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Assessment of Asthma Severity in Adults With Asthma Treated by Family Practitioners, Allergists, and Pulmonologists

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OBJECTIVES. **Accurate measurement of asthma severity is critical for research evaluating asthma health outcomes. There are, however, no widely accepted asthma severity measures. A severity-of-asthma score, which is based on self-reported information, was previously developed and validated in subjects recruited from pulmonary and allergy subspecialty practices. The purpose of this study was to validate the severity-of-asthma score in subjects treated by family practice physicians and to compare asthma severity in subjects treated by family practitioners (n = 150) with those seen by allergists (n = 217) and pulmonologists (n = 384).**

METHODS. **The study was an ongoing panel study of adults with asthma. Subjects were a random sample of board-certified family practice, allergy, and pulmonary physicians. Each physician registered patients with asthma aged 18 to 50 years. Of 869 subjects registered, 751 (86%) completed structured telephone interviews. The family practice panel was recruited approximately 3 years after the subspecialty panel.**

RESULTS. **In the family practice subjects, the severity-of-asthma score demonstrated internal consistency (Cronbach's alpha 0.76) and concurrent validity, correlating strongly with asthma-specific quality of life, SF-36 General Health and Physical Functioning scales, and subject-perceived asthma severity. After controlling for demographic characteristics, a 5-point score increment was associated with increased emergency department visits, urgent physician visits, and restricted activity days. The mean severity score was highest in the pulmonary group (11.8 ± 6.3), followed by the allergy (10.3 ± 5.3) and family practice (9.3 ± 5.5) groups.**

CONCLUSIONS. **The severity-of-asthma score was a valid measure in generalist-treated subjects. Asthma severity varied significantly by physician specialty.**

Key words: asthma; severity-of-illness index; family practice; pulmonary disease (Specialty); allergy and immunology. (Med Care 1998;36:1567–1577)

The impact of physician specialty on asthma health outcomes is currently an active area of research and debate. In several studies of asthma management, subspecialist care resulted in better patient outcomes and decreased health care utilization compared with generalist care.[1–7] Only one study, however, adjusted health outcomes for asthma severity.[7] In fact, very little is known about the relative severity of asthma in patients treated by subspecialists and generalists.

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Research in other chronic illnesses has clearly indicated that patient mix, including disease severity and demographic characteristics, can confound the association between physician specialty and patient outcomes.[8–10] For instance, the Medical Outcomes Study found that patients treated by medical subspecialists were characterized by older age, worse functional status, and more chronic illness diagnoses than those seen by family practitioners.[8] In the case of diabetes, subspecialist-treated patients had greater disease severity. Further analysis revealed that higher health care utilization by subspecialists could be partially explained by these differences in patient mix.[9] The assessment of disease-specific severity, then, is critical for studying the effect of physician specialty on health outcomes.

The failure to adequately consider asthma severity in outcomes research has resulted, in part, from the absence of a widely accepted asthma severity measurement.[11] To address this shortcoming, we developed a disease-specific severity-of-asthma score.[12,13] Based on asthma symptoms, current medication use, steroid dependency, and prior hospitalizations, the severity-of-asthma score originally was developed in adults with asthma seen at a university pulmonary specialty clinic.[12] Subsequently, the score was validated in a cohort of 601 asthma patients recruited from allergists and pulmonologists in Northern California.[13] The severity-of-asthma score's validity in patients seen by generalist physicians, such as family practitioners, had not been established. Because family practitioners may treat younger and healthier patients, the severity score might perform differently in this group.[8] In the current study, we assessed the severity-of-asthma score in asthma patients treated by board-certified family practitioners. We then tested the hypothesis that patients treated by family practitioners have less severe asthma than those seen by allergists and pulmonologists.

Because the severity-of-asthma score contains treatment-related items, the score could reflect disease-specific severity (a patient-level characteristic) or physician practice patterns (a quality-of-care issue). Increased medication use, for instance, could reflect either more severe asthma or more intensive physician prescribing behavior. Therefore, we also assessed whether subspecialty-treated subjects have higher severity scores because they have increased disease severity or physicians who treat asthma more aggressively.

Methods

Physician Recruitment

The study protocol was approved by the Committee on Human Research at the University of California, San Francisco. We obtained a list of all certified American Board of Medical Specialty family practice specialists (n = 2,041), internal medicine and pulmonary specialists (n = 252), and internal medicine and allergy/immunology specialists (n = 40). We used specialty board-based lists, rather than professional organization lists (eg, American Medical Association), to most clearly define physician specialty designations. From the family practice group, we randomly selected 167 physicians (8% of the total group). Of these 167 physicians, 42 (25%) did not have sufficient information for contact, and an additional 19 (11%) had moved outside the area. Of the remaining 106 family practitioners, 27 (25%) were excluded because they did not work in outpatient civilian settings at least 1 full day per week. From the pulmonary group, we randomly selected 145 physicians (58%). Of these 145 physicians, 13 (9%) did not have sufficient information for contact, and an additional 12 (8%) had moved outside the study area. Of the 120 remaining pulmonary specialists, 28 (23%) were excluded because they did not work in outpatient civilian settings at least 1 full day per week. From the allergist group, we randomly selected 20 physicians (50%). Of these, none had moved outside the area, and one (5%) was not in clinical practice.

We attempted to recruit all 79 eligible family practitioners, 92 pulmonologists, and 19 allergists. Of the eligible physicians, 39 (49%) family practitioners, 68 (74%) pulmonologists, and 17 (89%) allergists participated. These participation rates differed significantly among the physician groups ($P < 0.001$). Because some participating physicians ultimately contributed no patients, the final number of participating physicians was: 57 pulmonologists, 17 allergists, and 34 family practitioners.

Subject Recruitment

Detailed description of subject recruitment for the pulmonary and allergy groups has been published previously.[13] The same methods were used to recruit the family practice panel approximately 3 years later. Briefly, each participating family

practice, pulmonary, and allergy physician was asked to maintain a registry of persons aged 18 to 50 years with outpatient visits for asthma during a prospective 4-week period. Participating physicians were asked to register only those persons meeting clinical diagnostic criteria of asthma. Physicians were asked to exclude patients who also carried diagnoses of chronic bronchitis or emphysema.

Each person registered by a participating physician was contacted by mail with a description of the study. Those not declining interview by postcard were telephoned by the study interviewer to arrange an initial phone survey. In total, there were 869 subjects registered. Of all subjects registered, 96 (11%) declined participation and 22 (3%) were not successfully contacted, for an overall study participation of 751 subjects (86%). Of the total 751 subjects, 150 (20%) were recruited from family practitioners, 384 (51%) from pulmonologists, and 217 (29%) from allergists. The proportion of patients who declined or could not be contacted did not differ by specialty group: 21 (12%) for family practitioners, 57 (13%) for pulmonologists, and 40 (16%) for allergists ($P > 0.05$).

Interviews and Survey Instrument

All subject interviews were performed by a single trained survey worker. The format was a structured, close-ended, computer-assisted telephone interview lasting approximately 45 minutes. As previously described, the interview covered asthma history (medical history, symptoms, treatment), comorbidity, general health, functional status, demographic variables, cigarette smoking, psychosocial variables, and work history.[13]

Severity-of-Asthma Score

We previously developed a disease-specific severity-of-asthma score for use in outcomes research.[12,13] The score incorporates the current, widely accepted "stepwise" approach to asthma pharmacotherapy.[14] Also, the score reflects the fluctuating, variable nature of asthma status with time. For example, the troubling symptoms items measure recent disease activity, whereas the intubation and chronic corticosteroid items incorporate longer-term asthma status (Table 1).

We assigned each item a weight based on its expected contribution to overall asthma severity.

TABLE 1. Severity-of-Asthma Score in 150 Family Practice Subjects

Severity-of-Asthma Score Items*	Score	N (%)
Symptoms		
1. Troubling symptoms, last 2 wk		
None	0	3 (2)
Minimal	1	33 (22)
Occasional	2	55 (37)
Most days or nights	3	38 (25)
Every day or night	4	21 (14)
Systemic corticosteroids†		
2. Ever used	2	94 (63)
3. Used in past year	2	53 (35)
4. Used ≥3 months of last 2 yr	3	22 (15)
Other medication use, last 2 wk		
5. β-Agonist by metered-dose inhaler		
None	0	24 (16)
Use <2 puffs per day	1	18 (12)
Use ≥2 puffs per day	2	108 (72)
6. Corticosteroid by metered-dose inhaler		
None	0	70 (47)
Use <20 puffs per day	1	77 (51)
Use ≥20 puffs per day	2	3 (2)
7. Any cromolyn by metered-dose inhaler	1	22 (15)
8. Any ipratropium bromide by metered-dose inhaler	1	13 (9)
9. Any theophylline or other oral β-agonist	1	52 (35)
10. Any antihistamine, decongestant, or nasal spray	1	79 (53)
11. Any home nebulizer use	1	30 (20)
Hospitalizations/intubations		
12. Ever hospitalized for asthma	3	51 (34)
13. Ever intubated for asthma	5	7 (5)

*A total of 13 individual scale items are numbered 1 to 13. Maximum possible score = 28. Median score = 8, 25–75th interquartile range 5–13. Cronbach's alpha = 0.76.

†Not mutually exclusive categories. Subjects can receive between 0 and 7 points for systemic corticosteroid use.

Possible total scores range from 0 to 28, with higher scores reflecting more severe asthma. As shown in Table 1, the 13 items comprise four overall components of asthma severity: frequency of

current asthma symptoms, use of systemic corticosteroids, use of other medications (besides systemic corticosteroids), and history of hospitalizations and intubations. These component scores were defined on clinical grounds and do not reflect a formal statistical assessment of score domains (eg, by factor analysis).

In previous studies, we demonstrated a strong relation between the severity score and asthma-specific quality of life, general health status, work disability, self-perceived asthma control, and health care utilization in patients treated by allergists and pulmonologists.[12,13,15,16] In subspecialty-treated patients, the severity score correlated with percent predicted FEV_1 in the expected direction Spearman r = -0.22; $P < 0.0001$).[13]

The severity score appeared approximately normally distributed in the total sample ($n = 751$), with observed scores spanning the entire range from 0 to 28 points. The mean (10.9) and median scores (10) were similar. Also, the 16th percentile score approximated the mean score less one standard deviation (4 versus 4.9). Similarly, the 84th percentile score and mean score plus one standard deviation were nearly identical (17 and 16.8, respectively). Based on the frequency distribution, there were no apparent floor or ceiling effects.

Other Measures: Concurrent and Predictive Validity

To assess the severity-of-asthma score's concurrent validity within the family practice sample, we examined the association between the severity score and several measures of asthma status: Asthma Quality-of-Life Questionnaire; General Health and Physical Functioning scales of the Medical Outcomes Study (MOS) Short-form Health Survey (SF-36); and subject-reported perceived asthma severity.[17–19]. In the family practice sample, adequate spirometry data were not available.

The Asthma Quality-of-Life Questionnaire is a 20-item Likert response scale that measures disease-specific quality of life in adults with asthma.[17] The questions focus on worries, limitations, restrictions, and negative emotions attributed to asthma. Subject-perceived asthma severity, a construct delineated by Janson-Bjerklie et al,[19] was assessed with the following question:"Do you believe that your asthma is severe, moderate, or mild?" Greater self-perceived asthma severity has been associated with increased clinical severity, poorer psychological status, lower life satisfaction, and increased utilization of emergency department services.[19]

The MOS SF-36 questionnaire was designed to measure overall health status. We chose the General Health and Physical Functioning scales because they distinguish levels of disease severity in patients with general chronic illness and asthma.[20,21] The General Health scale contains five items that measure self-perceived current health, health outlook, and health compared with other people. The Physical functioning scale has 10 items that ask about capacity for various activities, ranging from bathing or dressing to running or lifting heavy objects. Each of the SF-36 scales is scored from 0 to 100, with lower scores representing more negative health states.

We examined predictive validity, the score's ability to predict clinically meaningful asthma health outcomes. Although longitudinal data were not available, we assessed the cross-sectional relation between the severity-of-asthma score and several asthma outcome measures: subject-reported urgent physician visits for asthma during the past 12 months, emergency department visits for asthma during the past 12 months, and restricted activity days in the past 4 weeks. Because prior hospitalization comprises an item in the severity score, we did not use it as a measure of predictive validity.

Asthma Severity and Physician Specialty

After assessing the severity-of-asthma score's validity in the family practice sample, we compared severity scores among the family practice, allergy, and pulmonary groups. We then explored whether demographic factors explained any observed differences in asthma severity by provider group. Finally, we examined the component scores (current symptoms, systemic corticosteroid use, other medication use, and hospitalizations/intubations) among the three physician specialty groups.

Statistical Analysis

Interview data were exported into a PC-SAS compatible format. We evaluated the internal consistency of the severity score in the family practice patients by computing Cronbach's alpha and performing a principal components analysis.[22]

Within the family practice subset, concurrent validity was studied by examining the association between the severity score and asthma-specific quality of life, perceived asthma severity, physical functioning, and general health. We tested these associations using the Pearson product-moment correlation. In the family practice group, we then evaluated predictive validity by examining the independent association between severity-of-asthma score and urgent physician visits for asthma (two or more in the past 12 months), emergency department visits for asthma (two or more in the past 12 months), and restricted activity days (14 days or more in the past 4 weeks). We used multiple logistic regression analysis to assess the association of severity score and each of these outcomes, taking into account the simultaneous effect of demographic variables and smoking status.

We compared the severity-of-asthma scores among the pulmonologist, allergist, and family practitioner groups using an analysis of variance (ANOVA) technique. We then used the Tukey's Studentized Range Test to examine the hypothesis that asthma patients treated by family practitioners would have less severe disease than those seen by pulmonary or allergy specialists. Next, we examined the four severity-of-asthma component scores among the family practitioners, pulmonologists, and allergists. Because the component scores were non-normally distributed, the Kruskal–Wallis test was used to compare the asthma severity component scores among the three physician groups.

Multiple linear regression analysis was performed to examine the relation between physician specialty and severity score after controlling for demographic and smoking variables. Because physicians were selected randomly and because subjects were nested within physician practices, we fit a generalized estimating equation model that accounts for the clustering of subjects recruited from the same physician.

Finally, we assessed whether higher observed severity-of-asthma scores among subspecialty-treated subjects reflect greater patient-level disease severity or more intensive physician practice patterns. The Mantel–Haentsel χ^2 test for trend was used to evaluate the association between subject-perceived asthma severity (mild, moderate, or severe) and physician specialty. Similarly, we examined trends in history of intubation for asthma by physician specialty. We then re-examined the impact of physician specialty on severity-of-asthma scores after eliminating the high-dose versus low-dose inhaled corticosteroid distinction. Previous work has indicated that physician specialty is associated with high-dose, but not low-dose, inhaled steroid use.[16] Eliminating this dose distinction, then, should reduce the score's dependence on physician practice style and better reflect disease-specific severity.

Results

Demographic Characteristics

We interviewed 150 subjects recruited from family practitioners' practices (Table 2). The mean age was 38.7 ± 8.2 years. The majority of subjects were female (73%) and white, non-Hispanic (61%). Approximately one third (34%) smoked cigarettes at some time (defined as lifetime consumption of more than 100 cigarettes). As shown in Table 2, age, gender, race, and income did not differ significantly among the family practice, pulmonary, and allergy groups; however, the subjects treated by pulmonary specialists were most likely to have smoked cigarettes (41%) compared with both allergy (31%) and family practice subjects (34%; $P = 0.026$). Allergy subjects reported the most years of education (mean, 14.5 years), followed by the pulmonary (14.0 years) and family practice subjects (13.6 years; $P = 0.0036$).

Severity-of-Asthma Score Reliability

To assess the severity-of-asthma score's internal consistency in subjects treated by family practitioners, we computed the Cronbach's alpha (0.76; Table 1). This value was similar to Cronbach's alpha for both the pulmonary (0.77) and allergy (0.71) groups. In a principal components analysis of the severity score within the family practice group, the first component yielded an eigenvalue of 2.4 and contributed 59% of the model's variance. There was a rapid fall-off in the scree plot, with a second component eigenvalue of 0.81. Each of the individual items of the score loaded positively on the first principle component.

Severity-of-Asthma Score Concurrent Validity

To establish concurrent validity in asthmatic subjects treated by family practitioners, we evaluated the score's relation to other established

TABLE 2. Subject Characteristics: Adults With Asthma Treated by Family Practitioners, Pulmonologists, and Allergists

	Family Practitioners ($n = 150$)	Pulmonologists ($n = 384$)	Allergists ($n = 217$)	P
Age (mean years ± SD)*	38.7 ± 8.2	39.0 ± 8.5	39.2 ± 7.9	0.85
Female gender†	109 (73%)	266 (69%)	147 (68%)	0.6
Race and ethnicity				0.16
White, non-Hispanic	92 (61%)	264 (69%)	136 (63%)	
Other	58 (39%)	117 (32%)	84 (36%)	
Education (mean years ± SD)	13.6 ± 2.1	14.0 ± 2.6	14.5 ± 2.3	0.0036
Ever smoked cigarettes	51 (34%)	159 (41%)	67 (31%)	0.026
Income‡				
Median	22,500	25,000	25,000	0.097
Interquartile range	15,000–31,250	15,000–35,000	17,500–35,000	

*Age and education were examined using ANOVA.
†Gender, race, and smoking were compared with chi-square.
‡Income was analyzed with the Kruskal-Wallis test.

measures expected to vary directly with asthma severity. As predicted, a higher severity-of-asthma score was strongly associated with increased subject-perceived asthma severity (Table 3). In addition, a greater severity score was statistically associated with worse asthma-specific quality of life, perceived general health, and physical functioning.

Predictive Validity: Cross-Sectional Association with Asthma Outcomes

The severity score was associated with several important asthma health outcomes, even after adjusting for demographic and smoking variables in multiple logistic regression analysis (Table 4). In each case, a higher severity score was related to worse asthma outcomes. A 5-point increase in severity score was associated with increased emergency department visits for asthma (adjusted odds ratio (OR) 5.3; 95% Confidence Interval (CI) 2.7–10.3), urgent physician visits for asthma (adjusted OR 2.3; 95% CI 1.5–3.6), and restricted activity days (adjusted OR 4.4; 95% CI 2.5–7.9). Of note, the point estimate of each odds ratio increased after adjustment for demographic characteristics and smoking.

The severity-of-asthma score includes lifetime history of hospitalization as one element of severity. If the "lifetime history" of hospitalization actually reflected hospitalization during the past 12 months, then the score's association with urgent health care utilization during the same time period would not necessarily establish predictive validity. To address this concern, we repeated the logistic regression analyses excluding the subjects ($n = 17$; 11%) who reported hospitalization during the prior 12 months. A 5-point increase in severity score remained associated with increased emergency department visits (OR 3.1; 95% CI 1.3–7.3), urgent physician visits (OR 1.8; 95% CI 0.94–3.3), and restricted activity days (OR 5.8; 95% CI 5.0–6.7).

TABLE 3. Severity-of-Asthma Score: Concurrent Validity in 150 Family Practice Subjects

	Correlation With Asthma Severity Score	P
Asthma-specific quality of life*	0.57	<0.0001
Perceived asthma severity†	0.60	<0.0001
General Health‡	-0.63	<0.0001
Physical functioning	-0.60	<0.0001

*Asthma-specific quality of life scores range from 0 to 60, with higher scores indicating worse quality of life.
†Perceived asthma severity was rated as mild, moderate, or severe.
‡Perceived General Health and Physical Functioning scale scores range from 0 to 100, with higher scores reflecting better health.

TABLE 4. Severity-of-Asthma Score: Predictive Validity in 150 Family Practice Subjects

	n (%)	OR*	95% CI	OR, Adjusted†	95% CI
Emergency department visit for asthma (≥2 in past 12 mo)	26 (17)	3.5	2.2, 5.7	5.3	2.7, 10.3
Urgent physician visits for asthma (≥2 in past 12 mo)	30 (20)	2.1	1.4, 3.0	2.3	1.5, 3.6
Restricted activity days (health-related) (≥14 in past 4 wk)	38 (25)	3.8	2.4, 6.0	4.4	2.5, 7.9

CI, confidence interval; OR, odds ratio.
*Odds ratio per 5-point increment in severity of asthma.
†Odds ratio adjusted for age, gender, race, education, income, and smoking status (ever vs. never).

Asthma Severity

Asthma severity, as measured by the severity-of-asthma score, differed among the family practitioner, pulmonologist, and allergist groups (Table 5). The mean severity score was highest in the pulmonary subjects (11.8 ± 6.3), followed by the allergy (10.3 ± 5.3) and family practice (9.3 ± 5.5) subjects ($P < 0.0001$). In pairwise comparisons, the pulmonary subjects had more severe asthma than both the family practice (mean score difference 2.4 points; 95% CI 1.1–3.8) and allergy subjects (mean score difference 1.5 points; 95% CI 0.3–2.6). Although the allergy group had a higher mean asthma severity score than the family practice group (mean score difference 0.95 points; 95% CI -0.5–2.4), this difference was not statistically significant.

The severity-of-asthma component scores also differed among the three physician groups (Table 5). The systemic corticosteroid ($P < 0.0001$) and history of hospitalization or intubation ($P < 0.0002$) component scores were highest in the pulmonary subjects and lowest in the family practice subjects. The use of other medications ($P = 0.6$) and recent troubling symptom ($P = 0.16$) scores were not significantly different among the three physician groups.

We performed a multiple linear regression analysis to examine the independent association between physician specialty and severity score, controlling for the potential confounding effects of demographic mix and personal smoking. In

TABLE 5. Asthma Severity Component Scores and Physician Specialty: Mean ± SD

	Family Practitioners ($n = 150$)	Pulmonologists ($n = 384$)	Allergists ($n = 217$)
Asthma severity component scores			
Troubling symptoms*	2.3 ± 1.0	2.4 ± 1.3	2.3 ± 1.1
Medication use*	3.4 ± 1.7	3.5 ± 1.9	3.6 ± 1.6
Systemic corticosteroids†	2.4 ± 2.4	3.6 ± 2.7	3.1 ± 2.4
Hospitalization/intubation†	1.3 ± 1.9	2.2 ± 2.8	1.3 ± 2.2
Severity-of-asthma score (total)‡	9.3 ± 5.5	11.8 ± 6.3	10.3 ± 5.3

*$P > 0.10$ by Kruskal-Wallis test, for comparison between family practice, pulmonary, and allergy groups.
†$P < 0.001$ by Kruskal-Wallis test.
‡$P < 0.0001$ by ANOVA for overall comparison; $P < 0.05$ for pulmonologist vs. family practitioner, pulmonologist vs. allergist comparisons by Tukey's Studentized range test; $P > 0.05$ for allergist vs. family practitioner comparison by Tukey's test. Difference in mean scores 2.4 (95% CI 1.1,3.8), 1.5 (95% CI 0.3,2.6), and 0.95 (95% CI -0.5,2.4), respectively.

this analysis, the clustering of patients by physician also was taken into account. Compared with the family practice subjects, the pulmonary subjects had greater mean severity-of-asthma scores (score difference 2.5 points; 95% CI 1.5–3.6 points). Similarly, subjects treated by allergists had greater severity scores than those seen by family practitioners (score difference 2.1 points; 95% CI 0.5–3.8 points).

Because the severity-of-asthma score includes treatment items such as medication use, the score could reflect either patient-level asthma severity or physician practice style. Several additional analyses suggested that the score indicates disease-specific severity. First, subjects treated by pulmonologists were most likely to indicate "severe" self-perceived asthma severity (28%), followed by those treated by allergists (24%) and family practitioners (19%; $P = 0.01$). Second, a history of intubation and mechanical ventilation for asthma, which reflects near-fatal asthma and would be less dependent on physician practice style, varied by physician specialty in the expected direction.[23] Pulmonary-treated subjects were most likely to report a history of intubation (15.9%), compared with allergy-treated and family practice-treated subjects (6.5% and 4.7%, respectively; $P < 0.0001$).

Finally, we evaluated the impact of physician specialty on an alternate severity-of-asthma score, redefining inhaled corticosteroid use as present or absent (rather than high-dose, low-dose, or none). Because high-dose inhaled steroid use is more dependent on physician specialty than is low-dose treatment, the alternate score should be more independent of practice style and better reflective of patient-level severity.[16] Compared with family practice subjects, pulmonary and allergy subjects still had greater asthma severity scores (score increase 2.5 and 1.8 points, respectively) after controlling for the same covariates in multiple linear regression ($P < 0.02$ in both cases).

Discussion

Severity-of-Asthma Score: Reliability and Validity

The current study demonstrates the severity-of-asthma score's reliability and validity in asthmatic patients recruited from family practitioners. In reliability analyses, the severity score possessed a high degree of internal consistency. Concurrent validity was examined by evaluating the severity score's relation with other measures expected to vary with asthma severity. In all cases, strong relations were found in the expected directions. Higher severity scores were associated with worse perceived asthma severity, asthma-specific quality of life, general health, and physical functioning. In prior analyses, we reported a modest correlation between severity score and FEV_1.[12,13] We assessed predictive validity by analyzing the association between severity-of-asthma scores and selected health outcomes. The severity score was strongly associated with health care utilization and restricted activity. The severity-of-asthma score, then, is a reliable and valid measure in subjects treated by generalist physicians.

The accurate assessment of asthma severity is critical for research evaluating the impact of physician specialty on asthma outcomes; however, there previously have been no generally accepted asthma severity measures.[11] To assess asthma severity, we developed and validated a questionnaire-based severity score[12,13]; however, the severity score's psychometric properties in a sample recruited from generalist physicians remained unclear. Previous research has demonstrated that patients followed by family practitioners differ significantly from those seen by medical subspecialists.[8] In demographic terms, family practitioners' patients were younger and better educated than subspecialists' patients. Further, family practice patients had better functional status, fewer chronic illnesses, and lower disease-specific severity (in the case of diabetes). Therefore, the severity score's reliability and validity could not be assumed for family practice patients, a potentially healthier group. In the present study, we demonstrated the severity score's validity in adults with asthma treated by family practitioners.

Other existing measures of asthma severity have limitations that make application to survey-based asthma outcomes research difficult. Prior asthma severity measures have included items better classified as health outcomes, such as emergency department visits, activity limitation, and quality of life.[24–29] Inclusion of these items as severity measures precludes their use as outcome variables in the same analysis. Equally important, other asthma severity measures have failed to capture the variability of asthma status with time, such as severity assessment based on emergency department encounters for acute exacerbations.[30]

Further, many severity measures have included pulmonary function testing, which can be costly and logistically difficult to obtain in survey-based research.[14,24,31] Even if spirometric data are collected, they reflect asthma status at only one point in time. We designed our severity-of-asthma score to avoid these important shortcomings of previous measures.

Because the severity-of-asthma score incorporates medications and other treatment-related variables, the score could reflect patient-level disease severity or physician practice patterns. Several lines of evidence suggest that the severity score assesses important patient-level characteristics. Although medication prescription can reflect physician style, intubation and mechanical ventilation for asthma generally indicate an acutely life-threatening exacerbation.[23] As such, the decision to intubate is unlikely to depend on physician practice style. The increased prevalence of self-reported previous intubation in subjects treated by pulmonary physicians suggested greater patient-level severity. Second, self-perceived severity, which is a patient-level attribute, was greater in pulmonary-treated and allergy-treated patients. Finally, pulmonary physicians were more likely than allergists to treat patients with high-dose inhaled corticosteroids.[16] After redefining the severity score to eliminate this high-dose versus low-dose distinction, which should blunt the influence of physician practice style on severity scores, subjects treated by subspecialists still had higher scores than those seen by family practitioners. Although these analyses suggest that the severity score measured important patient-level characteristics, the score also may reflect some aspects of physician practice style. This complicated interrelationship should be considered when comparing severity differences across physician specialty groups.

Asthma Severity and Physician Specialty

Few studies of specialist care and asthma outcomes have systematically assessed disease-specific severity.[1–6] In a study of asthma practice patterns, investigators found no differences in asthma severity between allergists' and primary care physicians' patients; however, asthma severity was assessed by a limited, symptom-based questionnaire.[4] More recently, Vollmer et al[7] found that allergists treated more severe asthmatics than generalists. These researchers used an asthma severity index based on two variables: corticosteroid use and baseline spirometry. Our approach to severity assessment also included corticosteroid use, consistent with Vollmer's approach, but further incorporated other important clinical information. We have not identified other published studies that have assessed asthma outcomes adjusted for disease-specific severity.

Research focusing on diseases other than asthma, however, has clearly established the association between physician specialty and illness severity. In a study of acute myocardial infarction, Jollis et al[32] found that patients admitted by cardiologists had a lower predicted mortality than those admitted by primary care physicians. Conversely, the Medical Outcomes Study investigators found that ambulatory patients seen by subspecialists were older, had more chronic illnesses, and had worse functional status than patients of generalist physicians.[8] Our finding that asthma severity varied significantly with physician specialty is consistent with previous work examining illness severity in other chronic diseases.

The current study has several limitations that may affect interpretation of our results. First, because the study interviews were conducted 18 months apart, we were unable to assess short-term test–retest reliability. Second, the definition of asthma depended on physician diagnosis. Although we cannot ensure that physicians applied uniform diagnostic criteria in defining asthma, we explicitly instructed them to exclude patients with chronic bronchitis or emphysema. In addition, we attempted to exclude patients with chronic obstructive pulmonary disease by limiting subject inclusion to less than 50 years of age. Despite these precautions, some possibility of incorrect asthma classification still exists.

Third, as we have previously noted, persons with asthma drawn from allergy and pulmonary subspecialist practices may differ from those followed by generalists or those without regular medical care.[13,15] By including the family practice sample, we increased the generalizability of our severity score. Fourth, physician participation may have introduced bias. The allergists were most likely to participate, followed by the pulmonologists and family practitioners. If there were unrecognized differences between asthma patients treated by participating and nonparticipating physicians, the association between physician specialty and asthma severity could be distorted. Recruitment of registered subjects was compara-

ble for each physician specialty, however, minimizing introduction of bias at that level. Fifth, the recruitment of family practice subjects approximately 3 years later than subspecialty subjects could have influenced severity score performance, especially if physician medication prescribing patterns underwent change. Finally, adult asthmatics living in California could differ from those residing in other regions. Overall, we believe that our study conclusions remain valid despite these limitations.

In conclusion, we have demonstrated that the severity-of-asthma score is a reliable and valid instrument for adults with asthma treated by generalists and subspecialists. Asthma severity, as we anticipated, was greatest in pulmonary subjects and lowest in family practice subjects. Future research investigating the impact of physician specialty on asthma outcomes should measure and control for asthma severity. Our severity score provides a useful and valid instrument for performing such severity adjustments.

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