

Predictors of asthma-related health care utilization and quality of life among inner-city patients with asthma

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Background: Asthma morbidity and mortality are highest among minority inner-city populations.

Objective: To identify factors associated with acute health care resource utilization and asthma-related quality of life among high-risk, minority patients with asthma.

Methods: We interviewed a prospective cohort of 198 adults hospitalized for asthma in an inner city hospital over a period of 1 year. Detailed information about sociodemographics, asthma history, access to care, asthma medications, and self-reported allergy to aeroallergens was collected at baseline. Data on resource utilization (emergency department visits and hospital admissions for asthma) and asthma-related quality of life were obtained at 6 months after discharge. Multivariate analyses were used to identify predictors of resource utilization and quality of life.

Results: The mean age of patients was 49.9 ± 17.4 years, 78% were women, and 97% were nonwhite. At 6 months, 49% of patients had an emergency department visit or hospitalization. In multivariate analysis, adjusting for age, sex, medication regimen, and asthma severity, patients with a physician in charge of their asthma care had lower odds of resource utilization (odds ratio, 0.4; $P = .03$). Conversely, a self-reported history of cockroach allergy was associated with greater utilization (odds ratio, 2.3; $P = .05$). Asthma-related quality of life was worse among patients who spoke mostly Spanish or who reported allergy to cockroaches ($P < .004$).

Conclusion: Lack of an established asthma care provider, language barriers, and self-reported allergy to cockroaches are associated with higher resource utilization and worse quality

of life among minority, inner-city patients with asthma. Interventions targeting these factors may lead to better outcomes among these patients. (*J Allergy Clin Immunol* 2005;116:636-42.)

Key words: Asthma, hospitalization, quality of life, predictors, allergic sensitization

Asthma is a serious chronic condition that currently affects approximately 15 to 17 million persons in the United States at a cost of 12.7 billion per year.^{1,2} Minority, inner-city populations have disproportionately higher rates of asthma incidence, morbidity, and mortality.^{1,3,4} This problem is particularly serious in East Harlem, a community with one of highest hospitalization rates in the nation and with an asthma mortality rate that is nearly 10 times higher than the national average.^{5,6} Reducing the use of health services for asthma among these patients is a key focus of numerous payer, provider, and public health initiatives.

Several studies have identified risk factors for asthma hospitalization or ED visits.^{5,7-24} Many demographic, clinical, utilization, medication, and social/environmental factors have been associated with an increased risk of acute asthma-related resource utilization. Among the most consistent risk factors reported were sex, lower socioeconomic status, more clinically severe asthma (including previous utilization), and increased use of rescue medications. Most of these studies, however, were retrospective or cross-sectional in nature and were not focused on inner-city Hispanics, a group at high risk of poor outcomes. Although disease severity and socioeconomic factors are well known contributors to asthma morbidity, the influence of access to care, language barriers, and allergic sensitization has been less well studied.

An additional important clinical outcome to patients with asthma is health-related quality of life, which considers the effect of health on physical and social function and overall well-being. Some studies have assessed predictors of asthma quality of life among patients with asthma.^{14,25,26} Age, sex, depression, and self-efficacy have been identified as independent factors associated with asthma quality of life.^{25,26} These studies, however, have primarily focused on ambulatory populations. There is scant information about factors associated with asthma-related quality of life among patients with more severe

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Abbreviations used

AQLQ: Asthma Quality of Life Questionnaire
ED: Emergency department
OR: Odds ratio

asthma, especially among inner-city Hispanics and African Americans.

The purpose of this study was to identify patient and system factors associated with asthma-related acute health care resource utilization and quality of life among high-risk inner-city minority individuals. We specifically focused on potentially modifiable factors that can be the target of interventions to improve the outcomes of these individuals.

METHODS

Study participants

We prospectively identified an inception cohort of all adults hospitalized for asthma at Mount Sinai Hospital, a 1100-bed academic health center in New York City during a consecutive 12-month period (September 2001 through September 2002).²⁷ Mount Sinai is the largest hospital serving the East Harlem population. We screened computerized admission logs to identify all adults with a primary or secondary admission diagnosis of asthma (493, 493.X, and 493.XX). Mount Sinai's Institutional Review Board approved the study, and all patients signed informed consent before participation.

Inclusion and exclusion criteria

Eligible patients (1) were age ≥ 18 years, (2) spoke English or Spanish, (3) were competent to give informed consent, and (4) had asthma as the primary reason for admission (confirmed by chart review). Exclusions were (1) primary chronic obstructive pulmonary disease, other lung disease, or home oxygen therapy; and (2) patients admitted and discharged on the same weekend when study personnel were not available.

Data collection and measurements

Trained research staff conducted an interviewer-administered survey in English or Spanish during the index admission and 1 and 6 months after discharge. During the baseline interview, patients were asked a series of demographic questions including sex, age, race/ethnicity, educational level, employment status, primary language, insurance, and household income. Comorbid conditions were reported by patients as present or absent, including chronic sinusitis, gastroesophageal reflux disease, congestive heart failure, chronic bronchitis, diabetes, depression, and anxiety or panic attacks.

Access to care was evaluated by questions about trouble reaching a physician or nurse by telephone, getting an urgent appointment, or getting medication for asthma. In addition, patients were asked if they had a physician primarily responsible for managing their asthma and to report the physician's specialty.

We used several indicators to assess asthma severity including chronic use of systemic corticosteroids, frequency of ED visits or hospitalizations during the 12 months before the index admission, and history of endotracheal intubation. We also collected information regarding the patient's asthma regimen, the quality of asthma care, self-reported adherence, and self-management behaviors. Quality of asthma care was assessed by comparison with the processes of care

outlined by the national asthma guidelines, including metered dose inhaler instruction, prescription of spacers, peak flow meter monitoring, and action plans.²⁸ Self-management behaviors of interest included patient's use of spacers, peak flow meters, regular physician visits in the absence of symptoms, and adjustment of controller medications, among others. Patients treated with inhaled corticosteroids and/or leukotriene inhibitors were classified as receiving asthma controller medications.

We collected data regarding previous history of physician evaluation for allergic sensitization and the type of testing used (skin prick testing vs blood testing). In addition, patients were asked if they were ever diagnosed by a physician as being allergic to cockroaches, cats, dogs, birds, feathers, pollen, trees, grasses, dusts mites, or molds.

Outcome data was collected during the 6-month telephone follow-up interview. Acute asthma-related health care resource utilization was defined as ≥ 1 hospitalization or visit to the ED for asthma symptoms. We used the Mini Asthma Quality of Life Questionnaire (AQLQ), developed by Juniper et al,²⁹ to assess the effect of asthma on the patient's quality of life. This instrument contains 15 questions divided into 4 domains: activity limitations, symptoms, emotional function, and environmental stimuli. Scores for each domain, as well as a total composite score, can range from 1 to 7, with higher scores indicating better quality of life. The instrument has shown good responsiveness, reliability, and construct and criterion validity and is the most widely used asthma quality of life instrument.^{25,30,31}

Statistical analysis

Means \pm SDs are presented for normal data. We used χ^2 , Wilcoxon rank-sum, and pooled *t* test and ANOVA (as appropriate) to examine the association between acute asthma-related resource utilization or AQLQ scores and the presence of risk factors. Pearson product-moment correlation coefficients were calculated between pairs of continuous variables.

To identify factors independently associated with acute resource utilization (≥ 1 hospital admission and/or ED visit), a multiple logistic regression model was developed adjusting for age, sex, severity of chronic asthma, and medication regimen. Variables associated with acute resource utilization on the univariate analysis were grouped into domains (sociodemographic variables, comorbidities, asthma drug regimen, medication adherence, self-management, asthma history, asthma severity, psychosocial, access to care, quality of care, and allergic sensitization) and assessed for collinearity. The best candidate factors for each domain were carried forward into the multivariate models. The criteria used to select these variables was based on the distribution of patients' responses, previous knowledge of the importance of the variable as a predictor of asthma morbidity, and the results of the correlation and the univariate analysis (variables with *P* value $< .2$ were carried into the multivariate models). Multivariate models were built manually by using a forward strategy. The decision to remove variables from the models was determined on the basis of the result of the likelihood ratio test (criterion 0.05). All models were fitted adjusting for age, sex, asthma severity, and use of controller medication. The final model was evaluated by using the Hosmer-Lemeshow test and the *c*-statistic. Alternative multivariate models that adjusting for other severity measures (age of asthma diagnosis, frequency of oral steroid use, previous hospitalization/ED visits) produced similar results. Odds ratios (ORs) are presented with 95% CIs.

We used multiple linear regression to assess the association between risk factors and asthma-related quality of life. Variable testing and model fitting was performed as described above. All analyses used 2-tailed significance levels of *P* $< .05$ and were conducted with SAS statistical software 9.0 (SAS Institute, Cary, NC).

TABLE I. Demographic and clinical characteristics of study patients

Characteristic	Value
Age in years (mean \pm SD)	49.9 \pm 17.4
Female (%)	78
Ethnicity (%)	
Hispanic	62
Black	28
White, non-Hispanic	3
Other	6
Insurance status (%)	
Medicaid	53
Medicare	22
Commercial	16
Uninsured	8
Native language (%)	
English	61
Spanish	39
Income < \$15,000 per year (%)	64
Education < high school (%)	40
Asthma history	
Age of asthma onset \leq 20 (%)	64
Previous intubation (%)	23
Previous oral steroid use (%)	88
Oral steroids (all/most of time past year) (%)	31
ED visits past 12 months (mean \pm SD)	3.7 \pm 6.1
Hospitalizations past 12 months (mean \pm SD)	1.5 \pm 2.9
Comorbid conditions (%)	
Allergic rhinitis	57
Diabetes mellitus	28
Gastroesophageal reflux disease	24
Depression	36
Anxiety/panic disorders	32
Current smoker (%)	24
Current problem drinking (alcohol) (%)	12
Inhaled drug use past 12 months (%)	11

RESULTS

Of the 384 hospitalizations with a primary or secondary diagnosis of asthma, 335 were confirmed primary asthma admissions among 250 unique patients. Of these, 218 patients met eligibility criteria, and 204 (94%) consented to participate. Reasons for exclusion were readmissions among study participants ($n = 85$), active psychiatric problems ($n = 9$), and admitted/discharged on the same weekend ($n = 23$). Of the 204 who consented, 198 (97%) patients completed the baseline interview, 177 (87%) the 1-month survey, and 170 (84%) the 6-month survey. Interviews were conducted in Spanish for 28% of patients.

Demographic and asthma characteristics for enrolled patients are listed in Table I. The mean age of patients was 49.9 ± 17.4 years, 78% were women, and 97% were nonwhite. At 6 months, 49% of patients had a ED visit or hospitalization. Consistent with the epidemiology of inner-city asthma, this was largely a group of low-income Hispanic and African American patients with high rates of previous intubation, oral steroid use, and asthma-related ED visits and hospitalizations. The methods of allergic

TABLE II. Univariate predictors of acute asthma-related resource utilization

Variable	No hospitalization or ED visit	Hospitalization or ED visit	P value
Demographic			
Age in years (mean \pm SD)	52 \pm 18	51 \pm 14	.87
Gender (%)			
Female	55	45	.05
Male	37	63	
Race/ethnicity (%)			
Hispanic	51	49	.29
African American	43	57	
White	77	23	
Other	54	46	
Speaks mostly Spanish			
Yes	46	54	.51
No	52	48	
Asthma history—severity			
Previous intubation (%)			
Yes	34	66	.002
No	55	45	
Chronic oral steroids (%)			
Yes	39	61	.002
No	73	27	
Childhood asthma (%)			
Yes	48	52	.46
No	54	46	
Comorbid conditions			
Gastroesophageal reflux disease			
Yes	51	49	.99
No	51	49	
Congestive heart failure			
Yes	34	66	.15
No	53	47	
Depression			
Yes	45	55	.23
No	55	45	
Asthma controller (%)			
Yes	50	50	.65
No	55	45	
Access to care			
Regular asthma provider (%)			
Yes	54	46	.08
No	40	60	
Able to obtain urgent office visit during flare-up (%)			
Very hard/somewhat hard	48	52	.57
Very easy/somewhat easy	52	48	
Allergy to cockroaches (%)			
Yes	43	57	.15
No	55	45	

sensitization evaluation reported by participants were skin prick testing (85%) and blood testing (15%).

Univariate predictors of acute asthma-related health care resource utilization

Overall, women were less likely to have a ED visit or hospitalization (45% vs 63%; $P = .05$; Table II). Age,

race, ethnicity, and primary language were not associated with increased resource utilization. Several measures of asthma severity (such as previous intubation, chronic oral steroid use, number of ED visits or hospitalization during the previous year) were significantly associated with increase resource utilization.

Acute resource utilization was somewhat less frequent among patients who reported having a primary physician in charge of their asthma management; however, the difference did not reach statistical significance ($P = .08$). Difficulty reaching a physician by telephone and difficulty getting an urgent appointment to see a physician during a flare-up were not associated with increased ED visits or hospitalizations. Patients followed by an asthma specialist (pulmonologist or allergist) were more likely to present to the ED or have been hospitalized for asthma during the 6-month follow-up period ($P = .002$). Presence of comorbid illnesses (diabetes, gastroesophageal reflux, congestive heart failure, depression, and anxiety) was not related to the use of health care services. There was a trend for increased resource utilization among patients who reported allergy to cockroaches ($P = .15$). Sensitization to other aeroallergens (cats, dogs, birds, feathers, pollen, trees, grasses, dusts mites, or molds) was not associated with acute resource utilization.

Univariate predictors of asthma-related quality of life

The univariate relationships between patient characteristics and AQLQ scores are shown in Table III. AQLQ scores were not significantly different in men compared with women ($P = .22$). Older patients ($r = 0.2$; $P = .01$) and African American and Hispanic patients had worse AQLQ scores ($P = .02$). Patients who spoke mostly Spanish had worse AQLQ scores than patients who reported being fluent in English ($P = .0001$). History of gastroesophageal reflux and depression was associated with worse AQLQ scores. Patients on chronic oral steroids or who had a physician diagnosis of allergy to cockroaches or dogs also had worse AQLQ scores. Access to care, measured both as the ability to obtain urgent office visit and the patient having a primary asthma care provider, was not significantly associated with AQLQ scores.

Multivariate predictors of acute asthma-related health care resource utilization

In multivariate analysis, we found that having a physician in charge of the patient's asthma care greatly reduced the odds of acute resource utilization (OR, 0.4; $P = .03$), and self-reported allergy to cockroaches doubled the odds of hospitalization or ED visits (OR, 2.3; $P = .05$) even after adjusting for age, sex, asthma severity, and asthma regimen (Table IV). Female sex (OR, 0.3; $P = .03$) and chronic use of steroids (OR, 5.2; $P = .002$) were also related to the risk of hospitalization or ED visits.

TABLE III. Univariate predictors of AQLQ scores

Variable	Mini-AQLQ score (mean ± SD)	P value
Demographic		
Sex		
Female	4.2 ± 1.4	.22
Male	4.5 ± 1.6	
Race/ethnicity		
Hispanic	4.0 ± 1.5	.02
African American	4.6 ± 1.4	
White	5.0 ± 1.7	
Other	4.7 ± 1.2	
Speaks mostly Spanish		
Yes	3.9 ± 1.4	.0001
No	4.5 ± 1.4	
Asthma history—severity		
Previous intubation		
Yes	4.3 ± 1.4	.98
No	4.3 ± 1.5	
Chronic oral steroids		
Yes	4.0 ± 1.5	.01
No	4.8 ± 1.2	
Childhood asthma		
Yes	4.2 ± 1.3	.43
No	4.3 ± 1.2	
Comorbid conditions		
Gastroesophageal reflux disease		
Yes	3.8 ± 1.2	.03
No	4.4 ± 1.5	
Congestive heart failure		
Yes	3.9 ± 1.7	.34
No	4.3 ± 1.4	
Depression		
Yes	3.7 ± 1.4	.0001
No	4.6 ± 1.4	
Asthma controller		
Yes	4.2 ± 1.5	.55
No	4.4 ± 1.4	
Access to care		
Regular asthma provider		
Yes	4.3 ± 1.3	.82
No	4.3 ± 1.3	
Able to obtain urgent office visit during flare-up		
Very hard/somewhat hard	4.3 ± 1.4	.79
Very easy/somewhat easy	4.3 ± 1.2	
Allergy to cockroaches		
Yes	3.8 ± 1.4	.003
No	4.5 ± 1.4	

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Multivariate predictors of asthma-related quality of life

Table IV shows the results of the multiple regression analysis to identify independent predictors of AQLQ scores. These analyses showed that speaking mostly Spanish ($P = .004$) and self-reported allergy to cockroaches ($P = .0005$) were significantly associated with worse AQLQ scores after controlling for age, sex, asthma severity, and asthma regimen. Chronic use of systemic steroids was also associated to worse AQLQ scores

TABLE IV. Multivariate predictors of acute asthma-related resource utilization and asthma quality of life

Variable	Acute asthma-related resource utilization†			Asthma quality of life		
	OR	SE	P value	β-Coefficient	SE	P value
Age‡	1.05	0.02	.74	−0.2	0.009	.06
Female	0.3*	0.54*	.03*	−0.23	0.29	.43
Speaks mostly Spanish	1.0	0.50	.96	−0.86*	0.29*	.004*
Chronic oral steroids	5.2*	0.54*	.002*	−0.64*	0.30*	.03*
Childhood asthma	1.2	0.45	.72	−0.06	0.27	.83
Given an asthma controller medication	1.5	0.68	.57	−0.73	0.39	.07
Has a regular asthma provider	0.4*	0.45*	.03*	0.15	0.25	.56
Allergic to cockroaches	2.3*	0.42*	.05*	−0.86*	0.24*	.0005*

*Significant at the $p < 0.05$ level.

†C-statistic, 0.745.

‡OR and β-coefficient for 10-year increase in age.

($P = .03$), possibly reflecting the use of these medications for the treatment of the sicker patients.

DISCUSSION

Asthma-related morbidity and mortality have risen sharply in the United States since the late 1970s, particularly in urban areas with predominantly minority populations. In this study of a consecutive cohort of high-risk inner-city adults hospitalized for asthma, we found that lack of a regular asthma care provider and history of allergy to cockroaches were risk factors for ED visits and hospitalizations even after adjusting for disease severity and medication regimen. Language barriers and allergy to cockroaches were independent predictors of asthma-related quality of life. Our findings are particularly relevant because these are potentially modifiable risk factors that could be targeted in future interventions designed to improve the outcomes of these high-risk patients.

Of the variables assessed in this study, self-reported allergy to cockroaches was a strong predictor of ED visits, hospitalizations, and asthma related-quality of life. Sensitization to cockroach allergens has been identified as an important determinant of asthma-related health problems in inner-city children.³² The National Cooperative Inner City Asthma Study demonstrated that children who were both allergic to cockroach allergen and exposed to high levels of this allergen in their homes had higher rates of hospitalization, unscheduled visits for asthma, and worse asthma control.³² An intervention to reduce the levels of indoor exposure of inner-city children to cockroach allergen resulted in reduced asthma-associated morbidity.³³

Epidemiologic evidence for the role of cockroach allergen exposure as a cause of morbidity among adults with asthma is sparse. Lewis et al³⁴ found that among 140 women with asthma, the 18 subjects sensitized and exposed to cockroach allergen had a significantly increased risk for use of oral steroids. Our findings are consistent with the results of Rogers et al,³⁵ who found an

association between cockroach sensitization and asthma severity among elderly urban patients. Because this is an observational cohort study, our data on allergy evaluation and allergic sensitization are based on patient self-report (not direct testing), so there is always potential for recall biases or inaccuracies.³⁶ Patients with worse asthma control may be more likely to report allergic sensitization if they are aware of a potential association between asthma and aeroallergens. However, the validity of self-report for most straightforward medical events and risk factors is well established,³⁷ and our approach was similar to that of other recent asthma and allergy epidemiologic studies.^{37,38} In addition, the patterns of allergen sensitization that we identified by self-report are largely similar to those found in other studies of inner-city patients with asthma that performed direct testing. Further research using objective measures of allergic sensitization and exposure is needed to assess the importance of cockroach sensitization as a cause of asthma morbidity among inner-city individuals and as a potential target for environmental interventions.

Several ecologic studies based on US census data have demonstrated a strong relationship between household income and asthma hospitalization rates.^{5,12,17,39,40} Our findings differ from those of previous studies that found female sex to be a risk factor for increased acute asthma-related resource utilization.^{8,11,41,42} Sex, however, has not consistently been related to hospitalization,^{7,14,22,43} and some studies found that males have greater health care use, particularly in the inner city.^{20,44,45} Race and ethnicity have been also associated with higher risk of acute health care resource utilization.⁴⁶ Other studies have shown that excessive use of β-agonist medication, therapeutic non-adherence, social disadvantage, poor quality of care, and psychological factors are other important risk factors for excess ED visits and hospital admissions.^{9-11,17,22,46,47} Because our cohort consisted mainly of low socioeconomic status minority patients, we were not able to assess differences in the risk of urgent visits according to income or race. Our results are consistent with previous studies that found asthma severity (measured in a variety of ways) was a predictor of acute resource utilization and quality of

life.^{7,9,18,20,21,48} Use of an asthma controller medication was not a significant factor associated with acute health utilization or quality of life. This may be a result of several factors, including confounding by severity (or indication), as well as potential overreporting of adherence. Similarly, we found that care by a subspecialist was associated with increased resource utilization on univariate analysis. This probably reflects the fact that sicker patients are more likely to be referred to specialists and probably is not related to differences in management.

Our finding highlights the significance of the patient-physician interaction as an important determinant of asthma outcomes. Haas et al⁴⁷ showed that patients with no regular source of care had significantly worse asthma control as measured by peak flow rate and dyspnea scores. Inner-city patients with an usual source of care were also more likely to receive inhaled corticosteroids, spacers, and peak flow meters.²⁷ This study extends this association by showing an increased risk of acute health care resource utilization among patients without a regular provider. One possible explanation for our findings is that having a regular provider may lead to better patient-physician communication, higher likelihood of appropriate anti-inflammatory therapy, and better self-management. An alternative explanation may be that more adherent patients are also more likely to establish a long-term relationship with their asthma care provider. In addition, these patients may have as poorly controlled asthma as those without a regular source of asthma care but use office visits with their established asthma doctor rather than the ED to treat acute exacerbations. Unfortunately, some reports suggest that minorities are less likely to have a regular source of care.^{47,49} Thus, addressing this problem may be an effective strategy to improve the outcome of minorities with asthma.

Even after controlling for severity, access, medication regimen, and allergic sensitization, patients who spoke mostly Spanish had worse AQLQ scores. All of these patients were interviewed in their native language, and the Spanish version of AQLQ has been shown to preserve its metric properties.⁵⁰ Language barriers have been suggested as an important obstacle to communication between providers and inner-city patients with asthma. Manson et al⁵¹ conducted a retrospective chart review of 96 patients followed at a clinic in New York City and found that language concordance tended to be associated with better medication adherence, improved office attendance, and decreased ED visits. Thus, these data suggest that language barriers may partially explain the higher rates of asthma morbidity among Hispanics.⁵ Efforts to reduce disparities in asthma care and outcomes will need to address more directly some of the language barrier difficulties that we presume impaired adequate doctor-patient communication.

Some limitations of this study are worth addressing. This was a modest-sized cohort of patients who were enrolled at a single institution. However, patients received their ambulatory care from a variety of hospital, community health center, and office-based outpatient sites, thus

improving the generalizability of our findings. Because patients had to be hospitalized to be eligible, our data overrepresent those with more severe asthma. We deliberately studied a population with more severe asthma because these patients have the highest utilization rates and the greatest need for interventions to improve their outcomes. Moreover, a recent survey found that 77% of all adults with asthma had symptoms consistent with moderate or severe disease.⁵² Substantial numbers of people with asthma therefore have levels of symptoms similar to those in this study. Data generated from this study can be used to target future interventions to the most relevant determinants of asthma morbidity among these high-risk individuals. All of our outcome measures were self-reported. Because patients may visit an ED or be admitted to different hospitals, patient reports were deemed the best source for these data. Patient reports of acute resource utilization are considered to be reliable²⁴ and have been used in several similar studies.^{13,18,19,26,46,53} Finally, our sample size was modest, so we had limited statistical power to detect weak associations or to test possible interactions between predictors. Because we tested several related variables in the model, we can not completely rule out the possibility of colinearity among predictors.

In conclusion, this longitudinal study demonstrated that in addition to asthma severity, lack of a regular asthma care provider, language barriers, and self-reported allergy to cockroaches are significant predictors of increased acute resource utilization and worse asthma quality of life among inner-city minority adults with asthma. These are potentially modifiable variables and may be promising targets for interventions for these high-risk individuals.

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