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The effect of sex on asthma control from the National Asthma Survey

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Background: Previous studies have demonstrated conflicting results with regard to differences in asthma control between the sexes.
Objective: We sought to identify sex differences in short-term and long-term measures of asthma control in adults from the National Asthma Survey.
Methods: This study analyzed data from the National Asthma Survey (Four-State sample) sponsored by the National Center for Environmental Health, Centers for Disease Control and Prevention. Asthma control was compared between the sexes based on short-term (recent symptoms, asthma attacks, and albuterol use) and long-term (asthma attacks, work days lost, and urgent-care visits and hospitalizations in the prior year) measures. Composite scores for short-term and long-term control were calculated based on any single measure of poor asthma control and based on a sum of poor asthma control measures.
Results: Women were more likely to have poor short-term asthma control based on any measure (adjusted odds ratio [OR], 1.20; CI, 1.01-1.44) or sum of measures (adjusted OR, 1.24; CI, 1.08-1.53) compared with men. Women also demonstrated worse asthma control based on any uncontrolled long-term measure (adjusted OR, 1.52; CI, 1.29-1.79) or sum of measures (adjusted OR, 1.68; CI, 1.45-1.93). These findings were present despite higher reported inhaled corticosteroid use and scheduled health care visits for asthma among women.
Conclusions: Women demonstrated worse asthma control compared with men with regard to several short-term and long-term measures, despite reporting higher rates of inhaled corticosteroid use and routine asthma care visits. Further studies are needed to elucidate whether these findings are due to differences in health reporting or to pathophysiologic differences in asthma between the sexes. (J Allergy Clin Immunol 2009;123:854-60.)

Key words: *Asthma, control, cross-sectional, epidemiology, sex, national, severity, survey, symptoms*

Asthma is a chronic inflammatory disorder of the lower airways that is categorized into 4 levels of severity: intermittent, mild persistent, moderate persistent, and severe persistent.[1] The level of severity is typically based on the level of symptoms before treatment and the medication requirement to control symptoms.[2] Although asthma severity classification is relatively static, asthma symptom control is often dynamic. Therefore a focus on asthma control has been emphasized in recent literature.[1-5]

Asthma control has several components. Short-term measures of asthma control include the frequency of daytime and nighttime symptoms, the degree of interference with daily activity, the frequency of short-acting β_2-agonist use for symptom control, pulmonary function, and quality of life.[2,4] Long-term measures of asthma control include the number of canisters of short-acting β_2-agonist used over a specified time period, the frequency of urgent or emergency care for asthma symptoms, hospitalizations for asthma, and use of systemic steroids.[2,4]Female sex has been shown to be a risk factor for the persistence of asthma into adulthood and adult-onset asthma and has been associated with increased asthma severity and diminished lung function in adulthood.[6,7] Previous studies have suggested that female subjects might have worse asthma control than male subjects, especially in regard to measures of health care use.[8-13] However, 2 recent studies have suggested that male subjects have worse asthma control than female subjects based on the level of β_2-agonist use.[14,15]

The objective of this study was to identify sex differences in both short-term and long-term measures of asthma control from the Four-State sample of the National Asthma Survey (NAS).

METHODS

Data set

This study was approved by the University of Kentucky Institutional Review Board. Data from the 2003 Four-State sample of the NAS were used for analysis.[16] This survey is sponsored by the National Center for Environmental Health, Centers for Disease Control and Prevention. This NAS is a survey module for the State and Local Area Integrated Telephone Survey program conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics. The State and Local Area Integrated Telephone Survey is a random-digit-dial household telephone survey used to collect data on a broad range of topics at the national, state, and local levels. The NAS was designed to produce national prevalence estimates of adults and children with asthma; to describe the health, socioeconomic, behavioral, and environmental predictors that relate to better control of asthma; and to

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Abbreviations used
BMI: Body mass index
ED: Emergency department
HRQOL: Health-related quality of life
NAS: National Asthma Survey
OR: Odds ratio

characterize the content of care and limitations of persons with asthma.[17] Further details regarding the survey construction and administration have been published.[17]

Participants for the survey were randomly selected. The Four-State sample includes data from Alabama, California, Illinois, and Texas. Survey participants from these 4 states were asked detailed questions regarding their asthma. These states were selected for detailed questioning by the project officer at the Center for Disease Control and Prevention's National Center for Environmental Health, the NAS sponsor. Texas, California, and Illinois were chosen because they provided a good geographic mix. Alabama was chosen to provide a rural Southern balance and because detailed asthma data were not available for that state.[17] The survey contains approximately 160 questions, with 114 questions related to asthma. The remaining questions were related to survey eligibility and demographics.

Data analysis

This study included respondents from the Four-State sample of the NAS who were aged 17 years or older and currently had asthma. Current asthma was defined as respondents who answered yes to the following questions: "Have you ever been told by a doctor or other health professional that you have asthma?" and "Do you still have asthma?" The sampling period for this survey was from March 2003 to March 2004.

Demographic variables analyzed included sex, age (17-34, 35-54, 55-74, and ≥75 years), income (<$15,000, $15,000-$34,900, $35,000-$64,900, and ≥$65,000), race (white and nonwhite), Hispanic ethnicity, education (<12 years, high school degree or some college, and college graduate or higher), body mass index (BMI; underweight, normal weight, overweight, and obese), health insurance status, ever smoker, current smoker, state (Alabama, California, Illinois, and Texas), and inhaled corticosteroid use in the prior 3 months. BMI was calculated from self-reported weight and height and then transformed to underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2), and obese (≥30 kg/m^2) categories. Asthma severity was categorized as intermittent or persistent based on inhaled corticosteroid use in the prior 3 months. Survey respondents were asked the following to assess the presence and frequency of routine asthma care: "In the past 12 months, How many times did you see a doctor or other health care professional for a routine checkup for your asthma?"

Asthma control was divided into both short-term and long-term measures, as shown in Table I. The number of days with asthma symptoms in the past 30 days was divided into 2 categories: well controlled (defined as ≤8 days in the prior month with symptoms) and uncontrolled (defined as >8 days in the prior month with symptoms). Eight days of symptoms per month was used to distinguish well-controlled from uncontrolled asthma because current guidelines define well-controlled asthma as the presence of symptoms for 2 days or less per week. The number of nights with symptoms was similarly categorized as well controlled (2 nights or less per month with symptoms) or not well controlled (>2 nights per month with symptoms). For both short-term and long-term control measures, 2 composite measures were calculated: (1) poor control, indicating poor asthma control based on any single poorly controlled response to individual short- and long-term measures, and (2) a control score, which was calculated by summing the number of short- or long-term uncontrolled responses to each individual measure from each subject. Control score ranges for short-term measures were 0 to 5, and those for long-term measures were 0 to 4.

Data were analyzed with SAS version 9.1 software (SAS Institute, Inc, Cary, NC). Univariate analyses were performed on the Four-State sample for demographic characteristics. Bivariate analyses were performed to demonstrate associations between sex and demographic characteristics, as well as between sex and the short- and long-term asthma control variables noted above. Multivariate logistic regression analyses were conducted to identify odds ratios (ORs) for female sex on asthma control variables while controlling for the demographic characteristics of the study population. Independent variables used in multiple logistic regression analysis included income (≤$15,000 and >$15,000), race (white and nonwhite), Hispanic ethnicity, education (<12 years and >12 years), presence of health insurance, smoking status (ever smoker or never smoker and current smoker or exsmoker), inhaled corticosteroid use in the prior 3 months, and BMI (obese and nonobese).

RESULTS

Demographics

The Four-State sample of the NAS had 5741 respondents, of which 3736 were aged 17 years or older. Of the adults in the study, 3060 were identified as having current asthma and were included in the analyses. As shown in Table II, 2130 were women, and 930 were men. There were significant differences between the sexes with regard to age ($P < .001$), income ($P < .001$), education level ($P < .001$), BMI ($P < .001$), presence of health insurance ($P < .05$), being an ever smoker ($P < .001$), and inhaled corticosteroid use ($P < .05$). Women were more likely to have lower incomes, have health insurance, be categorized as obese, have used inhaled steroids in the prior 3 months, and have had household exposure to an indoor pet in the prior 30 days than men. Women were less likely to have a college degree and to be an ever smoker than men.

Bivariate analysis of sex and short-term measures of asthma control

A greater proportion of women than men reported experiencing asthma symptoms in the past week, although this was not statistically significant ($P = .1602$). Measures indicating poorer short-term asthma control in women that were significant in bivariate analysis included experiencing 1 or more asthma attacks in the prior 3 months, uncontrolled asthma with regard to daytime and nighttime symptoms in the prior 30 days, and more frequent rescue albuterol use for asthma attacks (Table III). Women were also more likely to experience any measure indicating poor short-term asthma control than men (adjusted OR, 1.26; CI, 1.06-1.49) and had a higher mean short-term control score than men, indicating poorer asthma control (Table III).

Bivariate analysis of sex and long-term measures of asthma control

Women reported significantly worse long-term asthma control on several different measures (Table IV). Women were more likely than men to have had an asthma attack in the prior 12 months, miss any work days because of asthma in the past year, have had 2 or more urgent-care visits in the prior year because of asthma, and to have been hospitalized for asthma in the prior 12 months. Women were more likely than men to report any measure of poor long-term asthma control (adjusted OR, 1.55; CI, 1.32-1.82) and had a higher mean long-term control score than men, indicating poorer asthma control (Table IV). Women were also significantly more likely to have received routine asthma care in the prior 12 months than men.

TABLE I. Definition of short- and long-term measures of asthma control

Asthma control measure	Definition
Short-term	
Asthma symptoms in past week	Any asthma symptoms in the prior week
Asthma attack in past 3 months	Episodes or periods of worsened asthma symptoms limiting activity or necessitating medical care in the prior 3 months
Uncontrolled daytime symptoms	Greater than 8 days in the prior month with symptoms
Uncontrolled nighttime symptoms	More than 2 nights in the prior month with symptoms
Albuterol use for an attack in past 3 months	Albuterol used as rescue for acute symptoms in the prior 3 months
Any measure of poor short-term control	Poor asthma control based on any poorly controlled response to individual short-term measure noted above
Short-term control score	Sum of the number of short-term uncontrolled responses from each subject (range, 0-5)
Long-term	
Asthma attack in past 12 months	Episodes or periods of worsened asthma symptoms limiting activity or necessitating medical care in the prior 12 months
Any work days lost in past 12 months	Any absenteeism from work or school in the prior 12 months
Two or more urgent-care visits in past 12 months	Two or more urgent-care or emergency visits in the prior 12 months for asthma
Hospitalized for asthma in past 12 months	Any hospitalization for asthma in the prior 12 months
Any measure of poor long-term control	Poor asthma control based on any poorly controlled response to individual long-term measure noted above
Long-term control score	Sum of the number of long-term uncontrolled responses from each subject (range, 0-4)

Multivariate analysis of sex and short-term measures of asthma control

Women continued to be more likely to have an asthma attack in the prior 3 months than men (Table III). Additionally, women were more likely to report uncontrolled nighttime asthma symptoms, uncontrolled daytime asthma symptoms, and albuterol use for an asthma attack in the prior 3 months. After controlling for demographics, women were still more likely to report any measure of poor short-term control than men (adjusted OR, 1.20; CI, 1.01-1.44) and had higher composite short-term control scores, indicating poorer asthma control than men (Table III).

Multivariate analysis of sex and long-term measures of asthma control

Multivariate logistic regression analyses controlling for the aforementioned independent variables continued to demonstrate worse asthma control among women with regard to many long-term asthma control measures (Table IV). Women were significantly more likely to have had any work days lost because of asthma symptoms, have had an asthma attack in the prior 12 months, have had 2 or more urgent-care visits for asthma symptoms in the prior 12 months, and have required hospitalization for asthma in the prior 12 months. Additionally, women were more likely to report poor-long term asthma control based on any measure (adjusted OR, 1.52; CI, 1.29-1.79) and had worse composite long-term control scores. Despite these findings, women were still more likely to have had routine care for asthma in the prior 12 months than men.

TABLE II. Characteristics of adults from the NAS by sex

Characteristics		Female sex (%), n = 2130	Male sex (%), n = 930	*P* value, χ^2
Age (y)	17-34	27.51	35.16	.0003
	35-54	43.43	40.32	
	55-74	23.80	20.00	
	≥75	5.26	4.52	
Income	<$15,000	16.06	10.32	<.0001
Race	Nonwhite	19.01	18.60	NS
Hispanic ethnicity		11.55	11.18	NS
Education	<12 y	11.74	11.83	NS
Insured		86.01	83.12	.0245
State	Alabama	27.04	25.70	NS
	California	23.57	25.05	
	Illinois	24.27	24.30	
	Texas	25.12	24.95	
BMI	Obese	32.16	27.42	.0089
Ever smoker		40.33	48.17	<.0001
Current smoker		16.48	18.60	NS
Inhaled corticosteroid use		34.27	28.82	.0031
Indoor mold exposure		11.69	9.78	NS
Indoor pet exposure		50.70	45.38	.0067
Cockroach exposure		12.54	12.15	NS
Indoor smoke exposure		21.78	23.23	NS

NS, Not significant.

DISCUSSION

Analysis of the Four-State sample of the NAS demonstrated significant differences between the sexes in both short- and long-term measures of asthma control. These findings persisted after controlling for several demographic variables, including age, race, socioeconomic status, education, health insurance, BMI, and smoking status. Additionally, these findings persisted despite using inhaled corticosteroid use to control for asthma severity.

Several recent articles have addressed the distinction between asthma control and asthma severity.[2,5] Asthma control includes several measures of impairment and risk according to the most recent National Asthma Education and Prevention Program guidelines.[1] These components include the frequency of daytime and nighttime symptoms, interference with normal activity, rescue medication use, pulmonary function, and quality of life. Although inadequate data exist to correlate exacerbation frequencies (and resultant health care use) with different levels of asthma control,

TABLE III. Analyses of short-term measures of asthma control by sex

Asthma control measure	Female sex (%)	Male sex (%)	OR	OR CI	AOR*	AOR CI
Asthma symptoms in past week	49.86	47.10	1.12	0.96-1.30	1.08	0.92-1.27
Asthma attack in past 3 mo†	46.67	40.22	1.25	1.08-1.45	1.22	1.05-1.42
Uncontrolled daytime symptoms‡	40.80	36.02	1.22	1.04-1.44	1.18	1.00-1.40
Uncontrolled nighttime symptoms§	27.56	22.90	1.28	1.07-1.53	1.24	1.03-1.50
Albuterol use for an attack in past 3 mo	37.09	31.83	1.26	1.07-1.49	1.22	1.04-1.45
Any measure of poor short-term control	74.23	69.57	1.26	1.06-1.49	1.20	1.01-1.44
Mean short-term control score‖	2.02	1.78	1.30	1.13-1.49	1.24	1.08-1.43

AOR, Adjusted OR.
*Adjusted ORs from logistic regression analysis controlling for the following variables: income (≤$15,000 and >$15,000), race (white and nonwhite), Hispanic ethnicity, education (<12 years and >12 years), presence of health insurance, smoking status (ever smoker or never smoker and current smoker or exsmoker), inhaled corticosteroid use in the prior 3 months, and BMI (obese and nonobese).
†Asthma attacks defined as episodes or periods of worsened asthma symptoms limiting activity or necessitating medical care.
‡Uncontrolled daytime symptoms defined as greater than 8 days in the prior month with symptoms.
§Uncontrolled nighttime symptoms defined as more than 2 nights per month with symptoms.
‖Short-term control score range is 0 to 5, with higher levels indicating poorer asthma control (mean score for female and male subjects given).

TABLE IV. Analyses of long-term measures of asthma control by sex

Asthma control measure	Female sex (%)	Male sex (%)	OR	OR CI	AOR*	AOR CI
Asthma attack in past 12 mo†	61.83	53.23	1.42	1.22-1.66	1.41	1.20-1.65
Any work days lost in past 12 mo	37.23	23.98	1.88	1.58-2.24	1.87	1.56-2.23
Two or more urgent-care visits in past 12 mo	27.28	16.56	1.89	1.55-2.30	1.80	1.50-2.10
Hospitalized for asthma in past 12 mo	5.92	3.55	1.71	1.16-2.53	1.64	1.10-2.45
Received routine asthma care in past 12 mo	62.82	50.86	1.62	1.40-1.86	1.48	1.28-1.71
Any measure of poor long-term control	69.20	59.14	1.55	1.32-1.82	1.52	1.29-1.79
Mean long-term control score‡	1.32	0.97	1.74	1.51-2.00	1.68	1.45-1.93

AOR, Adjusted OR.
*Adjusted ORs from logistic regression analysis controlling for the following variables: income (≤$15,000 and >$15,000), race (white and nonwhite), Hispanic ethnicity, education (<12 years and >12 years), presence of health insurance, smoking status (ever smoker or never smoker and current smoker or exsmoker), inhaled corticosteroid use in the prior 3 months, and BMI (obese and nonobese).
†Asthma attacks defined as episodes or periods of worsened asthma symptoms limiting activity or necessitating medical care.
‡Long-term control score range is 0 to 4, with higher levels indicating poorer asthma control (mean score for female and male subjects given).

the National Asthma Education and Prevention Program guidelines do state that more frequent and intense exacerbations do indicate poorer asthma control. In fact, one recent study demonstrated increased health care use among patients with uncontrolled asthma.[18] Asthma severity, on the other hand, is based on the level of symptoms before treatment and on the medication requirement necessary to maintain symptom control. Although these concepts are unquestionably interrelated, a distinction can be made because those with severe asthma can have good symptom control and those with mild forms of asthma can have episodes of poor symptom control.

Previous studies have demonstrated differences between the sexes with regard to asthma control.[8,11,14,15,19-21] The current study also demonstrated significant differences between the sexes, with female subjects having worse short-term asthma control in terms of recent asthma attacks, uncontrolled daytime and nighttime symptoms in the prior 30 days, and recent albuterol use for an asthma attack. Short-term measures of asthma control that have been demonstrated to be worse among female subjects compared with male subjects in previous studies include the frequencies of daytime and nighttime symptoms, interference with daily activities, and quality-of-life scores. In a study by Laforest et al,[8] tobacco use, female sex, and a BMI of greater than 30 kg/m^2 were all significant predictors of poor asthma control, as assessed by using the Asthma Control Test.[22] Another study using the Asthma Therapy Assessment Questionnaire demonstrated worse asthma control among women, despite having better postbronchodilator FEV_1 values compared with men.[11] A study by Osborne et al[19] found increased daytime and nighttime symptoms in women with asthma but no differences between men and women in postbronchodilator FEV_1 in a large health maintenance organization population.

In this study women were more likely to have used short-acting β-agonists for an asthma attack in the prior 3 months than men. This effect persisted despite controlling for other demographic variables. Other studies, however, have not consistently demonstrated this finding. For instance, 2 previous studies demonstrated increased short-acting β-agonist use in male subjects compared with female subjects,[14,15] whereas others have demonstrated increased short-acting β-agonist use in female subjects compared with male subjects[19,20] or no difference between the sexes.[23,24] One possible explanation for the differences found in this study with the studies demonstrating increased short-acting β-agonist use in men is that the prior studies used canisters dispensed, whereas this study used subject self-report. Moreover, prior studies showing increased short-acting β-agonist use in female subjects also relied on self-report.[19,20] Although not having information on the number of short-acting β-agonist canisters dispensed could be a potential limitation in our study, actual patient medication use might not equate with medication dispensed, especially if short-acting β-agonist use is over a short period of time and for intermittent exacerbations. As noted, this

study examined albuterol use over a period of 3 months and only for asthma exacerbations.

All long-term measures of asthma control analyzed in this study revealed poorer control among women. Other studies have found similar results. Rhodes et al[10] demonstrated that female subjects experienced more asthma attacks in the prior 12 months and more emergency visits for asthma when evaluating Behavioral Risk Factor Surveillance System data from 2001. Additionally, data from the Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens study that were analyzed for sex differences found that women had greater health care use, increased steroid bursts, and more work days lost than men, despite better lung function and similar treatment patterns.[11] A cross-sectional study in Canada also reported higher rates of absenteeism and urgent-care visits among female subjects, despite higher reported rates of inhaled corticosteroid use.[9]

Two measures of health care use, urgent-care visits and hospitalizations, were found to be higher in female subjects in this study, as well as in several other studies.[10,13,14,19,25-29] Higher rates of emergency department (ED) visits were reported in Behavioral Risk Factor Surveillance System data from 2001, and Osborne et al[19] also demonstrated significantly more ED visits in adult female subjects aged 33 to 55 years compared with their male counterparts in a large health maintenance organization population.[10] Schatz et al[14] found higher rates of ED visits and hospitalizations among women when evaluating a health care database of more than 30,000 adult asthmatic subjects. Increased rates of hospitalization for exacerbations have also been noted in female subjects compared with male subjects in multiple studies.[25-29] Interestingly, one study found that despite higher rates of hospitalization among female asthmatic subjects, female subjects had significantly higher oxygen saturations and peak expiratory flow rates on presentation than male subjects.[28]

The difference in asthma control between men and women in this study was greater for the long-term measures, particularly the measures of health care use and work days lost. Moreover, worse asthma control among women was present despite a higher likelihood of routine care received by women for their asthma. One possible explanation for the larger differences demonstrated between the sexes for the long-term measures is that women might seek care more readily than men because of a greater knowledge or perception of asthma control. Additionally, women might experience greater disability from their asthma because of a greater frequency of asthma attacks or a greater severity of asthma. However, multivariate analysis used in this study that controlled for inhaled corticosteroid use as a marker of asthma severity continued to demonstrate differences between the sexes in the asthma control variables.

Similar to this study, other studies have demonstrated higher rates of routine asthma care in female asthmatic subjects and worse asthma control among female subjects.[10,20] One possible explanation for this finding would be a higher degree of asthma severity in female subjects compared with that seen in male subjects. However, worsened asthma control in female subjects has been demonstrated, despite similar or better levels of asthma severity in women compared with men, based on pulmonary function or when controlling for inhaled corticosteroid use.[11,19,25]

Higher rates of routine asthma care in women with worsened asthma control could also reflect a better perception of incremental decreases in pulmonary function or a greater knowledge of well-controlled versus poorly controlled asthma among women. In fact, one study demonstrated significantly higher peak flow rates in women compared with men on presentation to the ED for an asthma exacerbation.[25] Other possible factors that could explain worse asthma control despite more frequent routine health care include a poorer response to traditional therapies in women compared with men, poorer compliance with prescribed therapies in women, or hormone-related effects causing more asthma symptoms. Estrogen receptor 1 polymorphisms have been associated with bronchial hyperresponsiveness and lung function decline, especially in female subjects.[30] Other studies have shown that premenstrual or menstrual worsening of asthma can affect as many as 20% to 40% of female subjects.[31-36]

Differences in allergic sensitization and exposure to common asthma triggers have also been evaluated to account for differences in asthma prevalence and control among male and female subjects, with varying results.[11,25,37-39] Using data from the Third National Health and Nutrition Examination Survey, Arbes et al[37] demonstrated that more than 50% of asthma cases were attributable to atopy, with the effect greater in male than in female subjects. Sex analysis from the Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens study demonstrated more allergic comorbidities, allergic triggers for asthma, and difficulty avoiding allergic triggers by women despite higher total IgE levels in men.[11] An article by Singh at al[25] also reported higher rates of hay fever and known asthma triggers in women, although both sexes reported similar rates of environmental allergens as triggers for asthma. Other studies have demonstrated contradictory results, with both sexes having similar levels of allergic sensitization and living conditions[38] and similar seasonality trends in asthma exacerbations.[39] Although the current study did not include a measure of allergic sensitization, subjects were stratified by reported exposure to common asthma triggers (data not shown). The authors of this study did not find any consistent interaction between sex and environmental exposures (indoor pets, indoor mold, and cockroach) on short- and long-term asthma control measures. This suggests that differences in asthma control between men and women are likely not due to exposure differences to asthma triggers between the sexes.

Although this study and the aforementioned studies support differences in asthma control between the sexes, it is possible that asthmatic female subjects report more problems than male subjects with similar levels of morbidity. Studies for other medical illnesses have reported mixed results. Although men have higher mortality rates than women, multiple studies have demonstrated higher morbidity and health care use for women.[40-42] Women have been shown to have increased health care use but worse quality of care provided compared with men for cardiovascular disease, especially in postmenopausal women.[43] Women have also been shown to receive better preventive care for cardiovascular disease and cancer than men but were less likely to receive colorectal cancer screening and received worse treatment for end-stage renal disease and cardiovascular disease than men.[43] Women are also less likely to receive elective inpatient and high-technology procedures than men but are more likely to use primary care and home health services.[44-49] Elderly women were shown to use less hospital and outpatient surgical services than men but were more likely to use home health and physician services.[50] Other studies that control for specific conditions, such as colon cancer, common colds, and osteoarthritis, have demonstrated either no difference

in reporting between the sexes[51] or that men overreport the severity of their condition compared with women.[52,53]

Sex differences in health-related quality of life (HRQOL) have consistently demonstrated worse reports by female subjects compared with male subjects in several populations.[54-56] The relationship between self-reported HRQOL and functional limitation has been less frequently studied, however. In one study, Orfila et al[57] demonstrated that elderly women in Barcelona reported more problems with arthritis, back pain, and depression and had worse HRQOL scores than male subjects. However, when the statistical models were adjusted for functional capacity by using a physical test for standing, walking, and balance, the differences between the sexes resolved, suggesting that the differences were due to greater disability among female subjects and not due to differences in health reporting. It has also been suggested that because women have longer survival rates then men, women have an increased frequency of nonfatal conditions, causing higher levels of disability and lower subsequent HRQOL.[57]

The current study does have limitations. First, as with all cross-sectional studies, cause-and-effect relationships cannot be established. However, as previously noted, other studies support many of the current findings. Second, findings from this study are based on self-report and are subject to recall bias. Database utilization studies could be more accurate if study subjects received all of their care at the center included in the database. However, health care use studies are also subject to selection bias depending on the method used for inclusion of study subjects. Additionally, database studies could underreport health care use if participants seek care outside the center or overreport medication use if patients fill prescriptions but do not actively use the medication. Another potential limitation based on the study design is that there were more than twice as many women who responded to the survey as men. Because women are more likely to have asthma in adulthood and might respond to surveys with a greater frequency, this could influence the results found in this study.

Categorization of symptom control is another potential limitation for a couple of reasons. First, the measures used to assess short-term and long-term asthma control have not been validated or used in other studies; however, these measures have been described in previous reports.[2,4] Additionally, these items encompass measures of asthma control from the most recent Expert Panel Report on the diagnosis and monitoring of asthma.[1,5] Also, uncontrolled daytime symptoms indicated more than 8 days in the prior month with symptoms. Because daytime symptom control is categorized as well controlled if symptoms occur 2 times or less per week, this study might not have captured all those without well-controlled symptoms. However, this classification scheme should underestimate the number of patients with uncontrolled daytime symptoms. Therefore asthma control based on this scheme might actually indicate even poorer symptom control among women than evidenced in this analysis.

Although inhaled corticosteroid use was used to categorize persistent asthma in this study, positive reports only indicated use in the prior 3 months and not regular or compliant use; however, inhaled corticosteroid use as an indicator of asthma severity has been used in previous studies.[5,58] Additionally, no baseline measure of pulmonary function was available for analysis. Therefore increased symptoms among those considered to have more severe disease might have been due to poor compliance with medication regimens and not necessarily due to greater severity of underlying asthma.

Quality of life is a short-term measure of asthma control that was not available for this data analysis. Other studies have demonstrated worse quality of life in asthmatic female subjects compared with male subjects.[59-64] In 2 of these studies, women also were found to have increased health care use,[61] worsened dyspnea, and higher levels of medication use.[62] One study that correlated the Asthma Control Test and the Asthma Therapy Assessment Questionnaire with scores from the Mini-Asthma Quality of Life Questionnaire did find significant correlations between asthma control and the symptoms and activity themes of the Mini-Asthma Quality of Life Questionnaire.[60] Therefore although quality- of-life data were not obtained for this study, it is likely that patients with more symptoms and greater health care use would also have worse asthma-related quality of life.

Finally, although we attempted to stratify patients based on exposure to common asthma triggers (data not shown), data were not available on allergic sensitization in these patients. It is possible that a higher proportion of female subjects are sensitized to molds, pets, or cockroaches than male subjects. Therefore a difference might have existed in asthma control in those sensitized versus those not sensitized to these allergens. If this were the case and female subjects were more often sensitized to such allergens, allergic sensitization could be responsible for differences in asthma control identified between the sexes.

In summary, this cross-sectional study evaluated several short- and long-term measures of asthma control in a large sample. Sex differences were identified for several measures of asthma control and persisted after controlling for several factors, including inhaled corticosteroid use. Additionally, these findings were present despite higher reported rates of routine asthma care by women. Further studies are needed to determine whether the current findings are due to differences in health reporting or to intrinsic differences in asthma between the sexes.

Clinical implications: Health care providers should recognize that differences in asthma control might exist between the sexes. Improved asthma education, monitoring, or treatment in women might lead to reduced disparities in this population.

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