

Hospitalizations for asthma in an urban population: 1995–1999

David M. Lang, MD*; Marcia Polansky, ScD†; and Michael S. Sherman, MD‡

Background: Asthma hospitalizations occur commonly. Many are preventable if asthma is well controlled. Medications and demographic factors affect asthma hospitalization rates. Recent studies suggest that inhaled long-acting β -agonists (LABAs) may heighten risk of serious asthma exacerbation, particularly in African Americans.

Objectives: To further our understanding of the greater asthma morbidity associated with African American race and to investigate possible risk associated with LABAs.

Methods: In an ecologic analysis, asthma hospitalization rates in individuals aged 5 to 64 years were determined for Philadelphia zip codes in period 1 (1995–1997) and period 2 (1997–1999) and were studied for associations with asthma drug prescription rates, demographic factors, and numbers and types of asthma care providers.

Results: Higher hospitalization rates were found in African Americans vs Caucasians (45.7 vs 7.6 per 10,000) and in 5- to 17-year-olds vs 18- to 34- and 35- to 64-year-olds (30.4 vs 11.9 and 13.7 per 10,000). Hospitalizations were correlated directly with prescriptions for inhaled short-acting β -agonists (SABAs) in periods 1 ($r_s = 0.61$) and 2 ($r_s = 0.60$) and inversely with LABA prescriptions in periods 1 ($r_s = -0.56$) and 2 ($r_s = -0.66$). Higher SABA prescription rates were also correlated with greater proportions of African Americans per zip code in periods 1 ($r_s = 0.58$) and 2 ($r_s = 0.53$). At all poverty levels, African Americans had higher hospitalization rates than Caucasians. Asthma hospitalization was significantly associated with poverty area residence (relative risk [RR], 2.29) and with African American race (RR, 4.31) and age (RR, 1.15) as individual-level variables ($P < .001$, Poisson regression).

Conclusions: These data do not support the contention that LABA exposure is a major cause of asthma morbidity. Risk of asthma hospitalization is strongly associated with being African American.

Ann Allergy Asthma Immunol. 2009;103:128–133.

INTRODUCTION

Hospitalizations for asthma occur commonly¹ and account for substantial health care expenditures.² The third Expert Panel Report (EPR) guidelines³ regard hospitalization within the past year as an event reflecting greater disease severity, poor asthma control, or both. Asthma hospitalization rates vary inversely with inhaled corticosteroid (ICS) use,^{4,5} implying that most hospitalizations are preventable.

Asthma hospitalization has also been associated with greater risk of asthma mortality.⁶ Annual rates of asthma

mortality in the United States have declined in recent years.¹ However, rates of fatal asthma remain higher in African American vs Caucasian patients and are highest in African Americans residing in poverty areas of large cities.^{1,7,8}

In the Salmeterol Multicenter Asthma Research Trial, salmeterol therapy was associated with a higher rate of serious and fatal asthma episodes compared with placebo, primarily in African American subjects.⁹ Untoward outcomes in African American individuals associated with salmeterol use may reflect (1) “masking” of inflammation in individuals receiving inhaled long-acting β -agonists (LABAs) as monotherapy without concomitant ICSs; (2) lack of regular follow-up, which was not part of the Salmeterol Multicenter Asthma Research Trial design; or (3) greater potential for untoward outcomes in the asthmatic subgroup homozygous for the Arg/Arg-16 genotype of the β -adrenergic receptor¹⁰ based on the contention¹¹ that increased risk of morbidity in asthmatic patients who are B16 Arg/Arg associated with inhaled short-acting β -agonists (SABAs) also applies to LABAs. A meta-analysis¹² found that compared with placebo, LABAs were associated with a significantly greater risk of life-threatening exacerbations and hospitalizations for asthma. The authors stated in the “Discussion” section of this article that “salmeterol may be responsible for approximately 4,000 of the 5,000 asthma-related deaths that occur in the United States each year”^{12(p909)} and that “concomitant inhaled corticosteroids do not adequately protect against the adverse effects.”^{12(p910)} On

Affiliations: * Respiratory Institute, Section of Allergy and Immunology, Cleveland Clinic Foundation, Cleveland, Ohio; † School of Public Health, Drexel University, Philadelphia, Pennsylvania; ‡ Division of Pulmonary and Critical Care Medicine, Department of Medicine, Drexel University, Philadelphia, Pennsylvania.

Disclosures: Dr Lang has received honoraria from, has performed clinical research in collaboration with, or has served as a consultant for GlaxoSmithKline, AstraZeneca, Schering/Plough, Genentech/Novartis, Centocor, Merck, Critical Therapeutics, Sanofi-Aventis, and MedImmune. Dr Sherman has received honoraria from Boehringer Ingelheim and Pfizer and has performed clinical trials in collaboration with Pfizer, Genentech, Angiotech, Johnson & Johnson, and Chiron.

Funding Sources: This study was supported by an unrestricted grant from GlaxoSmithKline and by the William Wagner Memorial Research and Education Fund.

Disclaimer: GlaxoSmithKline had no role in design of this study, the interpretation of data, or the writing of the manuscript.

Received for publication February 5, 2008; Received in revised form February 25, 2009; Accepted for publication March 14, 2009.

the basis of these recent studies, the evidence-based recommendation in the EPR3 guidelines³ for the “step up” option for patients insufficiently controlled with low-dose ICS therapy was modified. The preferred option in EPR2,¹³ based on level A evidence, was low-dose ICSs combined with LABAs. In EPR3,³ the option of increasing the ICS dose is viewed as “equally acceptable” compared with low-dose ICSs and LABAs based on “potential risk” associated with the latter. The magnitude of this putative risk, particularly for African American patients, in association with LABA exposure would be substantial because LABAs are commonly prescribed. Hospitalizations for asthma are also common. For this reason, this risk, if it exists, would be important from a public health standpoint and should be detectable at a population level as a direct relationship between LABA prescriptions and asthma hospitalizations.

To further our understanding of greater risk for untoward asthma care outcomes associated with African American race and to investigate possible risks associated with salmeterol use, we analyzed hospitalization rates and asthma drug prescriptions for 4 years (April 1, 1995, through March 31, 1999). This period is the 2 years before and after release of the EPR2 guidelines,¹³ which also precedes the availability of formoterol and the combination product containing salmeterol and fluticasone propionate (Advair; GlaxoSmithKline, Research Triangle Park, North Carolina) in the United States. This period was also a time when ICS use was less prevalent, and LABA monotherapy was likely more common. We examined overall trends and demographic factors associated with asthma drug prescriptions, including salmeterol, in the context of asthma hospitalization patterns.

METHODS

Data describing hospitalizations for asthma (493.X) between April 1, 1995, and March 31, 1997 (period 1), and between April 1, 1997, and March 31, 1999 (period 2), for Philadelphia, Pennsylvania, residents were obtained from the Pennsylvania Health Care Cost Containment Council. Age, sex, and race/ethnicity for each patient were recorded. Hospitalization rates (number of hospitalizations per zip code population) were determined for individuals aged 5 to 64 years and were calculated for all zip codes. Data from zip codes with more than 1,000 residents were analyzed.

Monthly estimates of the number of drug prescriptions for asthma between April 1, 1995, and March 31, 1999, were provided by Wolters Kluwer Health (Phoenix, Arizona). The Wolters Kluwer Health database analyzes more than 120 million prescriptions per month, representing 70% of the dispensed volume from US (chain and independent retail) pharmacies. We analyzed data representing an audit of dispensed prescriptions from a representative sample of retail pharmacies in Philadelphia. The data were organized into 8 drug categories: LABAs, ICSs, SABAs, oral β -agonists, theophylline, anticholinergics, cromones (cromolyn and nedocromil), and antileukotrienes. Data for oral corticosteroids were not included. Prescription rates for these cate-

gies of asthma drugs were determined for all zip codes in Philadelphia. Prescriptions in zip codes with an average monthly asthma drug prescription rate of 100 or greater were analyzed.

Information identifying physicians in Philadelphia by office address was obtained from the 1998 edition of *Dorland's Medical Directory* (Legal Communications Ltd, Philadelphia). Physicians listed as family/general practice, internal medicine, or pediatrics were categorized as primary care physicians; allergy/immunology and pulmonary physicians were classified as asthma specialists. Numbers (primary care physicians + asthma specialists) and proportions (asthma specialists/[primary care physicians + asthma specialists]) of asthma care providers were determined for each zip code.

Demographic data (race/ethnicity, marital status, educational attainment, sex, and poverty level) in each zip code area were obtained from the 1990 Census enumeration for Philadelphia.¹⁴ Poverty status was assigned using a definition originated by the Social Security Administration in 1964, subsequently modified by federal interagency committees in 1969 and 1980, and prescribed by the Office of Management and Budget as the standard used by federal agencies for statistical purposes. This definition uses total income adjusted to poverty thresholds weighted by the number and ages of household members.¹⁵

Spearman correlation coefficients (r_s) were used to evaluate associations of asthma hospitalization rates with asthma drug prescriptions and sociodemographic factors. Correlations of asthma drug prescriptions with hospitalizations were analyzed separately for period 1 and period 2 to ascertain whether release of EPR2 guidelines at the end of period 1 had affected prescribing patterns. Poisson regression was used for multivariable analysis¹⁶ to evaluate risk of hospitalization for asthma according to race and poverty status. In this analysis, demographic factors were entered into the regression model as population-level variables (eg, according to proportions of residents in each zip code who were African American); age, sex, and African American race were entered as individual-level factors (eg, according to proportions of hospitalized asthmatic patients who were African American). The population was stratified by zip code into thirds (high, intermediate, and low) for each sociodemographic variable used in the Poisson regression model. Two-tailed $P < .01$ was regarded as statistically significant.

RESULTS

Asthma Hospitalizations

Hospitalizations of Philadelphia residents totaled 22,266 between April 1, 1995, and March 31, 1999. During this period, median annualized rates of hospitalizations were higher in African American individuals (45.7 per 10,000) compared with Caucasian individuals (7.6 per 10,000) and in 5- to 17-year-olds (30.4 per 10,000) compared with those aged 18 to 34 years (11.9 per 10,000) and 35 to 64 years (13.7 per 10,000). Between periods 1 and 2, rates of hospitalization

declined significantly in the overall population (from 23 to 19 per 10,000; $\chi^2 = 30.62$; $P < .001$), in African American individuals (from 51.1 to 41.0 per 10,000; $\chi^2 = 28.24$, $P < .001$), and in Caucasian individuals (from 8.1 to 7.3 per 10,000; $\chi^2 = 3.01$; $P = .08$).

Asthma Drug Prescriptions

Asthma drug prescriptions totaled 2,284,093 between April 1, 1995, and March 31, 1999. In 45 zip codes (97.7% of Philadelphia residents) with an average monthly asthma drug prescription rate of at least 100, there were 788 asthma care providers. The proportion of prescriptions for SABAs declined from 50% to 45% of total asthma drug prescriptions from period 1 to period 2, whereas the proportion of total drug prescriptions composed of "controllers" (ICSs, LABAs, antileukotrienes, and cromones) increased from 25% to 32%.

Association of Asthma Drug Prescriptions With Patterns of Hospitalization

Table 1 displays annual mean rates of prescriptions for asthma drugs per zip code and correlations with hospitalizations for asthma. Hospitalizations were correlated directly with prescriptions for SABAs in period 1 ($r_s = 0.61$, 95% CI, 0.38 to 0.76; $P < .001$) and in period 2 ($r_s = 0.60$; 95% CI, 0.37 to 0.76; $P < .001$) (Figure 1) and with oral β -agonists in period 2 ($r_s = 0.39$; 95% CI, 0.11 to 0.61; $P = .008$). Hospitalizations were inversely correlated with prescriptions for ICSs in period 1 ($r_s = -0.45$; 95% CI, -0.66 to -0.18 ; $P = .001$) and in period 2 ($r_s = -0.42$; 95% CI, -0.63 to -0.14 ; $P = .004$) and with anticholinergics in period 1 ($r_s = -0.46$; 95% CI, -0.66 to -0.19 ; $P = .001$). Hospitalizations were inversely correlated with LABA prescriptions in period 1 ($r_s = -0.56$; 95% CI, -0.73 to -0.31 ; $P < .001$) and in period 2 ($r_s = -0.66$; 95% CI, -0.80 to -0.45 ; $P < .001$) (Figure 2). Prescriptions for LABAs were inversely correlated with prescriptions for SABAs in period 1 ($r_s = -0.71$, 95% CI, -0.83 to -0.53 ; $P < .001$) and in period 2 ($r_s = -0.71$; 95% CI, -0.83 to -0.52 ; $P < .001$).

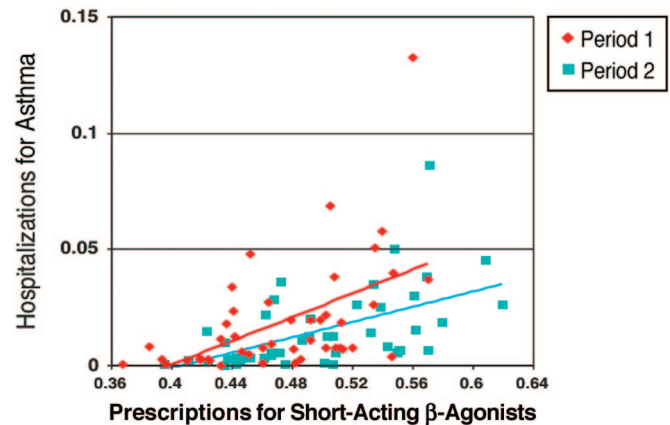


Figure 1. The annualized rate of asthma hospitalizations per zip code was significantly correlated with the annual rate of dispensed prescriptions per zip code population for inhaled short-acting β -agonists in period 1 ($r_s = 0.61$; 95% confidence interval, 0.38 to 0.76; $P < .001$) and in period 2 ($r_s = 0.60$; 95% confidence interval, 0.37 to 0.76; $P < .001$).

Association of African American Race With Risk of Hospitalization

African American individuals were hospitalized 6 times more frequently than were Caucasian individuals. Figure 3 displays the correlation between SABA prescriptions and proportions of African American residents per zip code in period 1 ($r_s = 0.58$; 95% CI, 0.34 to 0.74; $P < .001$) and in period 2 ($r_s = 0.53$; 95% CI, 0.27 to 0.71; $P < .001$).

We further examined the risk of hospitalization associated with African American race by analyzing rates of hospitalization in African American and Caucasian residents within 3 strata of poverty in zip codes of residence. In African American and Caucasian individuals, asthma hospitalization rates increased directly in association with rates of poverty in zip codes of residence (Figure 4). At all levels of poverty, African American individuals had substantially higher rates of hospitalization than Caucasian individuals. African American

Table 1. Asthma Drug Prescription Rates and Correlations With Hospitalizations for Asthma

Asthma drug	Period 1 (1995–1997)			Period 2 (1997–1999)		
	Annual prescriptions per zip code, mean (SD), No.	Correlation with hospitalization for asthma, r_s (95% CI)	P value	Annual prescriptions per zip code, mean (SD), No.	Correlation with hospitalization for asthma, r_s (95% CI)	P value
Short-acting β -agonists	4,988 (557)	0.61 (0.38 to 0.76)	$<.001$	4,731 (497)	0.60 (0.37 to 0.76)	$<.001$
Long-acting β -agonists	429 (212)	-0.56 (-0.73 to -0.31)	$<.001$	645 (251)	-0.66 (-0.80 to -0.45)	$<.001$
Inhaled corticosteroids	1,764 (378)	-0.45 (-0.66 to -0.18)	.001	1,882 (348)	-0.42 (-0.63 to -0.14)	.004
Oral β -agonists	206 (155)	0.35 (0.05 to 0.58)	.02	186 (140)	0.39 (0.11 to 0.61)	.008
Antileukotrienes	57 (37)	-0.26 (-0.51 to 0.03)	.09	523 (152)	-0.16 (-0.43 to 0.14)	.30
Anticholinergics	686 (221)	-0.46 (-0.66 to -0.19)	.001	1,000 (321)	-0.23 (-0.49 to 0.07)	.13
Theophylline	1,596 (385)	0.21 (-0.09 to 0.47)	.17	1,128 (330)	0.33 (0.03 to 0.56)	.03
Cromones	283 (150)	-0.42 (-0.64 to -0.14)	.004	186 (140)	-0.21 (-0.47 to 0.09)	.16

Abbreviation: CI, confidence interval.

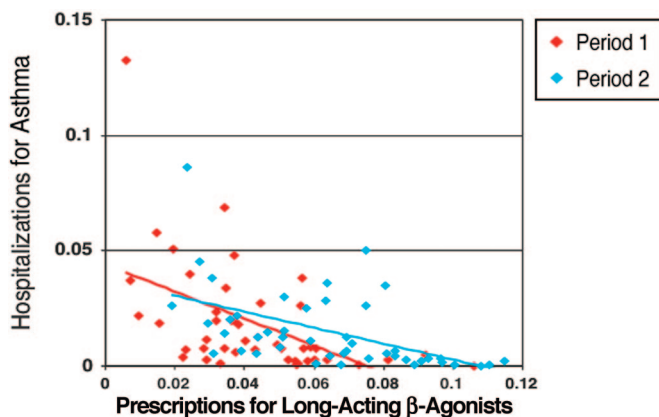


Figure 2. The annualized rate of asthma hospitalizations per zip code was significantly and inversely correlated with the annual rate of dispensed prescriptions per zip code population for inhaled long-acting β -agonists in period 1 ($r_s = -0.56$; 95% confidence interval, -0.73 to -0.31 ; $P < .001$) and in period 2 ($r_s = -0.66$; 95% confidence interval, -0.80 to -0.45 ; $P < .001$).

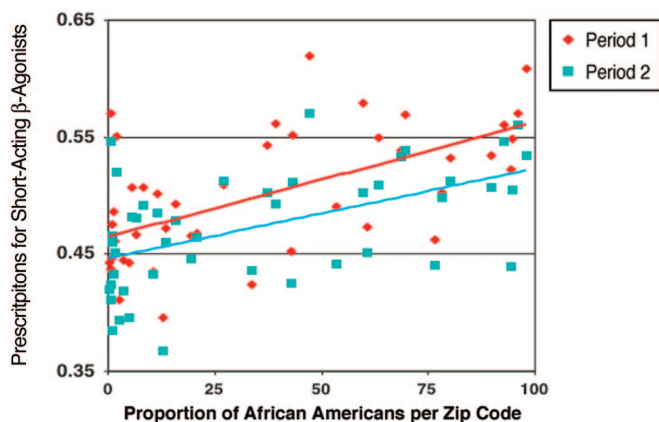


Figure 3. The annual rate of dispensed prescriptions per zip code population for inhaled short-acting β -agonists was significantly correlated with proportions of zip code residents who were African American in period 1 ($r_s = 0.58$; 95% confidence interval, 0.34 to 0.74 ; $P < .001$) and in period 2 ($r_s = 0.53$; 95% confidence interval, 0.27 to 0.71 ; $P < .001$).

individuals residing in zip codes with low rates of poverty had approximately 2.5 times higher hospitalization rates for asthma compared with Caucasian individuals residing in high-poverty areas (33.3 vs 13.4 per 10,000). We found that African American race as an individual-level variable was an independent risk factor for asthma hospitalization (relative risk [RR] = 4.31, $P < .001$) in a Poisson regression model, in which poverty area residence (RR = 2.29, $P < .001$) and age as an individual-level variable (RR = 1.15, $P < .001$) were also significantly associated with risk of hospitalization.

DISCUSSION

In association with more favorable patterns of asthma drug prescribing, rates of asthma hospitalization declined during

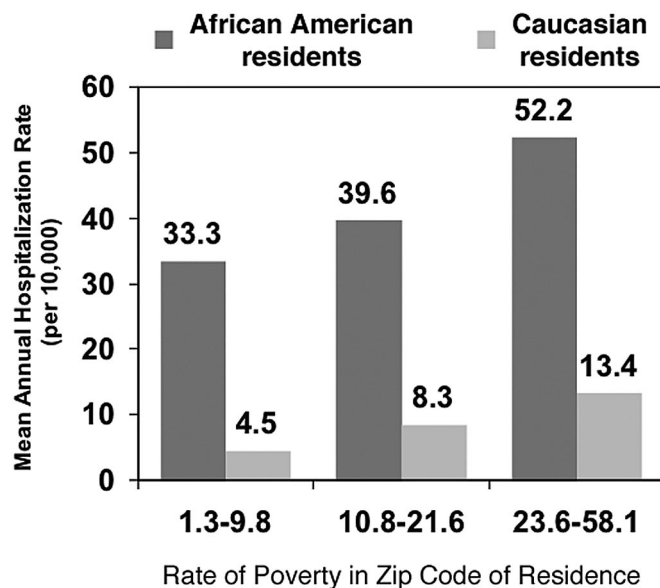


Figure 4. Asthma hospitalization by race and poverty level. Zip code tertiles are displayed (15 zip codes per tertile) according to increasing proportions of residents in poverty. As proportions of zip code residents in poverty rise, a direct increase in rates of hospitalization for asthma in African American and Caucasian residents was observed; however, even African American individuals residing in zip codes with low rates of poverty had substantially higher hospitalization rates compared with Caucasian individuals residing in high-poverty areas.

this study. We observed a substantial disparity in hospitalization rates between Caucasian and African American individuals. Whereas rates of dispensed prescriptions for ICSs were inversely associated with rates of hospitalization for asthma, prescriptions for SABAs, which may be considered a “proxy” for poor asthma control,¹⁷ were directly and strongly associated with asthma hospitalization. Higher SABA use rates were also strongly associated with greater proportions of African American residents per zip code.

A remarkable finding of this study is that higher asthma hospitalization rates in African American individuals were not fully explained by poverty status: at all levels of poverty, African American individuals had higher rates of hospitalization for asthma than did Caucasian individuals (Fig 4). Although the level of poverty among African American and Caucasian individuals residing in the same zip code may not be equivalent, we do not believe that the magnitude of the disparity in hospitalization rates can be explained by this consideration alone. It is likely that a combination of factors accounts for this observation, and we offer several hypotheses to explain this. First, the disparity cannot be fully explained by lack of access; however, physician bias in asthma drug prescribing may be occurring. Although not specifically investigated for asthma, physician bias in the management of patients with cardiovascular disease according to race has been described.^{18,19} Second, the disparity may reflect the effect of genetic factors.¹⁰ Racial variation in the distribution

of genetic polymorphisms, such as the gene encoding β_2 -adrenergic receptor,¹¹ may place African American individuals, who the present study suggests have higher exposure to SABAs, at greater risk for asthma exacerbation. Third, the disparity may be a result of different asthma care behaviors in African American and Caucasian patients. African American patients are less likely to receive continuous, ongoing medical care, the sine qua non for optimal control of asthma, and are more likely to obtain asthma care episodically in an emergency department.^{20,21} Similarly, African American children and adolescents with diabetes are hospitalized more frequently than are Caucasian children, tend to miss more outpatient appointments, and exhibit poorer metabolic control, even with adjustment for insulin dose, diabetes duration, and socioeconomic status.²² African American individuals have lower rates of health service utilization for diabetes screening, prevention, and care despite having greater prevalence and severity of diabetes compared with Caucasian individuals.²³ For African American individuals, disparities in health care outcomes^{24,25} translate into impaired quality of life, greater morbidity, and premature mortality and encourage the perception of injustice. The present findings highlight the need to more fully understand the factors that contribute to these disparities²⁵ and to address the sociophysical and cultural factors that underlie them.

During this study, a time during which LABA use as monotherapy was likely more common than at the present time, LABA prescription patterns were inversely correlated with hospitalizations for asthma. These data do not support the contention that LABA exposure is a major cause of asthma morbidity; however, whereas ecologic studies such as this one have utility for revealing important insights,²⁶ "aggregation bias" may exist: there may be a difference between population effects and individual-level effects. The present findings regarding LABA prescription patterns and hospitalization should be viewed in the context of additional studies being undertaken to achieve a clearer understanding of the relative benefits and risks associated with LABAs.

A limitation of these analyses of asthma drug prescriptions is that they did not include over-the-counter asthma medications or physician dispensing of drug samples, and we could not gauge therapeutic adherence. These analyses also did not entail knowledge of diagnoses for which these prescriptions were dispensed. Lack of information about numbers of prescriptions written but not dispensed may also have introduced bias into these analyses. These data do not include prescriptions dispensed at pharmacies located in hospitals and closed health maintenance organizations; hence, our interpretations assume that asthma drug-prescribing patterns in Philadelphia do not differ between these pharmacies and retail (chain and independent) pharmacies.

We found that the rate of hospitalizations for asthma declined significantly from period 1 to period 2 in African American residents ($\chi^2 = 28.24$) but not in Caucasian residents ($\chi^2 = 3.01$); a city or region more populous than Philadelphia may be required for statistically significant de-

clines in rates to be observed in Caucasian individuals. We did not include a separate analysis of multiple admissions. For this reason, higher rates of admissions in African American individuals in this study may, in part, reflect a tendency for more frequent repeated hospitalizations. This study analyzed patterns of hospitalization in Philadelphia, and these findings may not be generalizable to urban areas with different ethnodemographic characteristics or to rural areas.

An asthma epidemic has occurred in the United States. We do not find evidence to support the contention that asthma morbidity is substantially associated with LABA use.¹² These findings are consistent with those of other studies in demonstrating that asthma morbidity disproportionately affects urban residents who are poor or African American. Although asthma mortality and hospitalization rates are declining in the United States, African American individuals continue to be disproportionately burdened.^{1,2,24} Despite asthma being a condition that is "intervention sensitive," inequality in asthma care outcomes persist. The present findings further support the contention that African American race is a substantial asthma risk marker.²⁵ There is a continuing need for novel interventions to address and remedy these ongoing disparities.

REFERENCES

1. Moorman JE, Rudd RA, Johnson CA, et al. National Surveillance for asthma—United States, 1980–2004. *MMWR Surveill Summ.* 2007;56: 1–54.
2. Sullivan SD. The burden of uncontrolled asthma on the U.S. health care system. *Manag Care.* 2005;14(suppl):4–7.
3. Expert Panel Report 3 (EPR3): guidelines for the diagnosis and management of asthma. <http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm>. Accessed August 31, 2007.
4. Suissa S, Ernst P, Kezough A. Regular use of inhaled corticosteroids and the long term prevention of hospitalization for asthma. *Thorax.* 2002; 57:880–884.
5. Adams RJ, Fuhlbrigge A, Finkelstein J, et al. Impact of inhaled anti-inflammatory therapy on hospitalization and emergency department visits for children with asthma. *Pediatrics.* 2001;107:706–711.
6. Rea HH, Scragg R, Jackson R, Beaglehole R, Fenwick J, Sutherland DCA. Case-control study of deaths from asthma. *Thorax.* 1986;41: 833–839.
7. Carr W, Zeitel L, Weiss K. Variations in asthma hospitalizations and deaths in New York City. *Am J Public Health.* 1992;82:59–65.
8. Lang DM, Polansky M. Patterns of asthma mortality in Philadelphia: 1969–1991. *N Engl J Med.* 1994;331:1542–1547.
9. Nelson H, Weiss S, Bleecker E, Yancey S, Dorinsky P. The Salmeterol Multicenter Asthma Research Trial: a comparison of usual pharmacotherapy for asthma or usual pharmacotherapy plus salmeterol. *Chest.* 2006;129:15–26.
10. Wechsler M, Israel E. How pharmacogenetics will play a role in the management of asthma. *Am J Respir Crit Care Med.* 2005;172:12–18.
11. Wechsler M, Lehman E, Lazarus S, et al. β -Adrenergic receptor polymorphisms and response to salmeterol. *Am J Respir Crit Care Med.* 2006;173:519–526.
12. Salpeter SR, Buckley NS, Ormiston TM, Salpeter EE. Meta-analysis: effect of long acting β -agonists on severe asthma exacerbations and asthma-related deaths. *Ann Intern Med.* 2006;144:904–912.
13. National Asthma Education and Prevention Program. *Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma.* Bethesda, MD: National Heart, Lung, and Blood Institute; 1997. NIH publication 97–4051.
14. *Vital Statistics Report: 1990.* Philadelphia, PA: Philadelphia Department of Public Health; 1990.

-
15. *Poverty in the United States: 1992*. Washington, DC: US Bureau of the Census; 1993. Series P-60-185.
 16. Kleinbaum DG, Kupper LL, Nizam A, Muller KE. *Applied Regression Analysis and Other Multivariable Methods*. 4th ed. Belmont, CA: Duxbury Press; 2008.
 17. Schatz M, Nakahiro R, Crawford W, Mendoza G, Mosen D, Stibolt T. Asthma quality of care markers using administrative data. *Chest*. 2005; 128:1968–1973.
 18. Ibrahim SA, Whittle J, Bean-Mayberry B, Kelley ME, Good C, Conigliaro J. Racial/ethnic variations in physician recommendations for cardiac revascularization. *Am J Public Health*. 2003;93:1689–1693.
 19. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999;340:618–626.
 20. Lozano P, Connell FA, Koepsell TD. Use of health services by African-American children with asthma on Medicaid. *JAMA*. 1995;274: 469–473.
 21. Zoratti EM, Havstad S, Rodriguez J, Robens-Paradise Y, Lafata JE, McCarthy BD. Health care service use by African-Americans and Caucasians with asthma in a managed care setting. *Am J Respir Crit Care Med*. 1998;158:371–377.
 22. Delamater AM, Albrecht BA, Postellon DC, Gutai JP. Racial differences in metabolic control of children and adolescents with type I diabetes mellitus. *Diabetes Care*. 1991;14:20–25.
 23. Pichert J, Briscoe VJ. A questionnaire for assessing barriers to health care utilization. *Diabetes Educ*. 1997;23:181–191.
 24. Centers for Disease Control and Prevention. Health disparities experienced by black or African Americans—United States. *MMWR Morb Mortal Wkly Rep*. 2005;54:1–3.
 25. Joseph CLM, Williams LK, Ownby DR, Saltzgaber J, Johnson CC. Applying epidemiologic concepts of primary, secondary, and tertiary prevention to the elimination of racial disparities in asthma. *J Allergy Clin Immunol*. 2006;117:233–240.
 26. Pearce N. The ecologic fallacy strikes back. *J Epidemiol Community Health*. 2000;54:326–327.
- Requests for reprints should be addressed to:*
David M. Lang, MD
Cleveland Clinic Foundation
9500 Euclid Ave
Desk C22
Cleveland, OH 44195
E-mail: langd@ccf.org
-

Answers to CME examination—*Annals of Allergy, Asthma & Immunology*, July 2009 Weldon D: The effects of corticosteroids on bone: osteonecrosis (avascular necrosis of the bone). *Ann Allergy Asthma Immunol*. 2009;103: 91–97.

1. d
2. a
3. a
4. b
5. c