

Inadequate use of asthma medication in the United States: Results of the Asthma in America national population survey

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Background: Studies of the use of anti-inflammatory asthma therapy have been limited to selected populations or have been unable to assess the appropriateness of therapy for individuals. **Objective:** We sought to describe the current use of asthma medication in the United States population and to examine the influence of symptoms and sociodemographics on medication use.

Methods: This study was based on a cross-sectional, national, random-digit-dial household telephone survey in 1998 designed to identify adult patients and parents of children with current asthma. Respondents were classified as having current asthma if they had a physician's diagnosis of asthma and were either taking medication for asthma or had asthma symptoms during the past year.

Results: One or more persons met the study criteria for current asthma in 3273 (7.8%) households in which a screening questionnaire was completed. Of these, 2509 persons (721 children <16 years) with current asthma were interviewed. Current use of anti-inflammatory medication was reported by 507 (20.1%). Of these, most were using inhaled corticosteroids (72.5%), with use of antileukotrienes reported by 11.4% and use of cromolynedocromil reported by 18.6%. Of persons with persistent asthma symptoms in the past month, 26.2% reported current use of some form of anti-inflammatory medication. In bivariate analysis persons reporting lower income, less education, and present unemployment, as well as smokers, were significantly ($P < .001$) less likely to report current anti-inflammatory use than were other populations. In a multiple regression model nonsmokers and those of white, non-Hispanic ethnicity, as well as persons reporting less asthma control, were more likely to report current anti-inflammatory medication use.

Conclusion: In the United States use of appropriate asthma therapy remains inadequate. Strategies to increase use of anti-inflammatory therapy among patients with asthma are need-

ed. These might include methods to increase access to asthma care for minorities and the socioeconomically disadvantaged. (J Allergy Clin Immunol 2002;110:58-64.)

Key words: Asthma, asthma medication, population survey, race, socioeconomic status

Anti-inflammatory therapies for asthma have proven efficacy in clinical trials¹⁻⁴ and effectiveness in real-world practice settings⁵⁻⁷ in reducing asthma morbidity. These medications are the central component of current national clinical guidelines for asthma management.⁸ Despite this, a number of studies have concluded that the use of inhaled anti-inflammatory medication for asthma in the United States is suboptimal.⁹⁻¹³

A number of sociodemographic factors have been identified as contributing to low use of anti-inflammatory medication, including preschool age or adolescence, economic disadvantage, lower level of formal education, minority race or ethnicity, residence in the inner city, use of a language other than English as first language, and episodic or discontinuous medical care associated with socioeconomic disadvantage.^{9,10,12-20}

Although these studies provided insights into selected subpopulations, such as inner-city children or patients in managed care settings, they provided little information that was representative of the US population. Also, many of these studies were based on automated databases or survey data that lacked detailed clinical information on individuals, making it very difficult to determine the appropriateness of therapy.

The main aim of this article was to describe self-reported use of asthma medication in the United States, specifically use of anti-inflammatory therapy, stratified by symptom severity. We also examined the influence of sociodemographic variables on medication use.

METHODS

The data for this study come from a national sample of adult patients and parents of children with current asthma. Eligible subjects were identified by means of telephone screening of a national random-digit-dialing sample of telephone-owning households. Sample weights were applied to correct the minor degree of disproportionate sampling when making estimates for the total population. Interviews were conducted by trained interviewers in 42,022 households with telephones in the United States and were refused or terminated in another 4153 households, providing a participation rate of 91%. For children less than 15 years of age, the parent or responsible adult who knew the most about the child's asthma was identi-

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Received for publication July 10, 2001; revised April 3, 2002; accepted for publication April 5, 2002.

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0091-6749/2002 \$35.00 + 0 1/81/125489

doi:10.1067/mai.2002.125489

Abbreviation used

NAEPP: National Asthma Education and Prevention Program

fied and asked to complete the interview. Persons were classified as having current asthma if they had ever been diagnosed by a physician as having asthma and if they were either taking medication for their asthma or had asthma symptoms in the past year. If more than one household member qualified as currently having asthma, one designated respondent in each household was randomly selected by computer. One or more persons who met the criteria for current asthma were identified in 3273 (7.8%) of the 42,022 households in which a screening interview was completed. Interviews were completed with 2509 (76.7%) of the 3273 selected asthmatic patients or parents. The vast majority (94.6%) of eligible nonrespondents were awaiting callback for interviews when the field period for the survey ended, and only 150 qualified respondents (4.6%) refused to conduct the interview or terminated the interview before completing it.

Questionnaire

Patient screening and interviews were conducted between May 21 and July 19, 1998. The interview averaged 30 minutes in length. Survey items covered the following areas: sociodemographics; asthma symptoms, medications, and health service use; health insurance and personal health care costs; patterns of care delivery, including types of provider and frequency of visits; ratings of patient-physician interactions; and attitudes and beliefs regarding asthma and asthma therapy.

To characterize medication use, interviewers asked respondents whether they had taken any prescription medication in the past weeks for quick relief from asthma symptoms or to treat airway inflammation or whether they had taken any other prescription medications for asthma or any over-the-counter medications during the past 4 weeks. Respondents were also asked questions on the mode of administration and frequency of medication use. Medications classified within the anti-inflammatory group in this study included all inhaled corticosteroids, cromolyn and nedocromil, and oral antileukotriene preparations. Those classified as relievers included all short-acting inhaled β -agonist preparations and inhaled anticholinergics, such as ipratropium bromide, but excluded long-acting β -agonists, such as salmeterol. Because the use of theophylline was minimal, we have not reported data on its use separately.

Asthma burden classification

Asthma burden was divided into 3 components: short-term symptom burden, long-term symptom burden, and functional impact. Short-term symptom burden was categorized on the basis of reported daily and nocturnal symptoms over the past month. Long-term symptom burden combined long-term symptoms and the functional impact of asthma. Long-term symptoms included the recall of average weekly symptoms and the frequency of asthma exacerbations over a 12-month period. Functional impact comprised 3 components: physical, social, and nocturnal impact. Components of functional impact were graded on a 4-point Likert scale from 0 (none) to 3 (a lot). Respondents were asked: "How much do you feel that asthma limits what you can do in each of the following areas? Do you feel your asthma restricts you in" sports and recreation, normal physical activity, housekeeping chores, social activities, friendships, lifestyle, and sleeping.

The criteria for categorizing asthma burden were based on the National Asthma Education and Prevention Program (NAEPP) Expert Panel II recommendations for assessing asthma severity.⁸ This created 4 categories of increasing severity (mild intermittent, mild persistent, moderate persistent, and severe persistent). The NAEPP

Expert Panel II criteria assign individuals to the highest grade in which any feature occurs.⁸ No lung function data were available.

Statistical analysis

The main outcome of interest was reported use of anti-inflammatory therapy during the past month. Asthma burden, as assessed by short-term and long-term symptom burden, was used as the main variable for stratification in all analyses. We then examined the effect on medication use within each stratum of sociodemographic, health insurance, and personal health care cost variables. Differences in the proportion of persons reporting medication use in each stratum were assessed for significance by using χ^2 tests and Mantel-Haenszel methods for analysis of $2 \times k$ tables. Separate analyses were performed with stratification by short-term symptom burden and by long-term symptom burden. A multiple regression model was developed for the outcome of reported use of anti-inflammatory medication use in the past 4 weeks. Variables significant in bivariate analysis were entered simultaneously into the model.

RESULTS

The survey yielded a national sample of 2509, with 721 children younger than age 16 years and 1788 adults with current asthma. The majority (58.2%) of persons in the sample were younger than 35 years of age, and the age range was less than 1 to 89 years. The demographic characteristics of the population are shown in Table 1.

When classified on the basis of short-term symptoms, 1275 (50.8%) respondents reported persistent asthma, with 19.2%, 13.1%, and 18.4% having disease categorized as mild, moderate, and severe persistent, respectively. This contrasted with long-term symptom burden, with 2257 (90.1%) describing limitations in their lives because of asthma. The majority had either moderate (32.2%) or severe (38.3%) functional limitations that they attributed to asthma. When the individual components of functional effect were examined more closely, social effect contributed less to the categorization of asthma burden than did physical effect. This is because the NAEPP criteria assigns individuals to the highest severity category that a particular feature incurs, and physical effect was usually scored higher than social effect. Moderate or severe limitations on physical activity were reported by 58.4% of persons with asthma.

Only 507 (20.1%) of the persons with asthma reported anti-inflammatory use in the past 4 weeks (ie, inhaled steroids and/or cromolyn-nedocromil and/or oral antileukotrienes). Fig 1 shows that 26.2% of those with persistent symptoms during the 4 weeks described current use of anti-inflammatory medication. Although those with mild intermittent symptoms (13.8%) were significantly less likely to report use of anti-inflammatory medication than those with persistent symptoms ($P < .001$), there were minimal differences among the different categories of persistent severity (Fig 1). When stratified by the degree of long-term symptom burden caused by asthma, only 21.3% who described some limitations from asthma reported current use of anti-inflammatory medication, and only 26.4% with severe limitations reported such current use. Among those who reported using anti-inflammatory medication, the majority

Asthma, rhinitis,
other respiratory
diseases

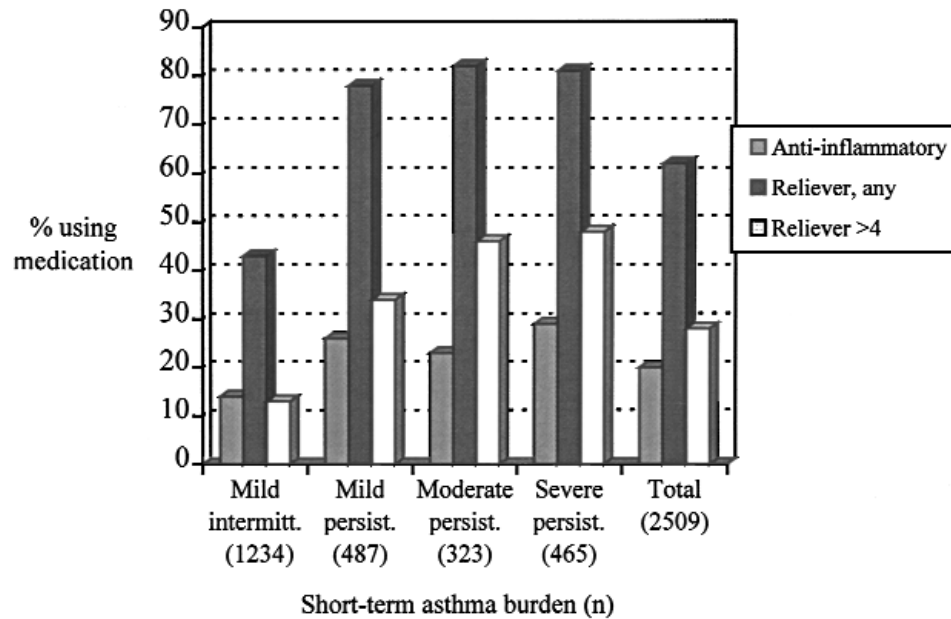


FIG 1. Proportion of persons within each short-term asthma symptom category who reported current use of any anti-inflammatory medication, any reliever medication, or more than 4 canisters of reliever medication during the past year.

TABLE I. Demographic characteristics of the sampled population (n = 2509)

Variable	Category	No. unweighted	% Weighted ($\pm$ SD)
Age	<6 y	202	8.1 $\pm$ 0.5
	6-15 y	519	20.7 $\pm$ 0.8
	16-34 y	728	29.3 $\pm$ 0.9
	≥ 35 y	1058	41.8 $\pm$ 1.0
Sex	Female	1554	61.7 $\pm$ 1.0
Race	White, non-Hispanic	1807	70.2 $\pm$ 0.9
	Black, non-Hispanic	323	12.7 $\pm$ 0.7
	Other, non-Hispanic	173	7.3 $\pm$ 0.6
	Hispanic (white or black)	177	8.7 $\pm$ 0.6
Education	<High school	375	14.9 $\pm$ 0.7
	High school	838	32.9 $\pm$ 0.9
	>High school	1284	51.7 $\pm$ 1.0
Employment	Employed	1588	63.6 $\pm$ 1.0
	Unemployed	139	5.5 $\pm$ 0.5
	Retired-student-homemaker	770	30.3 $\pm$ 0.9
Income	<\$15,000	468	18.4 $\pm$ 0.8
	\$15,000-\$35,000	623	24.7 $\pm$ 0.9
	\$35,001-\$50,000	865	15.3 $\pm$ 0.7
	>\$50,000	613	24.9 $\pm$ 0.9
Smoking	Yes	505	20.0 $\pm$ 0.8

(72.5%) were using inhaled corticosteroids, with use of antileukotrienes reported by 11.4% and use of cromolyn-nedocromil reported by 18.6%. The type of drug used varied by age. Among those with persistent symptoms over the past 4 weeks, 10.8% of children reported using cromolyn compared with 2.9% of adults. The situation was reversed with inhaled corticosteroids, with 20.4% of adults with persistent symptoms reporting use compared with 12.7% of children. The use of antileukotrienes was reported by 7.5% of adults and 5.5% of children with recent persistent symptoms.

In the past 4 weeks, 64.1% of persons reported using either relievers or anti-inflammatory medication (65.9% of adults and 59.6% of children). Among recent users of asthma medications, only 65 (4.0%) reported using anti-inflammatory medication without any use of relievers. Around four fifths (79.7%) of all persons with persistent asthma symptoms during the past month reported current use of reliever medication compared with 42.6% of those with mild intermittent asthma ($P < .0001$). There was a clear association between asthma symptoms and the intensity of reliever use. Significantly more ($P < .001$)

TABLE II. Frequency of anti-inflammatory use among persons in different sociodemographic categories stratified by short-term asthma symptoms among 2509 persons sampled

Category (n)	Mild intermittent (n = 1234)	Mild persistent (n = 487)	Moderate persistent (n = 323)	Severe persistent (n = 465)	Total (n = 2509)
Age					
>15 y (1783)	109 (14)	98 (27)	58 (23)	112 (29)	377 (21)
6-15 y (519)	46 (13)	19 (22)	11 (21)	18 (34)	94 (17)
<6 y (207)	19 (16)	10 (29)	3 (13)	4 (18)	36 (18)
Sex					
Female (1554)	86 (12)	85 (27)	47 (24)	103 (33)	321 (21)
Male (965)	88 (16)	42 (25)	25 (20)	31 (21)	186 (19)
Education					
>High school (1284)	110 (16)	81 (32)	45 (30)	56 (30)	292 (23)
High school (838)	53 (14)	40 (23)	21 (18)	54 (31)	168 (20)
<High school (375)	11 (7)	5 (8)	6 (11)	24 (24)	46 (12)
Employment					
Employed (1588)	119 (14)	87 (27)	49 (25)	77 (31)	332 (21)
Retired-student (770)	50 (14)	34 (26)	23 (20)	54 (30)	161 (21)
Unemployed (139)	4 (6)	5 (18)	0	3 (9)	12 (9)
Race-ethnicity					
White, non-Hispanic (1807)	140 (15)	90 (26)	60 (26)	103 (32)	393 (22)
Nonwhite (673)	34 (10)	34 (25)	11 (14)	30 (21)	109 (16)
Income					
>\$50,000 (613)	118 (15)	78 (31)	42 (27)	73 (32)	311 (22)
\$35,000-\$50,000 (805)	56 (12)	38 (28)	19 (24)	42 (29)	155 (19)
\$15,000-\$35,000 (623)	38 (14)	37 (26)	14 (16)	32 (27)	122 (19)
<\$15,000 (468)	18 (10)	11 (13)	16 (21)	29 (24)	74 (16)

Values are given as number (percentage).

persons in both the moderate persistent (46.3%) and severe persistent (47.5%) short-term symptom categories reported using more than 4 canisters of reliever medication during the past year than those in the mild persistent group (33.6%) or the mild intermittent group (13.2%, Fig 1). Of the 660 persons (27.6% of the total population) who used more than 4 reliever canisters during the last year, 158 (23.6%) were in the mild intermittent category of short-term symptoms during the past 4 weeks.

In bivariate analyses we observed that persons reporting lower income, less education, nonwhite race, and present unemployment were significantly ($P < .001$) less likely to report current anti-inflammatory use than were other populations (Table II). In addition, among those with more severe symptoms, young adults (16-34 years) were significantly less likely than children and older adults ($P < .01$), and male subjects were less likely than female subjects ($P < .01$), to report use of anti-inflammatory medications (Table II). Smokers also reported significantly less use of anti-inflammatory medication than did nonsmokers across all severity categories (overall, 29% vs 18%; $P < .001$). In contrast, there were only minimal, nonsignificant differences in the use of relievers by different sociodemographic groups.

In general, persons who had used acute health services during the past year or who had missed days from school or work because of asthma were more likely than persons without these events to describe use of anti-inflammatory medication, although this difference was only significant ($P < .01$) for individuals with current severe persistent asthma (Table III). A similar pattern was seen when

persons were stratified by long-term symptom burden. Among individuals who reported persistent short-term asthma symptoms and who also had a hospitalization, an emergency department visit, or 2 or more urgent care visits in the past year, fewer than one half reported current use of anti-inflammatory medication (Table III).

In a multiple logistic regression model, reported current use of anti-inflammatory medication was significantly associated with white, non-Hispanic ethnicity, as well as with markers of poorer asthma control, such as reported asthma hospitalization, urgent care visits, or missing work or school from asthma in the past year. Current smokers, those of younger age, and those using 4 or less canisters of reliever medication in a year or who report less long-term impact from asthma were less likely to report current use of anti-inflammatory medications (Table IV).

We have reported only the use of anti-inflammatory medication. Other long-term controller medications, such as salmeterol and theophylline, were used infrequently. The inclusion of these medications in the analyses reported above did not demonstrate a significantly different overall pattern of therapy use. Similarly, when long-term symptom burden was used to stratify the analysis, the proportions in comparable strata were usually 2% to 3% lower but did not significantly alter the findings presented when short-term symptoms were used for stratification. When examined by individual racial groups (ie, black, Asian-American, Native American, or Hispanics [either white or black]), the reported use of anti-inflammatory medication was similar between groups and showed the clear difference between their

TABLE III. Frequency of anti-inflammatory use among persons according to acute use of health care services in the past year stratified by short-term symptoms among 2509 persons sampled

Category (n)	Short-term symptoms				
	Mild intermittent (n = 1234)	Mild persistent (n = 487)	Moderate persistent (n = 323)	Severe persistent (n = 465)	Total (n = 2509)
Hospitalized past year for asthma					
Yes (217)	16 (28)	13 (35)	10 (27)	44 (52)	83 (38)
No (2291)	158 (13)	113 (25)	62 (22)	90 (24)	423 (18)
Emergency department visit in past year for asthma					
Yes (578)	39 (19)	27 (23)	21 (26)	66 (39)	153 (26)
No (1926)	134 (13)	100 (27)	51 (22)	67 (23)	352 (18)
Urgent care visits in past year for asthma					
≥2 (514)	36 (20)	37 (32)	28 (34)	73 (51)	174 (34)
1 (194)	11 (11)	15 (30)	7 (24)	5 (22)	38 (19)
0 (1785)	126 (13)	75 (23)	37 (18)	21 (18)	290 (16)
Days missed from school or work past year					
≥6 (358)	25 (23)	24 (32)	18 (26)	57 (48)	124 (34)
1-5 (401)	32 (15)	19 (23)	11 (21)	16 (30)	78 (19)
0 (1721)	115 (12)	81 (25)	40 (21)	59 (21)	295 (17)

Values are given as number (percentage).

TABLE IV. Multiple regression analysis for the outcome of reported anti-inflammatory medication use in the past 4 weeks among 2509 persons sampled

	Odds ratios (95% CI)
Younger age	0.87 (0.77-0.98)
Smoker	0.49 (0.36-0.65)
White, non-Hispanic	1.51 (1.18-1.94)
Asthma control: less long-term effect	0.82 (0.71-0.94)
Hospitalized in past year for asthma	1.90 (1.32-2.75)
Urgent care visits in past year for asthma	1.54 (1.22-1.95)
Missed work-school in past year because of asthma	1.33 (1.05-1.70)
Use of ≤4 canisters of reliever in past year	0.48 (0.42-0.55)

anti-inflammatory use and that of white, non-Hispanics reported in Table II.

DISCUSSION

The results from this representative national population study present a bleak picture of the status of asthma treatment in the United States. Reported use of anti-inflammatory asthma medications is low in persons for whom they are strongly indicated (ie, those with persistent asthma symptoms). It is even slightly lower in persons who describe asthma-related limitations in their lives, irrespective of their recent symptoms. Hence regardless of whether the criteria for judging the appropriateness of therapy are based on a medium-to-longer-term perspective of asthma burden or on more recent symptoms over the past month, the findings remain the same: Only one fourth to one third of persons who, according to national guideline recommendations, should be using anti-inflammatory medication report actually using them. An asthma-related hospitalization during the previous 12 months is a strong marker of subsequent risk for readmission and death.^{21,22} Although an

acute health service event, such as a hospitalization or an emergency department visit, was associated with increased use of anti-inflammatory medications, even among persons with recent severe persistent symptoms who had experienced an acute event during the past year, only one half reported the use of anti-inflammatory therapy. Again, this proportion was even lower among persons who reported severe limitations from asthma compared with those with severe concurrent symptoms. Thus even among those most at risk for serious adverse consequences from asthma, at least one half were not using appropriate preventive therapy.

There is little difference in the reported anti-inflammatory use between persons with different categories of persistent symptoms. This is a reflection, in part, of better asthma control by some persons with more severe underlying asthma with anti-inflammatory therapy, and hence they might classify their current symptoms as mild. To some extent, this lack of difference in anti-inflammatory use is also likely to reflect the inconsistencies in how patients and clinicians assess the impact of asthma and asthma symptoms and, consequently, what is needed to manage it adequately.

The socially and economically disadvantaged are at risk for suboptimal care. The bivariate analyses found that, at every level of asthma severity, significantly fewer poor, uninsured, unemployed, less educated, nonwhite persons with asthma report anti-inflammatory use. In the multivariate analysis controlling for factors such as severity, education, and income, being white and non-Hispanic emerged as an important variable independently associated with greater use of anti-inflammatory medication. Because race and socioeconomic status are closely linked, it is difficult to reliably isolate racial disparities in health care from those associated with disparities in socioeconomic status.²³ This difficulty is underlined by the finding that those of Hispanic ethnicity reported similar levels of anti-inflammatory use as those

of nonwhite race, regardless of whether they identified themselves as white or black. Our results from national data are consistent with previous studies in specific, limited populations that showed an association between socioeconomic status, race, or both and less intensive or lower quality of care for asthma.^{14,15} The factors underlying these observations are complex²⁴ and include cost and access to care, preferences and attitudes, racial concordance between physician and patient, and provider biases in clinical and diagnostic assessment.^{20,25-27} The importance of any particular issue is likely to vary with different patients and physicians.²⁴

The starkness of our findings on the disparities of medication by socioeconomic status, and in particular by race-ethnicity, emphasize that the current systems used for asthma management are failing to provide adequate care for a large proportion of the population. Recently, in a call for the stratification by race-ethnicity and socioeconomic status of measures of quality and performance, such as the Health Plan Employer Data and Information Set, Fiscella et al²⁴ suggested that the rise of managed care and increased interest in accountability offered an “unprecedented opportunity to move ... to potential solutions.” These authors stressed that the first necessary step is the recognition of these disparities as a quality problem and that national data, such as reported in this study, can help this process.

Adolescents, young adults, and preschool-age children were significantly less likely to report using anti-inflammatory medication than were adults older than 35 years when stratified by asthma burden and in the multivariate models. Although the risk of inadequate management in these age groups has been reported previously,^{9,10} the strength of the association seen in our study, in which we were able to control for many other factors, indicates its considerable importance. Managing asthma with adolescents and young adults is challenging.^{28,29} In addition to personal attitudes and beliefs, external influences can have major effects; for example, in a recent study 26% of adolescents who used inhalers were not allowed to carry their medication on their person while at school.³⁰ Adolescents and young adults initiate visits to physicians at much lower rates than do younger children,³¹ and lack of contact with clinicians might contribute to their low rates of use of anti-inflammatory medication. Smokers were the other large group found to be at significant risk for less use of anti-inflammatory medication. Although the risks to smokers' health are well recognized, it might not be universally appreciated that they represent a risk group for inadequate asthma therapy. Efforts focusing on improving the systems of care are needed for these 2 easily identified at-risk groups.

Our study has some limitations. Although our survey was limited to households with telephones, 94.1% of occupied housing units in the United States had telephone service in 1998 (Federal Communications Commission, Trends in Telephone Service, July 1999). However, our study population is representative of the US population. Recent US census figures for the general

population report a distribution of race and education level similar to that of our asthma population. The study population did have a higher proportion of adult women compared with the proportion from census figures for the general population. Female predominance has been commonly reported in adult asthmatic populations. In addition, our findings indicated that socially disadvantaged groups were less likely to report currently using anti-inflammatory medications. Hence any bias in sampling by using telephone-owning households only that underrepresents minority or poor households will tend to underestimate the extent of this problem. This study was based on self-reported information. Therefore there are no objective data, such as spirometry or measures of airway responsiveness, to assist in the classification of asthma severity. However, because the Expert Panel II criteria assign individuals to the highest grade in which any feature occurs, the addition of lung function measurements would most likely only serve to increase the numbers of persons classified into higher-severity or higher-burden categories, thereby further lowering the proportion with a higher burden of persistent asthma who report using anti-inflammatory medication. We have no objective data on actual patient use of medication or any information on whether patients are making appropriate use of their medication or on the length of time they are using medication. The use of repeat questions in asking about medication use, including querying the use of any type of medicine, makes it less likely that there was significant underreporting of medication use. Given the potential for recall bias noted previously for self-report of inhaler use,^{32,33} we are thus likely to be overestimating anti-inflammatory use. The cross-sectional study design makes it difficult to draw strong conclusions about temporal trends in medication use. However, comparative data from studies in specific subpopulations from earlier time periods suggest that there have been minimal increases in appropriate use of anti-inflammatory therapy over the past decade.^{9,10,12,13}

Attainment of optimal asthma care remains elusive. The use of proven asthma therapies remains inadequate. Linking health care quality to efforts to reduce disparities in asthma care can assist the national objective of eliminating racial-ethnic disparities in overall health.³⁰

We acknowledge the assistance of Patricia Vanderwolf and John Boyle of Schulman, Ronca & Bucuvalas for statistical analysis with this study.

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