

Medication use and indicators of poor asthma control in patients with and without allergies

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ABSTRACT

Background: Approximately two-thirds of people with asthma have some evidence of allergy; their condition differs from nonallergic asthma in terms of predominant symptoms and clinical outcomes.

Objective: To compare asthma control and medication use among patients with persistent asthma with evidence of allergy (PA-EA) and patients with persistent asthma with no evidence of allergy (PA-NEA).

Methods: A retrospective analysis of survey responses and medication claims data from the Observational Study of Asthma Control and Outcomes study, a prospective survey linked to retrospective claims-based analysis of patients ages ≥ 12 years with persistent asthma in a U.S. health maintenance organization. Evidence of allergy was defined as both a positive response to a survey question about hay fever and/or seasonal allergies and one or more medical diagnostic codes for atopic conditions. Regression models were used to compare asthma control (Asthma Control Questionnaire [ACQ] scores) and asthma medication use between PA-EA and PA-NEA.

Results: Adjusted data showed that, versus the patients with PA-NEA ($n = 312$), patients with PA-EA ($n = 971$) had higher (worse) 5-item and 6-item ACQ (ACQ-5 and ACQ-6) scores (by 0.34 [95% confidence interval {CI}, 0.24–0.44]; and 0.31 [95% CI, 0.21–0.40], respectively), were more likely to have poorly controlled asthma (ACQ-5 score ≥ 1.5 : odds ratio 3.37 [95% CI, 2.07–5.50]; ACQ-6 score ≥ 1.5 : odds ratio 3.46 [95% CI, 2.13–5.62]) and less likely to have well-controlled asthma (ACQ-5 score ≤ 0.75 : odds ratio 0.21 [95% CI, 0.13–0.34]; ACQ-6 score ≤ 0.75 : odds ratio 0.21 [95% CI, 0.13–0.35]). Patients with PA-EA also had greater asthma medication use, most notably 2.5 times more prescriptions of high-dose inhaled corticosteroid in a 4-month period (95% CI, 1.21–5.16) and 16.15 times higher odds of chronic oral corticosteroid use (95% CI, 1.50–174.09) versus PA-NEA.

Conclusion: The patients with PA-EA versus PA-NEA had worse asthma control and greater medication use. These patients may need more vigilant clinical oversight and treatment management to ensure adequate asthma control.

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Asthma is a heterogeneous disease characterized by chronic airway inflammation.^{1–3} It is defined by a history of respiratory symptoms, including wheeze, shortness of breath, chest tightness, and cough that vary over time, and confirmed variable airflow limitation.¹ Asthma has been shown to have a negative effect on important clinical and patient outcomes, including productivity, health-related quality of life, and health

resource utilization^{3,4}; these outcomes are strongly associated with the level of asthma control.⁵ Approximately two-thirds of people with asthma and approximately half of people with severe asthma, have some evidence of allergies and asthma triggered by inhaled allergens.^{2,6} Asthma with allergies differs from asthma without allergies in terms of the immune-inflammatory cell profile, symptomatology, and treatment response.^{3,6} Asthma control in patients with asthma with and without allergies in the real-world setting is not

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well documented. The aim of this study was to compare asthma control and medication use in patients with persistent asthma with evidence of allergy (PA-EA) versus patients with persistent asthma with no evidence of allergy (PA-NEA).

METHODS

Data Source and Study Design

This was a retrospective analysis of survey responses and medication claims data from the Observational Study of Asthma Control and Outcomes (OSACO)⁵, a prospective survey linked to retrospective claims-based analysis of patients in a large health maintenance organization in Colorado. Details of the OSACO study have previously been published⁵; no additional inclusion criteria were imposed. The original OSACO study included claims from October 2010 to February 2013. Eligible patients ages ≥ 12 years with a diagnosis of persistent asthma within the previous 12 months, received three identical surveys (waves 1–3) over a 15-month period. Surveys included the Asthma Control Questionnaire ACQ-5 and ACQ-6. Subsequent surveys were sent only to patients who completed the previous survey. A fourth survey (wave 4), identical to the previous three, was conducted in patients with poorly controlled asthma (ACQ score ≥ 1.5) who had completed two or more surveys. The OSACO study was approved by the Kaiser Permanente of Colorado Institutional Review Board, and the dataset used in this analysis was de-identified.

Evidence of Allergy

Evidence of allergy was defined as having both a positive response to a survey question about hay fever and/or seasonal allergies in the previous 6 weeks and one or more diagnostic codes (*International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]*)⁷ for atopic conditions at any time during the study period; patients who met these criteria were included in the PA-EA cohort. Allergy-related ICD-9-CM codes included allergic rhinitis (477.xx), anaphylaxis (995.0, 999.4), conjunctivitis (372.1x, 372.3x), eczema/dermatitis (691.xx–692.xx), food allergy (693.1), urticaria/angioedema (708.x, 995.1), acute mucoid otitis media (381.04), allergic gastroenteritis and colitis (558.3), unspecified allergy (995.3), anaphylactic reaction due to unspecified food (995.60), and extrinsic (allergic) asthma (493.0x). Individuals with a negative response to a survey question and no diagnosis for any atopic conditions were included in the PA-NEA cohort. Individuals who could not be categorized as PA-EA or PA-NEA (positive survey response but no diagnosis for atopic conditions and vice versa) were excluded from the analysis.

Assessment of Asthma Control

Asthma control was measured by the ACQ score in PA-EA versus PA-NEA. The ACQ yields a continuous score from 0 to 6, with lower scores representing better asthma control.⁸ Well-controlled asthma was defined as an ACQ score of ≤ 0.75 and poorly controlled asthma was defined as a score of ≥ 1.5 .⁸

Assessment of Medication Use

Asthma medication use over a 4-month period in PA-EA versus PA-NEA was assessed based on the following: (1) the number of distinct prescription drug records for asthma medications, such as inhaled corticosteroid (ICS), oral corticosteroid (OCS), short-acting β_2 -agonist (SABA), and non-OCS controller medications; (2) the use (yes/no) of chronic OCS, OCS burst, and three or more SABA prescriptions in 4 months; (3) the ratio of controller-to-total prescriptions (assessed as a ratio > 0.70 , yes/no); and (4) self-reported exacerbation that requires use of OCS (yes/no).

Statistical Analyses

Analyses were performed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology statement⁹; descriptive statistical analyses only were reported for demographic and clinical characteristics, and inferential statistical analyses for outcome variables were limited to reporting confidence intervals (CI) for differences between the two groups.

Regression models were used to assess the association between PA-EA and asthma control and medication use; the comparison group was the PA-NEA cohort. All regression analyses used the panel data structure, and a Hausman test was used to determine whether to use fixed- or random-effects for multiple regression analyses. Each dependent (outcome) variable was separately regressed on PA-EA (dichotomous variable, yes/no), adjusting for the following covariates: survey wave and month, age, sex, family income level, race, educational attainment, ethnicity, and smoking status. Binary dependent variables, including uncontrolled asthma (ACQ score ≥ 1.5), well-controlled asthma (ACQ score ≤ 0.75), and other medication use (yes/no) variables were analyzed by using logistic regression. Negative binomial regression was used for count-dependent outcomes (e.g., the number of SABA prescriptions per 4-month period) and ordinary least-squares regression was used for continuous dependent variables (e.g., ACQ-6 score).

The patients who had completed one or more survey waves were included in the analyses; patients with no observations were excluded. Missing values for ACQ scores were imputed after the imputation guidelines provided by the creators of the instrument. Missing

Table 1 Baseline characteristics by allergic status*#

Characteristic	PA-EA Group (n = 971)	PA-NEA Group (n = 312)
Female patients, no. (%)	673 (69.3)	182 (58.3)
Age, mean $\pm$ SD, y	47.1 $\pm$ 17.1	50.0 $\pm$ 17.6
Age category, no. (%)		
12–24 y	139 (14.3)	39 (12.5)
25–34 y	90 (9.3)	24 (7.7)
35–44 y	164 (16.9)	45 (14.4)
45–54 y	229 (23.6)	59 (18.9)
55–64 y	226 (23.3)	93 (29.8)
65–74 y	88 (9.1)	30 (9.6)
75–84 y	30 (3.1)	18 (5.8)
>85 y	5 (0.5)	4 (1.3)
Race, no. (%)		
White	819 (84.3)	261 (83.7)
Asian	23 (2.4)	6 (1.9)
African American	47 (4.8)	15 (4.8)
American Indian	43 (4.4)	10 (3.2)
Native Hawaiian	13 (1.3)	4 (1.3)
Multiple race	0 (0)	0 (0)
Missing	26 (2.7)	16 (5.1)
Ethnicity, no. (%)		
Hispanic	113 (11.6)	40 (12.8)
Non-Hispanic	852 (87.7)	268 (85.9)
Missing	6 (0.6)	4 (1.3)
Annual income, no. (%)		
<\$10,000	27 (2.8)	8 (2.6)
\$10,000 to <\$30,000	68 (7.0)	18 (5.8)
\$30,000 to $\leq$ \$90,000	445 (45.8)	160 (51.0)
>\$90,000	315 (32.4)	87 (27.9)
Prefer not to answer	68 (7.0)	26 (8.4)
Missing	48 (4.9)	13 (4.2)
Education attainment, no. (%)		
<High school graduate or GED	86 (8.9)	28 (9.0)
High school graduate or GED	135 (13.9)	51 (16.3)
Some college education or higher	746 (76.8)	232 (74.4)
Missing	4 (0.4)	1 (0.3)
Smoking history, no. (%)		
Never smoked	678 (69.8)	208 (66.7)
Current smoker	37 (3.8)	19 (6.1)
Previous smoker	252 (26.0)	85 (27.2)
Missing	4 (0.4)	0 (0)

PA-EA = Persistent asthma with evidence of allergy; PA-NEA = persistent asthma with no evidence of allergy; SD = standard deviation; GED = General Education Development; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification.

*Of the 2681 patients initially included in this study, 1398 could not be clearly classified into either subgroup due to missing survey responses, or “yes” response to the survey allergy questions but no The ICD-9-CM code for one or more atopic conditions based on claims, or “no” response to the survey allergy question but with an ICD-9-CM code for one or more atopic conditions based on claims.

#Percentages may not add up to 100 due to rounding.

Table 2 Asthma control according to evidence of allergy (unadjusted data)

Outcome	PA-EA Group (n = 2808)*	PA-NEA Group (n = 719)*
ACQ-5 score, mean $\pm$ SD	1.09 $\pm$ 0.90	0.74 $\pm$ 0.75
ACQ-6 score, mean $\pm$ SD	1.06 $\pm$ 0.85	0.75 $\pm$ 0.73
ACQ-5 score $\leq$ 0.75, no. (%)#	1146 (41.0)§	417 (58.4)¶
ACQ-5 score $\geq$ 1.5, no. (%)	811 (29.0)§	116 (16.2)¶
ACQ-6 score $\leq$ 0.75, no. (%)#	1201 (43.4)**	424 (60.1)##
ACQ-6 score $\geq$ 1.5, no. (%)	825 (29.8)**	118 (16.7)##
ACQ, score mean $\pm$ SD		
Question 1	0.71 $\pm$ 1.00	0.44 $\pm$ 0.83
Question 2	1.11 $\pm$ 1.07	0.72 $\pm$ 0.90
Question 3	0.89 $\pm$ 1.06	0.59 $\pm$ 0.90
Question 4	1.53 $\pm$ 1.18	1.12 $\pm$ 1.09
Question 5	1.22 $\pm$ 1.19	0.80 $\pm$ 1.01
Question 6	0.88 $\pm$ 0.95	0.77 $\pm$ 0.95

PA-EA = Persistent asthma with evidence of allergy; PA-NEA = persistent asthma with no evidence of allergy; ACQ = Asthma Control Questionnaire; SD = standard deviation.

* Data are based on surveys completed across all waves; n = 2808 for patients with PA-EA and n = 719 for patients with PA-NEA; multiple survey responses may have been provided by the same patient.

An ACQ score $\leq$ 0.75 indicates well-controlled asthma.

§ A total of 2795 completed surveys.

¶ A total of 714 completed surveys.

|| ACQ $\geq$ 1.5 indicates uncontrolled asthma.

** A total of 2766 completed surveys.

A total of 705 completed surveys.

demographic variables were only imputed if the same question was answered on a previous survey wave. After these imputations, there remained an insignificant number of missing values, and no further data imputation was conducted for missing data.

RESULTS

Study Population

A total of 5951 patients met the OSACO inclusion criteria and were invited to participate *via* a mailed survey. Overall, 2681 patients completed the wave 1 survey and were included in this study. Of these, 971 patients were included in the PA-EA group and 312 patients were included in the PA-NEA group. There were 1398 patients who could not be clearly categorized into either group. Baseline characteristics of the patients with PA-EA and PA-NEA are presented in Table 1. The mean $32 \pm$ standard deviation (SD) age of the patients in the PA-EA and PA-NEA groups were 47.1 ± 17.1 and 50.0 ± 17.6 years, respectively. A greater percentage of patients in the PA-EA group versus the PA-NEA group were female patients (69.3% versus 58.3%), but the characteristics of race, ethnicity, annual income, education attainment, and smoking history were generally similar in both groups. Overall, the majority of the patients were white (PA-EA, 84.3%;

PA-NEA, 83.7%), had incomes $\geq$ \$30,000 per year (PA-EA, 78.2%; PA-NEA, 78.9%), and had at least some college education (PA-EA, 76.8%; PA-NEA, 74.4%). In the PA-EA and PA-NEA groups, 26.0% and 27.2% of the patients, respectively, had previously smoked, and 3.8% and 6.1%, respectively, were current smokers. A total of 3527 surveys were completed across all the waves: 2808 were from the patients with PA-EA and 719 were from those with PA-NEA. Multiple survey responses, therefore, may have been provided by the same patients.

Asthma Control

Unadjusted data for asthma control are presented in Table 2. The mean $\pm$ SD ACQ-5 scores were 1.09 ± 0.90 for patients with PA-EA and 0.74 ± 0.75 for patients with PA-NEA. Uncontrolled asthma was observed in 29.0% of the patients with PA-EA and 16.2% of the patients with PA-NEA; percentages for well-controlled asthma were 41.0% and 58.4% for patients with PA-EA and patients with PA-NEA, respectively. Similar observations were made based on ACQ-6 data (Table 2). In both groups, the mean $\pm$ SD score for an individual ACQ item was highest for question 4, which assesses the frequency with which shortness of breath is experienced (PA-EA, 1.53 ± 1.18 ; PA-NEA, 1.12 ± 1.09); the

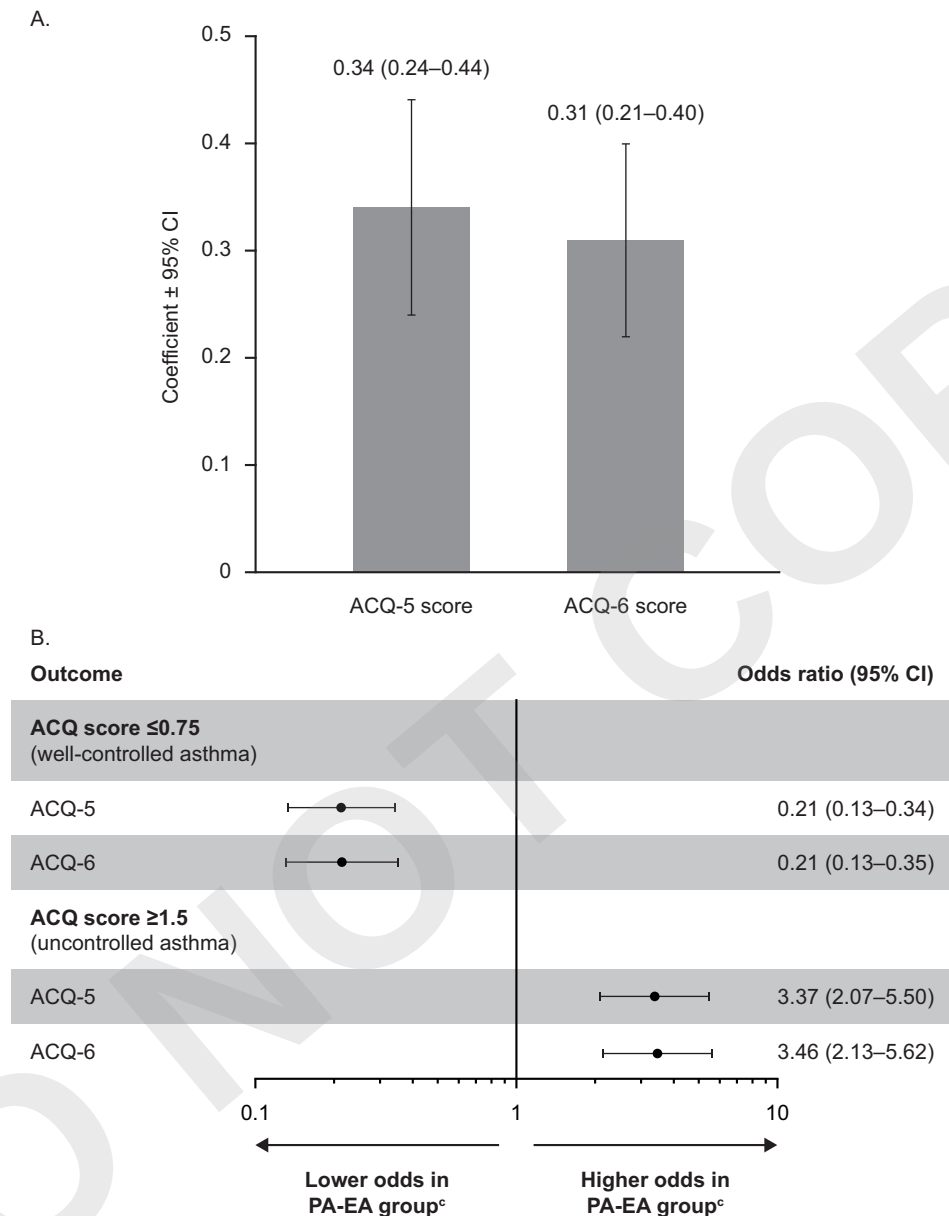


Figure 1. The association between PA-EA versus PA-NEA and the (A) ACQ score^a and (B) ACQ score category^b (adjusted results). CI = confidence interval; ACQ = Asthma Control Questionnaire; PA-EA = persistent asthma with evidence of allergy; PA-NEA = persistent asthma with no evidence of allergy. ^aResults of random-effects generalized least-squares regression when controlling for wave and group fixed-effects, season, age, sex, family income level, race, educational attainment, ethnicity, and smoking status. ^bResults of random-effects logistic regression when controlling for wave and group fixed-effects, season, age, sex, family income level, race, educational attainment, ethnicity, and smoking status. ^cVersus the PA-NEA group.

score was lowest for question 1 on the frequency of night-time awakening (PA-EA, 0.71 ± 1.00 ; PA-NEA, 0.44 ± 0.83) (Table 2). After adjustment for covariates, patients with PA-EA had higher ACQ-5 and ACQ-6 scores, by 0.34 and 0.31, respectively, than those with PA-NEA (Fig. 1A). The patients with PA-EA were also more likely to have poorly controlled asthma (ACQ-5 score ≥ 1.5 : odds ratio [OR] 3.37 [95% CI, 2.07–5.50]; ACQ-6 score ≥ 1.5 : OR 3.46 [95% CI, 2.13–5.62]) and less likely to have well-controlled asthma (ACQ-5

score ≤ 0.75 : OR 0.21 [95% CI, 0.13–0.34]; ACQ-6 score ≤ 0.75 : OR 0.21 [95% CI, 0.13–0.35]) versus the patients with PA-NEA (Fig. 1B).

Medication Use

Unadjusted medication use data are presented in Table 3. After adjustment for covariates, asthma medication use was higher in the patients with PA-EA than in the patients with PA-NEA (Fig. 2A and B). The

Table 3 Medication use according to evidence of allergy (unadjusted data)*

Medication Use	PA-EA Group, mean $\pm$ SD (n = 2808)#	PA-NEA Group, mean $\pm$ SD (n = 719)#
NPD controllers	1.68 $\pm$ 1.44	1.44 $\pm$ 1.28
NPD ICS	1.53 $\pm$ 1.18	1.36 $\pm$ 1.11
NPD high-dose ICS	0.11 $\pm$ 0.45	0.07 $\pm$ 0.32
NPD OCS	0.26 $\pm$ 0.67	0.13 $\pm$ 0.42
NPD SABA	0.85 $\pm$ 1.10	0.77 $\pm$ 1.17
Chronic OCS	0.02 $\pm$ 0.15	0.01 $\pm$ 0.07
OCS burst	0.15 $\pm$ 0.36	0.09 $\pm$ 0.29
≥ 3 SABA prescriptions	0.07 $\pm$ 0.26	0.08 $\pm$ 0.27
Ratio of controller-to-total prescriptions > 0.70	0.48 $\pm$ 0.50§	0.49 $\pm$ 0.50¶
Self-reported exacerbation requiring use of OCS	0.20 $\pm$ 0.40	0.14 $\pm$ 0.35**

PA-EA = Persistent asthma with evidence of allergy; PA-NEA = persistent asthma with no evidence of allergy; SD = standard deviation; NPD = number of prescriptions dispensed; ICS = inhaled corticosteroid; OCS = oral corticosteroid; SABA = short-acting β_2 -agonist.

* Data are based on medication use over a 4-month period.

Data are based on surveys completed across all waves; n = 2808 for patients with PA-EA and n = 719 for patients with PA-NEA; multiple survey responses may have been provided by the same patient.

§ A total of 2460 completed surveys.

¶ A total of 581 completed surveys.

|| A total of 2750 completed surveys.

** A total of 705 completed surveys.

patients with PA-EA received 2.5 times the number of high-dose ICS prescriptions in 4 months compared with the patients with PA-NEA (95% CI, 1.21–5.16); a similar incidence rate ratio was observed for OCS prescriptions (Fig. 2A). Individuals with PA-EA also had higher odds of having had an OCS burst and exacerbation that required OCS during the 4-month period (Fig. 2B). The odds of chronic OCS use for asthma were 16.15 times higher in the patients with PA-EA versus those with PA-NEA (95% CI, 1.50–174.09).

DISCUSSION

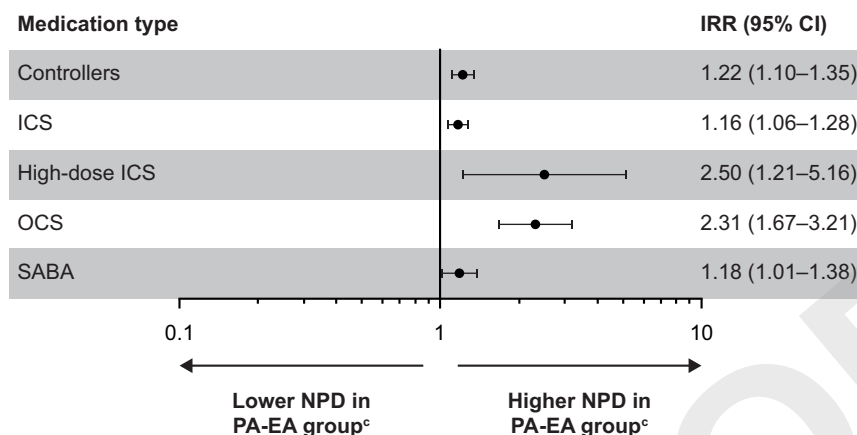
This retrospective study of real-world data from the OSACO study⁵ showed that PA-EA was associated with poorer asthma control than was PA-NEA. Our results were in contrast to previous reports that atopy and/or atopic symptoms were not associated with poor asthma control.^{10,11} However, both of these previous studies used substantially different methods to our own for determining evidence of allergy, with both studies, including a positive skin-prick test and/or a history of atopic disease.^{10,11} In our study, PA-EA was associated with greater medication use than PA-NEA, including use indicative of greater asthma severity or more poorly controlled asthma versus PA-NEA; the patients with PA-EA had significantly higher numbers of prescriptions for controllers, ICS, high-dose ICS, and

OCS, and higher odds of requiring chronic OCS. However, in some previously published reports, patients with allergies were suggested to have less-severe asthma than those without allergies.^{6,12,13} Potential reasons for this contrast may include the differing symptomatology in asthma with versus asthma without allergies.

Typically, two criteria are recommended for the identification of patients with allergic asthma: (1) allergic sensitization (specific immunoglobulin E skin-prick test or an *in vitro* specific immunoglobulin E test to a panel of seasonal and perennial allergens); and (2) one or more symptoms in response to allergen exposure.^{12,13} In the current retrospective analysis of claims data, we used a comprehensive definition of PA-EA based on both a positive response to the survey question on hay fever and/or seasonal allergies and one or more ICD-9-CM codes for atopic conditions. Patients who could not be clearly categorized as having PA-EA or PA-NEA were excluded from our analyses to ensure an accurate comparison of patients with and without evidence of allergy. The use of several ICD-9-CM codes for atopic conditions in our definition of PA-EA resulted in > 1900 reports of allergic symptoms and inclusion of 971 patients in the PA-EA cohort.

However, there were only 41 claims with ICD-9-CM 493.0x (the commonly used diagnostic code for extrin-

A.



B.

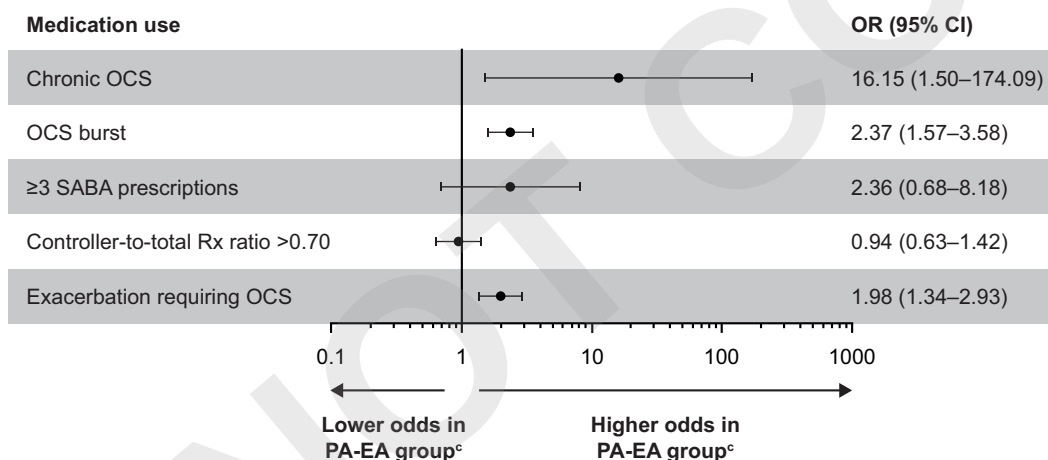


Figure 2. The association between PA-EA versus PA-NEA and the (A) numbers of prescriptions dispensed for asthma medications,^a and (B) odds of requiring asthma medications^b (adjusted results). Data are based on medication use over a 4-month period. IRR = incidence rate ratio; CI = confidence interval; ICS = inhaled corticosteroid; OCS = oral corticosteroid; SABA = short-acting β_2 -agonist; PA-EA = persistent asthma with evidence of allergy; OR = odds ratio; Rx = prescription; PA-NEA = persistent asthma with no evidence of allergy. ^aResults of random-effects negative binomial regression when controlling for survey wave and group fixed-effects, season, age, sex, family income level, race, educational attainment, ethnicity, and smoking status. ^bResults of random-effects logistic regression on dichotomous outcomes (yes/no), when controlling for survey wave and month, season, age, sex, family income level, race, educational attainment, ethnicity, and smoking status. ^cVersus the PA-NEA group.

sic asthma) in the OSACO dataset, which highlighted the comprehensiveness of the diagnostic code selection to eliminate underreporting of the frequency of PA-EA in the study population. The use of a comprehensive definition is elucidated by the findings of Lafeuille *et al.*² in a large claims data base study of 2.67 million people with asthma (defined as having two or more diagnoses of asthma [ICD-9-CM 493.x]), only 64,781 (~2%) had one or more diagnoses of extrinsic asthma (ICD-9-CM 493.0x) and one or more allergy-related comorbidities.

Our findings highlighted important clinical implications, including a need for allergy evaluation and appropriate treatment based on the presence of allergies, *e.g.*, greater vigilance and titration to higher treatment steps may be needed for patients with PA-EA. These

patients may require more-rigorous follow-up, *e.g.*, serial spirometry and fractional exhaled nitric oxide testing, development of an asthma action plan.¹ Previous analyses of data from OSACO showed that poor asthma control and exacerbations were associated with increased health-care resource use and costs,^{5,14} but less is known about the impact of allergies on asthma control.^{15,16} Because prescription medications were found to be the largest contributors to medical expenditure in people with asthma,³ the greater use of medications in the PA-EA group was also likely to have increased the cost burden associated with this patient group versus the PA-NEA group.

The mechanisms by which atopy and allergic comorbid conditions affect asthma control are multifactorial and incompletely understood.^{17,18} The presence of al-

lergic rhinitis, for example, has been linked to poor asthma outcomes, including increased health-care utilization.¹⁹ In addition, treatment directed at allergic rhinitis (*i.e.*, intranasal corticosteroids) has been associated, in some studies, with improved asthma symptoms and reduced health-care utilization.^{19–22} Chronic rhinitis (allergic and/or nonallergic) has also been reported as being significantly associated with an increased risk of 30-day asthma-related hospital readmission.²³ For these reasons, guidelines recommend optimal treatment of comorbid conditions in asthma to increase the likelihood of achieving control.^{1,24}

In addition to the unique definition of PA-EA, a strength of this study compared with previous studies of allergic asthma was the provision of real-world data from a general asthma population in managed care in the United States. Many studies of patients with allergic asthma are conducted in clinical trial or specialty care populations, which typically include patients with more severe disease than those found in a general asthma population and thus may not reflect the average patient with asthma. The large OSACO claims data base provides a combination of patient-reported outcomes and survey responses to the ACQ with pharmacy claims data. In the current study, we were able to show greater severity and poorer control for those with PA-EA versus PA-NEA in a general asthma population.

Our study had several limitations, including those associated with retrospective analyses of claims data. These included retrospective data analysis and the absence of *in vivo* or *in vitro* allergic testing, pulmonary function testing, and imaging data to confirm the accurate diagnosis of PA-EA made when using ICD-9-CM codes. In addition, pharmacy claims data indicated only that prescriptions were filled and the claim was submitted, which may not reflect actual medication use. There also was the potential for selection bias and study questionnaire response bias: patients who were willing to participate in this study might have differed from other patients with asthma. Although sociodemographic characteristics and comorbidities were controlled for in the regression analyses, there was potential for confounding from unobserved variables. We believe that our results were generalizable to individuals who are commercially insured, but they may not have reflected patients from specialty asthma clinics or certain minority populations not widely represented in Colorado. Our restrictive PA-EA definition also meant that our data were not directly comparable with other claims-based analyses that used a different definition for asthma with an indicator of allergy.

CONCLUSION

In this longitudinal study, PA-EA was associated with worse asthma control (as measured when using

the validated ACQ instrument) and greater medication usage than PA-NEA. Our findings have important clinical ramifications, which suggests that patients with persistent asthma and comorbid allergy may require more rigorous treatment management to achieve optimal asthma control.

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