Original Article

Clinician Agreement, Self-Efficacy, and Adherence with the Guidelines for the Diagnosis and Management of Asthma

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What is known about this topic? Adherence to the 2007 National Asthma Education and Prevention Program's Expert Panel Report 3 asthma guidelines has been suboptimal, and a long-standing target of implementation interventions. However, little national data are available on adherence.

What does this article add to our knowledge? Nationally representative data show higher adherence among asthma specialists versus primary care clinicians, and highlights overall low clinician adherence with written asthma action plans, home peak flow monitoring, spirometry testing, and assessment of inhaler technique.

How does this study impact current management guidelines? Among primary care physicians who deliver the majority of asthma care, self-efficacy with the recommended measures was a predictor of higher adherence. These data highlight areas for progress in realizing clinical asthma guidelines.

BACKGROUND: The 2007 Guidelines for the Diagnosis and Management of Asthma provide evidence-based recommendations to improve asthma care. Limited national-level data are available about clinician agreement and adherence to these guidelines.

OBJECTIVE: To assess clinician-reported adherence with specific guideline recommendations, as well as agreement with and self-efficacy to implement guidelines.

METHODS: We analyzed 2012 National Asthma Survey of Physicians data for 1412 primary care clinicians and 233 asthma specialists about 4 cornerstone guideline domains: asthma control, patient education, environmental control, and pharmacologic treatment. Agreement and self-efficacy were measured using Likert scales; 2 overall indices of agreement and self-efficacy were compiled. Adherence was compared between primary care clinicians and asthma specialists. Logistic regression models assessed the association of agreement and self-efficacy indices with adherence.

RESULTS: Asthma specialists expressed stronger agreement, higher self-efficacy, and greater adherence with guideline recommendations than did primary care clinicians. Adherence was low among both groups for specific core recommendations, including written asthma action plan (30.6% and 16.4%, respectively; $P < .001$); home peak flow monitoring, (12.8% and 11.2%; $P = .34$); spirometry testing (44.7% and 10.8%; $P < .001$); and repeated assessment of inhaler technique (39.7% and 16.8%; $P < .001$). Among primary care clinicians, greater self-efficacy was associated with greater adherence. For specialists, self-efficacy was associated only with increased odds of spirometry testing. Guideline agreement was generally not associated with adherence.

CONCLUSIONS: Agreement with and adherence to asthma guidelines was higher for specialists than for primary care

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Abbreviations used
CHC- Community health center
EPR-3- Expert Panel Report 3
ICS- Inhaled corticosteroid
NAEPP- National Asthma Education and Prevention Program
NAMCS- National Ambulatory Medical Care Survey
NAS- National Asthma Survey of Physicians
NCHS- National Center for Health Statistics
OR- Odds ratio

clinicians, but was low in both groups for several key recommendations. Self-efficacy was a good predictor of guideline adherence among primary care clinicians but not among specialists. Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2018;6:886-94)

Key words: *Asthma guidelines; Agreement; Confidence; Adherence; Specialist; Primary care; National Asthma Survey*

INTRODUCTION

Clinical guidelines aid in disease diagnosis and management, and exist for multiple conditions including asthma.[1] Previous reports on primary care clinicians and specialists demonstrate that adherence to guidelines in general is low[2-6] and that adherence to the 2007 National Asthma Education and Prevention Program's (NAEPP's) Expert Panel Report 3 (EPR-3) asthma guidelines[1] is no exception.[7-10] The National Ambulatory Medical Care Survey (NAMCS), an ongoing nationally representative survey, covers visits to office-based physicians and clinicians in community health centers (CHCs).[11] In 2012, the National Asthma Survey of Physicians (NAS) was fielded as a 1-time provider questionnaire supplement to NAMCS.[12] The supplement was conceived of and sponsored by the NAEPP Coordinating Committee. The questionnaire design group was co-led by the National Center for Environmental Health, the Centers for Disease Control and Prevention, and the National Heart, Lung, and Blood Institute with staff and NAEPP Coordinating Committee members participating (see this article's Online Repository at www.jaci-inpractice.org). It queried primary care clinicians' and specialists' opinions, self-efficacy, and self-reported adherence regarding asthma care and key recommendations in the EPR-3 report. The goal of this article was to characterize and compare agreement with the national asthma guidelines by primary care and asthma specialty clinicians, their confidence in implementing the guidelines, and assess their self-reported adherence to the 4 core components of the guidelines. This information could inform new guidelines and future studies.

METHODS

Data source and study population

NAMCS is conducted annually by the National Center for Health Statistics (NCHS) to collect information about patient, clinician, and office visit characteristics. Data from the 2012 NAS supplement[12] to NAMCS were released in 2017. Clinician eligibility for NAMCS was determined by responses to the Physician Induction Interview.[11,13] Participating clinicians who responded affirmatively to the Physician Induction Interview asthma screener question ("Do you treat patients with asthma?"), regardless of specialty, were included in the NAS. Since 2006, NAMCS has included visits to office-based physicians and a panel of CHCs with up to 3 physicians and/or mid-level clinicians sampled per CHC. Sample selection is designed to produce nationally representative estimates for both NAMCS and CHC visits. Starting in 2012, the office-based component of NAMCS was split from the CHC component to produce separate data files for visits to private physician offices and CHCs to increase flexibility in use of patient visit data.[11] However, patient visit data from either component could not be linked to physician responses to the NAS supplement. This analysis used the 2012 NAS file released by NCHS that included NAMCS office-based physicians, CHC physicians, and CHC mid-level clinicians. The 2012 NAS file included specific physician/clinician survey weights provided by NCHS. The NAMCS physician sampling frame included nonfederally employed physicians who were classified as being engaged primarily in office-based patient care by the American Medical Association or the American Osteopathic Association and included general/family practitioners, internists, pediatricians, and obstetricians. Specialty physicians in anesthesiology, radiology, and pathology and those older than 85 years were excluded. Allergists and pulmonologists were oversampled to provide a sufficient sample size of asthma specialists for the NAS supplement. The CHC sampling frame included physicians and mid-level practitioners (ie, physician assistants, nurse practitioners, and nurse midwives) from sampled CHC delivery sites. No asthma specialists were sampled in the CHC-based portion of the NAS. The NCHS Institutional Review Board approved NAS, and informed consent was obtained from participating clinicians.

The unweighted and weighted response rates for the overall combined NAS sample were 38% and 28%, respectively, similar or higher than those to other national physician surveys.[14] The weighted response rate was higher for CHC providers (73%) than for NAMCS physicians (26%). Of the 1726 respondents, 49 were specialists unlikely to directly manage asthma, leaving 1677 eligible participants. Seventeen records were missing demographic data and were excluded from the sample. Clinician race/ethnicity was not included in the NAMCS questionnaire used in CHCs. Nonclinical respondents were also excluded (n = 15). The final sample of 1645 included 1412 primary care clinicians (primary care physicians from the office-based and CHC physicians and CHC mid-level practitioners from the CHC sample) and 233 asthma specialists (allergists and pulmonologists from the office-based sample). Available information on demographic characteristics included clinician specialty, age and sex, practice Census region, urbanization level and ownership, and age of patient population.

Outcomes

Outcome variables were categorized into the 4 EPR-3 cornerstones of care: assessment and monitoring of asthma, patient education, environmental control, and pharmacologic treatment (see Table E1 in this article's Online Repository at www.jaci-inpractice.org). Clinician agreement with and adherence to specific EPR-3 recommendations and self-efficacy defined as clinician confidence in their ability to competently implement specific EPR-3 recommendations were determined by self-report (see Table E2 in this article's Online Repository at www.jaci-inpractice.org). Missing responses were low (0.01%-2.0%) and were excluded for individual outcomes.[15]

Indices for agreement and self-efficacy

The association between adherence and overall agreement and overall self-efficacy with providing guideline-based care were assessed using 2 index variables. An agreement index variable was defined dichotomously as a response of "strongly agree" versus all other

TABLE I. National Asthma Survey clinician characteristics, 2012[12]

Characteristic	Total (n = 1645)		Primary care clinicians (n = 1412)*	Asthma specialists (n = 233)†	
	n	Weighted % (SE)	Weighted % (SE)	Weighted % (SE)	*P* ‡
Clinician age (y)					
<40	372	15.6 (1.4)	16.0 (1.5)	9.5 (2.3)	.004
40-59	907	60.3 (2.1)	60.6 (2.2)	54.0 (4.1)	
60+	366	24.1 (1.9)	23.4 (2.0)	36.5 (4.0)	
Clinician sex					
Female	772	40.0 (2.0)	41.4 (2.1)	15.7 (2.7)	<.001
Male	873	60.0 (2.0)	58.6 (2.1)	84.3 (2.7)	
Ownership of practice					
Private	653	61.7 (1.8)	60.3 (2.0)	84.4 (2.8)	<.001
CHC	688	16.0 (0.8)	17.0 (0.8)	0.0§ (0.0)	
HMO, academic center, other hospital/health care corporation	194	16.1 (1.6)	16.4 (1.7)	12.0 (2.5)	
Missing	110	6.2 (1.1)	6.3 (1.2)	3.6§ (1.4)	
Census region					
Northeast	255	20.7 (0.9)	20.6 (0.9)	21.1 (2.0)	.007
Midwest	400	19.5 (0.6)	19.6 (0.7)	17.8 (1.5)	
South	553	30.2 (0.8)	29.7 (0.9)	38.0 (2.7)	
West	437	29.7 (0.8)	30.1 (0.9)	23.2 (1.8)	
Level of urbanization					
Large metro	737	56.8 (1.9)	56.3 (2.0)	66.5 (3.8)	.002
Medium/small metro	532	28.8 (1.9)	28.9 (2.0)	27.2 (3.7)	
Nonmetro	376	14.3 (1.1)	14.8 (1.2)	6.3§ (2.2)	
Patient population					
Pediatric only	333	22.6 (1.7)	23.4 (1.8)	8.2§ (2.8)	<.001
Adult or all ages	1312	77.4 (1.7)	76.6 (1.8)	91.9 (2.8)	

HMO, Health maintenance organization.
*Primary care clinicians include general/family practitioners, internists, pediatricians, obstetricians, and CHC mid-level providers.
†Asthma specialist include allergists and pulmonologists.
‡χ^2 test for difference between primary care clinicians and asthma specialists.
§The relative standard error is >30%.

responses to all 5 questions about agreement (Table E2). Similarly, a self-efficacy index variable was defined as a response of "very confident" versus all other responses for all 5 questions about self-efficacy (Table E2).

Statistical analysis

Descriptive statistics were used to summarize clinician characteristics and outcome measures using provided sample weights to calculate nationally representative estimates. Differences between primary care clinicians and asthma specialists in distributions across response categories for guideline adherence outcomes were assessed using chi-square tests, with $P < .05$ (2-sided) considered statistically significant. Thus, *P* values in the text and tables reflect differences across the range of Likert scale response categories (eg, "never [0% of the time]" to "almost always [75%-100% of the time]") rather than differences for one particular response category. Separate logistic regression models assessed the impact of agreement and self-efficacy on guideline adherence for each outcome that could be dichotomized to "almost always" versus all other responses. For some covariate categories, there were 0 cells for asthma specialists. Therefore, the simplest models with the indices for agreement and self-efficacy as the only independent variables are reported. Multivariate results that include additional covariates but that omit covariates with 0 counts for any category are shown in this article's Online Repository at www.jaci-inpractice.org. National estimates were calculated using NAS sample weights that accounted for the probability of clinician selection and nonresponse. Estimation of SEs and statistical inference took the complex survey design into account. Analyses were conducted using SAS 9.4 (SAS Institute, Inc, Cary, NC) and SUDAAN 11.0 (RTI, Research Triangle Park, NC). Estimates with a relative SE of more than 30% (SE/estimate) are flagged to indicate that these estimates have lower precision.

RESULTS

Compared with primary care clinicians, asthma specialists were more likely to be older, male, work in private practice settings, and practice in the South, and in large metropolitan areas (Table I). Asthma specialists were less likely to exclusively treat pediatric populations.

EPR-3 Component 1: Assessment and monitoring of asthma severity and control. EPR-3 recommends that clinicians assess asthma impairment (symptom frequency and asthma control) and risk for adverse outcomes (hospitalizations, emergency department visits, and courses of systemic

TABLE II. Assessment and monitoring of asthma severity and control: Clinician-reported adherence to EPR-3 asthma guideline component 1[12]

		Primary care clinicians			Asthma specialists			
Guideline recommendation	n	Almost always	Often	Sometimes/ never	Almost always	Often	Sometimes/ never	*P*
Assessment of impairment frequency, weighted % (SE)								
Document asthma control	1550	32.0 (2.2)	44.6 (2.4)	23.4 (2.0)	76.8 (3.8)	20.5 (3.7)	2.7* (1.2)	<.001
Ask about ability to engage in normal activities	1625	48.4 (2.4)	38.7 (2.3)	12.9 (1.5)	84.5 (3.3)	14.9 (3.2)	0.6* (0.6)	<.001
Ask about frequency of daytime symptoms	1632	56.0 (2.3)	35.9 (2.3)	8.1 (1.3)	91.1 (2.5)	8.5 (2.5)	0.4* (0.4)	<.001
Ask about frequency of nighttime awakening	1630	53.4 (2.4)	31.8 (2.2)	14.8 (1.8)	81.7 (3.6)	14.9 (3.3)	3.4* (1.9)	<.001
Ask about perception of control	1629	50.7 (2.4)	33.1 (2.1)	16.2 (1.8)	70.7 (4.2)	26.0 (4.0)	3.3* (1.9)	<.001
Use control assessment tool	1629	13.2 (1.5)	17.2 (1.9)	69.7 (2.2)	28.6 (3.5)	20.4 (3.4)	51.0 (4.2)	<.001
Ask about frequency rescue inhaler	1632	72.3 (2.1)	23.1 (1.9)	4.6 (1.1)	90.6 (2.8)	6.5* (2.2)	2.9* (1.7)	<.001
Assessment of risk frequency, weighted % (SE)								
Ask about oral steroid frequency	1629	52.9 (2.4)	34.0 (2.2)	13.1 (1.6)	86.8 (3.1)	11.6 (3.1)	1.6* (0.8)	<.001
Ask about ED visit frequency	1631	56.2 (2.3)	29.2 (2.0)	14.6 (1.8)	81.9 (3.4)	12.6 (3.2)	5.6* (2.2)	<.001
Objective assessment and monitoring, weighted % (SE)								
Ask about peak flow results	1628	11.2 (1.5)	22.9 (2.0)	65.9 (2.2)	12.8 (2.5)	27.9 (3.7)	59.3 (4.1)	.34
Perform spirometry	1611	10.8 (1.6)	25.1 (2.0)	61.6 (2.2)	44.7 (4.1)	35.0 (4.0)	20.3 (4.0)	<.001
Ongoing monitoring frequency, weighted % (SE)								
Assess daily controller use for persistent asthma	1625	59.5 (2.3)	31.6 (2.1)	8.9 (1.4)	91.7 (2.4)	8.2 (2.4)	0.2* (0.1)	<.001
Repeated assessment of inhaler technique	1627	16.8 (1.7)	38.7 (2.4)	44.6 (2.3)	39.7 (4.0)	44.9 (4.3)	15.5 (3.0)	<.001

ED, Emergency department.
*The relative standard error is >30%.

corticosteroids) during clinic visits. A higher percentage of asthma specialists almost always assessed all measures of asthma impairment than did primary care clinicians, including a patient's ability to engage in normal daily activities (84.5% vs 48.4%), frequency of daytime symptoms (91.1% vs 56.0%) and nighttime awakenings (81.7% vs 53.4%), and patient's perception of control (70.7% vs 50.7%) ($P < .001$ for distributional comparison across the Likert scale for all comparisons) (Table II). Most primary care clinicians (72.3%) asked about frequency of rescue inhaler use, albeit less frequently than did asthma specialists (90.6%; $P < .001$). In contrast, use of a control assessment tool (eg, Asthma Control Test, Asthma Control Questionnaire, Asthma Therapy Assessment Questionnaire, or similar tool) was low in both groups. More than half of the specialists (51.0%) and 69.7% of the primary care clinicians reported that they either sometimes or never used such tools. Indeed, 39.7% of primary care clinicians and 28.9% of specialists reported that they never used control assessment tools (data not shown).

The assessment of risk also differed between the 2 groups (Table II). Although 86.8% and 81.9% of asthma specialists reported almost always asking patients about oral steroid use and emergency department/urgent care visits, fewer primary care clinicians (52.9% and 56.2%, respectively; $P < .001$ for comparison between clinician groups) almost always assessed these risk factors for adverse outcomes.

Both groups reported low frequencies of objective asthma assessment and monitoring. Only 11.2% of primary care clinicians and 12.8% of specialists almost always asked about home peak flow results ($P = .34$). Specialists were more likely than primary care clinicians to report almost always performing spirometry (eg, 44.7% vs 10.8%; $P < .001$). The 64.1% of primary care clinicians who reported that they sometimes or never performed spirometry included 36.3% who sometimes and 27.8% who never performed spirometry.

Asthma specialists were more likely than primary care clinicians to report assessing daily controller use for persistent asthma (91.7% vs 59.5%, respectively; $P < .001$). Repeated assessment of inhaler technique was less frequently reported by both groups: 39.7% of asthma specialists reported almost always assessing technique versus 16.8% of primary care clinicians ($P < .001$).

EPR-3 Component 2: Patient education. Guideline-recommended patient education items covered in the survey included the frequency of providing asthma action plans (Likert scale), and whether or not the clinician provided inhaler technique assessment and trigger and risk education, and advised changing home and work environment (Table III). Although written asthma action plans can improve asthma-related outcomes,[1,16,17] only 30.6% (SE, 3.6) of specialists and 16.4% (SE, 1.6) of primary care clinicians used them almost always ($P < .001$), and 6.1% (SE, 2.3; relative SE > 30%) and 17.6% (SE, 1.8) never used them, respectively ($P < .001$) (Table III, Panel A). Almost all specialists reported providing patient education regarding asthma symptom recognition, avoiding risk factors, inhaler technique, and changing the home/work environment. Primary care providers also reported providing patient education in these areas with a high frequency but with a lower frequency than specialists, especially for inhaler technique assessment (Table III, Panel B).

Both groups reported patient concerns and misunderstandings about asthma pharmacologic therapies (Figure 1). Both groups reported that patients sometimes or often misunderstood medication risks, were concerned about the side effects of inhaled corticosteroid (ICS) therapy, and were confused between rescue and controller medications. Specialists, however, more often than primary care clinicians reported that patients were almost always concerned about long-term ICS effects (8.6% vs 5.1%; $P = .002$) while primary care clinicians more often reported that patients were almost always confused between rescue and controller

TABLE III. Patient education: Clinician-reported adherence to EPR-3 asthma guideline component 2[12]

Guideline recommendation		Primary care clinicians				Asthma specialists				
Panel A: Frequency of asthma action plan provision, Likert scale (weighted %, SE)	**n**	**Almost always**	**Often**	**Sometimes**	**Never**	**Almost always**	**Often**	**Sometimes**	**Never**	***P***
Provide asthma action plan with medication, triggers, etc	1625	16.4 (1.6)	30.7 (2.2)	35.4 (2.2)	17.6 (1.8)	30.6 (3.6)	32.7 (4.1)	30.6 (4.3)	6.1* (2.3)	<.001
Panel B: Provision of patient education, yes vs no (weighted %, SE)	**n**	**Yes**		**No**		**Yes**		**No**		***P***
Educate patient to recognize symptoms	1645	95.2 (1.0)		4.8 (1.0)		99.9 (0.1)		0.1* (0.1)		<.001
Educate patient to avoid risk factors	1645	96.1 (0.8)		3.9 (0.8)		99.9 (0.1)		0.1* (0.1)		<.001
Observe inhaler use	1621	73.1 (2.1)		26.9 (2.1)		99.5 (0.3)		0.5* (0.3)		<.001
Advise patient to change home/work environment	1645	89.5 (1.6)		10.5 (1.6)		95.5 (1.6)		4.5* (1.6)		.009

*The relative standard error is >30%.

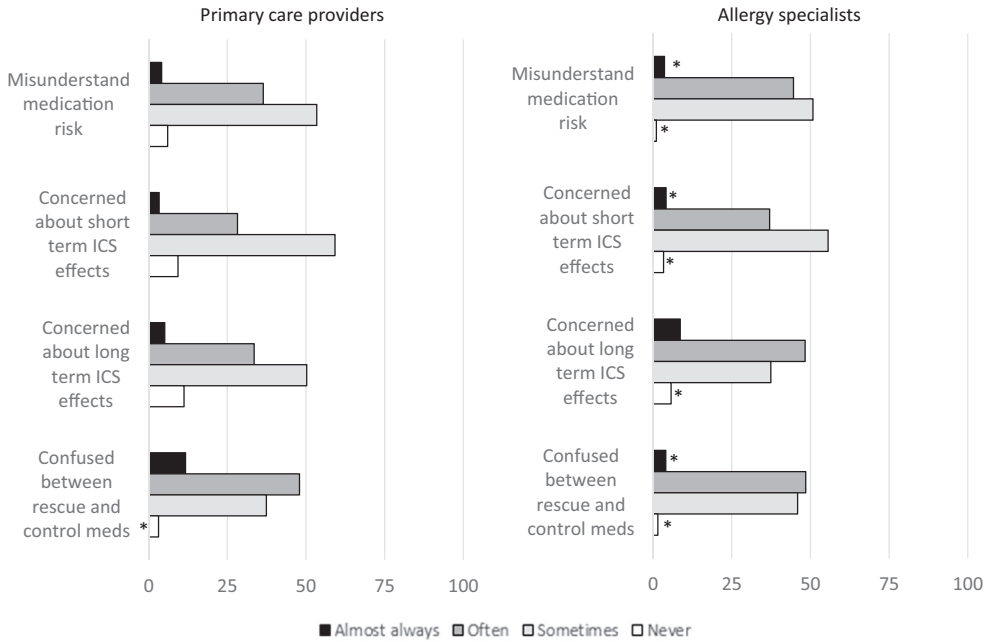

FIGURE 1. Clinician-reported frequency of patient misunderstanding and concerns about asthma medications.[12] *Meds*, Medications. *Note:* Results for all 4 medication questions differ statistically significantly between primary care clinicians and allergy specialists (χ^2 $P <$ .05). *Relative SE is more than 30%.

medications, although the estimate for asthma specialists had a relative SE of more than 30% (11.7% vs 4.0%; $P = .004$).

EPR-3 Component 3: Control of environmental factors. Control of environmental factors can reduce asthma morbidity.[18] Asthma specialists were more likely than primary care clinicians to assess environmental triggers at home, school, and/or workplace (Table IV). Specialists more often (67.3%) reported performing allergy testing "almost always" or "often" versus 24.8% of primary care clinicians ($P < .001$). Nearly a third (30.4%; SE, 2.2) of primary care clinicians reported never performing these tests versus 5.3% (SE, 2.1) of specialists ($P < .001$) (data not shown).

Recommendations for control of environmental factors differed between specialists and primary care clinicians. Primary care clinicians were less likely than specialists to recommend dust mite, mold, and pest control measures but almost 60% of all clinicians recommended removing pets from homes with pet-sensitive patients. Although both clinician groups provided recommendations on pollen avoidance, recommendations

TABLE IV. Control of environmental factors: Clinician-reported adherence to EPR-3 asthma guideline component 3[12]

Guideline recommendation		Primary care clinicians			Asthma specialists			
Assessment of triggers, weighted % (SE)	**n**	**Almost always**	**Often**	**Sometimes/never**	**Almost always**	**Often**	**Sometimes/never**	***P***
Assess home triggers	1628	40.1 (2.3)	42.0 (2.3)	17.9 (1.8)	58.7 (4.2)	35.2 (4.2)	6.1* (2.2)	<.001
Assess school or workplace triggers	1619	35.4 (2.3)	38.4 (2.2)	26.2 (2.0)	71.3 (3.9)	24.2 (3.6)	4.5* (2.0)	<.001
Test for allergic sensitivity	1617	7.2 (1.4)	17.6 (1.8)	75.3 (2.1)	35.0 (3.6)	32.3 (4.1)	32.8 (4.0)	<.001
Recommendations, weighted % (SE)	**n**	**Most patients**	**Patients with sensitivity**	**Sometimes/ never recommend**	**Most patients**	**Patients with sensitivity**	**Sometimes/ never recommend**	***P***
Recommend dust mite control measures	1609	40.8 (2.3)	46.8 (2.4)	12.4 (1.5)	36.5 (3.8)	56.8 (3.9)	6.8* (2.3)	.039
Recommend control of mold and pests	1608	44.1 (2.4)	42.6 (2.3)	13.3 (1.7)	46.9 (4.4)	47.1 (4.3)	6.0* (2.3)	.025
Recommend pet removal	1609	28.6 (2.1)	59.8 (2.3)	11.6 (1.4)	29.3 (3.9)	58.8 (4.1)	11.9 (2.4)	.97
Recommend avoiding pollen	1611	43.3 (2.3)	47.7 (2.3)	9.1 (1.6)	37.3 (4.4)	55.4 (4.3)	7.3 (1.9)	.28
Recommend avoiding air pollution	1604	44.8 (2.3)	33.6 (2.2)	21.6 (2.1)	63.2 (4.2)	30.0 (4.1)	6.8 (1.9)	<.001
Recommend cooking appliance change	1610	16.2 (1.8)	30.7 (2.2)	53.1 (2.4)	21.7 (3.5)	33.6 (4.0)	44.7 (4.3)	.18
Recommend avoiding ETS	1611	83.5 (1.8)	12.2 (1.5)	4.3 (1.1)	85.4 (3.3)	12.7 (3.2)	1.9* (0.8)	.24

ETS, Environmental tobacco smoke.
*The relative standard error is >30%.

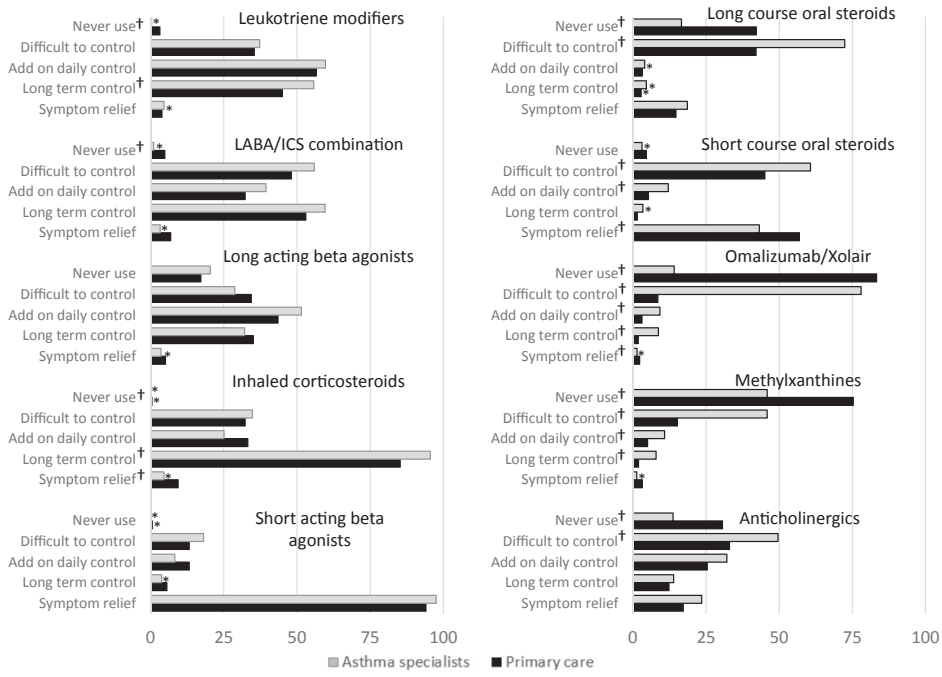

FIGURE 2. Clinician-reported use of asthma medications, by specialty.[12] *Relative standard error is more than 30%. †$P < .05$ for pairwise difference between asthma specialists and primary care.

regarding cooking appliances were infrequent (ie, 44.7%-53.1% of clinicians sometimes or never gave recommendations). Most specialists and primary care clinicians (>83%) recommended environmental tobacco smoke avoidance, whereas air pollution avoidance was more frequently recommended by specialists. The biggest differences between primary care clinicians and specialists were observed for recommendations regarding air pollution avoidance. Specialists more often recommended air pollution avoidance for most patients than did primary care clinicians (63.2% vs 44.8%; $P < .001$). In addition, more primary care clinicians sometimes/never recommended air pollution avoidance as compared with specialists (21.6% vs 6.8%; $P < .001$).

TABLE V. Clinician-reported agreement and self-efficacy with EPR-3 asthma guidelines[12]

Panel A: Agreement, weighted % (SE)	n	Primary care clinicians Strongly agree	Asthma specialists Strongly agree	P *
Spirometry is essential for diagnosis	1638	35.5 (2.3)	77.6 (3.8)	<.001
ICSs are effective for persistent asthma	1633	48.3 (2.3)	76.0 (3.4)	<.001
Asthma action plans are effective	1639	30.6 (2.1)	41.0 (4.1)	.026
Follow-up visits for persistent asthma every 6 mo	1639	48.9 (2.3)	68.8 (3.5)	<.001
Assessing severity is necessary for initial therapy	1632	50.3 (2.4)	79.3 (3.3)	<.001
Overall agreement index	*1642*	*12.1 (1.4)*	*27.9 (3.9)*	*<.001*
Panel B: Asthma self-efficacy, weighted % (SE)	**n**	**Very confident**	**Very confident**	**P**
Confidence using spirometry	1636	37.0 (2.3)	92.8 (2.1)	<.001
Confidence assessing severity	1635	49.4 (2.4)	81.3 (3.5)	<.001
Confidence prescribing ICSs	1642	65.2 (2.2)	91.1 (2.2)	<.001
Confidence stepping up therapy	1641	64.5 (2.3)	89.5 (2.4)	<.001
Confidence stepping down therapy	1639	49.8 (2.4)	87.0 (2.6)	<.001
Overall self-efficacy index	*1642*	*21.5 (2.1)*	*72.3 (3.9)*	*<.001*

Panel C: Association between adherence and strong agreement and high self-efficacy, OR (95% CI)†	Primary care clinicians n	Strong agreement (vs other)	High self-efficacy (vs other)	Asthma specialists n	Strong agreement (vs other)	High self-efficacy (vs other)
Provide asthma action plan	1391	2.0 (1.1-3.6) ‡	2.4 (1.3-4.3)‡	233	1.6 (0.7-3.3)	1.1 (0.5-2.5)
Document asthma control	1321	1.4 (0.8-2.5)	1.8 (1.0-3.0)‡	226	0.8 (0.3-2.1)	1.5 (0.6-3.5)
Ask about ability to engage in normal activities	1392	1.7 (0.9-3.2)	2.1 (1.2-3.5)‡	232	1.3 (0.4-4.4)	1.5 (0.6-4.3)
Ask about frequency of daytime symptoms	1398	1.5 (0.8-2.9)	2.3 (1.3-4.1)‡	233	1.6 (0.4-7.5)	3.9 (1.0-16.0)
Ask about frequency of nighttime awakenings	1396	1.4 (0.8-2.5)	1.7 (1.0-2.9)	233	0.7 (0.2-2.0)	2.7 (0.9-7.8)
Ask about patient perception of control	1395	0.9 (0.5-1.5)	1.9 (1.1-3.3)‡	233	1.6 (0.6-4.3)	1.2 (0.4-3.0)
Use a control assessment tool	1395	1.5 (0.8-2.9)	1.7 (0.9-3.0)	233	1.0 (0.5-2.1)	1.3 (0.6-2.9)
Ask about frequency of rescue inhaler use	1398	2.9 (1.6-5.5)‡	2.7 (1.5-4.7)‡	233	0.4 (0.1-2.2)	3.0 (0.6-14.4)
Ask about ED visit frequency	1398	1.3 (0.7-2.3)	3.0 (1.8-4.8)‡	232	0.8 (0.3-2.8)	2.9 (1.0-8.4)
Ask about oral steroid frequency	1396	1.1 (0.6-2.1)	4.3 (2.6-7.1)‡	232	0.7 (0.2-2.8)	1.4 (0.4-5.1)
Ask about home peak flow results	1396	2.0 (1.0-4.0)	3.1 (1.6-6.1)‡	231	1.8 (0.7-5.0)	2.4 (0.8-7.6)
Perform spirometry	1378	2.1 (0.9-4.7)	6.3 (3.0-13.4)‡	232	1.1 (0.5-2.2)	4.3 (2.0-9.0)‡
Assess daily controller use for persistent asthma	1392	1.9 (1.1-3.2)‡	2.4 (1.4-4.4)‡	232	0.7 (0.2-2.7)	2.0 (0.6-6.6)
Repeated assessment of inhaler technique	1393	1.5 (0.7-2.9)	2.8 (1.6-5.0)‡	233	1.5 (0.8-3.1)	0.8 (0.4-1.9)
Assess home triggers	1394	1.5 (0.9-2.5)	3.3 (1.9-5.5)‡	233	0.8 (0.4-1.7)	1.9 (0.9-4.2)
Assess school or workplace triggers	1408	1.4 (0.8-2.4)	4.1 (2.5-6.9)‡	233	0.8 (0.3-1.7)	1.5 (0.7-3.6)
Test for allergic sensitivity	1383	1.3 (0.5-3.7)	6.0 (2.5-14.4)‡	233	1.1 (0.5-2.4)	1.8 (0.9-3.8)

ED, Emergency department.
Italics denotes results for overall indices (agreement and self-efficacy) based on the 5 individual components shown for each.
*χ^2 test for difference between primary care clinicians and asthma specialists.
†Logistic regression models stratified by primary care clinicians and asthma specialists. Independent variables included agreement index (strong agreement vs all other responses) and self-efficacy index (high self-efficacy vs all other responses). For logistic regression models with additional covariates, see Table E3 in this article's Online Repository at www.jaci-inpractice.org.
‡$P < .05$.

EPR-3 Component 4: Pharmacologic treatment. Self-reported medication prescription for both groups was consistent with EPR-3 recommendations (eg, short-acting beta agonists for symptom relief, and ICSs for difficult-to-control asthma, add-on daily control, and long-term control) (Figure 2). Asthma specialists reported greater use of other asthma medications than did primary care clinicians (eg, the percentage reporting never using specific medications was 16.6% of specialists vs 42.2% of primary care providers for long-course oral steroids, 14.1% vs 83.3% for omalizumab, 45.9% vs 75.3% for methylxanthines, and 13.7% vs 30.6% for anticholinergics). Both groups prescribe short courses of oral steroids for asthma exacerbations, but specialists were less likely to prescribe short-course oral steroids for symptom relief (43.2% vs 56.9%), and more likely to prescribe this medication for difficult-to-control asthma (60.7% vs 45.1%) and as add-on daily therapy (12.1% vs 5.3%) ($P < .05$ for all comparisons).

Agreement and self-efficacy with EPR-3 guideline recommendations. More asthma specialists than primary care clinicians agreed strongly with the EPR-3 recommendations regarding spirometry for asthma diagnosis (77.6% vs 35.5%), the effectiveness of ICSs for persistent asthma (76.0% vs 48.3%), twice yearly follow-up visits for persistent asthma (68.8% vs 48.9%), and assessment of asthma severity for initial treatment (79.3% vs 50.3%) ($P < .001$ for all comparisons) (Table V, Panel A). In contrast, less than half of specialists and primary care

clinicians strongly agreed that asthma action plans are effective, but strong agreement was still higher among specialists (41.0% vs 30.6%; $P = .026$). Strong agreement with all 5 guideline recommendations included in the survey was higher among specialists than among primary care clinicians (27.9% vs 12.1%; $P < .001$).

Asthma specialists reported higher self-efficacy with providing guideline-recommended care than did primary care clinicians (Table V, Panel B). Specialists were very confident in using spirometry (92.8%), in assessing severity (81.3%), in prescribing ICSs (91.1%), and in stepping up or down therapy (89.5%, 87.0%), whereas percentages were lower among primary care clinicians (37.0%, 49.4%, 65.2%, 64.5%, and 49.8%, respectively; $P < .001$). Accordingly, self-efficacy for all 5 recommendations was higher among specialists than among primary care clinicians (72.3% vs 21.5%; $P < .001$).

The association between guideline agreement and self-efficacy with self-reported adherence to guideline recommendations was analyzed for outcomes for which responses could be dichotomized as "almost always" performed versus other responses (Table V, Panel C). Strong agreement was not associated with almost always performing any guideline component for either clinician group with 3 exceptions. In unadjusted models, among primary care clinicians, agreement with guidelines was significantly associated with almost always providing a written asthma action plan (odds ratio [OR], 2.0; 95% CI, 1.1-3.6), almost always asking about the frequency of rescue inhaler use (OR, 2.9, 95% CI, 1.6-5.5), and assessing daily controller use (OR, 1.9; 95% CI 1.1, 3.2), but not among specialists. For primary care clinicians, higher self-efficacy in providing guideline components was associated with higher adherence to most guideline recommendations. For specialists, high self-efficacy was associated with higher odds of performing spirometry (OR, 4.3; 95% CI, 2.0-9.0). In models adjusted for clinician age, sex, and region (see Table E3 in this article's Online Repository at www.jaci-inpractice.org), guideline agreement was associated with asking about rescue inhaler use and home peak flow monitoring, and assessing daily controller use for persistent asthma, but not with providing a written asthma action plan for primary care clinicians. Self-efficacy continued to be associated with adherence to most guideline recommendations for primary care clinicians in adjusted models but not for specialists in whom only high self-efficacy regarding spirometry and testing for allergic sensitivity were associated with guideline agreement (Table E3).

DISCUSSION

In this representative sample of US clinicians, most asthma specialists but less than half of primary care clinicians strongly agreed with key EPR-3 guideline recommendations for asthma assessment and treatment including use of spirometry, ICS therapy, follow-up visits for persistent asthma, and assessment of asthma severity. Self-reported asthma medication use for both groups was consistent with EPR-3 recommendations and more than 80% of both clinician groups recommended environmental tobacco smoke avoidance. Specialist self-efficacy overall was higher than primary care clinician self-efficacy and for most measures, including environmental control assessment and testing, specialist assessment and monitoring were higher. Primary care clinicians with high self-efficacy in using the guidelines were more likely to report guideline adherence while guideline agreement was generally not associated with adherence for either group. This suggests that further efforts to increase clinician self-efficacy might increase guideline use and adherence.

Although the lack of strong endorsement of guideline recommendations among primary care clinicians is notable, there were several key guideline recommendations that were not strongly endorsed by either group including the provision of a written asthma action plan. This result extends published data from several smaller studies and is in contrast to the evidence (grade B, small number of randomized controlled trials) that support use of treatment plans[19-23] although their effectiveness when used by specialists has recently been questioned.[24] In addition, neither of the clinician groups reported frequent use of asthma control assessment tools, and home peak flow assessment rates were especially low. Furthermore, rates of adherence to spirometry testing and repeated inhaler technique assessment were low among both specialists and primary care clinicians.

It is possible that the strength and/or the "age" of the scientific evidence supporting the recommendation influence agreement and adherence. The 2007 EPR-3 guidelines used an evidence-based approach to assess strength of evidence for the first time. The EPR-3 guidelines were also the first to recommend routine spirometry (grades B and C, observational studies), the assessment of risk in the determination of asthma severity (grades C and D, expert panel consensus), and use of peak flow testing (grade B).[1] However, the low uptake of components supported by higher grade evidence such as spirometry, asthma action plans, and peak flow testing suggests that adherence may not be directly related to strength of evidence. Of note, the survey did not ask clinicians about perceived usefulness of guideline recommendations, a factor related to adherence in smaller studies.[19] Time constraints, clinical inertia, and workflow barriers are factors in addition to agreement and self-efficacy that affect adherence, and these factors may work differently for primary care clinicians compared with specialists.[3,8,10,25] Further studies to understand barriers may be needed, especially in primary care, which provides most of the asthma care in the United States.

Results from this study could be used to help guide the NAEPP recommendations that are currently being revised. These revised guidelines should carefully assess the strength of evidence for specific recommendations, identify areas and approaches to implementation that are specific for primary care clinicians and specialists, and focus clinical research on strengthening recommendations that are currently not embraced by clinicians. The guidelines also need to recommend new approaches to meeting patient concerns and to improving adherence by addressing barriers, especially workflow barriers.

Perceptions of patient concerns were more similar than disparate, but primary care clinicians reported greater patient confusion between controller and rescue medications whereas specialists reported more patient concerns regarding long-term corticosteroid therapy. This and other observed differences may reflect differences in disease severity and visit duration. Specialists care for patients with greater asthma severity and may spend more time explaining how to use asthma medications because their patient visits are longer compared with primary care clinicians.[25]

Strengths of the NAS include the national representativeness of the survey sample, the inclusion of both adult and pediatric generalists and specialists, examination of the 4 cornerstones of the 2007 NAEPP guidelines, and the inclusion of guideline agreement and clinician self-efficacy. Two other studies have reported asthma guideline results in primary care clinicians—one[26] reported low utilization of spirometry in the assessment of newly diagnosed patients with asthma, while the other[27] surveyed both clinicians and patients and noted low use of asthma treatment plans and spirometry. In contrast to these studies, this study offers valuable

insight into areas of guideline disagreement and where additional evidence may be needed to achieve behavior changes. The differences between primary care clinicians and specialists suggest that the achievement of guideline adherence may require interventions specifically tailored to different groups of clinicians and to different health care systems and settings.

Although new literature/evidence has accumulated since 2007, the results reflect clinical practice after the latest guideline update. Self-reported behaviors are subject to social and recall bias, and actual behavior might differ.[27] Low response rates are known limitations in physician surveys,[28] and declining trends have been reported.[29,30] The NAS response rate is, however, higher than that for the 2014 National Physician Survey, which surveyed 63,817 physicians and had a response rate of 16%.[14] The characteristics of the NAS asthma specialists were also comparable to those of allergists in a 2014 workforce survey.[31] NCHS evaluated whether lower response rates and changes in the design and implementation (larger sample size, electronic data collection) introduced bias in 2012 NAMCS and found no or minimal bias in physician-level estimates.[29]

In conclusion, overall agreement, confidence, and adherence to the EPR-3 guidelines are higher for specialists than for primary care clinicians but vary between different elements. Low rates of agreement and adherence are reported for several important core elements of the guidelines including use of a written asthma treatment plan, use of an asthma control assessment tool, home peak flow monitoring, spirometry performance, repeated assessment of inhaler technique, and environmental control assessment and testing. Follow-up studies to examine reasons for low adherence and interventions designed to increase adherence in these areas may improve guideline use and overall asthma care and may reduce asthma morbidity.

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APPENDIX

NAEPP's NAS funders:
- Agency for Healthcare Research and Quality
- American Academy of Allergy, Asthma and Immunology (AAAAI)
- Environmental Protection Agency
- Merck Childhood Asthma Network (MCAN)
- National Center for Environmental Health, Centers for Disease Control and Prevention (CDC)
- National Heart, Lung, and Blood Institute, National Institutes of Health (NIH)
- National Institute for Allergy and Infectious Diseases, NIH
- National Institute for Child Health and Human Development, NIH
- National Institute for Occupation Safety and Health, CDC

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TABLE E1. Categorization of questionnaire outcomes by 4 key components of the EPR-3 guidelines*†

1. Assessment and monitoring of asthma severity and control	**Question**
Assessment of impairment frequency	
For what percentage of asthma visits do you document overall asthma control?	7
For what percentage of asthma visits do you ask about patient's ability to engage in daily activities?	8a
For what percentage of asthma visits do you ask about frequency of daytime symptoms?	8b
For what percentage of asthma visits do you ask about frequency of nighttime awakening?	8c
For what percentage of asthma visits do you ask about patient's perception of symptom control?	8d
For what percentage of asthma visits do you use control assessment tool (eg, Asthma Control Test, Asthma Control Questionnaire, and Asthma Therapy Assessment Questionnaire)	8e
For what percentage of asthma visits do you ask about frequency of rescue inhaler use (eg, albuterol)?	8f
Assessment of risk frequency	
For what percentage of asthma visits do you ask about frequency of emergency department visits or urgent care visits for asthma?	8h
For what percentage of asthma visits do you ask about frequency of exacerbations requiring oral steroids?	8g
Objective assessment and monitoring	
For what percentage of asthma visits do you ask about patient's peak flow results from home?	8i
For what percentage of asthma visits do you perform spirometry (among those who can perform spirometry)?	8j
Ongoing monitoring frequency	
For what percentage of asthma visits do you assess daily use of controller medication (eg, ICSs) for patients with severe asthma?	9g
For what percentage of asthma visits do you perform repeated assessment of inhaler technique?	9h
2. Patient education	**Question**
Asthma action plans	
For what percentage of asthma visits do you provide a new or review an existing written asthma action plan outlining medications, triggers, and when to seek emergency care?	9a
Asthma therapies	
How often do you encounter patient misunderstandings about medication risks or side effects or belief in myths (eg, muscle development, addiction)?	13a
How often do you encounter patient concerns about short-term side effects of ICSs (eg, thrush)?	13b
How often do you encounter patient concerns about long-term side effects of ICSs (eg, delayed growth in children)?	13c
How often do you encounter confusion between symptom relief medications and daily controller medications?	13d
3. Control of environmental factors	**Question**
For what percentage of asthma visits do you assess triggers at home (eg, pets, mold, and tobacco smoke)?	9b
For what percentage of asthma visits do you assess triggers at school or workplace (eg, mold, dust, exhaust, fumes, and chemicals)?	9c, 9e
For what percentage of asthma visits do you test allergic sensitivity via skin or allergen-specific IgE (eg, RAST) testing?	9f
For the following questions, do you make recommendations for (1) Most asthma patients, (2) Only patients with sensitivity to this trigger, or (3) Rarely or never recommend	
Do you recommend using dust mite control measures (eg, mattress covers)?	10a
Do you recommend controlling household mold and pests (eg, cockroaches)?	10b
Do you recommend removing pets from home?	10c
Do you recommend avoiding pollen (eg, limit outdoor time and close windows)?	10d
Do you recommend avoiding air pollution (eg, ozone warnings)?	10e
Do you recommend making changes to cooking appliances (eg, exhaust vents)?	10f
Do you recommend avoiding second-hand smoke?	10g
4. Pharmacologic treatment	**Question**
Do you use the following medications for: (1) Symptom relief/acute exacerbation, (2) Daily long-term control, (3) Add-on daily control therapy, (4) Difficult-to-control asthma, (5) Never use	
Short-acting beta agonists	11a
ICSs	11b
Long-acting beta agonists (LABAs)	11c
Combination medication that includes both LABAs and ICSs	11d
Leukotrine modifiers	11e
Anticholinergics	11f
Methylxanthines	11g
Omalizumab	11h
Short course of oral/injectable corticosteroids	11i
Long course of oral corticosteroids (>10 d)	11j

*(A) Adherence categories: Almost always (75%-100%), Often (25%-75%), Sometimes (1%-24%), Never (0%).
†2012 Asthma Supplement Questionnaire is available from: https://www.cdc.gov/nchs/data/ahcd/2012_NAMCS_Asthma_Supplement.pdf.

TABLE E2. Agreement and perceived competency*† with the EPR-3 guidelines

A. Assessment of agreement	**Question**
Spirometry is an essential component of a clinical evaluation for asthma diagnosis in patients able to perform it (please do not include peak flow monitoring as spirometry)	5a
ICSs are the most effective medications to control persistent asthma	5b
Asthma action plans are an effective tool to guide patient self-management efforts	5c
Patients with persistent asthma should have follow-up visits at least every 6 mo to assess control	5d
Assessing asthma severity is necessary to determine initial therapy	5e
B. Assessment of perceived competency	**Question**
Using spirometry data as a component of a clinical evaluation for an asthma diagnosis in patients	6a
Assessing underlying asthma severity using standard criteria	6b
Prescribing the appropriate dose of ICSs	6c
Evaluating the need to step up controller therapy	6d
Evaluating the need to step down controller therapy	6e

*(A) Agreement categories: Strongly agree, agree, neutral, disagree, strongly disagree; (B) Competency categories: Very confident, somewhat confident, not at all confident, do not perform.

†2012 Asthma Supplement Questionnaire is available from: https://www.cdc.gov/nchs/data/ahcd/2012_NAMCS_Asthma_Supplement.pdf.

TABLE E3. Adjusted odds* and 95% CIs of clinician-reported agreement and perceived confidence with EPR-3 guideline recommendations, 2012[12]

	Primary care clinician			Asthma specialists		
Guideline recommendations	n	Strong agreement (vs other)	High confidence (vs other)	n	Strong agreement (vs other)	High confidence (vs other)
Provide written asthma action plan	1391	1.8 (0.9-3.4)	3.7 (2.0-6.9)†	233	1.7 (0.8-3.4)	1.0 (0.4-2.4)
Assessment of impairment frequency						
Document asthma control	1321	1.4 (0.8-2.5)	2.0 (1.2-3.3)†	226	0.7 (0.2-1.9)	1.6 (0.6-4.1)
Ask about ability to engage in normal activities	1392	1.5 (0.8-2.8)	2.8 (1.6-4.8)†	232	1.2 (0.4-3.8)	1.6 (0.6-4.6)
Ask about frequency of daytime symptoms	1398	1.4 (0.7-2.5)	3.3 (1.9-6.0)†	233	2.0 (0.3-11.7)	3.7 (1.0-13.9)
Ask about frequency of nighttime awakening	1396	1.2 (0.7-2.2)	2.4 (1.4-4.1)†	233	0.7 (0.3-2.0)	2.4 (0.8-6.9)
Ask about perception of control	1395	0.8 (0.5-1.4)	2.2 (1.3-3.8)†	233	1.8 (0.7-4.6)	1.2 (0.5-3.1)
Use control assessment tool	1395	1.6 (0.8-3.1)	1.8 (1.0-3.4)	233	1.0 (0.5-2.1)	1.4 (0.6-3.2)
Ask about frequency rescue inhaler‡	1398	2.5 (1.4-4.7)†	3.6 (2.0-6.7)†	233	0.5 (0.1-2.2)	2.5 (0.6-10.8)
Assessment of risk frequency						
Ask about ED visit frequency	1398	1.1 (0.6-2.0)	3.9 (2.3-6.5)†	232	0.9 (0.3-2.9)	2.8 (1.0-7.8)
Ask about oral steroid frequency	1396	1.0 (0.5-1.8)	5.7 (3.3-9.7)†	232	0.6 (0.2-2.6)	1.2 (0.3-4.2)
Objective assessment and monitoring						
Ask about peak flow results§	1396	2.2 (1.1-4.6)†	3.4 (1.7-7.0)†	231	1.6 (0.5-4.9)	2.7 (0.8-9.0)
Perform spirometry	1378	2.2 (1.0-5.0)	6.6 (2.9-15.2)†	232	1.0 (0.5-2.1)	4.0 (1.8-8.7)†
Ongoing monitoring frequency						
Assess daily controller use for persistent asthma	1392	1.8 (1.1-3.1)†	2.8 (1.5-4.9)†	232	0.7 (0.2-2.6)	2.2 (0.7-7.0)
Repeated assessment of inhaler technique	1393	1.4 (0.7-2.8)	3.5 (1.9-6.3)†	233	1.6 (0.8-3.2)	0.8 (0.4-1.9)
Environmental assessment						
Assess home triggers	1394	1.5 (0.9-2.5)	3.7 (2.1-6.3)†	233	0.7 (0.3-1.6)	1.9 (0.9-4.4)
Assess school or workplace triggers	1408	1.5 (0.9-2.6)	3.9 (2.2-6.8)†	233	0.7 (0.3-1.6)	1.6 (0.7-4.1)
Test for allergic sensitivity	1383	1.1 (0.4-3.4)	6.9 (2.7-17.9)†	233	1.2 (0.5-2.6)	2.1 (1.0-4.5)†

*Adjusted for clinician age, clinician sex, region, and patient age group. Specialist model for assessment of frequency of rescue inhaler use omits clinician sex. Specialist model for assessing peak flow results omits patient age.

†$P < .05$.

‡Asthma specialist model controlled for clinician age, region, and patient age group because of 0 cells for clinician sex.

§Asthma specialist model controlled for clinician age, clinician sex, and region because of 0 cells for patient age group.