

Modifiable barriers to adherence to inhaled steroids among adults with asthma: It's not just black and white

Andrea J. Apter, MD, MSc,^{a,b} Ray C. Boston, PhD,^c Maureen George, MSN, RN, CS,^{a,d}
A. Lorraine Norfleet, BSN, MHA,^e Thomas Tenhave, PhD,^b James C. Coyne, PhD,^f
Kathleen Birck, BSN,^d Susan T. Reisine, PhD,^g Andrew J. Cucchiara, PhD,^e and
Harold I. Feldman, MD, MSCE^b Philadelphia, Pa, and Farmington, Conn

Background: Sociobehavioral factors influence adherence to inhaled corticosteroid (ICS) in adults with asthma and warrant exploration as explanations of apparent racial disparities in adherence.

Objective: The purposes of this study were to identify barriers to adherence, potentially modifiable by healthcare providers, in a group of African Americans and non-African Americans and to test modifiable barriers as explanations of racial-ethnic differences in adherence.

Methods: We conducted a cohort study of 85 adults (mean age, 47 ± 15 years; 61 [72%] female; 55 [65%] African American) with moderate or severe persistent asthma to determine modifiable sociobehavioral predictors of adherence. These were knowledge of the function of ICS, patient-perceived adequacy of communication with the provider, social support, attitude (perception of risks/benefits of ICS), depression, and self-efficacy. Adherence was calculated from electronic monitoring data as the mean of the number of doses recorded per 12 hours divided by the number prescribed, truncated at 100%. Past adherence, baseline severity of symptoms, and sociodemographics were treated as fixed confounders in ordinal logistic modeling.

Results: Adherence was 60% ± 30%. In bivariate analyses, favorable attitude to ICS ($P = .01$) was associated with better adherence. Of immutable predictors, African American race-ethnicity ($P = .001$), lower educational achievement ($P = .01$), lower household income ($P = .002$), and more baseline symptoms ($P = .003$) were associated with poorer adherence. In multivariable analysis, controlling for immutable predictors, favorable attitude was associated with adherence. Favorable

attitude was associated with greater adherence in African Americans and non-African Americans. Controlling for immutable factors, the race-adherence relationship was not mediated by the mutable factors, but economic factors (income and insurance) were mediators.

Conclusion: Attitude is strongly related to adherence but does not mediate the effect of race-ethnicity. (J Allergy Clin Immunol 2003;111:1219-26.)

Key words: Asthma, adherence, health beliefs, health disparities, inhaled corticosteroids, minority groups, African American, socioeconomic status

Adherence to inhaled corticosteroids (ICS), medications known to be safe and efficacious,^{1,2} is poor in all patient groups.^{1,3,4} We hypothesized that there are potentially modifiable barriers to adherence that can be addressed by the clinician during interactions with the patient.

Although we have been unable to separate the effect of minority status from determinants of socioeconomic status, we³ and others have found adherence to be poorer in minority groups. African Americans have twice the morbidity from asthma experienced by whites⁵ and, along with other minority groups, encounter more institutional barriers to health care.⁶ These barriers may contribute to poor adherence. Understanding and removing these barriers are a critical public health mission.⁶ Some of these barriers can be modified through more effective patient-clinician interactions. A recent Institute of Medicine report has specifically targeted these interactions for intervention to reduce health disparities.⁶ Our second hypothesis was that minority racial groups experience different barriers to adherence and that these may be potentially modifiable by the clinician. There has been little investigation of these barriers in urban minority adults with asthma.³

Because there are no conceptual models for assessing ICS adherence, adherence in asthma in general, or in minority groups, we formulated a heuristic model of predictors of adherence to ICS (Fig 1). This model incorporates the Health Belief Model,^{7,8} which states that for adherence to occur, a patient must believe that the benefits of taking a medication outweigh its risks, a concept we called attitude. It also incorporates elements from the Theory of Reasoned Action⁹ suggesting that environmental barriers and social support must be considered in understanding adherence. Finally, the model includes the concept of self-efficacy,^{10,11} a patient's

From the ^aDivision of Pulmonary, Allergy Critical Care Medicine, Department of Medicine; ^bCenter for Clinical Epidemiology and Biostatistics; ^cSchool of Veterinary Medicine; ^dSchool of Nursing; ^eGeneral Clinical Research Center; ^fDepartment of Psychiatry, Department of Family Practice and Community Medicine; University of Pennsylvania; and ^gDepartment of Behavioral Science and Community Health, University of Connecticut School of Dental Medicine.

Supported by National Heart Lung & Blood Institute (HL04337-01), University of Pennsylvania Research Trust, American Academy of Allergy Asthma & Immunology, General Clinical Research Center of the University of Pennsylvania and by the Public Health Services Research Grant M01-RR00040 from the National Institutes of Health.

Received December 17, 2002; revised February 1, 2003; accepted for publication February 17, 2003.

Reprint requests: Andrea J. Apter, MD, MSc, 829 Gates Building, Hospital of the University of Pennsylvania, 3600 Spruce Street, Philadelphia, PA 19104.

© 2003 Mosby, Inc. All rights reserved.

0091-6749/2003 \$30.00 + 0

doi:10.1067/mai.2003.1479

Asthma, rhinitis,
other respiratory
diseases

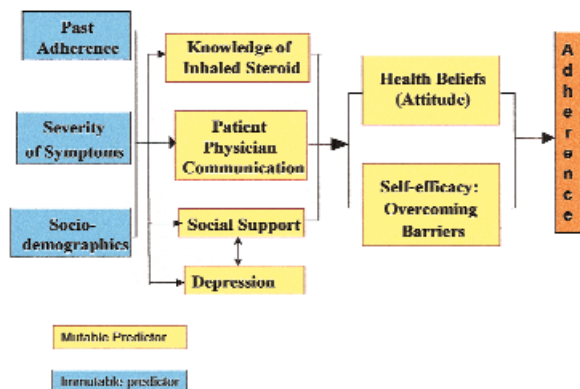


FIG 1. A conceptual model of some determinants of adherence. The yellow boxes indicate predictors (barriers) that are modifiable at the patient-provider interface. The blue boxes indicate predictors (barriers) that are not modifiable at the patient-provider interface and are treated as confounders in the analysis. Severity of symptoms refers to underlying severity before treatment.

Abbreviations used

- ASUI: Asthma Symptom Utility Index
- CES-D: Center for Epidemiologic Studies Depression Scale
- IAS: Inhaler Adherence Scale
- ICS: Inhaled corticosteroids

belief that barriers to medicine taking can be overcome. Self-efficacy and attitude may in turn rest on factual knowledge of a medicine's actions and side effects, which may be imparted through effective communication between patients and health care providers. Members of patients' social support network also may influence self-efficacy and attitude.

Depression has been associated with poor adherence to medical regimens.¹² DiMatteo et al¹² conducted a meta-analysis and found 10 studies of adults in which depression correlated with poor adherence to therapy. Two studies from Europe associated depression with poor adherence in adults with asthma.^{13,14} Sociodemographic attributes including age, gender, educational attainment, and race-ethnicity may influence a patient's ability to acquire knowledge, to communicate effectively with health care providers, and to obtain effective social support. Likewise, past adherence,¹⁵ baseline severity of symptoms, and sociodemographics³ may be predictors of adherence and immutable characteristics that influence knowledge of disease, communication with physician, and depression that may determine a patient's attitude toward inhaled steroids and conception of ability to take long-term medication. Some risk factors such as past poor adherence¹⁵ and low socioeconomic status are not amenable to modification by the clinician so we considered these immutable predictors to be confounders.

Adherence data were obtained by electronic monitoring of the use of ICS.

METHODS

The University of Pennsylvania Institutional Review Board approved this cohort study. As described below and in Fig 2, we assessed barriers to adherence by interviews. We monitored subjects' use of ICS for 42 days to determine adherence.

Patients

From August 2000 through May 2002 we recruited women and men, aged 18 years and older, with moderate or severe persistent asthma as defined by the National Asthma Education and Prevention Expert Panel.^{1,2} Subjects had a (1) pre-bronchodilator FEV₁ less than 80% predicted, obtained within 3 years of entry, (2) documentation of 15% improvement in FEV₁ after administration of bronchodilator within 3 years of entry, and (3) current use of ICS. Smokers were allowed to participate.

Patients were recruited from the asthma clinics of University of Pennsylvania Health System Comprehensive Asthma Center at Presbyterian Medical Center, the pulmonary-allergy and general medicine clinics of the Hospital of the University of Pennsylvania, and the primary care practices at Presbyterian Medical Center. Subjects were enrolled by 1 of 2 nurses either at the General Clinical Research Center of the Hospital of the University of Pennsylvania or the Comprehensive Asthma Center at Presbyterian Medical Center. Consistency of the delivery of the protocol between nurses was maintained through biweekly meetings with the principal investigator (A.J.A.). In addition, the principal investigator observed recruitment and enrollment procedures intermittently throughout the study period.

Subjects received inhaled steroids and 1 canister of albuterol. After completing all elements of the protocol and returning the monitors, they received \$50.

Protocol

After informed consent was obtained, subjects were interviewed to determine their demographic characteristics, socioeconomic status, asthma history, symptoms, current medications, and barriers to adherence. Spirometry was completed.

Monitoring

Patients' use of ICS was monitored for 42 days with an MDILog (Westmed, Inc, Englewood, Colo),¹⁶ an electronic sleeve that records the time and date of actuation of the inhaler. Before monitoring, to standardize scheduling of ICS, which can influence adherence,¹⁷ patients' schedules were converted to a twice daily regimen without changing the total daily dose. Participants were told that the MDILogs recorded the time and date of each inhaler actuation, but they were not told the study hypothesis.

Dependent measure (adherence)

ICS adherence was calculated for each 12-hour period as the following formula: (Number of recorded actuations ÷ Prescribed number of actuations for a dosing period) × 100. The mean percent adherence was calculated for each subject. Another measure of adherence, truncated adherence, was calculated by truncating mean adherence greater than 100% for any 12-hour period to 100%. Truncation eliminates potential artifacts from priming actuations and intentional or unintentional overuse of ICS. We and others have used this method previously^{3,18,19} and found it to be a better measure of adherence than mean adherence. Thus, mean truncated adherence was used as the primary outcome measure, and we will refer to this variable as adherence.

Independent measures

We categorized the independent variables as predictors if they represented potentially modifiable barriers to adherence and as con-

founders if they represented immutable barriers with respect to patient-physician interactions.

Predictors

The predictors, the potentially modifiable barriers to adherence, are presented in Fig 1. Because validated questionnaires were not available to measure understanding of the function of ICS, their benefits, and adverse effects, we developed and used an 8-item Knowledge questionnaire with a 5-point response scale (Cronbach's alpha, 0.73).³ A total score of this scale is calculated from the sum of the items. A higher score indicates more knowledge of the function of ICS.

We previously developed a Communication questionnaire to measure patient perceptions of the adequacy of communication with their physician. It also has 8 items and a 5-point response scale (alpha, 0.74).³ The sum is used as the measure, with higher score indicating better perceived communication. Depression was measured by using the Center for Epidemiologic Studies Depression Scale (CES-D).²⁰ The CES-D is a 20-item scale with a 4-point response scale. Responses to 4 positive questions are reversed and the responses are summed to provide a score ranging from 0 to 60. Scores of 16 or more are considered indicative of depression. It has been used in cross-cultural research and in minority patients.²¹

Because no measure was available, in a previous study we developed and modified a 7-item Attitude questionnaire to measure patients' assessments of the risks and benefits of inhaled steroids,³ a concept distinct from factual knowledge. A higher score indicates more appreciation of the benefits of ICS. The items of this questionnaire are listed in Table III. Self-Efficacy was measured by using a 12-item questionnaire with a 6-point response scale that measures perceived barriers to taking inhaled steroids.³ The Knowledge, Communication, Attitude, and Self-Efficacy questionnaires have been used with low income and minority subjects. To measure social support, we used the MOS Social Support Survey,²² which yields a total score calculated from the sum of items 2 to 20. A higher score implies more support.

Confounders

The immutable barriers or confounders considered were sociodemographics, disease severity, and past adherence. The sociodemographics included age, gender, race/ethnicity, type of health insurance, number of years of completed education, household income, number of children in the home, marital status, current and past smoking status, and whether the participant worked outside the home. Severity was measured as lifetime number of hospitalizations and lifetime number of emergency department visits. In addition, we obtained FEV₁ expressed as percent predicted according to American Thoracic Society criteria.²³ Participants also completed the Asthma Symptom Utility Index (ASUI),²⁴ which measures symptoms during the 2 weeks before enrollment. Past adherence was measured by using the Inhaler Adherence Scale (IAS),^{25,26} with a higher score (range, 0 to 6) associated with poorer adherence.

Data management

When a subject completed the protocol, the principal investigator scrutinized all questionnaires for completeness. If missing information was noted, the study nurses contacted the subject to retrieve the information.

The data from the MDILogs were downloaded directly into an Excel (Microsoft Corp, Redmond, Wash) spreadsheet and exported into Stata 7.0 (Stata Corp, College Station, Tex) for analysis. Data from the questionnaires were entered into a Microsoft Access 2000 database. Entries were made by one investigator and checked independently by a second investigator. This database was exported into Stata 7.0 for analysis. In Stata 7.0, all data elements underwent a

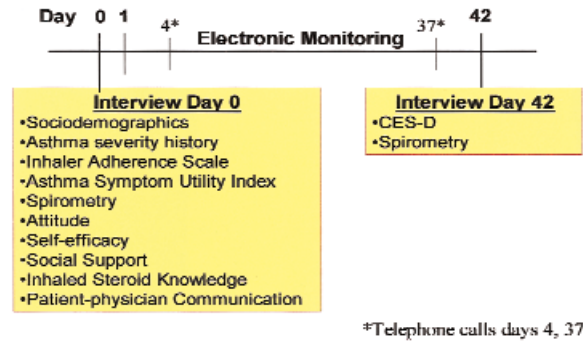


FIG 2. Study protocol. Subjects were interviewed to assess barriers to adherence. To determine adherence, subjects' use of ICS was monitored electronically for 42 days.

descriptive analysis, which included looking for outliers and missing values and examining the frequency distributions.

Data analysis

We assessed the independent and dependent variables for normality. We measured central tendency and variability of the variables as mean $\pm$ standard deviation for those that were normally distributed and median and range for those that were not. Cronbach's alpha was calculated for the questionnaires. For those questionnaires with relatively low consistency measures (Cronbach's alpha) the individual items were tested for association with adherence.

Neither average nor truncated adherence, the outcome, was normal and could not be transformed to a normal distribution. Thus, adherence (truncated) was categorized on the basis of its frequency distribution into 4 categories (less than 20%, 20% to less than 50%, 50% to less than 75%, and 75% to 100%). We conducted a univariate analysis by using ordinal logistic regression. We anticipated that the variables representing aspects of socioeconomic status would be highly correlated and anticipated using the one most significantly associated with adherence in multivariable models. For household income as a variable in the univariate and multivariable analyses we divided household income, a categorical variable, by number of household members. For the multivariable analysis, only those with *P* value less than .2 on univariate analysis were entered into the multiple regression.

We assessed the effect of race-ethnicity. Because the sample of non-African Americans was too small, we could not test for race-ethnicity differences with respect to multivariate models. First, we looked for effect modification between pairs of significant predictors, especially demographics and modifiable predictors, eg, race and attitude. For example, an effect modification of attitude by race-ethnicity would mean the association between attitude and adherence would be different (eg, weaker, stronger, reversed) in African Americans compared with non-African Americans.

Second, we explored whether significant modifiable predictors of adherence mediate the effect of race-ethnicity on adherence. A mediator is a type of confounder that is in the logical and statistical pathway between exposure and outcome. For example, if race-ethnicity were mediated by attitude, then including attitude in a test of association would change the strength of the association between race-ethnicity and adherence.

RESULTS

We enrolled 88 subjects and 85 completed the protocol for a dropout rate of 3%. Twenty-one patients who declined enrollment were similar to the final cohort in demograph-

Asthma, rhinitis,
other respiratory
diseases

TABLE I. Baseline (immutable) characteristics of 85 adults with asthma

Characteristic	Number of subjects (%)
Demographics	
Age (mean $\pm$ SD)	47 $\pm$ 15 y
Female	61 (72%)
Race-ethnicity	
African American	55 (65%)
Non-African American*	30 (35%)
Education: $\leq$ 12 y of school	61 (72%)
Household income < \$30,000	42 (49%)
Commercial insurance	45 (53%)
Current smoker	6 (7%)
Tobacco pack-years (mean $\pm$ SD)	9.0 $\pm$ 12.0
Disease severity	
ASUI†	0.59 $\pm$ 0.28
FEV ₁ (% predicted)	65% $\pm$ 19%
History of intubations for asthma	19 (22%)
Lifetime hospitalizations	6 (median), interquartile range: 1-25
Lifetime emergency department visits	19 (median), interquartile range: 3-50
Past adherence (IAS) ^{25,26}	2 (median), range: 0 - 5

*28 were white.

†This measure²⁴ is a utility with 1.0 indicating no symptoms and 0 the worst symptoms. In the 161 adults in whom this tool was validated (ref), the mean ASUI was 0.71 $\pm$.23 (fewer symptoms).²⁴**TABLE II.** Mean, range, and Cronbach's alpha of the modifiable predictors

Questionnaire*	Mean $\pm$ SD	Range	alpha
IAS	1.95 $\pm$ 1.45	0-5	0.55
ASUI	0.59 $\pm$ 0.28	0.40-1.00	0.91
Knowledge	30.8 $\pm$ 4.8	19-40	0.55
Communication	37.1 $\pm$ 3.2	28-40	0.61
Social Support	77.6 $\pm$ 14.7	31-95	0.95
Depression	11.8 $\pm$ 10.6	0-52	0.92
Attitude	29.2 $\pm$ 3.6	19-35	0.54
Self-Efficacy	57.3 $\pm$ 7.4	36-69	0.65

*The range of the IAS is 0 to 6, 0 to 1 for the ASUI, 8 to 40 for the Knowledge scale, 8 to 40 for the Communication scale, 19 to 95 for the MOS Social Support Survey, 0 to 60 for the CES-D Depression Scale, 7 to 35 for the Attitude Scale, and 6 to 72 for the Self-Efficacy scale.

ics. The demographics and disease severity of 85 patients are described in Table I. Table II displays mean, variability, and Cronbach's alpha of the questionnaires.

Mean adherence was 68% $\pm$ 42%. The mean truncated adherence was 60% $\pm$ 30%. Neither variable was normally distributed. Fig 3 displays the frequency distribution of truncated adherence.

Table III describes significant associations between independent variables and truncated adherence on univariate analysis. All the measures of socioeconomic status were associated with truncated adherence and with each other (Table III). More baseline asthma symptoms, measured with the ASUI, were associated with poorer

adherence. Asthma severity variables that were not associated with adherence included baseline FEV₁, prednisone use, number of lifetime hospitalizations, number of lifetime emergency department visits, and whether the subject had been intubated for asthma.

As displayed in Table II, the Cronbach's alphas for the questionnaires we had developed (Attitude, Knowledge, Communication, Self-Efficacy) were low. This was in part due to the small number of items. We performed ordinal logistic regression by using each item of these tools separately. The results for the individual analysis for the Attitude questionnaire are presented in Table III. Higher regard for the benefits and less fear of adverse effects of ICS were associated with better adherence. Only 1 item of the Self-Efficacy questionnaire ("I forget to take my inhaled steroids when my spirits are low.") was associated with adherence. There was no significant association between the items of the Communication and Knowledge questionnaires with adherence.

Table IV displays the multivariable analysis for the entire group. In Model A we entered those variables from the univariate analysis with a significance level of *P* less than or equal to .20. The results are similar if race-ethnicity is replaced by correlated socioeconomic variables, such as income or health insurance. The nested models (Models B and C) present the relationships between predictors and adherence when the significant immutable predictors are entered first and then the significant modifiable predictors are added one at a time to the model. When knowledge is added to model C, the change in the likelihood ratio for the model is not significant. These models demonstrate that only attitude is a strong predictor of adherence even when controlling for immutable predictors.

We examined the effect of race-ethnicity in 2 different ways: (1) effect modification of the above univariate relationships by race and (2) mediation of the race-adherence relationship by above predictors of adherence.

Effect modification of the association between attitude and other factors on adherence by race. First, there were no statistically significant interactions of race-ethnicity or socioeconomic factors with attitude (*P* > .32) or the other modifiable predictors of adherence (*P* > .30). Race-specific findings confirmed the absence of interactions of race-ethnicity with attitude or other modifiable predictors of adherence. Attitude was associated with adherence for non-African Americans (point estimate, 1.39; confidence interval, 1.08 to 1.79; *P* = .01). For African Americans, attitude was significantly associated with adherence (point estimate, 1.17; confidence interval, 1.02 to 1.36; *P* = .03).

Mediation of race-ethnicity effect on adherence by modifiable and immutable predictors of adherence. Two aspects of this relationship were assessed. First, we compared African Americans and non-African Americans with respect to the potential mediators in univariate rank sum statistics (Table V). In addition, mean and mean truncated adherence for African Americans was lower than for non-African Americans (52% $\pm$ 30% compared with 74% $\pm$ 24%, *P* < .001).

TABLE III. Univariate results: Variables associated with truncated adherence by using ordinal logistic regression

Independent variable	Point estimate of the odds ratio	Confidence interval of odds ratio	P value
Immutable predictors (confounders)			
Sociodemographics*			
Age	1.01	0.99-1.04	.39
Gender	1.36	0.58-3.19	.48
African American	0.23	0.10-0.56	.001
More than 12th grade education	3.46	1.35-8.75	.01
Commercial insurance	4.35	1.92-9.97	<.001
Household income†	3.56	1.60-8.00	.002
Tobacco pack years	1.00	0.97-1.03	.90
Asthma severity			
Baseline FEV ₁	1.01	0.99-1.03	.55
Lifetime intubations	0.88	0.71-1.01	.25
Lifetime hospitalizations	1.00	0.997-1.001	.30
Lifetime emergency department visits	1.00	0.999-1.001	.65
ASUI‡§	1.25	1.08-1.45	.003
Past adherence			
IAS	0.81	0.62-1.06	.12
Modifiable predictors			
Knowledge	1.08	0.99-1.17	.08
Communication	1.03	0.91-1.17	.61
Social support	1.01	0.98-1.03	.65
Depression	0.99	0.95-1.03	.50
Attitude	1.25	1.12-1.42	<.001
Item 1: Inhaled steroids help me.	1.77	0.94-3.35	.08
Item 2: Even though steroids help, it is not worth taking the medicine every day.¶	1.76	1.09-2.86	.02
Item 3: Since I have been using inhaled steroids, my asthma has gotten better.	1.88	1.17-3.00	.009
Item 4: I find inhaled steroids are easy to use.	1.30	0.75-2.26	.35
Item 5: If I take inhaled steroids regularly, I will become addicted to them.¶	1.39	0.99-1.96	.058
Item 6: Inhaled steroids take time to use, but it is worth the effort.	1.21	0.79-1.84	.39
Item 7: I am not sure how safe inhaled steroids are—they are steroids.¶	1.63	1.20-2.21	.002
Self-efficacy	0.99	0.94-1.04	.68

*Sociodemographics not associated with adherence were age, gender, age of diagnosis of asthma, current smoker, number of pack years smoked.

†Household income was calculated as household income (categorized) divided by number of household members.

‡Asthma severity variables not associated with adherence were baseline FEV₁, hospitalization, emergency department visits, intubations.

§Per 0.1 unit change on ASUI scale. Higher ASUI is associated with fewer symptoms and side effects.

¶These items were scored so that a higher Likert value was consistent with belief in the benefits of steroids.

Second, we assessed whether attitude and other factors, both mutable and immutable, diminish the effect of race-ethnicity on adherence in univariate models. For example, considering attitude as a mediator, we evaluated 2 models:

I. adherence = race-ethnicity and

II. adherence = race-ethnicity + attitude.

The coefficient for race-ethnicity in Model I is -1.466654 ($P = .001$). In Model II with attitude and race-ethnicity, the race-ethnicity coefficient is -1.28263 ($P = .005$). This is a 13% reduction in the race coefficient as a result of the inclusion of attitude in the model. According to the arbitrary threshold of 15%,²⁷ this is not significant. The reduction for knowledge, communication, and depression was 6%, for self-efficacy 4%, and for social support less than 1%. Although there is some reduction

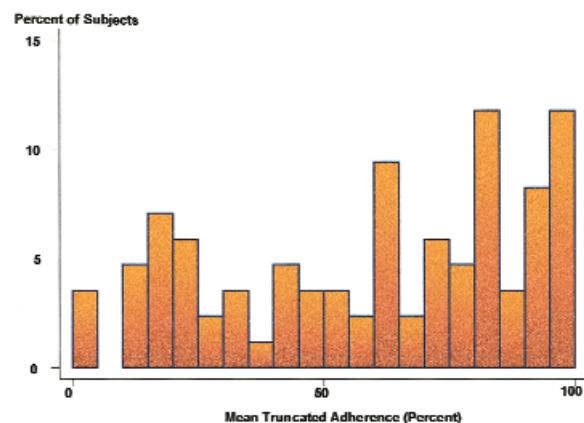


FIG 3. Frequency distribution of mean truncated adherence.

Asthma, rhinitis,
other respiratory
diseases

TABLE IV. Multivariable model of predictors of adherence for 85 adults with persistent asthma by using ordinal logistic regression

Model	Point estimate of the odds ratio	Confidence interval	P value
Model A: Entering variables with $P < .20$, LR = 27.20*			
ASUI†	0.36	0.063-2.10	.15
IAS	0.83	0.63-1.09	.18
African American‡	0.35	0.13-0.95	.04
Attitude	1.21	1.07-1.37	.002
Knowledge	.99	0.90-1.09	.84
NESTED MODELS			
Model B: Significant immutable predictors, LR = 17.34			
ASUI†	0.52	0.101-2.67	.05
IAS	0.82	0.62-1.08	.15
African American	0.33	0.13-0.84	.02
Model C: Significant immutable predictors and attitude, LR = 27.16			
ASUI†	0.34	0.064-1.82	.15
IAS	0.83	0.63-1.09	.18
African American	0.36	0.14-0.93	.04
Attitude	1.21	1.07-1.37	.002

LR, Likelihood ratio for the model.

†Per 0.1 unit change on ASUI scale. Higher ASUI is associated with fewer symptoms and side effects.

‡The results of the model are similar, if race-ethnicity (African American) is replaced by correlated socioeconomic variables like income or health insurance.

TABLE V. Comparing modifiable predictors of adherence by race-ethnicity*

Modifiable predictor	African American	Non-African American	P value†
Attitude	28.5 ± 3.6	30.5 ± 3.4	.01
Knowledge	29.2 ± 4.6	33.6 ± 3.8	<.001
Depression	14.3 ± 11.5	7.2 ± 6.6	.004
Social support	75.7 ± 15.2	81.1 ± 13.4	.10
Communication	37.4 ± 3.0	36.5 ± 3.4	.26
Self-efficacy	56.8 ± 7.5	58.1 ± 7.2	.43

*The range of the Attitude Scale is 7 to 35, 8 to 40 for the Knowledge scale, 0 to 60 for the CES-D Depression Scale, 19 to 95 for the MOS Social Support Survey, 8 to 40 for the Communication scale, and 6 to 72 for the Self-Efficacy Scale.

†Rank sum test.

in the race-ethnicity coefficient due to attitude, there is little evidence of true mediation of the race-ethnicity effect on adherence by attitude. However, several immutable predictors change the effect of race-ethnicity on adherence: household income (32%), having commercial insurance (42%), and symptoms in the 2 weeks before entry into the study as measured by the ASUI (23%). These findings suggest that the effects of race-ethnicity may be due in large part to socioeconomic status, although race-ethnicity still independently influences adherence.

DISCUSSION

We conducted a cohort study of 85 adults with persistent asthma to determine potentially modifiable barriers to adherence, as well as to examine potential mediators of racial-ethnic differences in adherence. The modifiable barriers were those that could be addressed in the patient-physician encounter. Better attitude, that is, less fear of adverse effects of ICS and stronger beliefs in their benefits, was associated with better adherence (Table IV). This is our most important finding: in all patient groups

including minority subjects, attitude is an important determinant of poor adherence.

We also explored differences in the impact of modifiable barriers on adherence between African Americans and non-African Americans, because African Americans have twice the rates of death and hospitalizations from asthma compared with whites.⁵ In addition, the recent Institute of Medicine report⁶ addresses the lower quality of health care received by racial and ethnic minorities. The report targets patient-provider relationships as an area to be strengthened to address these disparities. Our findings suggest that less advantaged groups have more modifiable predictors of adherence that can be addressed by health care providers. In our entire subject group better attitude was significantly related to better adherence. However, African Americans had more fear of ICS (lower attitude scores), higher depression scores, and lower knowledge scores than non-African Americans (Table V).

We further analyzed the effect of race-ethnicity in 2 ways: (1) race-ethnicity differences with respect to the above relationships of immutable and nonimmutable predictors and adherence and (2) the mediation of the race-adherence effect by these factors.

We found no effect modification of attitude by race-ethnicity. It is important to emphasize that in our sample the multivariable models relating multiple immutable and nonimmutable factors to adherence cannot be analyzed separately in African Americans and non-African Americans (effect modification with respect to multivariate relationships). However, we were able to assess differences with respect to univariate relationships between the above factors and adherence (effect modification with respect to univariate relationships).

We showed that mutable factors did not mediate the race-ethnicity adherence relationship and that the effects of race-ethnicity and attitude on adherence are separate effects. However, this same analysis showed that household income and having commercial health insurance do mediate the effect of race-ethnicity on adherence.

There are several possible implications to these findings. First, the effect of race-ethnicity in our subjects appears more strongly influenced by other immutable factors of social disparity (eg, household income and having commercial health insurance) than by the modifiable predictors we considered. Second, it is possible that there are other mutable predictors of adherence not measured in this study, such as patient trust of providers and the medical system, that mediate the relationship between race-ethnicity and adherence. Third, there are possibly other immutable factors (immutable at the patient-provider level but not the public policy level) that may be important mediators, such as the burden of care for other family members. The analysis of mediators underlines our chi-square analysis that in our subjects, the effect of race-ethnicity was not separable from measures of socioeconomic status, income status, educational status, or other measures of social position. It is quite possible that with a different sample, eg, of minority subjects with high income and non-minority with low income, the results would be different. Thus, in identifying modifiable barriers to adherence, the issue is not as simple as black and white, as our title implies.

Our study suggests it is important to determine patient understanding of the role, benefits, and adverse effects of ICS. In addition, our data suggest it is important to individualize educational information so that patients with different social and cultural backgrounds can understand the full impact of the information.

In this study, unlike our previous study,³ patient-perceived adequacy of communication was not a predictor of adherence. One explanation is that our Communication questionnaire measures patients' perception of physician responsiveness but not how effectively providers convey information and allay fears of adverse reactions to ICS. This issue too deserves further investigation.

Our study has additional limitations. First, the internal consistency of the Attitude questionnaire was low, suggesting that perhaps more than one theme is depicted in the question set. When we analyzed each question separately we found this to be the case. However, it is clear from considering each item individually (Table III) that fear of adverse effects is important to patients and influ-

ences adherence. Adding more items would likely improve the reliability of the questionnaire. As we noted above, it is possible that there are other elements of patient-physician interaction that were not measured, such as the adequacy of the interaction from the physician point of view. Finally, this study examined a relatively small group of patients who were willing and able to adhere to the study protocol.

What then are the lessons we can take away for clinical practice and research? For the clinician, it is important to explore patients' beliefs and concerns about the safety and benefits of medications. It is important for the provider to determine the best way to discuss this information by taking account of patients' health beliefs, educational attainment, and cultural background. For the researcher, the next step is to determine interventions that address patient beliefs. It is likely that these will have to be individualized interventions that then can be applied to clinical practice.

In summary, different patient groups may experience different barriers to adherence, but fear of side effects is important to many patients. It is important in patient-provider interactions and in the national setting of health care delivery to determine and to address barriers to adherence.

REFERENCES

1. Expert panel report II: guidelines for the diagnosis and management of asthma: publication 97-4051. Bethesda (MD): Public Health Service, National Institutes of Health, National Heart, Lung, and Blood Institute; 1997.
2. Expert panel report: guidelines for the diagnosis and management of asthma—update on selected topics—2002. *J Allergy Clin Immunol* 2002;110:S141-S218.
3. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids: socioeconomic and health-belief differences. *Am J Respir Crit Care Med* 1998;157:1810-7.
4. Bender B, Milgrom H, Rand C. Nonadherence in asthmatic patients: is there a solution to the problem? *Ann Allergy Asthma Immunol* 1997;79:177-86.
5. Mannino DM, Homa DM, Akinbami LJ, Moorman JE, Gwynn C, Redd SC. Surveillance for asthma: United States, 1980-1999. *MMWR* 2002;51(SS01):1-13.
6. Unequal treatment: confronting racial and ethnic disparities in health care. Washington, DC: Institute of Medicine; 2002.
7. Becker MH. The health belief model and personal health behavior. *Health Education Monographs* 1974;Winter:2.
8. Becker MH, Maiman LA. Sociobehavioral determinants of compliance with health and medical care recommendations. *Med Care* 1975;13:10-24.
9. Ajzen I, Fishbein M. Understanding attitudes and predicting behavior. Englewood Cliffs (NJ): Prentice Hall; 1980.
10. Bandura A. Self-efficacy in changing societies. Cambridge (UK): Cambridge University Press; 1995.
11. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 1977;84:191-215.
12. DiMatteo MR, Lepper HS, Croghan TW. Depression is a risk factor for non-compliance with medical treatment: meta-analysis of the effects of anxiety and depression on patient adherence. *Arch Intern Med* 2000;160:2101-7.
13. Picado C, Montserrat JM, de Pablo J, Plaza V, Agusti-Vidal A. Predisposing factors to death after recovery from a life-threatening asthmatic attack. *J Asthma* 1989;26:231-6.
14. Bosley CM, Fosbury JA, Cochrane GM. The psychological factors associated with poor compliance with treatment in asthma. *Eur Respir J* 1995;8:899-904.
15. Sherbourne CD, Hays RD, Ordway L, DiMatteo MR, Kravitz RL. Antecedents of adherence to medical recommendations: results from the Medical Outcomes Study. *J Behav Med* 1992;15:447-68.

16. Apter AJ, Tor M, Feldman HI. Testing the reliability of old and new features of a new electronic monitor for metered dose inhalers. *Ann Allergy Asthma Immunol* 2001;86:421-4.
17. Mann M, Eliasson O, Patel K, ZuWallack RL. A comparison of the effects of bid and qid dosing on compliance with inhaled flunisolide. *Chest* 1992;101:496-9.
18. Apter AJ, Reisine ST, Willard A, Clive J, Wells M, Metersky M, et al. The effect of inhaled albuterol in moderate to severe asthma. *J Allergy Clin Immunol* 1996;98:295-301.
19. Apter AJ, ZuWallack RL, Clive J. Common measures of asthma severity lack association for describing its clinical course. *J Allergy Clin Immunol* 1994;94:732-7.
20. Radloff LS. The CES-D Scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement* 1977;1:385-401.
21. McDowell I, Newell C. A guide to rating scales and questionnaires. 2nd ed. New York: Oxford University Press; 1996.
22. Sherbourne CD, Stewart AL. The MOS social support survey. *Soc Sci Med* 1991;32:705-14.
23. Society AT. Standardization of spirometry: 1994 update. *Am J Respir Crit Care Med* 1995;152:1107-36.
24. Revicki DA, Leidy NK, Brennan-Diemer F, Sorensen S, Togias A. Integrating patient preferences into health outcomes assessment: the multiattribute Asthma Symptom Utility Index. *Chest* 1998;114:998-1007.
25. Dolce JJ, Crisp C, Manzella B, Richards JM, Hardin JM, Bailey WC. Medication adherence patterns in chronic obstructive pulmonary disease. *Chest* 1991;99:837-41.
26. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care* 1986;24:67-74.
27. Rothman KJ, Greenland S. *Modern epidemiology*. Philadelphia: Lippincott Williams and Wilkins; 1998.