

# Medication Use, Emergency Hospital Care Utilization, and Quality-of-Life Outcome Disparities by Race/Ethnicity Among Adults With Asthma

David M. Mosen, PhD, MPH; Michael Schatz, MD, MS; Rachel Gold, PhD, MPH; Richard A. Mularski, MD, MSHS, MCR; Winston F. Wong, MD; and Jim Bellows, PhD

**A**sthma affects more than 20 million American adults; 7.7% of American adults (22.2 million) had asthma in 2005.<sup>1</sup> The 2003 National Health Interview Survey found that 29.8 million Americans had been diagnosed as having asthma at some point in their lifetime.<sup>2</sup> The disease accounts for about 3400 deaths a year<sup>1,3</sup> and is associated with substantial morbidity.<sup>4</sup> Moreover, asthma attacks are responsible for more than 130 million days of restricted activity each year among persons of all ages with asthma (*Healthy People 2010*<sup>3</sup>), including 10.1 million missed workdays among adults.<sup>1</sup>

Asthma results in significant healthcare utilization and costs. In 2004, asthma was associated with 14.7 million outpatient visits and with 2 million emergency department (ED) visits.<sup>1</sup> Furthermore, asthma is responsible for more than 500,000 hospitalizations annually.<sup>3</sup> The Agency for Healthcare Research and Quality<sup>4</sup> estimates that total 2004 asthma-related medical costs were more than \$16.1 billion, including \$11.5 billion in direct medical costs.

Among persons with asthma, significant disparities exist in rates of morbidity, mortality, and other outcomes.<sup>2,3,5</sup> Age-adjusted asthma mortality is significantly higher among non-Hispanic blacks (3.3 deaths per 100,000 persons) compared with non-Hispanic whites (1.1 deaths per 100,000 persons).<sup>1,3</sup> One study<sup>6</sup> found that African American patients with asthma were more likely than their white counterparts to have severe asthma, poor quality of life, more asthma control problems, and increased ED visits. They were also more likely to be treated with 3 or more long-term controller medications.

Disparities are also seen in asthma-related ED visits and hospitalizations, particularly race/ethnicity-based differences, which are well documented.<sup>7,8</sup> In 2005, African Americans had 201 asthma-related ED visits per 10,000 persons compared with 44 asthma-related ED visits per 10,000 whites (age-adjusted, including all ages).<sup>1</sup> Asthma-related ED visits declined 25% among whites between 1998 and 2005 but remained stable among African Americans.<sup>7</sup> Similar differences are seen for asthma-related hospitalizations,<sup>2,3</sup> with 2005 rates of 10 per 10,000 whites and 34 per 10,000 African Americans.<sup>1</sup>

Although evidence documenting disparities in asthma prevalence and outcomes is plentiful, the reasons behind these differences are poorly understood and do not seem to be fully explained by differences in severity or comorbid conditions.<sup>3,6,9,10</sup> Socioeco-

**Objectives:** To examine the association of race/ethnicity with medication use, emergency hospital care (EHC) utilization, and quality-of-life outcomes in a population with persistent asthma and to determine if factors related to severity of illness, treatment characteristics, and demographic, socioeconomic, and smoking status explain differences in study outcomes.

**Study Design:** Retrospective analysis.

**Methods:** We examined survey and administrative data for 974 adults with persistent asthma enrolled in a group-model health maintenance organization. Patients with persistent asthma were identified in 1999 using Healthcare Effectiveness Data and Information Set inclusion criteria. In 2000, the same patients were surveyed regarding quality of life using the Mini Asthma Quality of Life Questionnaire. In 2001, the use of controller medications, the ratio of controller medications to rescue medications, and EHC utilization were identified by electronic medical record. Multiple logistic regression and linear regression analyses were used to evaluate the independent association of race/ethnicity with study outcomes after adjusting for severity of illness, treatment characteristics, and demographic, socioeconomic, and smoking status.

**Results:** Compared with whites, African Americans (standardized  $\beta$  coefficient,  $-0.12$ ) and Native Americans/Aleutians/Eskimos (standardized  $\beta$  coefficient,  $-0.14$ ) had lower Mini Asthma Quality of Life Questionnaire scores ( $P < .05$  for both). African Americans were significantly ( $P < .05$ ) more likely to report EHC utilization (odds ratio, 5.2; 95% confidence interval, 2.6-10.3).

**Conclusions:** Disparities existed in 2 outcome measures, Mini Asthma Quality of Life Questionnaire scores and EHC utilization. A concerning finding is that African Americans were at least 5 times more likely to report higher EHC utilization, even after adjusting for factors such as income and education.

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### Take-Away Points

Significant racial/ethnic disparities in emergency hospital care utilization and quality of life exist among adults with persistent asthma.

- African Americans were more likely to have asthma-specific emergency hospital care utilization compared with whites even after adjusting for various explanatory factors.
- African Americans and Native Americans/Aleutians/Eskimos were more likely to report lower asthma-specific quality-of-life scores compared with whites.
- These disparities existed even though there were no reported differences in controller medication use among racial/ethnic groups.

ED visits or hospitalizations with a primary diagnosis of asthma, or (3) 3 or more asthma outpatient visits with 2 or more asthma medication dispensings.

Completed surveys were returned by 2219 members (61.4%), of whom 1998 (90.0%) had a confirmed diagnosis of physician-diagnosed asthma. The present study was restricted to 1100 respondents who met the HEDIS criteria for

economic status (SES) and the disproportionate burden of poverty among racial/ethnic minorities in the United States likely influence asthma-related disparities. Research suggests that SES affects race/ethnicity-based disparities in asthma-related ED use.<sup>7,8</sup> Genetic makeup, environmental risk factors, and differences in health behaviors may also contribute to observed racial/ethnic differences in asthma prevalence and health outcomes, yet none of these fully explain asthma disparities.<sup>3,10-13</sup>

Research findings are equivocal as to the extent to which asthma disparities are related to differences in quality of care, and factors contributing to disparities in asthma care are not well understood.<sup>6,14</sup> Multiple studies<sup>14-17</sup> report race/ethnicity-based disparities in asthma care received, demonstrating that members of minority groups are less likely to receive recommended elements of care. However, other research suggests that disparities in asthma care do not fully explain differences in asthma outcomes.<sup>9</sup>

With this background in mind, this study had the following 2 objectives: (1) to examine the association of race/ethnicity with dispensed medication use, emergency hospital care (EHC) utilization, and quality-of-life outcomes in a managed care population with persistent asthma and (2) to determine the extent to which severity of illness, treatment characteristics, and demographic, socioeconomic, and smoking status explain race/ethnicity differences in study outcomes.

persistent asthma in 2000 and in 1999 and had electronic healthcare utilization information available for 2001. Survey information did not statistically ( $P < .05$ ) differ by race/ethnicity or by demographic, socioeconomic, or smoking status among the total population with completed survey information ( $n = 2219$ ) or by the subset with electronic healthcare utilization information available ( $n = 1100$ ). Of these 1100 patients, 974 had complete race/ethnicity information and are the subject of this analysis. The study was approved by the Northern California Region and the Northwest Region Kaiser Permanente institutional review boards.

### Independent Variables

**Survey-Based Predictor Variables.** The primary predictor variable, namely, race/ethnicity (white, African American, Hispanic, Asian/Pacific Islander, or Native American/Aleutian/Eskimo), was obtained from patient surveys. Secondary survey-based predictor measures included 2 demographic variables (age and sex), 2 SES measures (highest grade in school completed and annual household income), and smoking status. All 3 survey-based measures were ordinal, including highest grade in school completed (eighth grade or less, some high school or technical school, high school graduate, some college or technical school graduate, college graduate, or postgraduate); annual household income (<\$10,000, \$10,000-\$14,999, \$15,000-\$19,999, \$20,000-\$24,999, \$25,000-\$34,999, \$35,000-\$49,999, and  $\geq$ \$50,000); and smoking status (never smoked, past smoker, less than one-half pack per day, one-half to 1 pack per day, 1-2 packs per day, or  $>2$  packs per day).

**Healthcare Utilization-Based Predictor Variables.** Using a unique record number, survey records were matched to administrative data from 2000. Secondary utilization predictor variables identified in 2000 included 3 severity measures and 1 treatment measure. The severity measures included any asthma-specific emergency or hospitalization utilization versus nonutilization,  $\beta$ -agonist overuse ( $\geq 14$  vs  $<14$  canisters), and any oral corticosteroid use versus nonuse.<sup>20</sup> The treatment measure included any inhaled corticosteroid use ( $\geq 1$  canisters vs nonuse).

## METHODS

### Patients

Patients in this study have been previously described.<sup>18</sup> Surveys were sent from Kaiser Permanente's Care Management Institute, Oakland, California, in August 2000, to a random sample of Kaiser Permanente Medical Care Program adult members aged 18 to 56 years from the Northern California ( $n = 3072$ ) and Northwest ( $n = 543$ ) regions who were diagnosed as having persistent asthma in 1999 based on Healthcare Effectiveness and Data Information Set (HEDIS) criteria.<sup>19</sup> The HEDIS criteria for persistent asthma comprise the following administrative database observations in a 12-month period: (1) 4 or more asthma medication dispensings, (2) 1 or more

### Dependent Variables

Dependent variables included 1 survey-based outcome measure from 2000. Also included were 3 healthcare utilization–based outcome measures from 2001.

**Survey-Based Outcome Measure.** The Mini Asthma Quality of Life Questionnaire (MiniAQLQ)<sup>21</sup> was the survey-based outcome measure used. The MiniAQLQ includes 15 questions in 4 domains (symptoms, activity, emotions, and environment). Scores range from 1 to 7, with higher scores indicating better quality of life.

**Healthcare Utilization–Based Outcome Measures.** Using a unique record number, survey records were matched to administrative data from 2001. Healthcare utilization–based outcome measures included (1) any inhaled corticosteroid use ( $\geq 1$  canisters vs nonutilization); (2) medication use ratio of inhaled corticosteroids to  $\beta$ -agonist medications ( $\geq 0.5$  vs  $< 0.5$ ), a measure shown to be related to better patient-reported and healthcare utilization asthma outcomes<sup>22</sup>; and (3) EHC, which comprised any asthma-specific hospitalization or ED visit (utilization vs nonutilization). For these analyses, asthma-related hospitalizations and ED visits were combined into a single variable to increase power.

### Statistical Analysis

All analyses were performed using commercially available statistical software (SAS version 9.1 for Windows; SAS Institute, Cary, NC). We examined bivariate associations of race/ethnicity with each categorical outcome measure using Pearson product moment  $\chi^2$  analysis; analysis of variance was also used for the MiniAQLQ scores. Multiple logistic regression models were constructed to analyze the independent effect of race/ethnicity on categorical outcomes (with significant relationships [ $P < .05$ ] in bivariate analysis) after adjustment for possible confounding factors, where race/ethnicity was treated as a 4-level categorical variable (white [reference group], African American, Hispanic, Asian/Pacific Islander, and Native American/Aleutian/Eskimo). Ordinary least squares regression was used to analyze the independent effect of race/ethnicity on MiniAQLQ scores.

Each outcome measure was regressed on race/ethnicity, adjusting for the following sequence of added covariates: (1) model 1, with no additional covariates; (2) model 2, with added demographics (age and sex); (3) model 3, with model 2 plus SES characteristics and smoking status; (4) model 4, with model 3 plus the severity markers of EHC utilization,  $\beta$ -agonist overuse, and oral corticosteroid use; and (5) model 5, with model 4 plus inhaled corticosteroid use, all in 2000. In these models, age, education, income, and smoking status were analyzed as continuous measures, while EHC (use vs nonuse),  $\beta$ -agonist overuse ( $\geq 14$  vs  $< 14$  canisters), oral corticosteroid use ( $\geq 1$  dispensings vs non-

use), and inhaled corticosteroid use ( $\geq 1$  canisters vs nonuse), all in 2000, were analyzed as dichotomous measures.

## RESULTS

As summarized in **Table 1**, whites constituted most of the participants (72.2%), followed by African Americans (9.3%), Hispanics (8.5%), Asian/Pacific Islanders (6.9%), and Native Americans/Aleutians/Eskimos (3.1%). The study population was also well educated (almost 40% had a college degree or higher), 67.9% were female, the mean age was 43.2 years, and less than half were current or former smokers.

Reflecting an asthma population with good health in 2000, less than 20% of the population reported  $\beta$ -agonist overuse or oral corticosteroid use in 2000, while 11.4% reported any EHC utilization (Table 1). These data are consistent with quality-of-care results reported within the 2 Kaiser Permanente study regions during the observed study periods (unpublished data, Michael Schatz, MD, MS, oral communication, 2009).

The descriptive analysis of study outcome measures also reflects a population with moderately high MiniAQLQ scores, high asthma controller use, and low EHC utilization (Table 1). The mean (SD) MiniAQLQ score was 4.8 (1.3) in 2000, most members of the study population (81.8%) were dispensed controller medications in 2001, and most (64.4%) had medication use ratios of 0.5 or higher in 2001. The 2001 EHC utilization was 11.4%.

Race/ethnicity was significantly associated with 2 of 4 study outcomes (self-reported MiniAQLQ scores in 2000 and EHC utilization in 2001) in unadjusted and multivariate analyses (**Tables 2, 3, and 4**). African Americans (standardized  $\beta$  coefficient,  $-0.12$ ) and Native Americans/Aleutians/Eskimos (standardized  $\beta$  coefficient,  $-0.14$ ) reported significantly lower MiniAQLQ scores compared with whites even after adjusting for study covariates ( $P < .05$  for both) (Table 3). African Americans were significantly more likely to have any EHC utilization (odds ratio = 5.2, 95% confidence interval, 2.6-10.3;  $P < .05$ ) compared with whites (Table 4). This association remained even after adjusting for age, sex, SES, smoking status, severity measures in 2000 (EHC utilization,  $\beta$ -agonist overuse, and oral corticosteroid use), and treatment measures (controller use) (Table 3). Compared with whites, Hispanics and Asian/Pacific Islanders were more likely to have had EHC utilization in unadjusted analysis; however, this association lost statistical significance after adjusting for potential confounders.

## DISCUSSION

This study found significant racial/ethnic disparities in quality of life and EHC utilization among adults with per-

■ **Table 1.** Baseline Characteristics of the Study Population

Characteristic	Study Population (n = 974)
<b>Age, mean (SD), y</b>	43.2 (9.3)
<b>Female sex, No. (%)</b>	661 (67.9)
<b>Race/ethnicity, No. (%)</b>	
White	703 (72.2)
African American	91 (9.3)
Hispanic	83 (8.5)
Asian/Pacific Islander	67 (6.9)
Native American/Aleutian/Eskimo	30 (3.1)
<b>Education, No. (%)</b>	
≤Eighth grade	5 (0.5)
Some high school or technical school	43 (4.4)
High school graduate	139 (14.3)
Some college or technical school graduate	372 (38.2)
College graduate	212 (21.8)
Postgraduate	148 (15.2)
Unknown	55 (5.6)
<b>Annual household income, \$, No. (%)</b>	
<10,000	26 (2.7)
10,000-14,999	21 (2.2)
15,000-19,999	22 (2.3)
20,000-24,999	38 (3.9)
25,000-34,999	75 (7.7)
35,000-49,999	165 (16.9)
≥50,000	503 (51.6)
Unknown	124 (12.7)
<b>Smoking status, No. (%)</b>	
Never smoked	567 (58.2)
Past smoker	292 (30.0)
<½ Pack per day	51 (5.2)
½ to 1 Pack per day	31 (3.2)
1-2 Packs per day	16 (1.6)
Unknown	17 (1.7)
<b>Asthma severity in 2000, %</b>	
Emergency hospital care utilization <sup>a</sup>	11.4
Overuse of ≥14 canisters of β-agonists	17.0
≥1 Dispensings of oral corticosteroids	18.3
<b>Use of ≥1 canisters of inhaled corticosteroids in 2000</b>	<b>84.6</b>
<b>Outcome measure</b>	
Mini Asthma Quality of Life Questionnaire score in 2000, mean (SD) <sup>a</sup>	4.8 (1.3)
Use of ≥1 canisters of inhaled corticosteroids in 2001, %	81.8
Medication ratio of inhaled corticosteroids to β-agonist medications ≥0.5 in 2001, % <sup>b</sup>	64.4
Emergency hospital care utilization in 2001, % <sup>c</sup>	11.4

<sup>a</sup>Scores range from 1 to 7, with higher scores indicating better quality of life.  
<sup>b</sup>Sum of inhaled corticosteroid canisters plus short-acting β-agonist canisters.  
<sup>c</sup>At least 1 asthma-specific emergency department visit or asthma-related hospitalization.

sistent asthma. Specifically, African Americans and Native Americans/Aleutians/Eskimos were more likely to report lower asthma-specific quality-of-life scores compared with whites. Moreover, African Americans were more likely to have asthma-specific EHC utilization compared with whites even after adjusting for various factors that could explain these differences. Therefore, in a large integrated healthcare delivery system with universal access to health services, substantial racial/ethnic quality-of-life and EHC utilization disparities were identified even after adjusting for a comprehensive array of demographics, SES, severity of illness, and use of controller medications. Of note, these disparities existed even though there were no reported differences in controller medication use among racial/ethnic groups.

Higher asthma morbidity among African American populations has been reported in other studies.<sup>1,3,6</sup> Our finding that African American patients were more likely to have asthma-specific EHC utilization may, in part, be driven by higher disease severity in the African American population. Although we adjusted for several proxy measures of asthma severity, residual confounding due to unmeasured disease severity could contribute to the observed racial/ethnic differences in EHC utilization.

Lower asthma-specific quality-of-life scores among African Americans and Native Americans/Aleutians/Eskimos and higher EHC utilization among African Americans could be

## Racial/Ethnic Disparities in Emergency Care Utilization Among Adults With Asthma

**Table 2.** Bivariate Association of Race/Ethnicity With Outcome Measures

Race/Ethnicity	Mini Asthma Quality of Life Questionnaire Score in 2000, Mean (SD) <sup>a</sup>	In 2001, %		
		Use of ≥1 Canisters of Inhaled Corticosteroids	Medication Ratio of Inhaled Corticosteroids to β-Agonist Medications ≥0.5 <sup>b</sup>	Emergency Hospital Care Utilization <sup>c</sup>
White	5.0 (1.2)	81.9	65.3	7.4
African American	4.3 (1.4)	80.0	57.5	30.0
Hispanic	4.5 (1.5)	80.5	59.3	17.1
Asian/Pacific Islander	4.8 (1.4)	79.1	69.5	13.4
Native American/Aleutian/Eskimo	3.8 (1.3)	83.3	65.5	23.3
<i>P</i> <sup>d</sup>	<.001	.97	.43	<.001

<sup>a</sup>Scores range from 1 to 7, with higher scores indicating better quality of life.  
<sup>b</sup>Sum of inhaled corticosteroid canisters plus short-acting β-agonist canisters.  
<sup>c</sup>At least 1 asthma-specific emergency department visit or asthma-related hospitalization.  
<sup>d</sup>Analysis of variance for Mini Asthma Quality of Life Questionnaire Score;  $\chi^2$  test for other comparisons.

**Table 3.** Linear Regression Models for Association of Race/Ethnicity With Mini Asthma Quality of Life Questionnaire Score After Sequentially Adjusting for Demographics, Socioeconomic Status, Smoking Status, Asthma Severity, and Asthma Treatment in 2000

Characteristic	Standardized $\beta$ Coefficient <sup>a</sup>				
	Model 1 (n = 974)	Model 2 (n = 938)	Model 3 (n = 782)	Model 4 (n = 782)	Model 5 (n = 782)
<b>Race/ethnicity vs white</b>					
African American	<b>-0.15</b>	<b>-0.13</b>	<b>-0.13</b>	<b>-0.12</b>	<b>-0.12</b>
Hispanic	<b>-0.10</b>	<b>-0.09</b>	-0.04	-0.05	-0.05
Asian/Pacific Islander	-0.03	-0.03	-0.008	0.002	0.002
Native American/Aleutian/Eskimo	<b>-0.15</b>	<b>-0.16</b>	<b>-0.14</b>	<b>-0.14</b>	<b>-0.14</b>
<b>Age<sup>b</sup></b>		<b>0.10</b>	0.03	0.005	0.004
<b>Female sex</b>		<b>-0.07</b>	-0.06	-0.06	-0.06
<b>Education<sup>c</sup></b>			<b>0.12</b>	<b>0.11</b>	<b>0.11</b>
<b>Annual household income<sup>d</sup></b>			<b>0.16</b>	<b>0.16</b>	<b>0.16</b>
<b>Current smoking</b>			-0.04	-0.03	-0.02
<b>Asthma severity</b>					
Emergency hospital care utilization				<b>-0.15</b>	<b>-0.15</b>
Overuse of ≥14 canisters of β-agonists				<b>-0.12</b>	<b>-0.12</b>
≥1 Dispensings of oral corticosteroids				<b>-0.11</b>	<b>-0.11</b>
<b>Use of ≥1 canisters of inhaled corticosteroids</b>					0.03
<b>Adjusted R<sup>2</sup></b>	0.044	0.053	0.100	0.151	0.150

<sup>a</sup>*P* < .05 for boldfaced data.  
<sup>b</sup>Per 1-year increase.  
<sup>c</sup>Per 1-unit increase on a scale of 1 to 6 (see Table 1).  
<sup>d</sup>Per 1-unit increase on a scale of 1 to 7 (see Table 1).

driven by differential response to asthma medications. However, no information was available in this study to evaluate patient response to medications. Future studies are needed to better understand whether minority populations respond differently than white populations to asthma medications, and if

so, why. The need for this research is highlighted by the fact that obese patients may be less responsive to asthma medications<sup>23</sup> and that obesity rates may vary by race/ethnicity.

Uncollected survey data related to several factors may have explained differences in asthma-related outcomes among Af-

**Table 4.** Logistic Regression Models for Association of Race/Ethnicity With Emergency Hospital Care Utilization in 2001 After Sequentially Adjusting for Demographics, Socioeconomic Status, Smoking Status, Asthma Severity, and Asthma Treatment in 2000

Characteristic	Odds Ratio (95% Confidence Interval) <sup>a</sup>				
	Model 1 (n = 974)	Model 2 (n = 938)	Model 3 (n = 782)	Model 4 (n = 782)	Model 5 (n = 782)
<b>Race/ethnicity vs white</b>					
African American	<b>5.3 (3.2-9.0)</b>	<b>4.7 (2.7-8.4)</b>	<b>4.7 (2.5-8.8)</b>	<b>5.0 (2.5-9.9)</b>	<b>5.2 (2.6-10.3)</b>
Hispanic	<b>2.7 (1.4-4.9)</b>	<b>2.7 (1.1-4.4)</b>	1.2 (0.50-3.1)	1.3 (0.49-3.6)	1.3 (0.49-3.6)
Asian/Pacific Islander	1.9 (0.88-4.0)	1.8 (0.79-4.0)	2.0 (0.85-4.8)	1.8 (0.71-4.6)	1.8 (0.72-4.6)
Native American/Aleutian/Eskimo	<b>3.7 (1.5-8.9)</b>	<b>4.1 (1.6-10.1)</b>	2.9 (1.0-8.2)	3.0 (0.97-9.5)	3.1 (0.99-9.8)
<b>Age<sup>b</sup></b>		<b>0.96 (0.94-0.98)</b>	0.98 (0.96-1.0)	0.99 (0.96-1.0)	0.99 (0.97-1.0)
<b>Female sex</b>		<b>2.2 (1.3-3.8)</b>	1.8 (0.99-3.1)	1.7 (0.95-3.2)	1.8 (0.98-3.3)
<b>Education<sup>c</sup></b>			<b>0.77 (0.61-0.97)</b>	0.78 (0.61-1.0)	0.80 (0.62-1.0)
<b>Annual household income<sup>d</sup></b>			0.99 (0.85-1.2)	1.0 (0.85-1.2)	1.0 (0.85-1.2)
<b>Current smoking</b>			0.99 (0.46-2.1)	0.71 (0.30-1.6)	0.69 (0.30-1.6)
<b>Asthma severity</b>					
Emergency hospital care utilization				<b>5.3 (2.9-9.7)</b>	<b>5.2 (2.9-9.6)</b>
Overuse of ≥14 canisters of β-agonists				<b>3.1 (1.7-5.6)</b>	<b>3.1 (1.7-5.6)</b>
≥1 Dispensings of oral corticosteroids				<b>2.1 (1.2-3.8)</b>	<b>2.2 (1.2-4.0)</b>
<b>Use of ≥1 canisters of inhaled corticosteroids</b>					0.64 (0.33-1.2)
<b>C statistic<sup>e</sup></b>	0.65	0.71	0.70	0.79	0.78

<sup>a</sup>P < .05 for boldfaced data.

<sup>b</sup>Per 1-year increase.

<sup>c</sup>Per 1-unit increase on a scale of 1 to 6 (see Table 1).

<sup>d</sup>Per 1-unit increase on a scale of 1 to 7 (see Table 1).

<sup>e</sup>Area under the receiver operating characteristic curve.

rican Americans and Native Americans/Aleutians/Eskimos with persistent asthma. Such factors as medication adherence, efficacy in self-management behaviors, and patient activation (ie, skills and abilities of an individual to manage health and engage providers in shared decision making) may explain differences in asthma-related outcomes. A 2007 study<sup>24</sup> conducted by Kaiser Permanente's Care Management Institute found that higher levels of self-efficacy and patient activation were associated with improved outcomes among adults with chronic conditions. It is possible that minority patients having persistent asthma differed in self-efficacy and patient activation<sup>25</sup> compared with white patients having persistent asthma, possibly explaining some of the differences seen in our study outcomes.

Moreover, we had no information regarding specific environmental characteristics that may have contributed to overall disparities in health outcomes. For example, African Americans may have had higher EHC utilization because

they were more likely to reside in neighborhoods with greater air pollution, which can exacerbate asthma. Such information might have explained disparate outcomes found in our study but were unavailable for analysis.

This study has several potential limitations. First, treatment factors other than controller medications may have explained racial/ethnic disparities in study outcomes. Specifically, Schatz and colleagues<sup>26</sup> found that 3 treatment factors (regular use of controller medication, regular use of long-acting β-agonist medications, and provision of care by an asthma specialist) were associated with better asthma outcome control. However, when we included these additional treatment characteristics in multivariate models (data not shown), the overall study findings remained the same, suggesting that particular differences in these treatment measures do not explain the racial/ethnic disparities in asthma-related outcomes reported herein. Nevertheless, it is possible other unmeasured factors may explain the observed

disparities. Second, limited measures of asthma control were available for analysis. Forced expiratory volume in the first second of expiration is an important measure of asthma control<sup>27</sup> that is also related to quality of life.<sup>28</sup> The lack of spirometry data in this study is mitigated by the fact that MiniAQLQ scores do not require spirometry testing. Third, no information was available regarding environmental factors such as air pollution and other adverse exposures that may affect asthma control. Fourth, we also had no information regarding comorbid conditions (eg, gastroesophageal reflux disease and obesity) that may have contributed to differences in study outcomes by race/ethnicity. Fifth, information was unavailable regarding nonrespondents. Sixth, this study was set in a large group-model integrated healthcare delivery system. It is possible that results are not generalizable to adults with asthma in other healthcare delivery systems. However, the Kaiser Permanente population has been shown to be representative of the demographics within regions it serves,<sup>29</sup> which may increase the generalizability of our findings. Moreover, Kaiser Permanente is a particularly valuable setting to study racial/ethnic disparities in asthma outcome measures because SES is more homogeneous compared with public delivery systems, in which racial/ethnic differences in outcome measures may be confounded by larger SES differences.

Notwithstanding these limitations, our results have important implications for policy and practice. More research is needed to understand specific factors such as environmental or behavioral factors that explain the race/ethnicity-based differences in study outcomes found herein. Once these factors are better identified, targeted interventions can be developed to reduce disparities in these important asthma outcome measures.

**Author Affiliations:** From the Center for Health Research (DMM, RG, RAM), Kaiser Permanente Northwest, Portland, OR; the Department of Allergy (MS), Kaiser Permanente Southern California, San Diego, CA; Care Management Institute (WFW, JB), Kaiser Permanente, Oakland, CA.

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**Address correspondence to:** David M. Mosen, PhD, MPH, Center for Health Research, Kaiser Permanente Northwest, 3800 N Interstate Ave, Portland, OR 97227-1110. E-mail: david.m.mosen@kpchr.org.

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