

Original Article

Race and Asthma Outcomes in Older Adults: Results from the National Asthma Survey

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What is already known about this topic? There are a significant number of older adults with asthma, and this number will continue to increase as the population ages.

What does this article add to our knowledge? In older adults with asthma, African American and Hispanic individuals are twice as likely to have an emergency room visit for asthma as compared with white individuals yet are less likely to report frequent daytime symptoms.

How does this study impact current management guidelines? This study identifies that the current guidelines are not successful in preventing asthma morbidity among older minority adults, and that the current tools to assess asthma symptoms in these adults may be inadequate.

BACKGROUND: The number of older adults with asthma continues to rise, yet the effects of race and ethnicity on asthma outcomes in this population are unknown.

OBJECTIVE: To characterize the effect of race and ethnicity on asthma outcomes in a large national sample of older adults and to identify factors that are associated with disparities found.

METHODS: Data from the 2015 Behavioral Risk Factor Surveillance Survey and Asthma Call-Back Survey were analyzed. Respondents were included if they had a current asthma diagnosis, were aged ≥ 55 , and self-identified as non-Hispanic white, African American, or Hispanic. Demographic variables, health care access, comorbidities, and asthma history were correlated with asthma outcomes (health care utilization and asthma control). Asthma outcome variables were further analyzed using multivariable logistic regression.

RESULTS: A total of 4700 individuals were included. Compared with non-Hispanic white respondents, African American and Hispanic respondents had lower incomes, greater impaired access to health care due to cost, and increased reliance on rescue medications. After controlling for factors including income, education, comorbidities, and health insurance, African American and Hispanic respondents were twice as likely to visit the emergency room (ER) for asthma ($P < .001$ for both) and 40%

less likely to report uncontrolled daytime symptoms ($P = .002$ and $.008$).

CONCLUSIONS: Racial differences in asthma outcomes persist despite controlling for multiple social determinants of health and access to health insurance through Medicare. Minority patients were more likely to visit the ER but less likely to report frequent daytime symptoms. These findings indicate that comprehensive strategies to address assessment, monitoring, and treatment are needed to decrease health disparities. © 2019 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;■:■-■)

Key words: Asthma; Older adults; Elderly; Race; Ethnicity; Health disparities; Emergency room; Asthma symptoms

For many years, racial and ethnic disparities in asthma prevalence, morbidity, and mortality have been documented. Asthma prevalence has been consistently higher among certain minority groups such as African Americans and Puerto Ricans.¹⁻⁴ Even accounting for the increased prevalence, minority populations have disproportionately higher rates of asthma exacerbations, missed days from school and work,^{1,5-7} emergency room (ER) visits, and hospitalizations.^{8,9} Asthma mortality rates in African American children and adults are nearly 8 and 3 times higher, respectively, than in non-Hispanic white individuals.¹⁰ The majority of literature on asthma health disparities has focused on children and adults under the age of 65. In fact, many asthma trials specifically exclude older adults.¹¹

It is becoming increasingly more important to understand how race and ethnicity affect asthma outcomes in older adults, as older adults with asthma make up a significant and growing population in the United States.¹² More than 1 million adults over age 65 carry a diagnosis of asthma.¹³ The number of older adults with asthma will continue to increase considerably in the near future as the population continues to age. In fact, it is estimated that 1 in 5 patients with asthma will be older than 65 years by 2050.^{14,15} Not only is asthma common in older adults, but older adults with asthma have been shown to have higher

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Abbreviations used

ACBS- Asthma Call-Back Survey
 BMI- Body mass index
 BRFFS- Behavioral Risk Factor Surveillance Survey
 COPD- Chronic obstructive pulmonary disease
 CAD- Coronary artery disease
 EPR 3- Expert Panel Report 3
 ER- Emergency room
 ICS- Inhaled corticosteroid

rates of ER visits, hospitalization, asthma-associated care costs, and mortality compared with younger individuals with asthma.^{14,16,17}

The purpose of this study was to characterize the effect of race and ethnicity on asthma outcomes in a large national sample of older adults, and to identify factors that are associated with these disparities.

METHODS

Data from the 2015 Behavioral Risk Factor Surveillance Survey (BRFSS) and Asthma Call-Back Survey (ACBS) were used for the analysis. The BRFSS is a random cross-sectional telephone surveillance survey conducted by state health departments in all 50 states, the District of Columbia, Guam, Puerto Rico, and the US Virgin Islands.¹⁸ The ACBS is an in-depth asthma survey conducted with BRFSS respondents who report a current or prior asthma diagnosis. The 2015 ACBS included 11,545 subjects from 28 states, including Puerto Rico.¹⁹ The survey asks questions to assess the individual's history of asthma, health care utilization, medications, asthma management plan, cost of asthma care, comorbid conditions, and complementary and alternative medicine use.

This study was restricted to those with current asthma aged ≥ 55 who self-identified as either non-Hispanic white, African American, or Hispanic. This age cutoff has been previously used in prior studies on older adults with asthma.^{17,20-24} An additional analysis was performed and restricted to those with current asthma aged ≥ 65 who self-identified as non-Hispanic white, African American, or Hispanic. Current asthma was defined as responding "yes" to the following 2 questions on the ACBS: "Did a physician ever tell you that you had asthma?" and "Do you still have asthma?" Of the total ACBS study population (11,545 subjects), these inclusion criteria resulted in 4700 subjects for the ≥ 55 analysis and 2743 subjects for the ≥ 65 analysis.

VARIABLES**Demographics**

Demographic variables included sex, age, body mass index (BMI), highest education level attained, annual household income, and smoking status. BMI was calculated from self-reported height and weight.

Asthma health care access

Asthma health care access variables included impaired access to health care due to cost and gap in health insurance coverage. Impaired access to health care due to cost was defined as responding "yes" to any of the following questions: "Was there a time in the past 12 months when you needed to see your PCP for asthma but could not because of cost?" "Was there a time in the last 12 months when you were referred to a specialist for

asthma care but could not go because of cost?" or "Was there a time in the past 12 months when you needed to buy medication for asthma but could not because of cost?" Gap in health insurance coverage was defined as responding "yes" to "During the past 12 months, was there any time that you did not have any health insurance or coverage?"

Comorbidities

The following comorbidities were included: depression, diabetes, chronic obstructive pulmonary disease (COPD), and coronary artery disease (CAD). Each of these variables was defined as responding "yes" to "Have you ever been told by a doctor or other health professional that you were 'depressed/have diabetes/have chronic obstructive pulmonary disease or emphysema or chronic bronchitis/have angina or coronary heart disease?'" Those with past or current COPD were purposefully included in the study to capture respondents who have been misdiagnosed with COPD²⁵ and those with asthma-COPD overlap syndrome.^{26,27}

Asthma history

Asthma history variables included asthma medication use and time since asthma diagnosis. Asthma medication use served as a surrogate for asthma severity and was divided into no medication or rescue medication only inhaled corticosteroid (ICS) or other single agent controller medication, 2 controller medications, and greater than 2 controller medications. Respondents were presented with a list of asthma medications, and rescue medication use was determined by responding "yes" to "Have you taken X medication?" where "X" was a short-acting β -agonist or anticholinergic taken through an inhaler. Those using a pill steroid daily for at least the past 3 months were placed in the greater than 2 controller medications group. Time since asthma diagnosis was determined based on respondents indicating whether their asthma diagnosis had been made within the past 12 months, 1 to 5 years, or more than 5 years.

OUTCOMES

Asthma outcomes assessed included health care utilization (ER visit, hospital visit, routine checkup for asthma, and availability of an asthma action plan) and asthma control (daytime symptoms, nocturnal symptoms, and activity limitation).

Health care utilization

An ER visit in the past 12 months due to asthma was determined based on the response to the question "During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma?" A hospital visit in the past 12 months due to asthma was determined based on the response to the question "Have you had to stay overnight in a hospital because of your asthma? Do not include an overnight stay in the emergency room." A routine checkup for asthma in the past 12 months was determined based on the response to the question "During the past 12 months, how many times did you see a doctor or other health professional for a routine checkup for your asthma?" Asthma action plan received was determined based on the response to the question "Has a doctor or other health professional ever given you an asthma action plan?"

Asthma control

Daytime symptoms were determined based on the response to the question "During the past 30 days, on how many days did

TABLE I. The relationship of race and/or ethnicity with demographic characteristics among ≥ 55 year olds

	Non-Hispanic white (%) ^{*,†}	African American (%) ^{*,†}	Hispanic (%) ^{*,†}	P value [‡]
Sex				.004
Male	1154 (31.4)	58 (30.6)	94 (45.6)	
Female	2903 (68.6)	238 (69.4)	253 (54.4)	
Age				.02
55-64	1653 (47.0)	144 (63.1)	160 (50.3)	
65-74	1515 (33.1)	103 (20.3)	121 (33.6)	
75+	889 (19.9)	49 (16.6)	66 (16.1)	
BMI				<.001
12 to <18.5	54 (1.9)	2 (0.4)	3 (0.5)	
18.5 to <25	909 (21.4)	48 (19.7)	56 (12.2)	
25 to <30	1260 (34.3)	62 (22.1)	114 (40.9)	
30+	1629 (42.4)	172 (57.8)	161 (46.5)	
Education				<.001
Did not graduate high school	237 (9.0)	66 (31.7)	124 (44.3)	
Graduated high school	1062 (29.4)	90 (37.2)	80 (25.2)	
Attended college or technical school	1203 (35.4)	75 (16.3)	69 (18.1)	
Graduated from college or technical school	1550 (26.2)	64 (14.8)	63 (12.3)	
Annual household income				<.001
<\$15,000	457 (12.1)	90 (32.3)	136 (40.2)	
\$15,000-50,000	1567 (42.4)	138 (59.7)	127 (45.0)	
>\$50,000	1485 (45.6)	40 (7.9)	31 (14.8)	
Impaired access to health care due to cost				<.001
No	3501 (84.1)	225 (72.3)	249 (66.5)	
Yes	543 (15.9)	70 (27.7)	95 (33.5)	
Gap in health insurance coverage				<.001
No	3860 (97.4)	272 (95.3)	305 (92.3)	
Yes	90 (2.6)	12 (4.7)	22 (7.7)	
Smoking history				<.001
Current smoker	419 (10.8)	46 (23.4)	27 (18.1)	
Former smoker	1665 (42.7)	107 (38.2)	108 (35.2)	
Never smoked	1945 (46.5)	143 (38.4)	210 (46.8)	
Comorbidities				
Depression	1469 (34.9)	100 (39.2)	160 (44.6)	.001
Diabetes	898 (22.1)	131 (48.9)	153 (38.9)	<.001
Coronary artery disease	511 (13.3)	52 (24.5)	76 (28.7)	<.001
Chronic obstructive pulmonary disease	1507 (40.1)	127 (49.9)	122 (42.4)	.08
Asthma medication use				.007
No medication or rescue medication only	1884 (45.6)	160 (61.1)	188 (59.0)	
ICS or other single agent	278 (7.6)	16 (6.1)	30 (6.1)	
2 controller medications	759 (18.4)	47 (8.8)	50 (11.8)	
More than 2 controllers	1136 (28.4)	73 (24.0)	79 (23.2)	
Time since asthma diagnosis				.83
<12 mo	98 (2.9)	8 (3.1)	7 (2.5)	
12 mo to 5 y	350 (9.4)	31 (6.1)	30 (5.9)	
≥ 5 y	3592 (87.8)	257 (90.7)	309 (91.6)	

BMI, Body mass index; ICS, inhaled corticosteroid.

*Frequencies are unweighted and proportions are weighted. Missing responses are excluded.

†Proportions are based on the total within each subset variable.

‡P values based on the χ^2 test.

you have any symptoms of asthma?” Daytime symptoms were considered well controlled if the respondent reported asthma symptoms on 8 or less of the past 30 days. Daytime symptoms were considered uncontrolled if the respondent reported asthma symptoms on 9 or more of the past 30 days. The cutoff between well-controlled and uncontrolled symptoms is consistent with

the National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3) Guidelines.²⁸ Nocturnal symptoms were determined based on the response to the question “During the past 30 days, on how many days did symptoms of asthma make it difficult for you to stay asleep?” Nocturnal symptoms were considered well controlled if the respondent reported difficulty

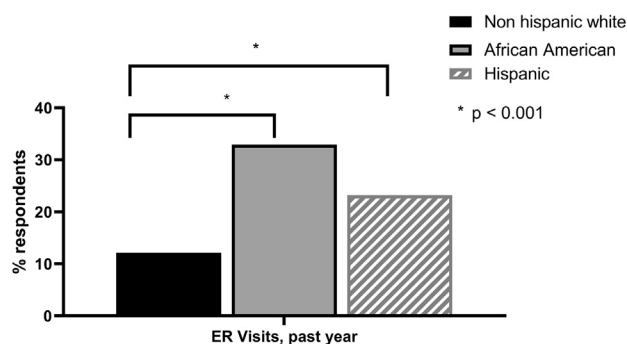


FIGURE 1. The relationship of race and/or ethnicity with ER visits among ≥ 55 year olds. ER, Emergency room.

sleeping due to asthma symptoms 2 or fewer times in 30 days and uncontrolled if the respondent reported difficulty sleeping due to asthma symptoms more than 2 times in 30 days. This is also consistent with EPR 3 Guidelines.²⁸ Activity limitation was determined based on the response to the question “During just the past 30 days, would you say you limited your usual activities due to asthma not at all, a little, a moderate amount, or a lot?” Those who responded “not at all” or “a little” were grouped together as “no” and those who responded “a moderate amount” or “a lot” were grouped together as “yes.”

Statistical analysis

Data were analyzed using SPSS statistics version 25 (IBM Corp., Armonk, NY). Univariable analysis between the demographic variables and asthma outcome variables and race and/or ethnicity was assessed using Pearson's χ^2 . Frequencies were unweighted, meaning they represent the actual responses of each respondent before any adjustments were made. Proportions were weighted, using iterative proportional fitting, meaning adjustments were made for loss of sample between the BRFSS interview and the ACBS interview, variation in respondents' probability of selection, and disproportionate selection of population subgroups relative to the state's population distribution or nonresponse.²⁹ To control for confounding demographic variables, we performed a series of multivariable logistic regressions to obtain odds ratios and 95% confidence intervals. See Tables E1 to E8 in this article's Online Repository at www.jaci-inpractice.org for the complete regression analyses. In each multivariable analysis, the dependent variable was one of the statistically significant ($P < .05$) asthma outcome measures found on univariate analysis. The main predictor was race and/or ethnicity, with non-Hispanic white as the reference. Covariates entered into the model included the demographic characteristics that differed significantly ($P < .05$) in the univariate analysis. Variance inflation factors were calculated for all regressions to check for collinearity, and only covariates with an acceptable level were entered into the model.^{30,31} Missing responses were not analyzed in the analysis.

RESULTS

Demographics

The study population was first limited to those with current asthma aged ≥ 55 who self-identified as non-Hispanic white, African American, or Hispanic and 4700 were included for

analysis. A total of 86.3% self-identified as non-Hispanic white, 6.3% as African American, and 7.4% as Hispanic. The mean age was 66.5 years (range, 55-99 years), with 67.3% females. The relationship of demographic characteristics and race and/or ethnicity is detailed in Table I. African Americans and Hispanics were younger and had higher BMIs compared with non-Hispanic whites. In addition, African Americans and Hispanics reported lower levels of educational attainment, with 69% of African Americans and 70% Hispanics either not graduating high school or graduating high school as their highest level of education versus 38% of non-Hispanic whites ($P < .001$). African Americans and Hispanics reported lower annual household incomes, with 32% of African Americans and 40% of Hispanics falling into the $< \$15,000$ income category compared with 12% of non-Hispanic whites ($P < .001$). There were a higher proportion of African Americans and Hispanics who were current smokers (23% and 18% vs 11%, $P < .001$) and a higher proportion of non-Hispanic whites who were former smokers (43% vs 38% of African Americans and 35% of Hispanics, $P < .001$). African Americans and Hispanics reported more physician-diagnosed depression (39% and 45% vs 35% for non-Hispanic whites, $P = .001$), diabetes (49% and 39% vs 22%, for non-Hispanic whites, $P < .001$), and CAD (25% and 29% vs 13% for non-Hispanic whites, $P < .001$). Of note, African Americans and Hispanics reported more COPD (50% and 42% vs 40% for non-Hispanic whites, $P = .08$), but the difference was not statistically significant.

Asthma health care access

Compared with non-Hispanic whites, African Americans and Hispanics reported higher proportions of impaired access to health care due to cost (28% and 34% vs 16%, $P < .001$) and gaps in health insurance coverage (5% and 8% vs 3%, $P < .001$).

Asthma history

A higher proportion of African Americans and Hispanics reported no asthma medication use or rescue medication use only compared with non-Hispanic whites (61% and 59% vs 46%, $P = .007$). Non-Hispanic whites reported slightly higher proportions of ICS or other single agent use (8% vs 6% and 6%, $P = .007$) and higher proportions of 2 controller medications (18% vs 9% and 12%, $P = .007$). Non-Hispanic whites reported higher use of more than 2 controllers compared with African Americans and Hispanics (28% vs 24% and 23%, respectively, $P = .007$). There was no significant relationship between race and/or ethnicity and time since asthma diagnosis.

Health care utilization

African Americans and Hispanics respondents reported more ER visits in the past 12 months due to asthma (32% and 23% vs 14%, $P < .001$) as shown in Figure 1 and Table II. After regression analysis (Table III), African Americans and Hispanics had 2.3- and 2.2-fold higher odds of having at least 1 ER visit in the past 12 months due to asthma ($P < .001$). Fewer African Americans and more Hispanics reported at least 1 overnight hospital stay due to asthma compared with non-Hispanic whites (4.9% and 13.7% compared with 6.1%, $P < .001$). However, the odds ratios for hospital visit did not differ significantly on regression analysis. There was no significant association between race and/or ethnicity and routine checkup for asthma or receiving an asthma action plan.

TABLE II. The relationship of race and/or ethnicity with asthma outcomes among ≥ 55 year olds

	Non-Hispanic white (%) ^{*,†}	African American (%) ^{*,†}	Hispanic (%) ^{*,†}	P value [‡]
ER visit				<.001
Yes	408 (13.7)	65 (31.7)	74 (23.2)	
No	2716 (86.3)	170 (68.3)	198 (76.8)	
Hospital visit				<.001
Yes	143 (6.1)	23 (4.9)	22 (13.7)	
No	2734 (93.9)	193 (95.1)	237 (86.3)	
Daytime symptoms				.001
≤ 8 d/mo	952 (33.7)	80 (34.7)	97 (44.9)	
> 8 d/mo	1776 (66.3)	99 (65.3)	119 (55.1)	
Nocturnal symptoms				.001
≤ 2 times/mo	254 (74.7)	14 (40.5)	23 (30.9)	
> 2 times/mo	78 (25.3)	11 (59.5)	20 (69.1)	
Asthma action plan received				.24
Yes	1132 (27.3)	95 (38.8)	92 (29.0)	
No	2854 (72.7)	195 (61.2)	247 (71.0)	
Routine checkup for asthma				.62
Yes	2475 (76.1)	181 (61.6)	222 (67.8)	
No	913 (23.9)	61 (38.4)	73 (32.2)	
Activity limitation due to asthma				<.001
Yes	838 (23.6)	81 (27.1)	122 (39.6)	
No	3188 (76.4)	210 (72.9)	225 (60.4)	

ER, Emergency room.

*Frequencies are unweighted and proportions are weighted. Missing responses are excluded.

†Proportions are based on the total within each subset variable.

‡P values based on the χ^2 test.

Asthma control

Asthma control outcomes are detailed in Table II. Non-Hispanic whites and African Americans reported higher proportions of uncontrolled daytime asthma symptoms compared with Hispanics (66% and 65% vs 55%, $P = .001$). However, after regression analysis (Table III), African Americans and Hispanics each had 0.6-fold lower odds of uncontrolled daytime symptoms ($P = .002$ and $P = .008$). African Americans and Hispanics reported higher proportions of uncontrolled nocturnal symptoms compared with non-Hispanic whites (60% and 69% vs 25%, $P = .001$). African Americans and Hispanics reported greater activity limitation due to asthma compared with non-Hispanic whites (27% and 40% vs 24%, $P < .001$). However, after controlling for confounding factors through regression analysis, there was no significant relationship between race and/or ethnicity and nocturnal symptoms or activity limitation due to asthma.

>65 year olds

When limiting the analysis to those with current asthma aged ≥ 65 who self-identified as non-Hispanic white, African American, or Hispanic, 2743 individuals were identified. Overall, the findings were similar to the findings described in ≥ 55 year olds. The relationship of asthma demographic characteristics and asthma outcomes with race and/or ethnicity in those aged ≥ 65 are detailed in Tables E9 to E11 and Figure E1 (available in this article's Online Repository at www.jaci-inpractice.org). A total of 87.6% self-identified as non-Hispanic white, 5.5% as African American, and 6.9% as Hispanic. The mean age was 73.1 years (range, 65-99 years) with similar distributions and associations

between race and/or ethnicity and sex, BMI, education, income, impaired access to health care due to cost, gap in health insurance coverage, smoking history, depression, diabetes, CAD, having at least 1 ER visit in the past 12 months due to asthma, daytime symptoms, and activity limitation due to asthma. No statistically significant associations were seen with age, COPD, asthma medication use, time since asthma diagnosis, hospital visit, nocturnal symptoms, receiving an asthma action plan, or routine checkup for asthma in the past 12 months. After regression analysis, African Americans had 2.0-fold higher odds of having an ER visit ($P = .01$). Hispanics had 1.3-fold higher odds of having an ER visit, but this was not significant. African Americans and Hispanics had 0.6- and 0.5-fold lower odds of having uncontrolled daytime symptoms ($P = .02$ and $P = .006$). African Americans and Hispanics also had 0.6-fold lower odds ($P = .03$ and $P = .01$) of having an activity limitation due to asthma.

DISCUSSION

The aim of this study was to identify racial differences and potential associated factors in asthma outcomes, among older adults using a large, nationally representative sample. To our knowledge, this is the first study to explore such differences. We found that social determinants of health accounted for many asthma outcomes; however, African American and Hispanic respondents were still twice as likely to visit the ER for asthma and 40% less likely to report frequent daytime symptoms even after controlling for factors such as education, income, impaired access to health care due to cost, and gaps in health insurance coverage. Our findings are consistent with studies in younger populations that have demonstrated an increased level of ER visits for asthma

TABLE III. Multivariable logistic regression of asthma outcomes associated with race and/or ethnicity among ≥ 55 year olds

	OR*	95% CI	P value
ER visit			
Non-Hispanic white	1.00	REF	REF
African American	2.34	1.65-3.33	<.001
Hispanic	2.17	1.51-3.10	<.001
Hospital visit			
Non-Hispanic white	1.00	REF	REF
African American	1.39	0.78-2.47	.26
Hispanic	1.41	0.80-2.46	.23
Uncontrolled daytime symptoms			
Non-Hispanic white	1.00	REF	REF
African American	0.59	0.42-0.83	.002
Hispanic	0.62	0.44-0.88	.008
Uncontrolled nocturnal symptoms			
Non-Hispanic white	1.00	REF	REF
African American	1.72	0.64-4.66	.29
Hispanic	2.09	0.84-5.20	.12
Activity limitation due to asthma			
Non-Hispanic white	1.00	REF	REF
African American	0.98	0.71-1.36	.92
Hispanic	1.14	0.84-1.55	.41

BMI, Body mass index; CI, confidence interval; ER, emergency room; OR, odds ratio.

*Covariates entered into the multivariable logistic regressions included race and/or ethnicity, sex, age, BMI, education, income, impaired access to health care due to cost, gap in health insurance coverage, smoking, depression, diabetes, coronary artery disease, and asthma medication use.

and decreased symptom reporting among minority individuals.^{8,9,32,33}

One explanation for these asthma health disparities is due to the findings that African American and Hispanic individuals are less likely to be on an ICS,³⁴ which increases the risk of emergency care.³⁵ Studies on African American and Hispanic children have shown that they were less likely to receive an ICS prescription compared with white children,³⁶ are under-filling ICS prescriptions when they do get written,³⁴ and are not taking prescribed ICS.³⁷ In our study, a significantly greater percent of minority older adults were using no medication or a rescue medication alone to control asthma.

However, even after controlling for medication use, African Americans and Hispanic respondents were still more likely to visit the ER for asthma. This indicates that factors other than medication use are contributing to higher ER visits in African American and Hispanic respondents. One contributing factor suggested by this study is decreased access to care due to cost in African American and Hispanics respondents, who were nearly twice as likely to note such a finding. In addition, those who reported decreased access to care due to cost were 2.4 times more likely to have to go to the ER than those who did not (Table E1, available in this article's Online Repository at www.jaci-inpractice.org).

Some may assume that decreased access to care due to cost would not be an issue in this population as individuals over 65 have access to health care through Medicare. In our study, gaps in insurance coverage for individuals over 65, regardless of race, were much smaller when compared with individuals over 55—in

fact, the mean percent of those with a gap in health insurance coverage for respondents age ≥ 65 across racial and/or ethnic groups was 2.4%. However, even after controlling for health insurance and impaired access to cost, African Americans and Hispanics still had increased asthma morbidity. These findings suggest that health disparities are due to multiple factors, with insurance attainment being only one.

Although screening, disease management, and clinical care play an integral role in health outcomes, multiple studies have found that social and economic factors contribute to health outcomes almost twice as much as clinical care.³⁸⁻⁴² For example, structural inequities in social support networks,⁴³⁻⁴⁵ culturally and linguistically appropriate care,^{8,9,38,46-51} patient attitudes and beliefs,^{8,38,45,52-60} racism and discrimination,^{38,61-64} and implicit bias^{38,65,66} could be playing a role. These factors deserve further exploration in the older adult population.

We also found that after controlling for many confounding factors, African American and Hispanic respondents were significantly less likely to report uncontrolled daytime asthma symptoms during the past 30 days. Previous studies have also shown racial differences in reporting and perception of asthma symptoms. For instance, in one study, African Americans reported less nighttime awakening and dyspnea.³³ Another study found that African Americans did not use typical symptoms of asthma such as "cough," "phlegm," and "wheezing" to describe their symptoms.³² An additional study found that minority children were more likely to have an inaccurate perception of symptom control.⁶⁷ However, despite this finding that African American and Hispanic respondents were less likely to report frequent daytime symptoms, African American and Hispanic respondents had more ER visits. Thus, a disconnect in the interpretation of asthma symptoms between minority individuals and clinicians as well as between minority individuals and research tools (ie, surveys) may be leading to undertreatment, a false level of asthma symptom control, and increased risk for morbidity and mortality.

There are several limitations to this study. The cross-sectional nature of this study limits the ability to infer causation. Respondents were exclusively from the United States, which limits global generalizability. There was a risk for self-selection bias because no information could be obtained from nonrespondents. The survey nature of this study is prone to errors in recall and relies on a self-reported physician diagnosis of asthma that older adults may confuse with diseases that have similar symptoms (ie, COPD).^{26,68} In addition, differences in care-seeking behavior as well as physician knowledge about adult-onset asthma may influence an underreported number of established asthma diagnoses. Although social determinants of health played an important role, there were items that were not measured such as transportation, housing, physical environment, employment, social environment, and public safety. In addition, the accuracy of self-reported income in the elderly may not always be accurate as other sources such as social security may be involved.⁶⁹ Finally, the surveys did not ask respondents about years smoked or number of packs/day, which would be necessary to calculate pack-years. Thus, we were unable to assess whether degree of smoking affected asthma outcomes.

Additional work is still required regarding racial disparities among older adults with asthma. Future studies should investigate causative mechanisms between contributing factors (eg, living conditions, poverty, comorbidities) and poor asthma

outcomes. Future studies could use multinomial multiple logistic regression to break activity limitation down further into well controlled, not well controlled, and very poorly controlled. The use of biologics was not examined in the 2015 ACBS, but with the significant recent increase in such medications it deserves future exploration. In addition, corticosteroid bursts should be examined in future studies. In conclusion, in older adults with asthma, health disparities persist even after controlling for many social determinants of health. For example, African American and Hispanic older adults were twice as likely to visit the ER yet 40% less likely to report frequent daytime symptoms. Taken together, these findings highlight how the subjective nature of symptom reporting could be leading to undertreatment, a false level of symptom control, and increased risk for morbidity and mortality. Asthma disparities in older adults are a complex issue with multiple factors playing a role, and the ability of seniors to access Medicare is not sufficient to mitigate other influences. As the US population ages, the burden of asthma seen among older patients will increase, and identifying specific areas of prevention and treatment should be a public health priority.

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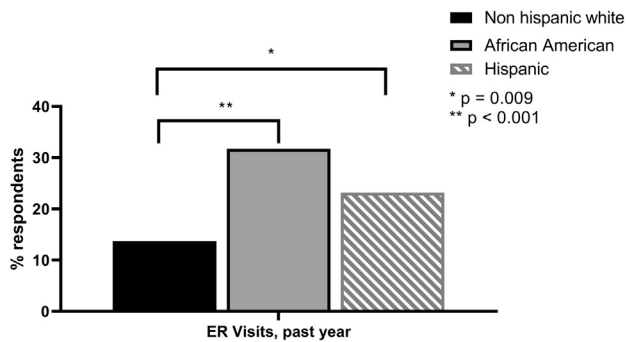


FIGURE E1. The relationship of race and/or ethnicity with ER visits among ≥ 65 year olds. *ER*, Emergency room.

TABLE E1. Multivariable logistic regression for ER visit among ≥ 65 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	2.34	1.65-3.33	<.001
Hispanic	2.17	1.51-3.10	<.001
Sex			
Male	1.00	REF	REF
Female	1.26	0.98-1.63	.08
Age			
55-64	1.00	REF	REF
65-74	0.86	0.68-1.09	.22
75+	0.69	0.50-0.96	.03
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.34	0.17-0.75	.007
25 to <30	0.39	0.19-0.83	.02
30+	0.34	0.16-0.72	.005
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.96	0.64-1.42	.82
Attended college or technical school	1.13	0.76-1.66	.55
Graduated from college or technical school	0.92	0.61-1.39	.70
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.80	0.60-1.06	.12
>\$50,000	0.66	0.47-0.93	.02
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	2.37	1.85-3.05	<.001
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	1.22	0.72-2.06	.47
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.50	1.20-1.89	<.001
Never smoked	1.22	0.85-1.74	.28
Depression			
No	1.00	REF	REF
Yes	1.30	1.04-1.62	.02
Diabetes			
No	1.00	REF	REF
Yes	0.92	0.71-1.18	.02
Coronary artery disease			
No	1.00	REF	REF
Yes	1.82	1.39-2.38	<.001
Asthma medication use			
No medication or rescue medication only	1.00	REF	REF
ICS or other single agent	1.27	0.83-1.93	.27
2 controller medications	1.21	0.90-1.62	.21
More than 2 controllers	1.34	1.05-1.72	.02

BMI, Body mass index; *CI*, confidence interval; *ER*, emergency room; *ICS*, inhaled corticosteroid; *OR*, odds ratio.

**P* values based on multivariable logistic regression calculation.

TABLE E2. Multivariable logistic regression for hospital visit among ≥ 55 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	1.39	0.78-2.47	.26
Hispanic	1.41	0.80-2.46	.23
Sex			
Male	1.00	REF	REF
Female	0.87	0.58-1.29	.49
Age			
55-64	1.00	REF	REF
65-74	1.06	0.72-1.56	.76
75+	1.11	0.67-1.84	.69
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.23	0.09-0.62	.004
25 to <30	0.25	0.09-0.64	.004
30+	0.22	0.08-0.57	.002
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	1.19	0.66-2.17	.56
Attended college or technical school	1.44	0.79-2.61	.23
Graduated from college or technical school	1.02	0.53-1.96	.94
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.62	0.42-0.94	.02
>\$50,000	0.27	0.15-0.49	<.001
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	3.35	2.3-4.81	<.001
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.50	0.19-1.33	.17
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	2.29	1.56-3.38	<.001
Never smoked	1.77	1.01-3.09	.05
Depression			
No	1.00	REF	REF
Yes	1.24	0.87-1.78	.23
Diabetes			
No	1.00	REF	REF
Yes	1.07	0.72-1.57	.75
Coronary artery disease			
No	1.00	REF	REF
Yes	1.93	1.30-2.87	.001
Asthma medication use			
No medication or rescue medication only	1.00	REF	REF
ICS or other single agent	1.32	0.67-2.57	.42
2 controller medications	1.07	0.66-1.75	.79
More than 2 controllers	1.30	0.88-1.93	.19

BMI, Body mass index; CI, confidence interval; ICS, inhaled corticosteroid; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E3. Multivariable logistic regression for uncontrolled daytime symptoms among ≥ 55 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	0.59	0.42-0.83	.002
Hispanic	0.62	0.44-0.88	.008
Sex			
Male	1.00	REF	REF
Female	0.78	0.0.64-0.95	.01
Age			
55-64	1.00	REF	REF
65-74	1.18	0.97-1.42	.09
75+	1.51	1.18-1.94	.001
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.45	0.20-1.03	.06
25 to <30	0.49	0.22-1.10	.08
30+	0.50	0.22-1.11	.09
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.99	0.63-1.26	.50
Attended college or technical school	0.97	0.68-1.37	.85
Graduated from college or technical school	0.77	0.54-1.10	.16
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.79	0.62-1.02	.07
>\$50,000	0.68	0.51-0.90	.01
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	1.44	1.14-1.83	.02
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.68	0.42-1.11	.12
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.27	1.07-1.53	.01
Never smoked	1.64	1.22-2.20	.001
Depression			
No	1.00	REF	REF
Yes	1.13	0.95-1.36	.17
Diabetes			
No	1.00	REF	REF
Yes	1.00	0.82-1.22	.98
Coronary artery disease			
No	1.00	REF	REF
Yes	1.13	1.389-1.44	.32
Asthma medication use			
No medication or rescue medication only	1.00	REF	REF
ICS or other single agent	1.00	0.71-1.39	.98
2 controller medications	1.23	0.98-1.54	.08
More than 2 controllers	1.83	1.5-2.23	<.001

BMI, Body mass index; CI, confidence interval; ICS, inhaled corticosteroid; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E4. Multivariable logistic regression for uncontrolled nocturnal symptoms among ≥ 55 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	1.72	0.64-4.66	.29
Hispanic	2.09	0.84-5.20	.12
Sex			
Male	1.00	REF	REF
Female	0.96	0.48-1.94	.91
Age			
55-64	1.00	REF	REF
65-74	0.74	0.38-1.42	.36
75+	2.29	1.02-5.13	.04
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.00	0.00	1.000
25 to <30	0.00	0.00	1.000
30+	0.00	0.00	1.000
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.94	0.30-2.90	.91
Attended college or technical school	0.89	0.28-2.85	.85
Graduated from college or technical school	1.60	0.50-5.12	.43
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.40	0.18-0.87	.02
>\$50,000	0.28	0.11-0.70	.007
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	0.68	0.31-1.47	.33
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.56	0.11-2.88	.49
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	0.74	0.41-1.34	.32
Never smoked	0.84	0.27-2.58	.76
Depression			
No	1.00	REF	REF
Yes	2.19	1.21-3.97	.009
Diabetes			
No	1.00	REF	REF
Yes	0.97	0.49-1.93	.94
Coronary artery disease			
No	1.00	REF	REF
Yes	3.25	1.51-7.02	.003
Asthma medication use			
No medication or rescue medication only	1.00	REF	REF
ICS or other single agent	1.96	0.61-6.27	.26
2 controller medications	1.49	0.73-3.04	.28
More than 2 controllers	1.06	0.54-2.09	.86

BMI, Body mass index; CI, confidence interval; ICS, inhaled corticosteroid; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E5. Multivariable logistic regression for activity limitation due to asthma among ≥ 55 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	0.98	0.71-1.36	.92
Hispanic	1.14	0.84-1.55	.41
Sex			
Male	1.00	REF	REF
Female	0.92	0.76-1.11	.39
Age			
55-64	1.00	REF	REF
65-74	1.09	0.91-1.32	.36
75+	1.12	0.88-1.43	.34
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.67	0.33-1.36	.27
25 to <30	0.74	0.37-1.48	.39
30+	0.53	0.39-1.56	.48
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.73	0.54-0.98	.04
Attended college or technical school	0.73	0.54-0.98	.04
Graduated from college or technical school	0.53	0.39-0.73	<.001
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.68	0.55-0.84	<.001
>\$50,000	0.37	0.28-0.48	<.001
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	2.18	1.77-2.68	<.001
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.83	0.52-1.33	.44
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.33	1.10-1.59	.002
Never smoked	1.35	1.03-1.78	.03
Depression			
No	1.00	REF	REF
Yes	1.37	1.15-1.63	<.001
Diabetes			
No	1.00	REF	REF
Yes	0.96	0.79-1.17	.70
Coronary artery disease			
No	1.00	REF	REF
Yes	1.90	1.53-2.34	<.001
Asthma medication use			
No medication or rescue medication only	1.00	REF	REF
ICS or other single agent	1.46	1.05-2.03	.03
2 controller medications	1.25	0.99-1.59	.07
More than 2 controllers	2.23	1.84-2.70	<.001

BMI, Body mass index; CI, confidence interval; ICS, inhaled corticosteroid; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E6. Multivariable logistic regression for ER visit among ≥ 65 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	2.02	1.23-3.32	.01
Hispanic	1.32	0.76-2.30	.33
Sex			
Male	1.00	REF	REF
Female	1.26	0.89-1.79	.19
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.30	0.11-0.80	.02
25 to <30	0.44	0.17-1.14	.09
30+	0.32	0.12-0.82	.02
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.90	0.53-1.53	.71
Attended college or technical school	1.03	0.61-1.76	.90
Graduated from college or technical school	0.86	0.49-1.49	.58
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.72	0.48-1.07	.11
>\$50,000	0.68	0.42-1.10	.12
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	3.06	2.17-4.30	<.001
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.91	0.35-2.38	.84
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.45	1.07-1.97	.02
Never smoked	1.72	1.01-2.92	.04
Depression			
No	1.00	REF	REF
Yes	1.16	0.86-1.57	.33
Diabetes			
No	1.00	REF	REF
Yes	1.04	0.74-1.45	.83
Coronary artery disease			
No	1.00	REF	REF
Yes	1.95	1.39-2.73	<.001

BMI, Body mass index; CI, confidence interval; ER, emergency room; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E7. Multivariable logistic regression for uncontrolled day-time symptoms among ≥ 65 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	0.58	0.36-0.93	.02
Hispanic	0.50	0.31-0.82	.006
Sex			
Male	1.00	REF	REF
Female	0.84	0.65-1.09	.18
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.21	0.06-0.73	.01
25 to <30	0.24	0.07-0.80	.02
30+	0.23	0.08-1.12	.02
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	1.02	0.66-1.58	.94
Attended college or technical school	1.11	0.72-1.72	.64
Graduated from college or technical school	0.78	0.50-1.22	.28
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.89	0.64-1.25	.51
>\$50,000	0.82	0.55-1.22	.32
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	1.31	0.95-1.80	.10
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	1.08	0.49-2.36	.85
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.29	1.02-1.62	.20
Never smoked	1.32	0.86-2.02	.29
Depression			
No	1.00	REF	REF
Yes	1.14	0.90-1.44	.29
Diabetes			
No	1.00	REF	REF
Yes	0.95	0.74-1.23	.71
Coronary artery disease			
No	1.00	REF	REF
Yes	1.13	0.84-1.52	.42

BMI, Body mass index; CI, confidence interval; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E8. Multivariable logistic regression for activity limitation due to asthma among ≥ 65 year olds

	OR	95% CI	P value*
Race/ethnicity			
Non-Hispanic white	1.00	REF	REF
African American	0.59	0.36-0.95	.03
Hispanic	0.55	0.35-0.87	.01
Sex			
Male	1.00	REF	REF
Female	1.09	0.85-1.39	.50
BMI			
12 to <18.5	1.00	REF	REF
18.5 to <25	0.57	0.25-1.31	.19
25 to <30	0.62	0.27-1.42	.26
30+	0.62	0.27-1.40	.25
Education			
Did not graduate high school	1.00	REF	REF
Graduated high school	0.63	0.43-0.92	.02
Attended college or technical school	0.66	0.45-0.96	.03
Graduated from college or technical school	0.49	0.33-0.74	.001
Annual household income			
<\$15,000	1.00	REF	REF
\$15,000-50,000	0.55	0.41-0.73	<.001
>\$50,000	0.32	0.22-0.46	<.001
Impaired access to health care due to cost			
No	1.00	REF	REF
Yes	1.91	1.44-2.53	<.001
Gap in health insurance coverage			
No	1.00	REF	REF
Yes	0.84	0.41-1.75	.64
Smoking history			
Current smoker	1.00	REF	REF
Former smoker	1.22	0.98-1.53	.08
Never smoked	1.25	0.84-1.85	.27
Depression			
No	1.00	REF	REF
Yes	1.35	1.08-1.68	.01
Diabetes			
No	1.00	REF	REF
Yes	1.05	0.82-1.34	.70
Coronary artery disease			
No	1.00	REF	REF
Yes	1.81	1.40-2.34	<.001

BMI, Body mass index; CI, confidence interval; OR, odds ratio.

*P values based on multivariable logistic regression calculation.

TABLE E9. The relationship of race and/or ethnicity with demographic characteristics among ≥ 65 year olds

	Non-Hispanic white (%) ^{*,†}	African American (%) ^{*,†}	Hispanic (%) ^{*,†}	P value [‡]
Sex				.01
Male	693 (30.7)	29 (33.8)	44 (39.7)	
Female	1711 (69.3)	123 (66.2)	143 (60.3)	
Age				.46
65-74	1515 (62.5)	103 (55.0)	121 (67.6)	
75+	889 (37.5)	49 (45.0)	66 (32.4)	
BMI				<.001
12 to <18.5	39 (2.4)	1 (0.1)	2 (0.3)	
18.5 to <25	578 (23.8)	29 (29.4)	34 (10.7)	
25 to <30	777 (34.2)	31 (18.3)	66 (40.5)	
30+	902 (39.6)	86 (52.2)	78 (48.6)	
Education				<.001
Did not graduate high school	155 (10.4)	38 (31.00)	90 (46.6)	
Graduated high school	655 (30.3)	44 (30.4)	41 (28.7)	
Attended college or technical school	679 (35.3)	41 (22.1)	30 (16.9)	
Graduated from college or technical school	912 (24.0)	29 (16.5)	25 (7.9)	
Annual household income				<.001
<\$15,000	229 (9.2)	44 (27.1)	82 (41.9)	
\$15,000-50,000	1091 (53.4)	69 (61.7)	61 (45.2)	
>\$50,000	732 (37.4)	20 (11.3)	11 (12.9)	
Impaired access to health care due to cost				<.001
No	2124 (85.7)	120 (75.3)	141 (71.2)	
Yes	274 (14.3)	31 (24.7)	43 (28.8)	
Gap in health insurance coverage				.001
No	2341 (98.2)	147 (9.7)	170 (94.8)	
Yes	39 (1.8)	2 (0.3)	10 (5.2)	
Smoking history				.004
Current smoker	167 (6.8)	16 (14.9)	13 (9.8)	
Former smoker	1099 (46.0)	63 (47.2)	62 (45.1)	
Never smoked	1117 (47.2)	73 (37.9)	111 (45.2)	
Comorbidities				
Depression	752 (28.7)	42 (19.0)	84 (38.7)	<.001
Diabetes	566 (23.3)	65 (45.0)	91 (46.1)	<.001
Chronic obstructive pulmonary disease	986 (45.1)	58 (43.1)	73 (43.7)	.70
Coronary artery disease	367 (15.8)	24 (18.7)	43 (25.1)	.02
Asthma medication use				.25
No medication or rescue medication only	1076 (43.1)	79 (56.6)	97 (50.2)	
ICS or other single agent	172 (8.0)	10 (5.9)	16 (6.5)	
2 controller medications	484 (20.4)	27 (10.7)	29 (12.2)	
More than 2 controllers	672 (28.5)	36 (26.8)	45 (31.00)	
Time since asthma diagnosis				.59
<12 mo	58 (2.6)	5 (2.2)	3 (0.7)	
12 mo to 5 y	213 (9.8)	18 (10.8)	19 (7.8)	
≥ 5 y	2122 (87.6)	129 (86.9)	165 (91.5)	

BMI, Body mass index; ICS, inhaled corticosteroid.

*Frequencies are unweighted and proportions are weighted. Missing responses are excluded.

†Proportions are based on the total within each subset variable.

‡P values based on χ^2 calculation.

TABLE E10. The relationship of race and/or ethnicity with asthma outcomes among ≥ 65 year olds

	Non-Hispanic white (%) ^{*,†}	African American (%) ^{*,†}	Hispanic (%) ^{*,†}	P value [‡]
ER visit				<.001
Yes	226 (12.1)	31 (32.9)	29 (23.2)	
No	1620 (87.9)	96 (67.1)	118 (76.8)	
Hospital visit				.08
Yes	85 (5.7)	11 (5.6)	10 (20.7)	
No	1607 (94.3)	105 (94.4)	127 (79.3)	
Daytime symptoms				.008
≤ 8 d/mo	529 (31.7)	37 (34.8)	53 (49.0)	
> 8 d/mo	1080 (68.3)	54 (65.2)	63 (51.00)	
Nocturnal symptoms				.60
≤ 2 times/mo	136 (66.2)	9 (86.5)	12 (74.1)	
> 2 times/mo	48 (33.8)	3 (13.5)	7 (25.9)	
Asthma action plan received				.90
Yes	649 (26.6)	39 (24.7)	49 (27.6)	
No	1714 (73.4)	112 (75.3)	133 (72.4)	
Routine checkup for asthma				.28
Yes	1448 (76.0)	92 (71.7)	120 (72.0)	
No	547 (24.0)	25 (28.3)	39 (28.0)	
Activity limitation due to asthma				.02
Yes	517 (24.7)	31 (25.7)	57 (28.9)	
No	1868 (75.3)	116 (74.3)	130 (71.1)	

ER, Emergency room.

*Frequencies are unweighted and proportions are weighted. Missing responses are excluded.

†Proportions are based on the total within each subset variable.

‡P values based on χ^2 calculation.**TABLE E11.** Multivariable logistic regression of asthma outcomes associated with race and/or ethnicity among ≥ 65 year olds

	OR [*]	95% CI	P value [†]
ER visit			
Non-Hispanic white	1.00	REF	REF
African American	2.02	1.23-3.32	.01
Hispanic	1.32	0.76-2.30	.33
Uncontrolled daytime symptoms			
Non-Hispanic white	1.00	REF	REF
African American	0.58	0.36-0.93	.02
Hispanic	0.50	0.31-0.82	.006
Activity limitation due to asthma			
Non-Hispanic white	1.00	REF	REF
African American	0.59	0.36-0.95	.03
Hispanic	0.55	0.35-0.87	.01

BMI, Body mass index; CI, confidence interval; ER, emergency room; OR, odds ratio.

*Covariates entered into the multivariable logistic regressions included race and/or ethnicity, sex, BMI, education, income, impaired access to health care due to cost, gap in health insurance coverage, smoking, depression, diabetes, and coronary artery disease.

†P values based on multivariable logistic regression calculation.