TITLE PAGE

Original Article

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

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Running Head: Development of the Asthma Self-Efficacy Questionnaire

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31 **Word count: 2911 Number of tables: 5**

32 **Keywords:** asthma, adolescent, self-efficacy, self-management

33 **Funding**: This study was supported by a research grant from Asthma UK (AUK-PG-2013-

34 213)

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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).

211 *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)	

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

309 *Table 5 Pearson's correlations (number of participants) between the AASEQ scale and sub-scales,*

310 *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)

311 Figures represent Pearson's correlation coefficients to assess how well the AASEQ agrees with

312 asthma parameters. *p<0.05; **p<0.01, p<0.001***

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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.

Acknowledgements

The study team would like to thank Asthma UK (the Joanna Martin Project) for funding and ongoing support with this study. We would also like to thank the trial steering group for their advice, in particular, Mike Thomas, Gary Connett, Hans Michael Haitchi, Woolf Walker, Arvind Nagra, Julian Legg and Tricia McGinnity. We are grateful to those who have helped with recruitment - the NIHR Clinical Research Network Wessex and staff at the following hospitals: Birmingham Children's Hospital, Countess of Chester, Heartlands Hospital, Macclesfield District General Hospital, Manor Hospital, New Cross Hospital, Royal Bolton Hospital, Royal Manchester Children's Hospital, Royal Preston Hospital, Royal Stoke Hospital, Russell's Hall Hospital, St Mary's Hospital (Isle of Wight), Southampton General Hospital, University Hospital Coventry, Walsall Manor Hospital, Warwick Hospital, Whiston Hospital, Worcestershire Royal Hospital. Finally we would like to thank all the participants – patients, parents and healthcare practitioners – who have taken time to help us with this research.

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