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Early View

Original article

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Original Article

Title: Development and validation of the Adolescent Asthma Self-Efficacy Questionnaire (AASEQ)

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ABSTRACT

Perceived self-efficacy is the belief that one can manage prospective situations. Good asthma self-management self-efficacy is associated with better asthma outcomes. However, a well-developed and validated tool to measure adolescent asthma self-management self-efficacy is lacking. Our objective was to develop and validate an Adolescent Asthma Self-Efficacy Questionnaire (AASEQ).

The first stage of the study included a review of the literature, interviews with adolescents with asthma and consultations with parents and relevant healthcare professionals to develop a prototype scale. To assess reliability and validity, a further group of adolescents completed the prototype scale, the General Self-Efficacy Scale and KidCope (measures coping styles). Re-testing was undertaken to assess longitudinal validity.

Interviews with 28 adolescents and consultations with other stakeholders resulted in a 38-item prototype scale. Key themes were medication, symptom management, triggers, knowledge, attitude and beliefs around asthma, supportive relationships, schools and healthcare professionals. The prototypte scale was completed by 243 adolescents. Factor and reliability analysis reduced it to a 27-item scale with 4 sub-sections: symptom management; medication; friends, family and school; asthma beliefs. The 27-item scale had respectable to excellent internal consistency (α's 0.78-0.91) with results that were stable over time (ICC=0.82) in 63 who completed it twice. Better adolescent asthma self-efficacy was associated with better general self-efficacy and indices of better asthma management.

The AASEQ is a reliable and valid tool that is likely to aid future research and practice focused on adolescent asthma self-management and could be a useful intermediate outcome measure to assess the impact of behavioural interventions.

INTRODUCTION

Many adolescents with asthma have suboptimal disease control despite the availability of effective therapies.[1] For some, poor asthma control will be a consequence of sub-optimal self-management, particularly adherence to treatment.[2] Research has identified several psychosocial and behavioural factors that influence asthma self-management in adolescence, e.g. forgetting treatment; lack of knowledge about asthma and treatments; treatment burden; erroneous beliefs; embarrassment at having asthma; and communication difficulties with healthcare practitioners (HCPs).[3]

Self-management self-efficacy in chronic disease is an important concept.[4] Perceived self-efficacy is defined as 'the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations'.[5 p5] Improving self-efficacy can lead to individuals feeling more confident to master challenging problems, developing a stronger sense of commitment to dealing with tasks and not feeling that situations are beyond their capabilities.[5] In asthma, self-management self-efficacy would cover strategies to prevent symptoms including the use of preventers, preparation to manage symptoms as well as managing them. Good asthma self-efficacy has been found to be associated with better asthma outcomes including less hospitalization [6-10]. There is also some evidence that interventions designed to improve self-efficacy may improve asthma outcomes.[11]

A child asthma self-efficacy measure exists that was developed in the US for 7-15 year olds.[12] Studies using this measure, to explore the role of self-efficacy in adolescents with asthma, have reported inconclusive results. Rhee et al[13] found that self-efficacy predicted barriers to self-management such as poor relationships with healthcare professionals, negative perceptions to medication, and difficulties with adherence. Meanwhile, Sleath et al[14] and Zebracki and Drota[15] found that asthma self-efficacy associated with better adherence to asthma medications in adolescents. In contrast, Zebracki et al[16] and Riekert et al[17] found better self-efficacy was not associated with improvements in other aspects of self-management. Improvements in self-efficacy have been shown in intervention studies

following the use of a mobile asthma action plan[18] and peer-led education[19] but not following the use of motivational interviewing intervention.[17]

A number of other groups have examined self-efficacy in asthma using other approaches. Van Dellen et al[20] reported that higher self-efficacy was associated with better adherence with self-efficacy being measured using a single question 'How difficult will it be for you to take your ICSs on a daily basis in the near future?'. Van Es et al used a short questionnaire to measure self-efficacy and did not find any improvements following an intervention program.[22]

One possible reason for the equivocal results found here is the way in which the child asthma self-efficacy scale was developed. Patient-reported outcome measures should be developed and validated using rigorous and established methods that establish content validity and reliability. Preliminary qualitative work using open-ended questions should be used to gain a meaningful perspective with adolescents with asthma as the population of interest.[23] Self-efficacy instruments in particular need to identify the challenges that people face to perform activities; questions should be formulated to include a judgment of perceived capability ("I can do") for carrying out specific activities; and the measurement scale should ideally range from 0 to 100.[24,25]

The asthma self-efficacy measure developed by Bursch et al[12] used structured interviews rather than semi-structured ones. There is also a lack of information regarding how scale items were selected, whether their construction involved adolescents, and test-retest reliability data. In addition, the measure may not be appropriate to use with adolescents given it was developed with children aged 8-17 years and so have a very different experience to younger children.[26] A further adolescent asthma self-efficacy questionnaire was developed 25 years ago in The Netherlands with participants aged 10-18 years.[27] It has similar methodological limitations (reviewed in Frei at al[28]).

In this study we describe the initial development and validation of a new measure, the Adolescent Asthma Self-Efficacy Questionnaire (AASEQ). This has been developed for use with 12-18 year olds following contemporary scale guidelines and focusing on asthma self-management self-efficacy.

METHODS

Ethical approval was provided by the NHS Ethics Committees (see online supplement). All participants and parents/carers gave informed consent.

Item Generation

Participants and procedures

This phase was conducted between October 2014 and March 2015 in the South of England. Participants were aged 12-18 years with doctor-diagnosed asthma (as coded in medical notes), prescribed regular prophylactic asthma medication and with no other significant long-term medical condition (apart from hay fever, eczema or food allergy), recruited from 3 general practitioners and two hospitals. Purposive sampling was used to ensure a range of participant ages, gender and asthma control were included. A number of their parents and healthcare professionals were also consulted (details in online supplement).

Interviews and analysis

Interviews and focus groups were conducted by a psychologist (SH), not previously known to them, with experience in conducting focus groups and interviews with adolescents. They were audiotaped and transcribed verbatim, then analysed by inductive thematic analysis,[29] further details can be found in the online supplement. The multidisciplinary group of authors used the themes from the initial analysis and the literature review to form items for inclusion in a prototype questionnaire. Feedback on the items and rating scale was then sought from parents and healthcare practitioners working with adolescents with asthma (including four paediatric consultants with an interest in respiratory disease and three paediatric asthma nurses). Six adolescent participants who had taken part in the qualitative interviews also

reviewed the prototype questionnaire to check that items and the rating scale were understandable; no changes were deemed necessary. Based on guidelines provided by Bandura,[24] items were worded as statements with a rating scale of 0 to 100 where participants are asked to rate how confident they are that they could do each item with 0 being cannot do at all, 50 being moderately can do and 100 being highly certain can do. This process resulted in a 38 item prototype Adolescent Asthma Self-Efficacy Questionnaire (AASEQ).

Scale reliability and validity

Participants and procedure

To assess reliability and validity of the scale in a large sample, participants with asthma were recruited from the general population to take part in an online questionnaire. Recruitment took place between July 2015 and June 2016. A convenience sample was recruited from 19 hospital outpatients and eight primary care general practitioner centres across England. Asthma UK and the Anaphylaxis Campaign advertised the study through social media outlets (Facebook and Twitter) and newsletters. Participants were provided with information about the study and a secure internet URL address where they could access the questionnaire after completing an online consent. Participants were informed that on completion of the questionnaire they would be entered into a prize draw to win a gift voucher (1 prize of £50, 5 runner-up prizes of £10). The inclusion criteria were 12-18 years with doctor-diagnosed asthma and no other chronic illness that has a major impact on daily life (apart from hay fever, eczema and food and animal allergy given the high level of co-morbidity of these with asthma). Participants could complete the questionnaire anonymously, although email addresses were requested in order to conduct the AASEQ repeat test.

Cross-sectional validation measures

Adolescents completed two scales to assess convergent construct validity - the KIDCOPE[30] and the General Self-Efficacy Scale (GSES) [31]. These scales are well-used, have excellent reliability and validity for the age range of our participants, are quick to complete and measure

constructs we hypothesised would correlate with the AASEQ. Further details are in the online supplement. Adolescents also provided details about their asthma such as length of time since diagnosis, triggers, medication and number of hospital admissions due to asthma. They were also asked to rate how often they forgot their preventer inhaler on a 6-point scale from never to always.

Consistency over time

Participants were sent an email asking them to repeat the AASEQ four weeks after completing the baseline questionnaire. They were asked whether they had experienced any asthma-related events during that time interval.

Statistical analysis

Data analyses were conducted using SPSS version 22, missing data was treated listwise. Standard analysis to explore reliability and validity was then applied.[32] Principal components analysis was conducted to shorten the questionnaire to remove redundancy. Cronbach's α coefficient and Guttman's split-half coefficient were conducted to assess internal reliability of the scale. Agreement with other validated questionnaires (construct validity) was assessed using Pearson's bivariate correlations. Consistency of the questionnaire over time (test-retest reliability) was assessed by Intra-Class Correlations (ICC). All tests were 2-tailed with a significance level set at $p<0.05$. Further details are available in the online supplement.

RESULTS

Item Generation

A total of 28 adolescents aged 12-18 years with doctor-diagnosed asthma participated. Six adolescents took part in one focus group and 22 adolescents took part in a 1:1 interview. Full details of this qualitative phase (Table S1), item generation and prototype AASEQ scale (Box S1) development can be found in the online supplement.

Scale reliability and validity

A total of 243 participants completed the baseline questionnaires. Demographic information and asthma characteristics of these participants can be found in Table 1. Three participants did not complete the AASEQ and were removed from analysis to assess scale reliability and validity. There were only 36 missing items across the whole dataset for the AASEQ (n=9,234 data points). Details of missing data and floor and ceiling effects are shown in the online supplement (Figure S1).

Table 1 Demographic information and asthma characteristics of participants

		Baseline N=243	Re-test N=63
Mean age in years (s.d.)		14.6 (1.8)	14.8 (1.9)
Age range in years		12 – 18	12 – 18
Mean age of onset of asthma in years (s.d.)		4.8 (4.2)	
Mean length of time since diagnosis in years (s.d.)		9.8 (4.3)	
Gender (%)	Male	97 (39.9)	16 (25.4)
	Female	146 (60.1)	47 (74.6)
Ethnicity (%)	White British	206 (84.8)	57 (90.5)
Managed by (%):	Primary care	102 (42.0)	32 (50.8)
	Secondary care	139 (57.2)	31 (49.2)
Recruited from (%):	Hospital	184 (75.7)	41 (65.1)
	GP	23 (9.5)	8 (12.7)
	Social media	34 (14.0)	14 (22.2)
Self-reported asthma triggers (%)	Weather	187 (77.0)	
	Pollen	161 (66.3)	
	Emotions	164 (67.5)	
	Fumes	136 (56.0)	
Self-reported asthma triggers (%)	Dust	73 (30.0)	
	Pets	140 (57.6)	
	Colds or flu	42 (17.3)	
	Cigarette smoke	118 (48.6)	
	Food or drinks	206 (84.8)	
	Soaps / sprays	147 (60.5)	
Self-report of forgetting preventer medication (%)	Never	59 (24.3)	
	Occasionally	95 (39.1)	
	Once a week	21 (8.6)	
	Half the time	20 (8.2)	
	Most of the time	28 (11.5)	
	All the time	18 (7.4)	
Mean number of asthma exacerbations in last year (s.d.)*		3.5 (5.0)	
Mean number of oral corticosteroid courses in last year (s.d.)**		3.2 (5.4)	
Mean total number of hospital visits due to asthma (s.d.)		7.7 (20.3)	
Other allergic disease (%)	Eczema	107 (44)	
	Hay fever	187 (77)	
	Food allergy	66 (27.2)	
	Animal allergy	115 (47.30)	

Figures represent mean (SD) or number (%). *How many asthma exacerbations did you have last year? ** How many courses of steroid (prednisolone) did you need in the last year?

Internal structural validity of the AASEQ

Principal components analysis with a varimax rotation was conducted on the 38 items of the prototype AASEQ (Box S1). Four items with low factor loadings were removed giving a 34 item solution which explained 58.3% of the total variance in the data. A clear interpretation of the factors could be made and factors were called: Friends, Family and School; Symptom Management; Asthma Beliefs; and Medication (see Table 2). Further details are in the online supplement.

Internal reliability of the AASEQ

The 34 items had excellent internal consistency (see Table 3). On inspection of the items, it was felt that some were very similar, for example, items such as 'talking to teachers' and 'talking honestly to teachers' were originally included in the scale to see which item was a more reliable indicator of self-efficacy. As these items contributed equally well in the analysis it was felt that the scale could be made more parsimonious by the removal of the item with the lower factor loading (indicated by a * in Table 2) resulting in a 27-item scale (see Box 1). This did not substantially affect the reliability of the scale (see Table 3). All AASEQ answers are summed and then divided by 27 to get a total mean score (0-100). Sub-scale items are also summed and divided by the number of items in each sub-scale. A higher score indicates greater self-efficacy for management of asthma.

Box 1. 27 item final Adolescent Asthma Self-Efficacy Questionnaire (AASEQ)

This questionnaire is designed to help us get a better understanding of how you manage your asthma. Please rate how certain you are that you can do each of the things described below by writing the appropriate number.

For each of the following statements, rate how confident you feel by choosing a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question	Confidence (0-100)
MEDICATION	
I am confident that:	
I know how to correctly use my asthma inhaler/spacer/medication	
I know when to use my asthma medication	
I know which of my inhalers I need to take	
I know what my preventer inhaler is for	
I know what my reliever inhaler is for	
SYMPTOM MANAGEMENT	
I am confident that:	
I can be prepared to deal with an asthma attack	
I know how to stay calm when I am having trouble breathing	
I know when I am out of breath because of my asthma rather than because of exercise	
I know when I am out of breath because of my asthma rather than because I feel a bit panicky	
I know how to control my asthma when I am having trouble breathing	
I know when to use my inhaler to manage a serious breathing problem	
I know when I might need to go to hospital because of a serious breathing problem	
I know what to do to avoid triggers for my asthma	
ASTHMA BELIEFS	
I am confident that:	
I am in control of my asthma	
I can do physical activity such as sports	
I can have a normal life	
I can do the things that I want to do	
I can control my asthma day-to-day	
FRIENDS, FAMILY AND SCHOOL	
I am confident that:	
I can take my inhalers in front of my friends	
I can take my inhalers around other people at school	
I can talk honestly to my friends about my asthma	
I can talk honestly to my parents about my asthma	
I can talk honestly to my doctor or nurse about my asthma	
I can talk honestly to my teachers about my asthma	
I can ask my parents for help if I am having trouble breathing or having an asthma attack	

I can ask my teachers for help if I am having trouble breathing or having an asthma attack	
I can ask my friends for help if I am having trouble breathing or having an asthma attack	

Cross-sectional validity of AASEQ

The total AASEQ score significantly correlated with total general self-efficacy with greater asthma management self-efficacy associated with greater general self-efficacy. Each sub-scale of the AASEQ also significantly correlated with the GSES (Table 4). In relation to coping, the total AASEQ score and all the sub-scales had small to medium positive correlations with problem solving coping, indicating that greater use of this coping strategy related to greater asthma self-efficacy (see Table 4).

Table 2 Factor analysis of the AASEQ 34-item scale

	Factor 1	Factor 2	Factor 3	Factor 4
FRIENDS, FAMILY AND SCHOOL				
I can talk honestly to my teachers about my asthma	**.83**	.19	-.01	-.04
I can talk to my teachers about my asthma*	**.82**	.18	.06	.03
I can talk honestly to my friends about my asthma	**.81**	.07	.20	.14
I can talk to my friends about my asthma*	**.81**	.05	.16	.09
I can take my inhalers in front of my friends	**.75**	.20	.16	.04
I can take my inhalers around other people at school	**.74**	.26	.07	-.02
I can ask my teachers for help if I am having trouble breathing or having an asthma attack	**.73**	.14	-.002	.04
I can ask my friends for help if I am having trouble breathing or having an asthma attack	**.69**	.06	.17	.10
I can talk honestly to my doctor or nurse about my asthma	**.69**	.15	-.02	.05
I can talk to my doctor or nurse about my asthma*	**.66**	.15	.01	.08
I can talk honestly to my parents about my asthma	**.65**	-.12	.35	.17
I can talk to my parents about my asthma*	**.61**	-.14	.33	.20
I can ask my parents for help if I am having trouble breathing or having an asthma attack	**.56**	-.13	.21	.27
SYMPTOM MANAGEMENT				
I know how to stay calm when I am having trouble breathing	.03	**.81**	.22	.07
I know how to control my asthma when I am having trouble breathing	.07	**.78**	.18	.20
I can stay calm when I am having trouble breathing*	.06	**.76**	.28	.003
I can be prepared to deal with an asthma attack	.06	**.69**	.12	.32
I know when to use my inhaler to manage a serious breathing problem	.05	**.64**	.06	.41
I know what to do to avoid triggers for my asthma	.04	**.60**	.12	.22
I know when I might need to go to hospital because of a serious breathing problem	.19	**.56**	.01	.34
I know when I am out of breath because of my asthma rather than because I feel a bit panicky	.27	**.53**	.04	.24
I know when I am out of breath because of my asthma rather than because of exercise	.36	**.52**	.02	.21
I can have my medication with me at all times*	.16	**.43**	-.22	.17
ASTHMA BELIEFS				
I can do the things that I want to do	.17	.05	**.88**	-.02
I can have a normal life	.20	-.001	**.87**	-.05
I can control my asthma day-to-day	.08	.28	**.83**	-.004
I can do physical activity such as sports	.23	.15	**.74**	-.03
I am in control of my asthma	.14	.29	**.69**	.03
MEDICATION				
I know what my preventer inhaler is for	.02	.21	-.01	**.80**
I know what my reliever inhaler is for	.01	.18	-.05	**.79**
I know what my inhalers are for*	.12	.26	-.03	**.75**
I know which of my inhalers I need to take	.08	.24	.01	**.69**
I know when to use my asthma medication	.18	.37	-.02	**.52**
I know how to correctly use my asthma inhaler/ spacer/ medication	.24	.21	.02	**.46**
EIGENVALUES	**7.35**	**5.00**	**3.89**	**3.60**
% VARIANCE EXPLAINED	**21.61**	**14.71**	**11.44**	**10.57**

Figures represent the factor loading for each question for each of the 4 factors. An eigenvalue of more than 1 indicates a factor as being important. * items removed to create a more parsimonious 27-item scale.

Table 3 Internal consistency and consistency over time of the 27-item AASEQ scale and sub-scales

AASEQ	All repeat participants (N=63)		Only repeat participants reporting no change (N=22)		Cronbach's alphas		Intra-class correlations for test re-test	
	Initial assessment Mean (SD)	Repeat assessment Mean (SD)	Initial assessment Mean (SD)	Repeat assessment Mean (SD)				
					34-item scale	27-item scale	All re-test participants (N=63)	Participants reporting no change (N=22)
Total Scale	82.32 (12.67)	82.92 (14.24)	83.27 (11.29)	85.13 (10.52)	.92	.91	.82	.81
Sub-Scales								
Friends, family and school	86.46 (17.27)	82.55 (21.66)	88.02 (12.04)	86.95 (12.89)	.93	.90	.90	.72
Symptom management	76.22 (18.36)	77.92 (18.23)	70.74 (17.32)	75.82 (18.45)	.88	.87	.65	.58
Asthma beliefs	77.33 (22.17)	82.05 (20.15)	90.94 (10.44)	90.21 (11.94)	.90	.90	.90	.72
Medication	90.35 (12.25)	92.48 (8.56)	87.14 (12.77)	91.68 (9.85)	.84	.78	.58	.64

Cronbach's alphas represent the consistency of the questionnaire and the sub-scales. Intra-Class Correlations (ICC) represent the consistency of the questionnaire over time (test-retest reliability). No change related to having not experienced an asthma attack; not being admitted to hospital due to their asthma; not being seen a healthcare professional for their asthma; no change in asthma medication; and having had no new asthma education since completing the initial questionnaire.

Greater asthma management self-efficacy (total score and all sub-scales apart from symptom management) significantly related to less use of social withdrawal, with small to medium sized correlations. Poorer asthma management self-efficacy for the family, friends and school sub-scale was associated with greater use of blaming others (medium sized correlation) and less use of social support as a way of coping (small correlation). Better symptom management and medication self-efficacy related to greater use of cognitive restructuring as a way of coping (Table 4). Together these results demonstrate good construct validity of the AASEQ compared to general self-efficacy and moderate construct validity compared to general coping styles.

The relationship between markers of poor asthma control and the AASEQ showed small to medium sized negative correlations (Table 5). A greater number of self-reported asthma exacerbations in the past year was significantly associated with poorer total asthma self-efficacy, asthma beliefs and use of friends, family and school. More self-reported use of oral corticosteroids in the past year and more self-reported hospital visits for asthma were associated with poorer asthma beliefs, but a belief in better symptom management, demonstrating that adolescents knew what to do if they had an asthma attack or needed to go to hospital, but felt that they were not able to have a normal life or be in control of their asthma.

Table 4 Pearson's correlations between the AASEQ scale and sub-scales, the GSES and the KIDCOPE

	AASEQ Total	**AASEQ sub-scales**			
		Friends, family and school	Symptom management	Asthma beliefs	Medication
GSES	.47**	.30**	.36**	.41**	.23**
KIDCOPE					
Distraction	-.09	-.10	.001	-.13	-.08
Social withdrawal	-.31*	-.32**	-.10	-.23*	-.26*
Cognitive restructuring	.14	-.09	.22**	-.09	.19*
Self-criticism	-.22	-.19	-.18	-.20	-.15
Blaming others	-.23	-.35*	-.05	-.16	-.18
Problem solving	.33**	.16*	.30**	.19*	.25**
Emotional regulation	-.01	-.01	-.01	-.03	.06
Wishful thinking	.09	.13	.02	.06	.00
Social support	.14	.18*	.07	.01	.11
Resignation	-.004	-.04	.09	-.01	.03

Figures represent Pearson's correlation coefficients to assess how well the AASEQ agrees with other questionnaires. *p<0.05; **p<0.01.

Factors likely to be related to self-management were also examined (Table 5). A greater frequency in forgetting their preventer inhaler significantly correlated with lower total asthma self-efficacy scores and lower sub-scale scores for friends, family and school, symptom management and use of medication. Having asthma for a longer duration was significantly correlated with better asthma symptom management. Poorer asthma self-efficacy also related to having co-morbid hay fever and food allergy (see online supplement).

Consistency over time of the AASEQ

A total of 183 participants were sent an email asking them to complete the AASEQ for a second time. Of these, 63 (34.4%) responded to the request to complete the re-test. There were no differences in responders except that they reported forgetting their preventer inhaler more often (mean (SD) 3.00 (1.69) versus 2.53 (1.52), $p<0.05$). There was a strong intra-class correlation (ICC) of 0.82 between the baseline total scale score and the re-test total scale score (see Table 3 for total and sub-scale ICCs). Adolescents reporting no change in their asthma (n=22) had similar results (ICC 0.81, Table 3).

Table 5 Pearson's correlations (number of participants) between the AASEQ scale and sub-scales, asthma control and factors that could affect asthma self-management

	AASEQ Total	**AASEQ sub-scales**			
		Friends, family and school	Symptom management	Asthma beliefs	Medication
Asthma Control					
Number of asthma exacerbations in last year	-.19** (224)	-.17* (230)	.05 (234)	-.43*** (236)	.07 (232)
Number of corticosteroid courses in last year	-.01 (217)	-.01 (223)	.22** (225)	-.37** (227)	.12 (223)
Number of hospital visits ever	-.07 (228)	-.03 (234)	.18** (238)	-.14* (240)	.13 (236)
Self-management					
Forgetting of preventer inhaler	-.23** (227)	-.16** (232)	-.34** (236)	.05 (238)	-.18** (235)
Length of time since diagnosis	.13 (227)	.07 (233)	.17** (237)	-.03 (239)	.12 (235)
Age of onset of asthma (years)	-.18** (227)	.15* (233)	-.20** (237)	-.02 (239)	-.10 (235)
Age at completion of the questionnaire (years)	-.12 (228)	-.17** (234)	-.06 (238)	-.10 (240)	.03 (236)

Figures represent Pearson's correlation coefficients to assess how well the AASEQ agrees with asthma parameters. *p<0.05; **p<0.01, p<0.001***

DISCUSSION

The Adolescent Asthma Self-Efficacy Questionnaire (AASEQ) (Box 1) is the first asthma self-efficacy scale developed specifically for adolescents aged 12 to 18 using recommended and robust scientific methods.[24] Previous scales for measuring adolescent asthma self-efficacy[12,27] have lacked rigorous development processes such as a systematic literature search; adequate inclusion of stakeholder opinion; test re-test reliability, and construct validity.[28] In contrast we conducted a comprehensive literature search, interviewed several stakeholder groups (adolescents, their parents and their healthcare professionals), and established test re-test reliability and construct validity. As an example, the AASEQ correlates with markers of asthma control. So the AASEQ focuses on the specific challenges that this group face in developing their independent self-management skills.[33]

The overall AASEQ scale and all sub-scales demonstrate good to excellent internal reliability and stability over time. In the test re-test, scores for self-efficacy for asthma medication increased slightly from time one to time two; it may be that completing the scale at time one prompted adolescents to think about and consequently remember information about their asthma medication, resulting in them reporting more confidence in using it when completing the scale again. Finally, the scale has good construct validity, as demonstrated by how it correlated with the General Self-Efficacy Scale and the KidCope (further discussed in the online supplement).

A strength of this study is the large sample of adolescents who completed the scale, enabling a range of validity analyses to be conducted. The majority were recruited from primary or secondary care, ensuring that the analysis was not completely reliant on self-report of an asthma diagnosis.

There are a number of limitations that need to be addressed in further work. Although we piloted the scale with adolescents, we did not conduct cognitive interviews and these would be useful to check understanding of the items and the response scale. Although not identified

as an issue by adolescents, the scale instructions could be further tested. Confirmatory factor analysis is needed which will enable us to see if the sub-scales found in the exploratory factor analysis reported here can be replicated. Although a large number of participants were included in the development phase, it is possible that a different structure would be apparent with an even larger number of participants. It would also be useful to explore whether greater self-efficacy reported by adolescents relates to better asthma management using more objective indices of asthma control and adherence to medication. The validation work thus far has relied on self-report from adolescents. The ability of the scale to measure change over time in response to an intervention to improve asthma management self-efficacy needs to be ascertained and this is work currently being conducted by the authors. Further work to assess the test re-test reliability, given the small number completing the re-test, would be valuable to provide further evidence for the consistency of the tool over time. It is possible that not all the participants had asthma as 14% were recruited via social media although they reported a doctor's diagnosis of asthma. There is the likelihood of a selection bias in our sample, as the most motivated adolescents (who may be more likely to self-manage asthma better) were probably most likely to participate in the survey.

We endeavoured to create a scale that could be used in both research and clinical practice. Whilst taking only 5-10 minutes to complete, an even shorter version of the scale may be valuable for use in clinical settings when time pressures may prevent the completion of a longer scale. The scale is self-administered and was developed to be understandable to the majority of adolescents aged 12-18 years and completed with little or no input from parents or other adults. We would suggest that adolescent patients could complete the AASEQ scale prior to a clinic consultation to highlight areas where they may most need support with self-management. Healthcare practitioners could then use this information to inform the areas covered in the consultation, ensuring that it focuses on the needs of the adolescent. With self-efficacy being an important in longterm conditions[4], we would suggest that the AASEQ scale could be useful in clinical research focused on understanding or improving self-management skills in adolescents with asthma.

In conclusion, the AASEQ is a reliable and valid tool to use with adolescents with asthma and further work on responsiveness of the scale to interventions and validity in relation to objective measures of asthma management should now be conducted. With self-efficacy being an important in the management of longterm conditions, the AASEQ should be useful in assessing adolescent asthma self-management. It should be a useful surrogate endpoint to assess the impact of interventions designed to optimise asthma self-management.[17,22] Healthcare practitioners, researchers and educators working with this patient group may find this tool useful as an aid to identifying areas in which adolescents are less confident in their asthma management in order to guide specific asthma management education and advice.

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ONLINE SUPPLEMENT TEXT

Original Article

Title: Development and validation of the Adolescent Asthma Self-Efficacy Questionnaire (AASEQ)

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METHODS

Ethical considerations

Ethical approval for the scale development phase was provided by the East of England National Research Ethics Committee – Cambridge Central (reference 14/EE/0172). Ethical approval for the scale reliability and validity phase was provided by the NRES Committee North West – Liverpool Central (reference 15/NW/0551). All participants and parents/carers gave informed consent.

Item generation: approach to thematic analysis

Development of interview topic guide

Following scale development guidelines,[1,2] a topic guide was developed for interviews and focus groups which asked about self-management, what was easy or difficult about managing asthma and how others influenced their self-management. The guide was informed by discussion with experts in the area, including psychologists with expertise in child and adolescent long-term medical conditions and self-efficacy for management of long-term conditions, including asthma and allergy; a paediatric allergy and asthma consultant; and a specialist asthma and allergy nurse. Relevant literature was also reviewed.[3]

Analysis of interview data

An interim analysis of adolescent transcripts was conducted by SH and GR to assess whether data saturation had been achieved. This involved reading and re-reading the manuscripts to identify themes that were emerging. Although it was clear at this point that no new themes were emerging, further interviews were conducted until information had been obtained from participants with an even spread of gender, ages and asthma severity.

Three authors (SH, GR, RR) were involved in generating the initial themes. Adolescent transcripts were analysed first and the early phases involved independently reading (and re-reading) a selection of the adolescent transcripts to become familiar with the data and generating initial codes. The three investigators met to discuss the initial codes and review the transcripts. Over a number of weeks all the transcripts were read and reviewed in this manner, with the three researchers refining and combining initial codes into themes. The same procedure was conducted with the parent and HCP transcripts, which were reviewed and discussed in tandem.

KIDCOPE [4]

A measure of coping was selected as it is theorised that perceptions of self-efficacy are related to the initiation of coping behaviour, the effort given to coping in a particular situation and how long coping will last during a stressful experience.[5] The adolescent version of the KidCope is a 10-item, brief self-report measure of child coping strategies that presents children with a problem scenario and they rate the level of negative affect (anxiety, sadness, or anger) elicited by the situation. Respondents indicate the incidence (yes or no) and frequency with which they use a given strategy on a scale of 0-3 (0=not at all; 1= sometimes; 2= a lot of the time; 3= always). It identifies 10 specific cognitive and behavioural coping strategies: distraction, social withdrawal, problem-solving, emotion regulation, wishful thinking, cognitive restricting, self-criticism, blaming, social support and resignation. The scale has demonstrated convergent and construct validity and has moderate test-retest reliability.[4,6]

General Self-Efficacy Scale (GSES)

The GSE is a 10 item measure of general perceived self-efficacy with satisfactory psychometric properties indicating the scale is reliable and valid.[7] Responses are given on a 4 point scale from 1 (not at all true) to 4 (exactly true). Example questions include: "It is easy for me to stick to my aims and achieve my goals" and "I can remain calm when facing difficulties because I can rely on my coping abilities".

Statistical analysis

Data analyses were conducted using SPSS version 22, missing data was treated listwise. Floor and ceiling effects for each item were checked to ensure that questions were not scored as zero or hundred by most participants.[2] Standard analysis to explore reliability and validity was then applied. Principal components analysis with a varimax rotation was conducted to assess internal structural validity to enable identification of questions that correlated together which may form sub-sections of the questionnaire and to identify questions that correlated too highly with others or did not correlate with any items at all, which could then be considered for removal. Cronbach's α coefficient and Guttman's split-half coefficient were conducted to assess internal reliability of the scale to explore how the items in the questionnaire and in the sub-sections correlated with each other. Agreement with other validated questionnaires (construct validity) was assessed using Pearson's bivariate correlations. Consistency of the questionnaire over time (test-retest reliability) was assessed by Intra-Class Correlations. Following criteria set out by Pesudov *et al* [8] and DeVellis[2] and results reported by other similar scales[9], *a priori* hypotheses were set regarding reliability and validity. We expected Cronbach's alpha of >0.7 and <0.9 and moderate construct validity correlations of >0.3 with sub-scales measuring similar aspects to the scale. All tests were 2-tailed with a significance level set at $p<0.05$.

RESULTS

Qualitative research findings underpinning questionnaire development

A total of 75 adolescents were approached. Six adolescents took part in one focus group and a further 22 adolescents were interviewed 1:1 by SH. Twenty-four adolescents declined to take part and follow up contact was unsuccessful in the remaining 23 who did not respond to telephone calls or messages. Additionally, to triangulate the findings, we interviewed some of their parents and asthma healthcare professionals. Eighteen parents/guardians were approached, four declined (due to lack of time) and two did not attend the focus group as arranged. Twelve parents took part in the study, in two focus groups (4 participants in each) and four 1:1 interviews. Seventeen HCPs were approached to take part. Three were unable to attend the agreed focus group or 1:1 interview due to unforeseen circumstances. Fourteen HCPs took part in two focus groups (n=3, n=8) and three 1:1 interviews. The HCPs included respiratory paediatricians, secondary care asthma nurse specialists, primary care nurse, school nurse and general practitioners (GP). The focus groups lasted approximately 1.5 hours and interviews lasted 20-60 minutes. A summary of the themes and illustrative quotes are presented in Table S1.

Table S1 Themes with Illustrative quotes from adolescents, parents, and healthcare professionals

	Teenager	**Parent**	**Healthcare professional**
MEDICATION Have routines and reminders	" [I have] always lived in a routine... which if I didn't have it I wouldn't have been able to manage my asthma as well as I have or at least as I have cause it helps me set out the morning" (M17)	"She's also got a very regimented regime, because of how much she has to take, I think it's just ingrained in her now"	"If you can develop it into a habit then it's free from hassle, you do it automatically."
Take/use/carry medication appropriately			
Difficulties with inhalers / spacers	"It's really awkward having a spacer... carrying it everywhere... but some days you've got trousers on and you don't really wanna carry round a rucksack just for this or... and you don't really want to carry it around in your hand." (M13)	"She didn't want to use the spacer … the inhaler itself is quite small, isn't it, and you can pop it in your pocket, but they don't like to carry the spacer"	
Forgetting medication	"So sometimes I think I've done it but that might have been the day before… so like I need to remember when I've done it" (M13)	"I have to double check him, because he's forgotten or he's running late or he can't be bothered or he feels fine "	"The patient as well I think might have a false recollection of how much they have taken not because they are trying to mislead you but they might just forget it"
SYMPTOM MANAGEMENT MONITORING Breathing, being calm, panic	"Cause I feel like I'm gonna have to keep taking those massive breaths and that's what I think when I'm more worried it makes that asthma worse cause I'm breathing so hard" (M14)	"He knows now to calm himself down and sort of moderate his breathing"	
Recognise symptoms			
TRIGGERS Recognise/avoid/ minimise triggers			
MEDICATION BELIEFS Effectiveness	"I love my inhaler… it gives me instant relief" (F17)		
ASTHMA BELIEFS		"She didn't want to use the spacer … the	**"**"It's difficult to take regular treatment… If

control, treatment burden		inhaler itself is quite small, isn't it, and you can pop it in your pocket, but they don't like to carry the spacer"	you need to do this for the rest of your life more or less take control of the medication it's difficult and it doesn't change in adulthood."
ATTITUDES TO ASTHMA Motivation, acceptance, seriousness		"They don't think, they don't think things out properly, and everything will happen to everybody else, so it will never happen to me, don't worry about it, don't stress about it, is <son> word, 'why are you stressing about it - it's my body'"	"It's a lifestyle choice to not to be bothered about it because adolescents don't want to be bothered, and they will take the medication when they have to when it's symptomatic."
Embarrassment, confidence, wanting to be normal		"So I think she finds it embarrassing that she's got asthma, because she's taking inhalers and things to school and people have gone, Oh my god, what's that. So she's found that really embarrassing, really difficult and the devices that go with her inhalers that she should have taken to school and used she doesn't."	"They don't like it and they're embarrassed about, taking a big spacer into school"
Taking responsibility	"The worst thing you can ask a teenager is to remember something again and again and again… and their gonna be like 'oh I'm not gonna do this' and just give up or something.. they just won't bother... it sounds odd giving someone who has no sense of responsibility something to be responsible about it." (M16)	'I think she's learnt it's not worth getting sick and she doesn't enjoy that feeling… so I think I'm quite lucky in that she seems to be quite sensible and I think she realises how ill she can be'	"Trying to take them seriously as a growing adult now helps, so that they will probably take on their own responsibilities."
KNOWLEDGE Understand their treatment and condition	"I guess like I've only just realised when filling out the forms and stuff, that actually I don't 100% know what asthma is… like I get told to take medicines and do this and do that, but I don't actually get told what that will do….just get told to do it." (F16)	"It's not just a blue and a brown inhaler, there's a green one and purple one… so it is understand really what the medication is doing and because it gets changed, for the poor child to understand that when they are still getting to grips with the last regime, I think it can be quite confusing for them."	"You might have a patient that comes to you from the GP or another clinic and they don't understand their treatment, they haven't had it explained to them in the first place, and can sometimes be quite easy to slip through the net."

PARENTS Support, reminders, monitor, education, information		"Keep him calm when he is a bit off cause he panics and that's even worse it sets their asthma off.	
Communication with HCP consultation: barrier and facilitator	"Mum talks and I sit there and listen, but then I don't think the doctor fully knows how it's been for me, but mum always says I don't talk, but I would talk if I was given the chance to talk… I don't think they fully know cause when I come out I think I would have said this and I would have said that but I didn't have the chance to." (F16)		"It is helpful to try and make sure you see teenagers by yourself without their parents, at least for a proportion of the time that they come to see you…But I think that I usually a more constructive consultation with the individual."
Healthcare professionals Provide treatment and choices		"Luckily when he saw Dr x last time they gave him an easibreathe, and he thinks this is really the bee's knees… he doesn't mind flicking that"	"Just changing their volumatic to a vortex they are like, oh wow, I didn't know there were smaller spacers out there and would make such a difference in our bags, or we put them on easibreath, and just slight changes like that can hopefully motivate them a bit more"
Support, educate and inform			"I find when I'm teaching asthma, I have pictures of the airways and where the treatment, how it works, I have to have something visual to show them and I find that helps"
Communication: barrier and facilitator. Conflicting information, honesty	"Say I'm suffering with a specific thing and I want to talk to him about certain… err… things I can just speak to him about... easy... and he will give me an answer that I would understand as a teenager so it's not going to big words from doctor." (M14)	"What needs to be done in my mind to re-engage <son> is communicate properly so he needs good communication"	"If they smoke, nobody wants to admit if they smoke. But if they are without the parent they will tell me how often they have tried a cigarette, and then they start to tell me how often have they forgotten the last few weeks of taking medication, not how often have you taken it but how often have you forgotten it"

Clinics	“The children and how noisy they are… they're annoying… they are all running round and they've got the little play room with the little cars” (F16)	"Not wanting to miss school… that's proving difficult for appointments and things if you have to come a lot”	
Friends / peers Barrier or facilitator	“One of them laughs ‘cause their like ‘we've only walked up that hill and you already need your inhaler’... their making it worse and making me not want to take it which is like making me iller.” (F16)	“She's got quite a close group of friends that she's known a long time and I don't think she would feel uncomfortable saying I don’t feel well I need to go... so that helps”	"Friends can have quite a powerful influence and they might actually stick up for each other and look out for each other if they have the knowledge.”
Schools Institutional support / Support from teachers	“I’ve said I can't do PE today cause my asthma's been really bad over the weekend, they'll [the teacher] be like ‘well why can't you do it, everyone else has got to do it, you've got to do it as well’, or they'll say you need to get your PE kit on and stand outside and watch everyone else, which really is not gonna benefit at all, ‘cause if you're stood in the cold, the air’s going to your chest anyway.” (F15)	“Some people in schools seem to kind of view it as if it’s maybe the child making an excuse… And I think sometimes teachers, staff in school maybe don’t understand that it can be very serious and they think that maybe that child’s just trying to skip off of games.”	

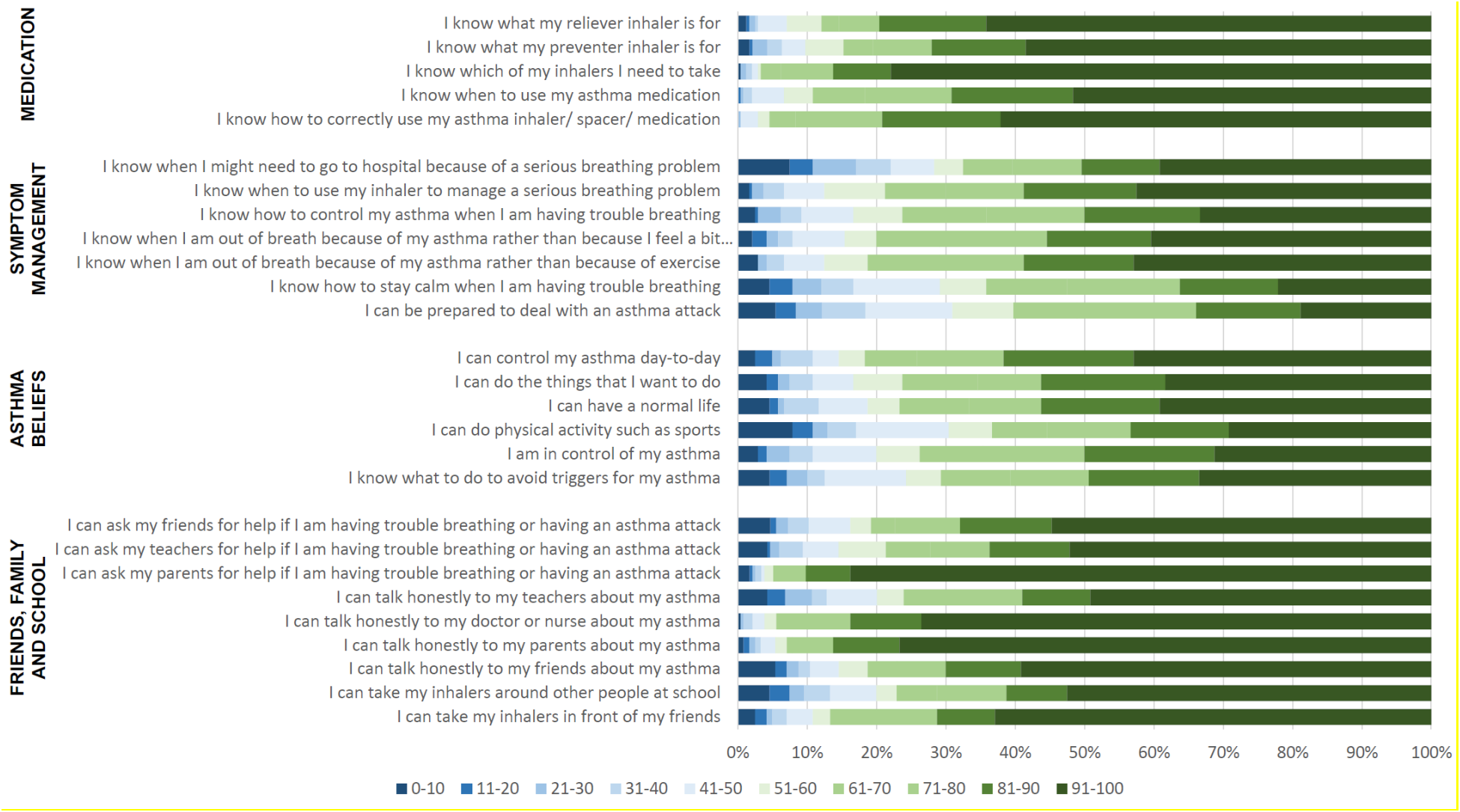
Item Generation and prototype scale development

Themes generated from interviews with adolescents with asthma, healthcare professionals involved in management of asthma and the published literature were reviewed by a multi-disciplinary study team. A prototype scale was developed which was further reviewed by healthcare practitioners working with adolescents with asthma and adolescent participants who had taken part in the qualitative interviews. No changes were deemed necessary giving a 38 item prototype Adolescent Asthma Self-Efficacy Questionnaire (AASEQ) (Box S1).

Floor and ceiling effects and missing data

Floor and ceiling effects were checked for all items in the prototype scale. No item had an overall mean more than 95. The highest was for the item 'I can ask my parents for help if I am having trouble breathing or having an asthma attack' with 94.78. A total of 79.4% of the sample scored 100 for this item. There were three additional items where over 70% of the sample scored 100. These were 'I can talk to my parents about my asthma' with 78.6%; 'I can talk honestly to my parents about my asthma' with 74.1% and 'I can talk to my doctor or nurse about my asthma' with 72.8%. Two items on the prototype scale had one missing answer from across the whole dataset, one item had four missing answers and five items had six missing answers. These five items were at the end of the prototype scale and missing items could be due to questionnaire fatigue. All items were all retained in the factor analysis to explore how well they loaded onto the model. Figure S1 shows the distribution of scores for each item.

Figure S1. Distribution of participant scores for Adolescent Asthma Self-Efficacy Questionnaire items



Box S1. 38 item prototype Adolescent Asthma Self-Efficacy Questionnaire (AASEQ)

This questionnaire is designed to help us get a better understanding of how you manage your asthma. Please rate how certain you are that you can do each of the things described below by writing the appropriate number.

For each of the following statements, rate how confident you feel by choosing a number from 0 to 100 using the scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all — Moderately can do — Highly certain can do

Question	Confidence (0-100)
MEDICATION	
I am confident that:	
I know how to correctly use my asthma inhaler/spacer/medication	
I know when to use my asthma medication	
I know which of my inhalers I need to take	
I can have my medication with me at all times	
I know what my inhalers are for	
I know what my preventer inhaler is for	
I know what my reliever inhaler is for	
I can remember to take my inhalers without being reminded	
SYMPTOM MANAGEMENT	
I am confident that:	
I can be prepared to deal with an asthma attack	
I can stay calm when I am having trouble breathing	
I know how to stay calm when I am having trouble breathing	
I know when I am out of breath because of my asthma rather than because of exercise	
I know when I am out of breath because of my asthma rather than because I feel a bit panicky	
I know how to control my asthma when I am having trouble breathing	
I know when to use my inhaler to manage a serious breathing problem	
I know when I might need to go to hospital because of a serious breathing problem	
ENVIRONMENT	
I am confident that:	
I know what to do to avoid triggers for my asthma	
I can avoid people when they are smoking	
I am able to go my doctor's appointments about my asthma	
ASTHMA BELIEFS	
I am confident that:	
I am in control of my asthma	
I can do physical activity such as sports	
I can have a normal life	
I can do the things that I want to do	
I can control my asthma day-to-day	
My inhalers help me control my asthma	

FRIENDS, FAMILY AND SCHOOL	
I am confident that:	
I can take my inhalers in front of my friends	
I can take my inhalers around other people at school	
I can talk to my friends about my asthma	
I can talk to my parents about my asthma	
I can talk to my doctor or nurse about my asthma	
I can talk to my teachers about my asthma	
I can talk honestly to my friends about my asthma	
I can talk honestly to my parents about my asthma	
I can talk honestly to my doctor or nurse about my asthma	
I can talk honestly to my teachers about my asthma	
I can ask my parents for help if I am having trouble breathing or having an asthma attack	
I can ask my teachers for help if I am having trouble breathing or having an asthma attack	
I can ask my friends for help if I am having trouble breathing or having an asthma attack	

Internal structural validity of the AASEQ

Principle components analysis with a varimax rotation was conducted on the 38 items of the prototype ASSE-Q. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.85, exceeding the recommended value of 0.6 [10] and Bartlett's Test of Sphericity (5966.31, *df* = 561, $p<0.001$) was significant, indicating that factor analysis on the correlations between items should produce meaningful factors. The initial solution produced 10 factors with eigenvalues over 1 but the scree plot suggested a solution with 4 or 6 factors would be optimal and so factor analysis forcing 4 and 6 factors was run.

A 6-factor solution resulted in some of the items loading onto more than one factor and a meaningful interpretation was unclear. In the 4-factor solution, 4 items had low factor loadings (less than 0.4) and communalities less than 0.20. These were removed and the analysis re-run, resulting in a solution with 34 items which explained 58.3% of the total variance in the data. All the items loaded onto factors above 0.4 and a clear interpretation of the factors could be made. Factors were called Friends, Family and School; Symptom Management; Asthma Beliefs; and Medication (see Table 2).

Internal reliability of the AASEQ

The 34 items had excellent internal consistency with a Cronbach's α of 0.923 overall. Removal of no items improved the overall alpha for the scale. Alphas for all sub-scales can be seen in Table 3. On examination of the 34-item scale it was felt that some items retained by the factor analysis and reliability analysis were very similar. For example, items such as 'talking to teachers' and 'talking honestly to teachers' were originally included in the scale to see which item was a more reliable indicator of self-efficacy. As these items contributed equally well in the analysis it was felt that the scale could be made more parsimonious by the removal of similar items. The item with the lower factor loading was removed (indicated

by a * in Table 2) resulting in a 27-item scale (Box 2). This did not substantially affect the reliability of the scale, with the overall Cronbach's alpha reducing from 0.92 to 0.91 (see Table 3).

Split half analysis was calculated which randomly splits the scale into two: Cronbach's α was 0.871 and 0.811 for the two halves; the Spearman Brown correlation was 0.710 and the Guttman split-half coefficient was 0.799. Cronbach's alphas for the sub-scales of the 27-item scale can be seen in Table 3.

Impact of allergic disease co-morbidities and asthma self-efficacy

Those with co-morbid hay-fever reported lower scores for asthma beliefs than those without hay-fever (mean=75.42, SD=22.69 verses 88.73, SD=19.17; $t(103.11)=2.70$, $p<0.01$). Those with co-morbid food allergy reported lower scores for total self-efficacy than those without food allergy (mean=79.3 SD=12.87 verses 83.54, SD=12.44; $t(226)=2.25$, $p=0.025$). They also reported lower self-efficacy for friends, family and school than those without food allergy (mean=80.8 SD=17.52 verses 88.50, SD=16.77; $t(232)=3.01$, $p<0.01$) and lower asthma beliefs than those without food allergy (mean=69.4 SD=22.30 verses 80.20, SD=21.09; $t(238)=3.40$, $p<0.001$). However, those with co-morbid animal allergy reported greater self-efficacy for symptom management than those without animal allergy (mean=79.23 SD=17.64 verses 73.59, SD=18.65; $t(236)=-2.38$, $p=0.02$).

DISCUSSION

Construct validity

The scale has good construct validity, as demonstrated by how it correlated with the General Self-Efficacy Scale and the KidCope. Greater use of adaptive coping strategies such as problem solving and cognitive restructuring of stressful situations correlated with greater asthma self-management self-efficacy and indicates that facilitation of these types of coping skills in adolescents may help them feel more confident in managing their asthma.[11,12] Similarly, greater use of social support was related to more confidence in using friends, family and school to support asthma self-management. Although correlations with these coping strategies were significant they were small to medium in size. This was expected and is probably due to the KidCope measuring general coping strategies, not strategies specific to asthma management. The AASEQ correlated with self-reported indices of asthma control, with adolescents with poorer asthma control having lower asthma management self-efficacy. Poorer self-efficacy correlated with asthma exacerbations, use of oral corticosteroids and number of hospital admissions for asthma, as has been seen in earlier studies.[13-16]

Adolescents who had been diagnosed at a younger age or had their asthma for longer had greater self-efficacy in managing their asthma. Younger adolescents at the time of completing the scale were more confident in using friends, family and school to help them manage their asthma. Research in children and adolescents with food allergy has shown that younger children feel more able to talk to their friends about their allergy whereas older children do not want to appear different or to be identified by their allergy and may only talk about it if they have to.[17] This may also be the case with adolescents with asthma as our findings here show that older adolescents are less likely to use the help of friends, family and school to manage their asthma and previous research identified embarrassment as a key barrier to asthma self-management in adolescents.[3] These older

adolescents may feel embarrassed about their asthma and therefore reluctant to seek support from others when managing their asthma.

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