent.

The risk of asthma hospitalization among Hispanics in California—comprised predominantly of Mexican-Americans—was greater than whites but consistently lower than blacks across all income and age groups. Moreover, the rate of asthma hospitalization among the California Hispanic population was lower than that reported for Hispanics of Puerto Rican descent, which is consistent with the body of literature reporting the increased prevalence and case severity of asthma among Puerto Ricans as compared with Cubans and Mexican-Americans.26-29 For example, Carter-Pokras and Gergen,26 using 1982 to 1984 National Health and Nutrition Examination Survey results, reported that the highest prevalence of active asthma was found among Puerto Ricans (11.2%),
followed by blacks (9.1%), Cubans (8.8%), Mexican-Americans (4.5%), and whites (3.3%). Increasingly, it is recognized that Hispanics are not a single homogeneous group. Economic, social, and clinical factors play an important role in the noted differences among Puerto Ricans, Mexican-Americans, and Cuban-Americans in their health status, illness behavior, and use of medical care services. For example, Puerto Rican women of reproductive age are more likely to smoke (33.5%) than Mexican-American women (23.2%), and children of mothers who smoke have a higher incidence of wheezing illness, especially in the first few years of life.\textsuperscript{31,32} Compared with Mexican-Americans and Cubans, Puerto Ricans are more likely to be near or below the poverty line, insured by Medicaid, have a greater number of disability days, and have the highest annual healthcare expenses.\textsuperscript{33}

In addition to the racial/ethnic differences in asthma hospitalization rates, particularly among Hispanics, differences between the east and west coast reported in this study may also be due to variations in access to health-care services, level of poverty (considered to be a surrogate measure of health-care access and use), as well as medical treatment practice patterns.\textsuperscript{22,24,39} Regional differences in the reporting of a specific illness as a primary diagnosis may also contribute to the underreporting of asthma in California. Finally, the indoor and outdoor environmental agents that east and west coast residents are exposed to may differ substantially. Because of the warmer climate, persons in Los Angeles may spend less time indoors, where dust mites, molds, and other triggers of asthma reside, as compared with east coast residents. Conversely, Los Angeles residents are exposed to higher concentrations of major air pollutants than residents of east coast cities.\textsuperscript{30} In the Los Angeles consolidated metropolitan statistical area, the national ambient air quality standards for carbon monoxide and ozone were not achieved for a total of 20 and 98 days, respectively, in 1993; by comparison, these standards were not met in the New York-New Jersey-Connecticut consolidated metropolitan statistical area during a total of zero and 6 days, respectively, in 1993. However, the association between asthma morbidity and mortality and outdoor air quality remains speculative. Lang and Polansky\textsuperscript{37} recently reported increasing rates of asthma mortality in Philadelphia between 1965 to 1990 despite declines in the concentrations of major air pollutants.

There are several noteworthy study limitations. First, the California Hospital Discharge data source used in this study did not permit an assessment of the prevalence of asthma in California because it is limited to hospital discharges only. Thus, it is unknown whether the lower rates of hospitalization among whites and Asians are due to a lower prevalence of asthma or simply fewer asthma-related hospitalizations. Furthermore, it is not possible to determine whether observed differences in rates among specific cohorts were due to higher numbers of individuals being hospitalized or a higher rate of readmission among some subgroups. Second, there are inherent problems of disease classification when employing secondary data sources. In the California Hospital Discharge file, the disease-specific estimates of inpatient health-care utilization are based on diagnostic information coded via ICD-9-CM diagnosis codes. The specific conditions and the sequence of how these conditions are reported on medical face sheets depend on the interpretation by medical personnel and may therefore not be consistent. Cunningham et al\textsuperscript{38} found that black race was an important risk factor for diagnosed asthma but not for persistent wheeze, suggesting that race plays a role in the diagnosis of asthma. Third, the rates of asthma hospitalization for blacks and Hispanics may be inflated to an unknown degree due to the potential undercounting of minority populations in the data obtained from the Bureau of the Census. Additionally, the identification and coding of race and ethnicity are also subject to reporting error in the 1993 California Discharge file. The effect of the reporting error present in both databases on the rates of hospitalization calculated in this analysis is unknown. Finally, the small area analysis of asthma hospitalization rates was based on ecologic data, \textit{i.e.}, median household income and racial composition, and is subject to the biases associated with ecologic analyses. Ecologic studies cannot provide information about the basic causality of a relationship; rather, only information on potential associations can be identified. The results of the multivariate regressions cannot be used to infer person-level relationships because of the risk of ecologic fallacies. However, as used in this and other studies,\textsuperscript{8,9,10,22} a small area analysis is a valuable tool to identify high-risk areas and subgroups that may benefit from public health programs aimed at the prevention and/or amelioration of asthma.

In conclusion, this study documents the substantial morbidity associated with asthma hospitalizations in the state of California. We found a differential independent risk of asthma hospitalization based on socioeconomic status and race. In particular, the risk of asthma hospitalization is elevated among blacks of all ages, among minority children, and among persons (especially blacks) residing in poorer areas. With the advent of managed care, intense pressure has been applied to reduce health-care costs, with a particular focus on inpatient care. Since asthma is a
leading cause of hospitalization for selected age groups, the management of this condition will face increasing scrutiny regarding both its clinical and cost-effectiveness. The resultant impact on the care of minority, young, and poor patients with a chronic disease, such as asthma, requires further investigation.

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