Costs of managing asthma as defined by a derived Asthma Control Test™ score in seven European countries

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ABSTRACT: **The present authors explored the relationship between asthma control status, as measured by a derived Asthma Control Test™ (ACT) score, and the utilisation and cost of healthcare in Europe.**

Data were derived from a European survey of asthma patients. Frequency of healthcare resource use was identified from the dataset and per-patient mean cost of asthma management estimated. Drug costs were not available. The ACT score was derived from questions in the survey identical or similar to the items comprising the ACT.

An ACT score was derived for 2,268 patients, of whom 48% (1,078) scored <20, suggesting their asthma was not well controlled, with 17% (381) scoring <15, suggesting poorly controlled asthma. The mean per-patient annual cost of asthma management for patients with a derived ACT of <15 was €1,604 (95% confidence interval: €1,219–2,084); for patients with a derived ACT score of 15–19, €512 (€404–660) and for patients with a derived ACT score of ⩾20, €232 (€192–286). A higher derived ACT score was associated with significantly lower expenditure on asthma management.

Worse asthma control, as measured by the derived Asthma Control Test™ score was associated with an increased requirement for unscheduled care and with higher cost.

KEYWORDS: Asthma, asthma control, Europe, healthcare costs

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Asthma is a chronic inflammatory respiratory disease and is a major cause of morbidity [1]. The prevalence of asthma in Western Europe ranges from 3.9% in Germany to 10.9% in the UK [2]. International guidelines recommend that the aim of asthma management should be to achieve and maintain control [3, 4]. The Global Initiative for Asthma (GINA) guidelines define control as minimal (ideally no) chronic symptoms, minimal (infrequent) exacerbations, no emergency visits, minimal (ideally no) need for rescue medications, no activity restriction, peak expiratory flow (PEF) circadian variation <20%, (near) normal PEF and minimal (or no) adverse effects from medicine [4].

However, no consensus exists on the optimum method to assess asthma control in practice. Composite measures used for assessing asthma control include the Asthma Control Questionnaire [5], which has recently been validated in a shortened format that does not require the assessment of lung function [6], and the Asthma Control Test™ (ACT) [7]. The ACT is a reliable and valid patient-completed measure of asthma control that was developed for easy use in a clinical setting [7]. The ACT comprises five items,

each relating to an aspect of asthma control over the previous 4 weeks: limitations to activities; shortness of breath; night-time awakening; use of rescue medication and patient perception of control. Completion of the ACT results in a score between 5 and 25, with a higher score indicating better control. A validation study found that an ACT score of ⩾20 indicated ''well-controlled'' asthma, and a score of <15 ''poorly controlled'' asthma [8]. The ACT has been shown to have a good specificity and sensitivity in identifying patients whose asthma control would be assessed as poor in a detailed specialist assessment [8].

The cost burden of asthma in Europe is high. The annual cost of asthma has recently been estimated to be €2.7 billion in Germany [9] and €1.5 billion in France. In the UK, asthma costs the National Health Service an average of £889 million per yr [10]. A Dutch study estimated the total burden of asthma and chronic obstructive pulmonary disease to be 1.3% of all healthcare expenditure in 1993, projected to increase by 60% by 2010 [11]. A recent study in hospital-based asthma clinics in Italy found a strong link between asthma symptoms and medical resource utilisation, concluding that asthma control is not

only a clinical but also an economic imperative [12]. Improved asthma control has been shown to reduce the frequency of exacerbations that may require physician and emergency room visits and hospitalisations, and therefore impact positively on the overall cost of asthma management [13, 14]. Unscheduled healthcare resource use has been found to be more than 2.5-fold higher in adults with poorly controlled asthma than those with well-controlled disease in France (€1,451.3 versus €549.8; 1997 values) [14].

The Asthma Insights and Reality in Europe (AIRE) survey identified, by telephone, a representative sample of people with asthma from a cross-section of households in seven European countries: France, Germany, Italy, the Netherlands, Spain, Sweden and the UK [15]. All respondents must have been diagnosed with asthma by a physician, be currently taking medication for their asthma or have had asthma attacks and symptoms during the past year. There was no upper or lower age cut-off point. Telephone interviews were performed using a structured questionnaire based on the American Thoracic Society questionnaire, with additional items relating to healthcare use and activity limitation. Respondents were questioned on symptom severity, sleep disruption, overnight hospitalisation, emergency room visits, unscheduled urgent care visits, activity limitations due to asthma, use of asthma therapy and perceived asthma control [15]. This was the first comprehensive multinational cross-sectional survey assessing asthma control among current asthma patients in Western Europe.

The AIRE survey [15] found that the level of asthma control in Europe fell short of the goals for long-term asthma management. A number of questions and response options in the AIRE survey were similar to or the same as the items and responses in the ACT. The objective of this study was to explore the distribution of asthma control as described by a derived ACT score and the relationship between the derived ACT score and the level of healthcare resource use and cost.

METHODS

Patients were included in this analysis if they took part in the AIRE study and were aged ⩾12 yrs. A symptom severity index (SSI) was developed for use with this dataset [16] which allocated patients into four categories: mild intermittent symptoms, mild persistent symptoms, moderate persistent symptoms and severe persistent symptoms. The SSI combined the reported frequency and severity of day- and night-time symptoms, exercise-induced symptoms and severe episodes and total symptom frequency. Data was collected on scheduled visits to their usual physician and specialist, as well as the use of unscheduled healthcare, including the number of asthma-related in-patient admissions, emergency room visits, and emergency contacts with a physician. These were combined with country-specific unit costs to estimate the annual healthcare costs of scheduled and unscheduled healthcare for each patient [17]. Unit costs were estimated from the perspective of public sector healthcare systems, which provide the majority of asthma care in all seven countries. Medication costs were not included, as patient responses were not sufficiently detailed to create a reasonable estimate of the cost of medications used.

ACT scores were derived for each patient from responses to the AIRE survey found to be similar or the same as the five items of the ACT. All of the questions used in AIRE for the development of the algorithm had a recall period of 4 weeks, the same as the ACT recall period. The mapping algorithms used to derive an ACT score are summarised in Appendix 1.

Patients were divided into groups using their derived ACT score: <15, 15–19, and ⩾20, and the proportion of patients in each group was calculated according to the SSI. The number and percentage of patients reporting hospital care (including both in-patient stay and emergency room visit) or any unscheduled healthcare over the past year was calculated for each group. The cost of unscheduled care, scheduled care and total healthcare was estimated for each group in each country.

In order to explore whether there was an independent effect of the derived ACT score on the cost of care, multiple regression of per-patient cost against country, SSI, age, sex and derived ACT was undertaken.

RESULTS

Of the 2,803 people with asthma included in the AIRE study, 2,276 patients were aged ⩾12 yrs and hence were eligible for inclusion in this analysis. The mean age of eligible patients was 39.9 yrs and was similar between countries, ranging from 36.3 yrs (France) to 42.3 yrs (Germany). Of respondents, 60% (1,355) were female. This differed little between countries, ranging from 57% (France) to 63% (Spain). Of the total, 19% were smokers, ranging from 16% in the UK to 24% in France. Nine hundred patients (40%) were classified as having mild intermittent symptoms and the proportion of patients with intermittent symptoms varied across the countries from 30% (Germany) to 47% (France). Of the 1,376 patients with persistent asthma symptoms, 430 reported mild persistent symptoms (19% of the eligible population), 504 (22%) moderate persistent symptoms and 442 (19%) severe persistent symptoms. Demographics and SSI for each country are presented in table 1.

A high percentage of patients reported frequent asthma symptoms: 44% of patients reported activity limitation all, most or some of the time (responses 1–3 on ACT question 1); 26% reported shortness of breath three times a week or more (responses 1–3 on ACT question 2); 33% reported that symptoms woke them up at night or earlier than usual in the morning either once a week or more frequently (responses 1–3 on ACT question 3) and 51% reported use of a rescue inhaler more than once a week (responses 1–3 on ACT question 4). Despite the high percentage of patients reporting symptoms and rescue medication use, 74% of patients reported that they considered their asthma was well or completely controlled (responses 4–5 on ACT question 5; fig. 1).

An ACT score could be derived for 2,268 patients, >99% of those eligible (table 2). Of patients with a derived ACT score, 48% (1,078) scored <20 and 17% (381) scored <15. Approximately one-third of patients (697, 31%) had a derived ACT score of 15–19. Eight per cent of patients (187) achieved the maximum possible derived ACT score of 25. Of the 1,370 patients with persistent asthma symptoms, 72% (984) scored <20, and only 2% (29) patients scored a derived ACT score of 25.

TABLE 1 Characteristics of eligible patients

	France	Germany	Italy	The Netherlands	Spain	Sweden	UK	Total
Eligible patients	298	346	320	317	341	337	317	2276
Age yrs	36.3±18.5	42.3±19.2	41.6±19.6	39.1±17.8	40.4±21.3	40.5±19.6	38.8±20.1	39.9±19.5
Females	169 (57)	199 (58)	191 (60)	191 (60)	215 (63)	199 (59)	191 (60)	1355 (60)
Smokers	73 (24)	67 (19)	52 (16)	65 (21)	60 (18)	70 (21)	52 (16)	439 (19)
SSI								
Mild intermittent	140 (47)	104 (30)	114 (36)	110 (35)	137 (40)	153 (45)	142 (45)	900 (40)
Mild persistent	59 (20)	66 (19)	67 (21)	56 (18)	50 (15)	71 (21)	61 (19)	430 (19)
Moderate persistent	58 (19)	82 (24)	73 (23)	76 (24)	91 (27)	64 (19)	60 (19)	504 (22)
Severe persistent	41 (14)	94 (27)	66 (21)	75 (24)	63 (18)	49 (15)	54 (17)	442 (19)

Data are presented as n, mean±SD or n (%). SSI: symptom severity index.
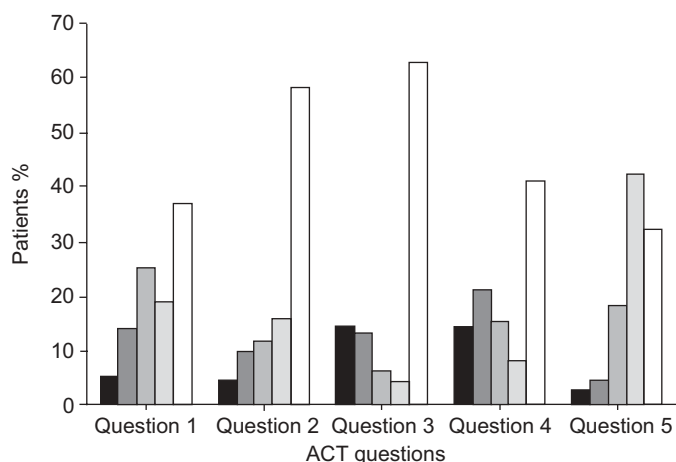
FIGURE 1. Derived responses to each of the Asthma Control Test™ (ACT) questions. Question 1: activity limitation; question 2: shortness of breath; question 3: night-time awakening; question 4: use of rescue medication; question 5: patient perception of control. ■: response 1; ◼: response 2; ◻: response 3; ◻: response 4; □: response 5.

A derived ACT score of ≥ 20 was reported by the majority of patients (90%) with mild intermittent asthma symptoms, but by only 8% of patients with severe persistent symptoms. This pattern was repeated across the individual countries (data not shown). There was no obvious association between the derived ACT score and smoking status, sex or age. Although there appeared to be an association between uncontrolled asthma and severe symptom severity, a small number of patients reported severe persistent symptoms combined with a derived ACT score of ≥ 20 (n=35; 8%) or a derived ACT score of ≤ 20 combined with mild intermittent symptoms (n=94; 10%; table 2).

Forty-one per cent of patients (443) with a derived ACT score of <20 had used unscheduled healthcare resources in the past year and 19% (210) had been hospitalised due to their asthma. Among patients with a derived ACT score of 20 or >21% had used unscheduled care and 7% had been hospitalised. Among patients with a derived ACT core of ≤ 15, 53% had used unscheduled care and 27% had been hospitalised (table 3).

The mean per-patient total annual cost of asthma-related healthcare for patients with a derived ACT score of <15 was €1,604 (95% confidence interval (CI): €1,219–2,084), for patients with a derived ACT score of 15–19 it was €512 (€404–660), and for patients with a derived ACT score of 20–25 it was €232 (€192–286; fig. 2). The pattern of cost was consistent across the seven European countries. For patients with a derived ACT score of <15, the mean annual/patient cost ranged from €1,049 (Italy) to €2,438 (Germany). For patients with a derived ACT score of 15–19 the range of mean annual/patient costs was

TABLE 2 Derived Asthma Control Test™ (ACT) scores and asthma symptom severity

Patient group[#]	Grouped ACT scores				
	ACT score < 15	ACT score 15–19	ACT score <20	ACT score 20–25	Total
All patients	381 (17)	697 (31)	1078 (48)	1190 (52)	2268
Mild intermittent symptoms	1 (0)	93 (10)	94 (10)	804 (90)	898
Mild persistent symptoms	13 (3)	187 (44)	200 (47)	229 (53)	429
Moderate persistent symptoms	103 (21)	275 (55)	378 (76)	122 (24)	500
Severe persistent symptoms	264 (60)	142 (32)	406 (92)	35 (8)	441

Data are presented as n (%) or n. All percentages refer to the number in the ACT group as percentage of row total. [#]: ACT was not evaluable for eight out of 2,276 eligible patients. See text for further information.

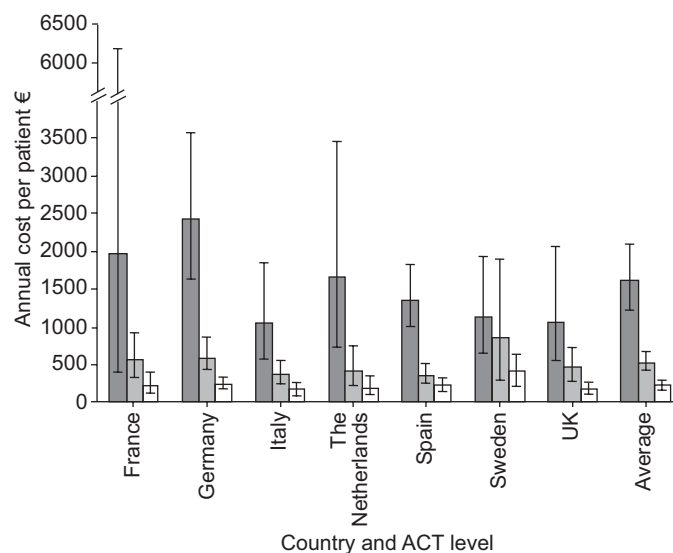| TABLE 3	Derived Asthma Control Test[TM] (ACT) scores and use of healthcare resources				
	Grouped ACT scores				
	ACT score < 15	**ACT score 15–19**	**ACT score < 20**	**ACT 20–25**	**Total**
Subjects n	381	697	1078	1190	2268
Hospital contact[#]	102 (27)	108 (15)	210 (19)	85 (7)	295 (13)
Any unscheduled care[¶]	202 (53)	241 (35)	443 (41)	246 (21)	689 (30)
Unscheduled care costing >€1000	57 (15)	32 (5)	89 (8)	17 (1)	106 (5)

Data are presented as n (% of ACT group) reporting in previous 12 months, unless otherwise indicated. [#]: defined as in-patient admission or emergency room visit; [¶]: defined as hospital contact or unscheduled primary care physician visit.

from €344 (Spain) to €841 (Sweden). The range for mean annual/patient costs among patients with a derived ACT score of ⩾20 was from €165 (Italy) to €386 (Sweden).

For patients with a derived ACT score of <15, unscheduled healthcare resource use accounted for 67% of cost (€1,068 per patient, 95% CI €730–1,602); for patients with a derived ACT score of 15–19, it accounted for 55% of cost (€284 per patient, 95% CI €184–416); and for patients with a derived ACT score of ⩾20, 27% (€62 per patient 95% CI 42–91) (fig. 3). A similar pattern was found across all included countries apart from Sweden, where the annual cost of unscheduled care was similar for patients with a derived ACT score of 5–14 and 15–19. The cost of unscheduled healthcare resource use in the past year exceeded €1,000 for 8% of patients (89) with a derived ACT score <20, and for 1% (17) of patients with a derived ACT score of ⩾20 (table 3).

The regression analysis found that, after correcting for country and symptom severity, a higher derived ACT score (improved asthma control) was associated with significantly lower total annual expenditure on asthma management (p<0.01). Age, sex and SSI were not significantly associated with total expenditure after correcting for derived ACT score.
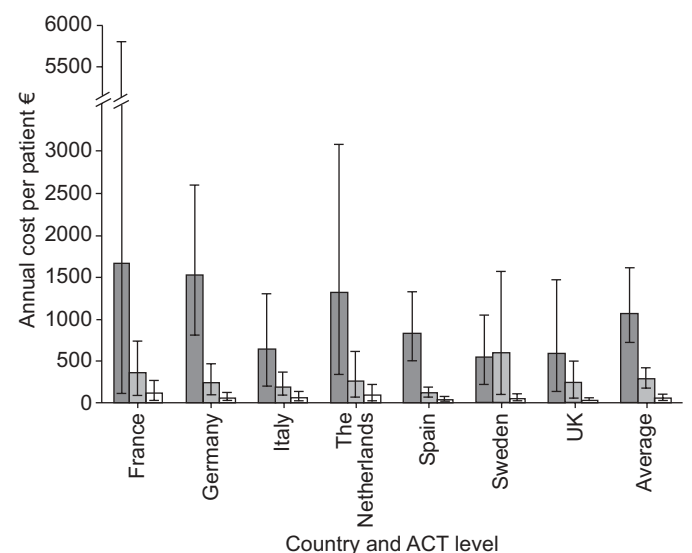
DISCUSSION

In this analysis of a large representative survey of patients with asthma in seven European countries, almost half of all asthma patients (48%) and 71% of patients with persistent asthma symptoms reported a derived ACT score of <20, indicating that their asthma was not well controlled. Patients with a lower derived ACT score reported higher frequency of hospitalisation and of unscheduled healthcare utilisation and higher per-patient cost over the past year.

Previous analysis of this dataset [15] found that only 5.3% of the population met all the GINA criteria for asthma control, considering day- and night-time symptoms, emergency visits, exacerbations, rescue inhalers, limitations on activities and lung function [4]. This analysis found that a slightly higher percentage of patients (8%) achieved the best possible derived ACT score, which could be considered to equate to the stringent GINA-based definition used in the original AIRE analysis. The difference in the items comprising the two definitions of control is likely to explain the small discrepancy found in the proportion of patients with controlled asthma. The discrepancy in the association between the derived ACT scores and symptom severity was greater, suggesting that

FIGURE 2. Annual total cost of healthcare by country and derived Asthma Control Test[TM] (ACT) scores. ■: ACT 5–14; ■: ACT 15–19; □: ACT 20–25.

FIGURE 3. Annual cost of unscheduled healthcare by country and derived Asthma Control Test[TM] (ACT) scores. ■: ACT 05–14; ■: ACT 15–19; □: ACT 20–25.

symptom severity alone is not an adequate measure of asthma control, with a small number of patients reporting severe persistent symptoms combined with a derived ACT score of $\geqslant 20$ or a derived ACT score of <20 combined with mild intermittent symptoms.

Previous work estimating the economic burden of asthma has found significantly higher management costs in patients with uncontrolled asthma and up to three-quarters of the total costs of asthma care are a result of inadequately controlled disease [13]. Unscheduled healthcare resource use has been found to be >2.5-fold higher in adults with poorly controlled asthma than those with well-controlled disease in France (€1,451.3 versus €549.8; 1997 values) [14]. In this study, higher derived ACT scores were associated with significantly lower annual expenditure on asthma healthcare with unscheduled healthcare accounting for over half the healthcare costs amongst patients who have asthma that is not well controlled (derived ACT score 5–19) compared with 27% of costs amongst patients with well-controlled asthma (derived ACT score 20–15).

National guidelines promote regular review of all patients by their prescribing physician in order for optimal control to be obtained and maintained. However, patients who perceive their asthma to be controlled are reluctant to undergo regular review [18]. In common with other studies, this analysis found that many patients who perceived their asthma to be well or completely controlled (ACT question 5), also reported symptoms and limitations to daily activities, suggesting that their asthma was not well controlled. Uncontrolled asthma puts patients at greater risk of exacerbation and negatively impacts on quality of life. It is therefore important that control is assessed effectively in clinical practice.

A limitation of these findings is that the ACT scores were estimated from questions that did not perfectly match the ACT items and were part of a much larger survey of patient-elicited information, not presented to the patient as a discrete questionnaire. Unfortunately, it was not possible to include medication costs to estimate the total cost of asthma management for a full cost of illness analysis. Other studies have reported the cost of asthma medication, such as a UK survey by NEVILLE et al. [18], which showed that the annual cost of asthma medication varied between €32 and €777. In their cost of illness analysis in the Netherlands, RUTTEN-VAN MOLKEN et al. [11] estimated that medication accounted for the greatest part (45%) of the annual costs for managing asthma.

Healthcare resource use was based on patient recall over a period of 1 yr, which could potentially introduce further inaccuracy [19, 20], although recall of emergency events in particular has been found to be acceptable over such a period [21]. The questions used to derive the ACT score refer to a period of 4 weeks and not over the full year for which resource use was reported.

The key strength of this study is that the data come from the AIRE survey, a large representative sample that generated consistent results across a range of countries and reported the frequency of symptoms and of healthcare contact. Findings generated in this study suggest a consistent association between asthma control and healthcare resource use in a broad group of patients across a range of European countries.

This study found a relationship between a derived ACT score, historical resource utilisation and cost over the past year. Further research would be needed to explore whether an ACT score can also predict the risk of hospitalisation and requirement for unscheduled healthcare spending in the future. Further research would also be required to explore the performance of this measure as a guide for clinical management.

In conclusion, almost half of all asthma patients (48%) and 71% of patients with persistent asthma symptoms reported a derived Asthma Control Test™ score of <20, indicating that their asthma was not well controlled. Furthermore, worse asthma control as measured by the derived Asthma Control Test™ was associated with an increased requirement for unscheduled care and with higher cost. The average cost of asthma management was more than six times higher among patients with a derived Asthma Control Test™ score of <15 than among patients with a derived Asthma Control Test™ score of $\geqslant 20$.

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APPENDIX 1. ASTHMA INSIGHTS AND REALITY IN EUROPE (AIRE) TO ASTHMA CONTROL TEST[TM] (ACT) MAPPING ALGORITHM

ACT items and corresponding AIRE survey question(s)	ACT responses and corresponding responses from the AIRE survey questions				
ACT question 1					
During the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school or home?	All of the time	Most of the time	Some of the time	A little of the time	None of the time
AIRE					
How much do you feel that your asthma limits what you can do in 1) social activities/playing and 2) housekeeping chores? Do you feel your asthma restricts you a lot, some, only a little or not at all?	Both responses ''a lot''	Worst response ''a lot''	Worst response ''some''	Worst response ''a little''	Both responses ''not at all''
ACT question 2					
During the past 4 weeks, how often have you had shortness of breath?	More than once a day	Once a day	3–6 times a week	Once or twice a week	Not at all
AIRE					
During the past 4 weeks have you had ..... shortness of breath? Yes/No How many times in a typical week (if any) do you experience (shortness of breath)?	Eight or more times per week	Seven times per week	3, 4, 5 or 6 times per week	Once or twice per week	Not at all
ACT question 3					
During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning?	Four or more times a week	2–3 times a week	Once a week	Once or twice	Not at all
AIRE					
In the past 4 weeks, have (you/your child) been awakened by a cough, or wheezing, or shortness of breath, or chest tightness during the night? Yes/No How often do (you/your child) have these symptoms at night?	''Every night'' OR ''Most nights''	''At least 3 nights a week'' OR ''Twice a week''	''Once a week (5 times a month)'' OR ''3 or 4 times a month''	Once or twice a month	None
ACT question 4					
During the past 4 weeks how often have you used your rescue inhaler or nebulizer medication (such as salbutamol)?	Three or more times a day	Once or twice a day	2–3 times a week	Once a week or less	Not at all

APPENDIX 1. (Continued)

ACT items and corresponding AIRE survey question(s)	ACT responses and corresponding responses from the AIRE survey questions				
AIRE					
In the past 4 weeks have you used any prescription medicine to give yourself quick relief from asthma symptoms? Yes/No How often do you use an inhaler for quick relief from asthma symptoms?	''Daily'' AND ''3 or more times a day''	''Daily'' AND ''1 or 2 times a day''	''1 or 2 times a week'' OR ''3–6 times a week''	Less than once a week	Not used any prescription medicine for quick relief
ACT question 5					
How would you rate your asthma control during the past 4 weeks?	Not controlled at all	Poorly controlled	Somewhat controlled	Well controlled	Completely controlled
AIRE					
Overall, how well would you say that (your/your child's) asthma has been controlled in the past 4 weeks?	Not controlled at all	Poorly controlled	Somewhat controlled	Well controlled	Completely controlled