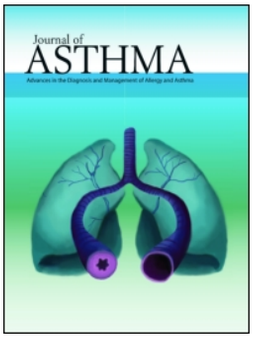

Journal of Asthma

ISSN: 0277-0903 (Print) 1532-4303 (Online) Journal homepage: http://www.tandfonline.com/loi/ijas20

Asthma control in London secondary school children

Katherine Harris MSc, Gioia Mosler PhD, Samson A. Williams BSc, Abigail Whitehouse MBChB, Rosalind Raine MBBS, PhD & Jonathan Grigg MD

To cite this article: Katherine Harris MSc, Gioia Mosler PhD, Samson A. Williams BSc, Abigail Whitehouse MBChB, Rosalind Raine MBBS, PhD & Jonathan Grigg MD (2017): Asthma control in London secondary school children, Journal of Asthma, DOI: 10.1080/02770903.2017.1299757

To link to this article: http://dx.doi.org/10.1080/02770903.2017.1299757

© 2017 The Author(s). Published with license by Taylor & Francis Group, LLC© Katherine Harris, Gioia Mosler, Samson A. Williams, Abigail Whitehouse, Rosalind Raine, and Jonathan Grigg

View supplementary material

Published online: 23 Mar 2017.

Submit your article to this journal

Article views: 1266

View related articles

View Crossmark data

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=ijas20

Download by: [University of Liverpool] **Date:** 27 April 2017, At: 09:47

JOURNAL OF ASTHMA
http://dx.doi.org/10.1080/02770903.2017.1299757

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS

Asthma control in London secondary school children

Katherine Harris, MSc[a], Gioia Mosler, PhD[a], Samson A. Williams, BSc[a], Abigail Whitehouse, MBChB[a], Rosalind Raine, MBBS, PhD[b], and Jonathan Grigg, MD[a]

[a]Centre for Genomics and Child Health, Blizard Institute, Barts and The London School of Medicine and Dentistry, London, UK; [b]Department of Applied Health Research, University College London, London, UK

ABSTRACT

Objective: The asthma control test (ACT) is a validated tool for assessing control in asthmatic children aged 12 years and older. Using the ACT, we sought to assess asthma control and knowledge in London secondary school children. *Methods*: Secondary schools in London, UK, participated in this study. Children with doctor-diagnosed asthma were invited to complete an online questionnaire that included the ACT and questions about asthma. Suboptimal asthma control was defined as an ACT score of $\leq$ 19 out of a maximum score of 25. Data are summarised as median and interquartile range (IQR), and were analysed by either Mann-Whitney test, or chi-square test. A p value of < 0.05 was considered significant. *Results*: A total of 799 children completed the questionnaire; 689 (86.2%) were included for analysis. Suboptimal asthma control was reported by 49.6% of students. Over a third (42.4%) of students prescribed a short-acting β2-agonist inhaler felt uncomfortable using it at school, and 29.2% ($n = 173$) reported not using this inhaler when wheezy. 56.4% ($n = 220$) of those with regular inhaled corticosteroids did not take them as prescribed, and 41.7% did not know what this inhaler was for. Suboptimal control was associated with a greater proportion of students reporting that they were 'somewhat', 'hardly' or 'not at all' comfortable using inhalers at school (52.7% vs 29.1%, $p < 0.01$) and outside school (22.8% vs. 14.8%, $p < 0.01$). *Conclusions*: Suboptimal asthma control and poor asthma knowledge are common in London schoolchildren.

ARTICLE HISTORY
Received 20 December 2016
Revised 13 February 2017
Accepted 21 February 2017

KEYWORDS
Paediatrics; treatment

Introduction

The aim of asthma therapy is to reduce morbidity and mortality by achieving good control of asthma symptoms [1]. However, the disproportionally high rate of asthma deaths in UK children compared with other European countries [2] indirectly suggests a high prevalence of poor asthma control in the UK paediatric population. In order to address this, an identification of children with suboptimal control is required, and in this subgroup, either adjust therapy, or improve adherence, or a combination of both [3]. One method suited to assessing asthma control in large numbers of secondary school-age children is the Asthma Control Test (ACT). The ACT consists of five questions asking about the frequency of asthma symptoms, use of 'reliever' short-acting β2-agonists (SABA) and the individual's own rating of their control over the previous month [4]. The ACT is a reliable method for assessing control [5], and is validated in adults and children aged 12 years and above [4]. An ACT score of below or equal to 19 reflects the cut-off with the best sensitivity and specificity for predicting suboptimal asthma control [5]. This cut-off is also associated with an increased risk of urgent health care use for asthma over a subsequent six months (adjusted odds ratio; 2.29 (95% CI 1.45 to 3.62)) [6]. Indeed, a recent European Respiratory Society Task Force recommends that an ACT score of $\leq$19 in a child should trigger more intense clinical monitoring [7].

To date, one community-based study has assessed asthma control in UK children. This international study administered, by telephone, the childhood asthma control test (C-ACT; a 7-item questionnaire validated in children of 4 to 11 years [8]) to families of asthmatic children aged 4 to 15 years. Overall, 40% of the 1284 children surveyed, including 200 from the UK, had either parent-reported (for children aged 4 to 15 years), or child-reported (for children and young people aged 8 to 15 years) suboptimal control by the C-ACT [9].

Current data on asthma knowledge in teenagers, and its impact on asthma outcomes, are limited, due to an absence of a validated measure to assess knowledge in asthmatic patients. To date, there are no published UK studies, which report asthma knowledge in children and/or caregivers.

CONTACT Katherine Harris k.harris@qmul.ac.uk Centre for Genomics and Child Health, Blizard Institute, Barts and The London School of Medicine and Dentistry, London, E1 2AT, UK.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ijas.

Published with license by Taylor & Francis Group, LLC © 2017 Katherine Harris, Gioia Mosler, Samson A. Williams, Abigail Whitehouse, Rosalind Raine, and Jonathan Grigg
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

In the present study, we sought to assess asthma control in London schoolchildren, aged 11 to 18 years, using an online questionnaire that included the ACT. We also sought to assess knowledge of asthma therapies, adherence to asthma therapies and the impact of asthma on school life.

Methods

Secondary schools in 32 London boroughs were contacted and were invited to participate. Contact was made by email and letter, followed by a telephone call and an email to a named science teacher if available. The Centre of the Cell at Queen Mary University of London and University College London Partners provided additional recruitment. All participants were required to be attending secondary school and have doctor-diagnosed asthma. Of the 585 schools contacted, the majority ($n = 541$) did not respond to the initial email or phone call. The remaining non-participating schools ($n = 19$) expressed an interest in participating, but could not accommodate the research due to teacher workload, timetabling difficulties or a lack of school resources.

The study was conducted between October 2014 and October 2015. The online questionnaire (Online Supplement) was delivered to students aged 11 to 18 years, who were identified either by the school by formal register, or by form teachers. Those students who were identified using the formal school register, the parents/carers had informed the school of their child's asthma diagnosis when they started the school aged eleven. The questionnaire, with exception to the ACT, was not validated. However, four focus groups were initially used to ensure that the questionnaire was both user-friendly, and suitable for the target population. The first two focus groups consisted of two young people and four young people, respectively, without asthma, to test the website design and accessibility. The final two workshops consisted of fifteen young people aged 13 to 17 years with asthma, and fourteen young people with asthma aged 11 to 13 years to test the content of the questionnaire.

The questionnaire was administered in schools in the presence of the research team and a member of school staff. Students were encouraged to clarify questions that they did not understand. The questionnaire consisted of five compulsory sections (i.e. each question had to be completed before the website moved to the next question) and one optional section. The compulsory sections included the 5-item ACT (4), which assessed symptom frequency, use of short-acting β_2-agonists (SABA), night-time symptoms and their perception of overall asthma control over the previous month. An ACT score of 19 or less (from a lowest possible score of 5 to a highest score of 25) indicates suboptimal asthma control [5]. The online questionnaire also included self-report questions about medication adherence, unplanned use of healthcare facilities, school attendance, smoking behaviour and knowledge of the role of the spacer and preventer inhaler. Throughout the questionnaire, the term 'reliever' and 'preventer' inhaler was used instead of SABA and inhaled corticosteroids (ICS) $\pm$ long acting β_2-agonists (LABA) (Online Supplement). To help students identify their medications, the questionnaire contained a list of all possible medications and colour pictures of these inhalers and oral tablets (both generic and branded). In order to assist the students during the questionnaire, they were encouraged to perform an internet search to assist them in identifying their asthma treatments, or ask a member of the research team for clarification. The questionnaire took approximately 15 minutes to complete, and included multiple-choice knowledge questions about the role of a spacer and the ICS $\pm$ LABA inhaler (called 'preventer' in the questionnaire). Five possible answers about ICS $\pm$ LABA therapy and the role of spacers were provided – only one of which was correct. How 'comfortable' students felt taking inhalers was measured on a Likert scale ranging from 1 (*not at all comfortable*) to 5 (*completely comfortable*).

The hypothesis tested by this study is that students with suboptimal asthma control have increased school absences due to asthma, greater unplanned medical attention and a reduced quality of life. In addition, we hypothesised that students with suboptimal asthma control feel less comfortable about using inhalers, both at school and away from school, and that knowledge regarding preventer medications is low in all students with asthma.

The study was approved by the Exeter Research Ethics Committee (14/SW/0120), and required both parental opt-out consent and student written assent.

Statistical analysis

This was an observational study; therefore, a power calculation was not required. There was no upper limit of schools; however, the sampling was limited by a timeframe of one year. Since data were not normally distributed, non-parametric analyses are used throughout; quantitative questionnaire data are summarised as median (IQR), unless indicated, and were analysed by Spearman's correlation co-efficient, Mann-Whitney, or chi-square test using IBM SPSS Statistics (version 23), A p value of < 0.05 was considered statistically significant.

Results

Of the 585 London schools contacted, 24 agreed to participate, and the questionnaire was administered in all 24 schools (Figure 1). In six schools, a temporary

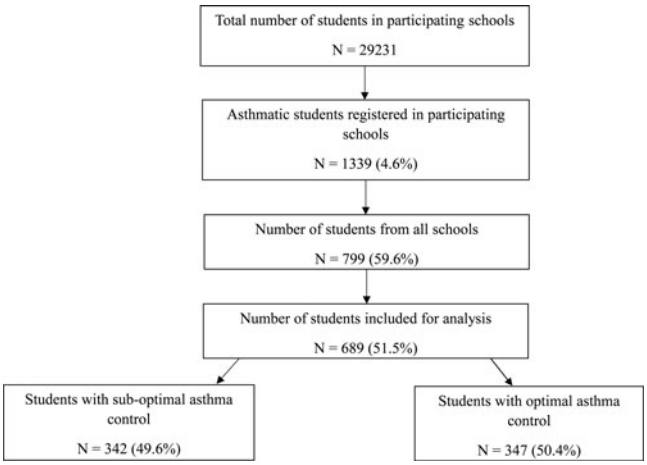

Figure 1. Recruitment of students with doctor-diagnosed asthma in participating schools.

lack of internet connectivity prevented use of the online questionnaire, and an identical paper version was used instead. Since this paper version allowed students to omit questions, 33 students omitted to answer one or more of the questions needed for an ACT score, and were therefore excluded. One hundred and six students (8.5%) with complete ACT scores by paper questionnaire, had missing data for other questions, but missing data never exceeded 7% of the total responses for compulsory questions (Table 1, and Online Supplement). Seventy-seven students were excluded from the analysis as they self-reported not taking any medication. The final sample for analysis comprised 689 students (i.e. a response rate of 51.5%).

In total, an ACT score was generated from 401 male and 283 female students (median age; 13 years (IQR; 12 to 15 years, Table 1)). Five students chose to provide no gender information (Table 1, and Online Supplement). Twenty of the participating schools were comprehensives (non-selective); thus, there were no entry requirements or examinations (Table 2, and Online Supplement). There were no missing data for ACT scores. Thirteen of the schools who expressed an interest but did not participate were also comprehensive (Table 3, and Online Supplement).

The majority of students (91.7%) were able to identify their medication (s). However, 8.3% of students could not identify what their medication was from the colour pictures of inhalers provided and an internet search.

Suboptimal asthma control was reported by 342 students (49.6%; Figure 2), and the overall median ACT score was 20 (IQR; 16 to 22). Thirty-nine students (5.7%) scored a maximum of 25 on the ACT (i.e. consistent with no symptoms of asthma). Six hundred and thirty-four students (92%) reported using a SABA inhaler; one hundred and six students (16.7%) reported that they did not need to use it at school. Of the remaining five hundred and twenty-eight, two hundred and twenty-four students (42.4%) reported that they felt 'somewhat comfortable', 'hardly comfortable' or 'not at all comfortable' using a SABA at school (Table 2). One hundred and seventy-three students (29.2%) reported that they did not use a SABA when they knew they needed it, at least for some of the time. Forty-two students did not answer. One hundred and twenty students (18.9%) with a SABA reported that

Table 1. Demographics of students completing the questionnaire.

	N (%)*
Gender	
Male	401 (58.2)
Female	283 (41.1)
Missing	5 (0.7)
Ethnicity	
White	105 (15.2)
Black	154 (22.4)
Bangladeshi	84 (12.2)
South Asian	31 (4.5)
East Asian	15 (2.2)
Mixed	83 (12.0)
Other	194 (28.2)
Missing	23 (3.3)

*Students who completed all ACT questions.

Table 2. Comfort using SABA inhaler at school.

	Total *N* (%)	Suboptimal control *N* (%)	Optimal control *N* (%)	*P* value*
Total = 528				< 0.001
Not at all comfortable	26 (4.9)	19	7	
Hardly comfortable	66 (12.5)	50	16	
Somewhat comfortable	132 (25)	88	44	
Very comfortable	105 (19.9)	57	48	
Completely comfortable	199 (37.7)	84	115	

Note. Missing data from 106 students.
*By chi-square test.

Table 3. ICS ± LABA Adherence.

	Total *N* (%)	Suboptimal control *N* (%)	Optimal control *N* (%)	*P* value*
Total = 390*				< 0.002
All the time	37 (9.5)	19	18	
Most of the time	75 (19.2)	47	28	
Sometimes	108 (27.7)	68	40	
A little of the time	107 (27.4)	69	38	
Never	63 (16.2)	32	31	

Note. Missing data from nine students.
*24 students reported that they did not use a preventer inhaler, despite selecting this option when identifying their medication at the beginning of the questionnaire.

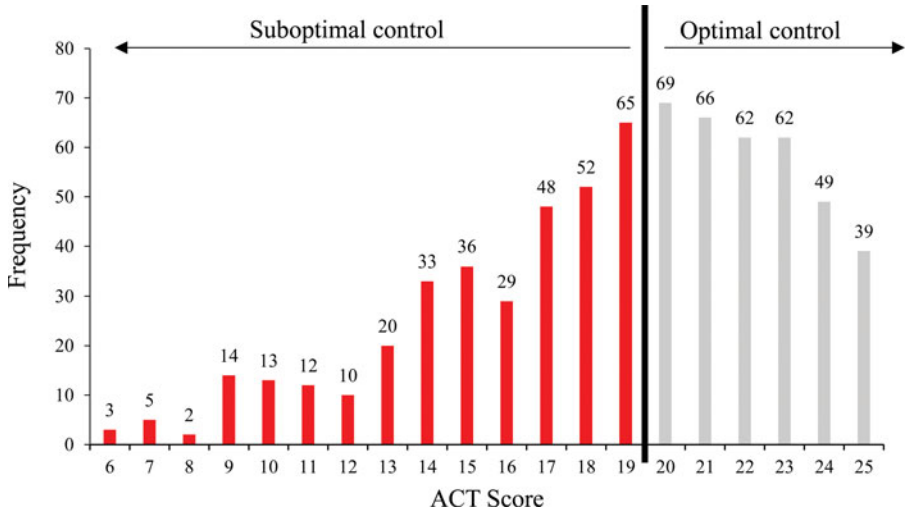

Figure 2. Distribution of Asthma Control Test (ACT) scores.

they felt 'somewhat comfortable', 'hardly comfortable' or 'not at all comfortable' using their inhalers outside school.

Twenty-four students reported that they did not have a preventer inhaler, despite stating that they had one earlier in the questionnaire; therefore, these students were removed from the analysis. For those students who self-reported being prescribed an ICS ± LABA (n = 390), 56.4% (n = 220) reported that they did not use this inhaler as prescribed 'at least some of the time'. Further, 19.2% did not use ICS ± LABA 'most of the time', and 9.5% did not use prescribed ICS ± LABA 'all of the time' (Table 3). Data for this variable were missing from nine students. The most frequent reason given for non-adherence to the ICS ± LABA inhaler, reported by 92 students, was 'forgetfulness', with students reporting that it was sometimes difficult to remember to take their ICS ± LABA due to distractions including getting ready for school in the mornings, homework and extracurricular activities (Table 4). When asked what an ICS ± LABA inhaler does, 41.7% of children prescribed an ICS ± LABA gave an incorrect answer, out of five options (individual data in Online Supplement). A spacer was used by 44.2% of students. Of these students, 52.5% used a spacer with all of their medications. When asked about what the spacer does, 16.4% could not identify the correct response.

At least one unplanned general practitioner (GP) /primary care physician visit due to asthma during the previous month was reported by 30.0% of students. At least one unplanned hospital visit due to asthma was reported by 16.5% of students (Table 5). There were twenty-three missing datasets for unscheduled medical attention.

At least one whole school day absence was reported by 21.9% of students ($n = 145$). One or more lesson absence was reported by 21.1% of students ($n = 140$). At least part of a physical education lesson missed due to asthma over the previous month was reported by 30.4% (Table 6), and 17.3% of students felt that their asthma had at least 'some negative impact on their school performance'. There were twenty-seven missing datasets for school attendance.

Table 4. Free text responses about non-adherence with an ICS ± LABA preventer inhaler.

Reason	Example	N*
Forgetfulness	'I forget because sometimes I go somewhere and I forget to take it'	92
Do not need it	'I only use it when I need it'	45
Not helpful	'I don't see the need in using the brown one'	7
Use beta-agonist instead	'My asthma is not that bad so I use the blue inhaler more'	6
Fear of reliance	'I want to cope without the help of my medication'	4
Unpleasant side-effects	'It doesn't taste nice'	4
Embarrassment	'I just don't feel comfortable with it'	4
Knowledge	'I didn't know I had to take it'	1

*Each student could give one optional free text response.

Table 5. Asthma control and unscheduled medical care.

	Total N (%)	Suboptimal control N (%)	Optimal control N (%)	P value*
Total = 666				
Unplanned GP visit				< 0.001
Never	466 (70.0)	181	285	
1—2 Times	151 (22.7)	114	37	
2—3 Times	34 (5.1)	26	8	
4 or more times	15 (2.3)	11	4	
Unplanned hospital visit				< 0.001
Never	556 (83.5)	242	314	
1—2 Times	81 (12.2)	66	15	
2—3 Times	20 (3.0)	15	5	
4 or more times	9 (1.4)	9	0	

Note. Missing data from 23 students.
*By chi-square test.

Table 6. Asthma control and school and lesson attendance.

	Total *N* (%)	Suboptimal control *N* (%)	Optimal control *N* (%)	*P* value*
Total = 662				
One or more complete school day missed	145 (21.9)	105	40	< 0.001
One or more complete or part lesson missed	140 (21.1)	111	29	< 0.001
One or more complete or part physical education missed	201 (30.4)	147	54	< 0.001
At least some negative impact recorded	115 (17.4)	88	27	< 0.001

Note. Missing data from 27 students.
*By chi-square test.

In questions regarding lifestyle and smoking, 34 students reported that they smoked (23 of these with suboptimal control), and 24.8% of all students stated that their parents, or someone living in their house, currently smoked. Thirty-one students chose not to report their smoking status, and twenty-nine students did not report on whether their parents/carers currently smoked.

Suboptimal asthma control was associated with a greater proportion of students reporting that they were 'somewhat', 'hardly' or 'not at all' comfortable using their reliever inhaler at school (52.7% vs 29.1%, $p < 0.01$) or outside school (22.8% vs. 14.8%, $p < 0.01$), and more students with suboptimal control forgot their ICS ± LABA preventer (57.0% vs. 55.5% $p < 0.01$). This is compared with students with optimal asthma control. By contrast, students with suboptimal control more often correctly identified the correct answer about spacers (86.0% vs. 80.3% $p < 0.01$). Asthma control was not associated with identification of the correct answer about the ICS ± LABA inhaler. Gender and ethnicity were not associated with suboptimal asthma control. A weak correlation was found between age and ACT ($r = .147$, $p < 0.01$).

In students with suboptimal control, 42.4% judged their asthma to be either 'well' or 'completely controlled'. The proportion of asthmatics with suboptimal control was higher in non-selective (comprehensive) schools, compared with selective (grammar and independent) schools (52.3% vs. 41.7%, $p < 0.05$ (Table 2, and Online Supplement)).

Discussion

In this study, we assessed asthma control in London secondary schools and found that over a third of children, identified by their school as having doctor-diagnosed asthma, had suboptimal control, and that more than 50% of students self-reported that they did not use their ICS ± LABA 'preventer' inhaler correctly, at least some of the time. There are no previous studies using the ACT in schools in the UK. However, these results are compatible with an international telephone-survey done in 2009 in a different population of children, which found 40% of children (aged 4 to 15 years) with suboptimal asthma control by the C-ACT [9]. To date, two studies have recruited UK schoolchildren with asthma, but neither has assessed asthma control. In one, McWhirter et al. [10] assessed in primary schools, quality of life, spirometry and inhaler technique [11]. In the other, Patterson et al. [11] assessed in primary schools, asthma knowledge, school attendance, daily well-being, perceived self-efficacy and quality of life [10]. Patterson et al. [11] found that 57% of parents claimed their children used preventers regularly, and 54% of these claims were verified by the children themselves during their assessments in school [11].

A strength of the present study is that, by assessing asthma control in the school environment, we have reduced the potential for students to be influenced by overoptimistic parental expectations of control, as previously reported [9]. Children with asthma who do not have a usual source of care, or who do not routinely visit their physician could also be captured by recruiting through schools. By including questions on knowledge of medications and allowing space for free text responses, our questionnaire provides insights into some of the drivers of suboptimal asthma control. First, overall knowledge about ICS ± LABA and recognition of asthma symptoms was poor, and knowledge was lower amongst students with suboptimal control. This finding is compatible with previous reports of poor levels of knowledge amongst teenagers with uncontrolled asthma [12]. Since we did not obtain dose of ICS ± LABA, and the clinical reasoning for inhaler therapy, we cannot determine whether suboptimal control is due to either inadequate prescribed treatment, or poor adherence, or a combination of both. Some children prescribed only a SABA and with a maximum ACT score (i.e. no symptoms) may well have outgrown their asthma, or have been mislabelled. However, this potential 'overtreated' group represented, at most, 4% of students with asthma.

A putative role of non-adherence in suboptimal control is suggested by the increased proportion of students with suboptimal control who either forgot to take their ICS ± LABA, or were uncomfortable in using inhalers – or a combination of both. Over a third of students with suboptimal control felt uncomfortable using their SABA while at school. However, there is no evidence that knowledge about asthma treatments is a driver of suboptimal

control, since students with an ACT ≤19 exhibited better knowledge about both ICS ± LABA preventer inhalers and the role of spacers. Indeed, free text responses suggested that poor adherence, as previously reported [13], is predominantly due to embarrassment regarding not conforming to social norms, forgetfulness and perceived barriers due to extracurricular activities, such as homework. These findings support the qualitative study of Naimi et al. [14], who collected data on medication adherence from 40 young people aged 15 to 18 years. Compatible with the present study, Naimi et al. [14] reported that 'forgetfulness' and 'ambivalence' to use of their inhaled medication were frequent in this age group, and that many young people remained 'unconvinced on the effectiveness' of their inhalers. A further possible reason for non-adherence is over-estimation of control. Mammen et al. [15] reported that teenagers with uncontrolled asthma tend to normalise their symptoms and have higher treatment thresholds. Similarly, we found that in students with suboptimal control, 42.3% considered that their asthma was either 'well' or 'completely controlled'. Similarly, the 'Asthma Insights and Reality in Europe' survey [16] found that 32% to 49% of patients with severe asthma symptoms, and 39% to 70% of patients with moderate asthma symptoms believed that their asthma was either 'well', or 'completely' controlled. Overoptimistic assessment of asthma control and of outcomes is of concern since the 2014 UK National Review of Asthma Deaths [17] reported that deaths in children and young people were associated with poor perception of the risk of adverse outcome. Although parent-reported control was not assessed in the present study, the 'Room to Breathe Survey' [9] suggests that parents' perception of control is even more optimistic than their own child's, since 73% of parents described their child's asthma as mild or intermittent, despite only 40% of children scoring 19 or less on the C-ACT.

There are limitations to the present study. First, it is unclear whether our data are generalizable to the London/UK population since only 24 schools agreed to participate, and these schools may have better asthma support structures than non-participating schools. Generalizability is also limited by the increased proportion of black and ethnic minority children compared with the London population [18], albeit, this does reflect the ethnic mix in some areas of London. Second, we did not screen all children for asthma since ethics approval limited recruitment to doctor-diagnosed asthmatics either on an official school register, or on an unofficial list. It is therefore likely that some asthmatics did not receive the invitation to participate. To date, there are no data on asthma prevalence in London secondary school children, but in Scottish primary schools, asthma prevalence is 14% [19]. The lower asthma prevalence of 4.6% in the present study (with one school reporting only 12 asthmatics out of 1256 students) suggests an under-reporting of asthmatics in schools, and highlights a need for more complete registration of asthmatics by schools. It may also indicate a reluctance for children in secondary schools to identify themselves as asthmatic. Third, responses given by students may not have always been accurate because the data is self-reported; thus, the reliability of the findings may be limited. We reduced the risk of peer pressure by ensuring that students were aware that all responses were anonymous, and that peers could not see their answers. However, it is also possible that inaccurate responses were due to students not understanding questions. To reduce this, we did extensive piloting of the questionnaire with asthmatic children, and ensured that research team members were available to assist students throughout data collection sessions. However, free text responses suggest that at least some students found the term 'on purpose' in the adherence questions (i.e. 'do you sometimes miss your regular preventer inhaler on purpose?') somewhat ambiguous. However, the majority of free text responses suggest that students who recorded 'forgetting' to use their inhaler were making a conscious decision to do so. Fourth, the total number of students with asthma, as reported by schools was 1339; however, 799 students completed the questionnaire and 689 were included for analysis (Figure 1). The discrepancy seen between the total number of students and actual number of students is due to parents opting out, student absence on the day of the data collection and students opting out. Some students were also working towards exams; therefore, they were unable to be excused from their lesson. Finally, we did not link student's responses about asthma morbidity with objective data such as unscheduled medical attendances for asthma recorded by schools. Although we planned to do this, absences recorded by schools were not accompanied by information about whether this was due to asthma or due to other reasons.

Despite these limitations, we found that administering the online questionnaire in schools, when combined with opt-out consent, was an effective and acceptable way of accessing asthmatic children. We therefore speculate that schools are an important 'third space' for delivering interventions aimed at improving asthma control, and that any school-based intervention should address asthma knowledge, perceived peer pressure about inhaler use and the establishment of a regular ICS ± LABA preventer inhaler habit. Indeed, previous US studies suggest that targeting knowledge of asthma in schools reduces unscheduled primary care and hospital visits [20, 21]. In one of these studies, Liptzin et al. [20] recently reported the results of the 'Step-Up' Asthma programme, a multidisciplinary

school-centred asthma program providing asthma counsellors as a bridge between subspecialty asthma care, primary care providers, school nurses and children with asthma. Although not a randomized control trial, in the 252 participants enrolled into the programme over 2 years, there were improvements in asthma knowledge scores, inhaler techniques and a sustained drop in exacerbations.

Conclusions

In summary, using an online questionnaire in schools, we found a high prevalence of poor asthma control, poor asthma knowledge and a high morbidity in London children with doctor-diagnosed asthma. Since suboptimal control by ACT is a risk factor for future severe exacerbations [6], and should prompt more intense clinical monitoring [7], our results suggest a need for interventions aimed at addressing poor asthma control in UK schoolchildren.

Acknowledgments

This project has been gifted the license to use the Asthma Control Test™ by GlaxoSmithKline, an industry partner of NIHR CLAHRC: North Thames. Thanks to Amanda Begley, at GlaxoSmithKline, and all the participants and teachers at the schools involved in this project for their continued support. Thanks to the Centre of the Cell Youth Membership Scheme and schools network and UCLPartners Schools Health and Wellbeing Research Network. Thanks to Professor Chris Griffiths for his continued support with this project.

Declaration of interest

JG was the principal investigator for the study, and planned and provided overall supervision to the rest of the team. KH contributed to the planning of the study, carried out the data collection, conducted the data analysis and wrote the final manuscript. GM contributed to the planning of the study and carried out the data collection, and contributed to the final manuscript. RR contributed to the planning of the study, and contributed to the final manuscript. AW participated in the planning of the study, and contributed to the final manuscript. SAW developed the data collection tool, contributed to the planning of the study, assisted on some data collection and contributed to the final manuscript.

Funding

This study was funded by the National Institute for Health Research; North Thames Collaboration for Leadership in Applied Health Research and Care.This study presents independent research funded by the National Institute for Health Research Collaboration Leadership in Applied Health Research and Care (NIHR CLAHRC) North Thames at Bart's Health NHS Trust. The views expressed are those of the author(s) and are not necessarily those of the NHS, the NIHR or the Department of Health.

References

1. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention, 2016. Available from: www.ginasthma.org
2. Wolfe I, Cass H, Thompson MJ, Craft A, Peile E, Wiegersma PA, et al. Improving child health services in the UK: insights from Europe and their implications for the NHS reforms. Bmj 2011;342.
3. Network BTSaSIG. British guideline on the management of asthma A national clinical guideline. 2016.
4. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, et al. Development of the asthma control test: a survey for assessing asthma control. J Allergy Clin Immunol 2004;113(1):59–65.
5. Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, et al. Asthma Control Test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists. J Allergy Clin Immunol 2006;117(3):549–556.
6. Ko FW, Hui DS, LEUNG TF, CHU HY, Wong GW, Tung AH, et al. Evaluation of the asthma control test: a reliable determinant of disease stability and a predictor of future exacerbations. Respirology 2012;17(2):370–378.
7. Pijnenburg MW, Baraldi E, Brand PLP, Carlsen KH, Eber E, Frischer T, et al. Monitoring asthma in children. Eur Respir J 2015;45(4):906–925.
8. Liu AH, Zeiger R, Sorkness C, Mahr T, Ostrom N, Burgess S, et al. Development and cross-sectional validation of the Childhood Asthma Control Test. J Allergy Clin Immunol 2007;119(4):817–825.
9. Carroll W, Wildhaber J, Brand P. Parent misperception of control in childhood/adolescent asthma: the Room to Breathe survey. Eur Respir J 2012;39(1):90–96.
10. McWhirter J, McCann D, Coleman H, Calvert M, Warner J. Can schools promote the health of children with asthma? Health Educ Res 2008;23(6):917–930.
11. Patterson EE, Brennan MP, Linskey KM, Webb DC, Shields MD, Patterson CC. A cluster randomised intervention trial of asthma clubs to improve quality of life in primary school children: the School Care and Asthma Management Project (SCAMP). Arch Dis Child 2005;90(8):786–791.
12. Edgecombe K, Latter S, Peters S, Roberts G. Health experiences of adolescents with uncontrolled severe asthma. Arch Dis Child 2010:archdischild171579.
13. Bitsko MJ, Everhart RS, Rubin BK. The adolescent with asthma. Paediatr Respir Rev 2014;15(2):146–153.
14. Naimi DR, Freedman TG, Ginsburg KR, Bogen D, Rand CS, Apter AJ. Adolescents and asthma: why bother with our meds? J Allergy Clin Immunol 2009;123(6):1335–1341.
15. Mammen JR, Rhee H, Norton SA, Butz AM. Perceptions and experiences underlying self-management and reporting of symptoms in teens with asthma. J asthma: off j Assoc Care Asthma 2016:0.
16. Rabe KF, Adachi M, Lai CK, Soriano JB, Vermeire PA, Weiss KB, et al. Worldwide severity and control of asthma in children and adults: the global asthma insights and

reality surveys. J Allergy Clin Immunol 2004;114(1): 40–47.
17. Physicians RCo. Why asthma still kills: the National Review of Asthma Deaths (NRAD) Confidential Enquiry Report London; 2014.
18. Census. Ethnicity and National Identity England and Wales. 2011:2011 [Available from: https://www.nomisweb.co.uk/census/2011/LC2109EWLS/view/2013265927?rows=c_age&cols=c_ethpuk11
19. Barnish MS, Tagiyeva N, Devereux G, Aucott L, Turner S. Diverging prevalences and different risk factors for childhood asthma and eczema: a cross-sectional study. BMJ Open 2015;5(6):e008446.
20. Liptzin DR, Gleason MC, Cicutto LC, Cleveland CL, Shocks DJ, White MK, et al. Developing, Implementing, and Evaluating a school-centered asthma program: step-up asthma program. J Allergy Clin Immunol: In Practice 2016.
21. Gerald LB, Redden D, Wittich AR, Hains C, Turner- Henson A, Hemstreet MP, et al. Outcomes for a comprehensive school-based asthma management program. J Sch Health 2006;76(6):291–296.

SAP Questionnaire

Registration and Agreement to take part

First Name(s): _____
Last Name: _____
Email: _____
Date of Birth: _____

Many thanks for taking the time to complete the questionnaire.
This questionnaire asks about you, your asthma and how it affects your school life. Your answers are important to us as they will help with research into how we can help young people with asthma have a better time at school.
The questionnaire will take no longer than 20-30 minutes and will ask you about:

- General information (e.g. age, what area you live in etc.)
- How well your asthma is controlled
- Use of asthma medication
- Unplanned medical attention
- Asthma at school
- Smoking and parental smoking
- Emotional and behavioural well-being

We will also ask your school for information about your attendance and sick leave. This information will be very helpful in working out whether asthma has an impact on attendance. If you would prefer us not to collect this information from the school, you can indicate this below.
All the information you give us will be kept in a secure database by our research team. Everything you tell us will be kept strictly confidential and at no time will we share any of your personal details with anybody not connected to the research.
If you have any questions about the survey or our research, please contact us at g.mosler@qmul.ac.uk.

I declare that (please tick)

- ○ I have read the study information and any questions I had about the study were answered.
- ○ I understand that I can stop taking part at any time.
- ○ I agree for the research team to collect information from my school.
- ○ I am happy to take part in the study.

Thank you very much for taking the time to fill out the questionnaire!

Section 1 (Personal details)

1. Are you male or female?

- ○ Male
- ○ Female

2. How old are you? _____

3. How would you describe your ethnicity?

- ○ White
- ○ Black
- ○ South Asian (e.g. Indian, Bangladeshi, Pakistani)
- ○ East Asian (e.g. Chinese, Japanese, Korean)
- ○ Mixed
- ○ Other: _____

4. What's your home postcode? Please write the first part of your postcode or your full postcode: _____

5. Do you have any long-term health conditions other than your asthma?

If the answer is yes please tick 'other' and describe your condition(s) in the text box

- ○ No
- ○ Other: _____

Thank you very much for taking the time to fill out the questionnaire!

Section 2: Asthma Control Test

6. In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school or home?

- ○ All of the time
- ○ Most of the time
- ○ Some of the time
- ○ A little of the time
- ○ None of the time

7. In the past 4 weeks, how often have you had shortness of breath?

- ○ More than once a day
- ○ Once a day
- ○ 3 to 6 times a day
- ○ Once or twice a week
- ○ Not at all

8. In the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, chest tightness, shortness of breath) wake you up at night or earlier than usual in the morning?

- ○ 4 or more nights a week
- ○ 2 to 3 nights a week
- ○ Once a week
- ○ Once or twice
- ○ Not at all

9. In the past 4 weeks, how often have you used your reliever inhaler (usually blue)?

- ○ 3 or more times per day
- ○ 1 to 2 times per day
- ○ 2 to 3 times per week
- ○ Once a week or less
- ○ Not at all

10. How would you rate your asthma control during the past 4 weeks?

- ○ Not controlled at all
- ○ Poorly controlled
- ○ Somewhat controlled
- ○ Well controlled
- ○ Completely controlled

Thank you very much for taking the time to fill out the questionnaire!

If you had completely controlled asthma in the last 4 weeks

11. Would you say your asthma has gone away

- ○ Yes
- ○ No

Section 3: Adherence

12. What type of inhaler(s) or other medications do you use on a regular basis?
Only mention medication you use on a daily or weekly basis

Inhaler	Please cross:
Blue inhaler (salbutamol or Ventolin)	
Red inhaler (ciclesonide or Alvesco)	
Purple inhaler (fluticasone/salmeterol or Seretide)	
Red/white inhaler (budesonide/formoterol or Symbicort)	
Brown/white inhaler (budesonide or Pulmicort)	
Brown inhaler (beclometasone)	
Orange inhaler (fluticasone or Flixotide)	
Green inhaler (salmeterol or Serevent)	
Steroid tablets: Prednisolone (usually pink)	
Theophylline tablets or Nuelin SA (usually white)	
LTRA tablet (montelukast or Singulair)	
I don't take any medication	
I have other inhalers or medications but I don't know their names	
Other:	

Thank you very much for taking the time to fill out the questionnaire!

13. Do you use a spacer with any of your inhalers?

- ○ Yes, I use a spacer with all of my inhalers
- ○ Yes, I use a spacer with some of my inhalers
- ○ No, I do not use a spacer with any of my inhalers

If you are using a spacer:

14. How often do you use your spacer?

- ○ All of the time
- ○ Most of the time
- ○ Some of the time
- ○ A little of the time
- ○ None of the time

If you are using a spacer

15. Know_02: What do you think your spacer is for

- ○ So I can see the spray from my inhaler
- ○ To make sure I don't breeze in too much medication
- ○ To help asthma medication go into my lungs
- ○ To improve the taste
- ○ Other: _____

16. 14-Adh2a: Do you feel comfortable when you use your inhaler at school?

- ○ Not at all comfortable
- ○ Hardly comfortable
- ○ Somewhat comfortable
- ○ Very comfortable
- ○ Completely comfortable

17. 14-Adh2b: Do you feel comfortable when you use your inhaler outside of school (e.g. at home)?

- ○ Not at all comfortable
- ○ Hardly comfortable
- ○ Somewhat comfortable
- ○ Very comfortable
- ○ Completely comfortable
- ○ I do not need to use it in school

If you are taking a regular inhaler (e.g. brown inhaler)

18. 16-Adh4: Do you sometimes forget to take your regular preventer inhaler (e.g. brown inhaler)?

- ○ All of the time
- ○ Most of the time
- ○ Some of the time
- ○ A little of the time
- ○ None of the time
- ○ I do not have a regular inhaler

Thank you very much for taking the time to fill out the questionnaire!

If you are taking regular preventer medication, e.g. brown inhaler

19. **17-Adh5: Do you sometimes miss your regular preventer inhaler (e.g. brown inhaler) on purpose?**
    - ○ All of the time
    - ○ Most of the time
    - ○ Some of the time
    - ○ A little of the time
    - ○ None of the time

18-Adh6: Would you like to tell us why? _____

_____

If you are taking a regular preventer inhaler, e.g. brown inhaler

20. **Know_01: What is your regular preventer inhaler for (e.g. brown inhaler):**
    - ○ To make my asthma go away for good
    - ○ To reduce symptoms during an asthma attack:
    - ○ To stop me getting an infection
    - ○ To reduce the chances of me having an asthma attack
    - ○ Other _____

21. **ADH_5b: Do you sometimes not use your blue reliever inhaler when you would need it?**
    - ○ All of the time
    - ○ Most of the time
    - ○ Some of the time
    - ○ A little of the time
    - ○ None of the time

ADH_7: Would you like to tell us why?

_____

Thank you very much for taking the time to fill out the questionnaire!

Section 4 Medical attention

22. How many times have you had an unplanned visit to your GP/doctor due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

23. How many times have you had an unplanned visit to the hospital due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

Section 5: School activity

24. How many times have you missed a whole day of school due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

25. How many times have you missed part of a day at school due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

26. How many times have you missed all or part of a regular class lesson due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

27. How many times have you missed all or part of a P.E. lesson due to your asthma in the last month?

- ○ 4 or more times
- ○ 2-3 times
- ○ 1-2 times
- ○ Not at all

Thank you very much for taking the time to fill out the questionnaire!

28. Do you feel that your asthma has a negative impact on how well you do in any of your classes or exams?

- ○ My asthma doesn't have an impact at all
- ○ My asthma hardly has an impact
- ○ My asthma has a little bit of an impact
- ○ My asthma has some impact
- ○ **My asthma has a big impact**

Would you like to tell us more about any negative impacts your asthma has on your classes or exams?

_____

_____

Section 6: Lifestyle and smoking

29. Do you smoke? (This includes cigarettes/cigars, shisha/hookah, marijuana/weed etc.)

- ○ Yes, everyday
- ○ Yes, 5-6 days a week
- ○ Yes, 3-4 days a week
- ○ Yes, 1-2 days a week
- ○ Yes, less than once a week
- ○ No, not at all

30. Do your parents/carers or other people you live with smoke at the moment?

- ○ Yes
- ○ No

Thank you very much for taking the time to fill out the questionnaire!

Table 1. Individual responses to each question, and all missing data

Question	Answer	Total Responses	Missing Data N (%)
Asthma Control Test			
In the past 4 weeks, how much time did your asthma keep you from getting as much done at work, school or home?		**766**	**0**
	All the time	6	
	Most of the time	57	
	Some of the time	144	
	A little of the time	235	
	None of the time	324	
In the past 4 weeks, how often have you had shortness of breath?		**766**	**0**
	More than once a day	60	
	Once a day	73	
	3 to 6 times a day	80	
	Once or twice a week	367	
	Not at all	186	
In the past 4 weeks, how often did your asthma symptoms wake you up at night or earlier than usual in the morning?		**766**	**0**
	4 or more nights a week	31	
	2 to 3 nights a week	90	
	Once a week	73	
	Once or twice	239	
	Not at all	333	
In the past 4 weeks, how often have you used your reliever inhaler (usually blue)?		**766**	**0**
	3 or more times per day	54	
	1 to 2 times per day	100	
	2 to 3 times per week	142	
	Once a week or less	242	
	Not at all	228	
How would you rate your asthma control during the past 4 weeks?		**766**	**0**
	Not controlled at all	13	
	Poorly controlled	47	
	Somewhat controlled	168	
	Well controlled	330	
	Completely controlled	208	
If you had completely controlled asthma		**201**	**7 (3.4)**

in the last 4 weeks: Would you say your asthma has gone away?			
	Yes	112	
	No	89	
Adherence			
What type of inhaler(s) do you use on a regular basis? Only mention medication you use on a daily or weekly basis		**766**	**0**
Do you use a spacer with any of your inhalers?		**762**	**4 (0.5)**
	Yes, I use a spacer with all of my inhalers	166	
	Yes, I use a spacer with some of my inhalers	145	
	No, I do not use a spacer with any of my inhalers	451	
If you are using a spacer: How often do you use your spacer?*		**327**	
	All of the time	82	
	Most of the time	46	
	Some of the time	63	
	A little of the time	97	
	None of the time	39	
If you are using a spacer: What do you think your spacer is for?*		**314**	
Do you feel comfortable when you use your inhaler at school?		**762**	**4 (0.5)**
	Not at all comfortable	31	
	Hardly comfortable	70	
	Somewhat comfortable	145	
	Very comfortable	120	
	Completely comfortable	226	
	I do not need to use it in school	170	
Do you feel comfortable when you use your inhaler outside school (e.g. at home)?		**762**	**4 (0.5)**
	Not at all comfortable	14	
	Hardly comfortable	25	
	Somewhat comfortable	98	
	Very comfortable	167	
	Completely comfortable	458	
If you are taking regular inhaler (e.g.		**752**	

brown inhaler): Do you sometimes forget to take your regular preventer inhaler?*			
	All of the time	61	
	Most of the time	91	
	Some of the time	150	
	A little of the time	150	
	None of the time	106	
	I do not have a regular inhaler	194	
If you are taking a regular preventer medication (e.g. brown inhaler): Do you sometimes miss your regular preventer inhaler on purpose?*		**551**	
	All of the time	24	
	Most of the time	28	
	Some of the time	71	
	A little of the time	99	
	None of the time	329	
Would you like to tell us why?	Free text response	**208**	**264 (55.9)**
If you are taking a regular preventer inhaler (e.g. brown inhaler): What is your regular preventer for?*		**523**	
Do you sometimes not use your blue reliever when you would need it?*		**720**	
	All of the time	34	
	Most of the time	46	
	Some of the time	116	
	A little of the time	182	
	None of the time	342	
Would you like to tell us why?			
	Free text response	**260**	**388 (59.9)**

Medical Attention			

How many times have you had an unplanned visit to your GP/doctor due to your asthma in the last month?		**743**	**23 (3)**
	4 or more times	15	
	2-3 times	34	
	1-2 times	160	
	Not at all	534	
How many times have you had an unplanned visit to the hospital due to your asthma in the last month?		**743**	**23 (3)**
	4 or more times	9	
	2-3 times	20	
	1-2 times	88	
	Not at all	626	

School Activity			

How many times have you missed a whole day of school due to your asthma in the last month?		**738**	**28 (3.7)**
	4 or more times	16	
	2-3 times	18	
	1-2 times	120	
	Not at all	584	
How many times have you missed part of a day of school due to your asthma in the last month?		**738**	**28 (3.7)**
	4 or more times	8	
	2-3 times	15	
	1-2 times	107	
	Not at all	608	
How many times have you missed all or part of a regular class lesson due to your asthma in the last month?		**738**	**28 (3.7)**
	4 or more times	6	
	2-3 times	17	
	1-2 times	121	
	Not at all	594	
How many times have you missed all or part of a P.E. lesson due to your asthma in the last month?		**738**	**28 (3.7)**
	4 or more times	16	
	2-3 times	29	
	1-2 times	166	
	Not at all	527	
Do you feel that your asthma has a negative impact on how well you do in any of your classes or exams?		**740**	**26 (3.4)**
	My asthma doesn’t have an impact at all	323	
	My asthma hardly has an impact	176	
	My asthma has a little bit of an impact	119	
	My asthma has some impact	98	
	My asthma has a big impact	24	
Lifestyle and Smoking			

Do you smoke?		**733**	**33 (4.3)**
	Yes, everyday	8	
	Yes, 5-6 days a week	4	
	Yes, 3-4 days a week	5	
	Yes, 1-2 days a week	4	
	Yes, less than once a week	18	
	No, not at all	694	
Do your parents/carers or other people you live with smoke at the moment?		**734**	**32 (4.2)**
	Yes	185	
	No	549	

*The paper version of the questionnaire allowed some participants to answer questions that were not directly relevant to them (e.g. some students answered questions regarding the use of a spacer, despite reporting not having a spacer)

Table 2. Details of participating London schools

Type of School*	Total students N	Method of recording asthmatics †	Reported asthmatics N (%)	Asthmatic Participants‡ N (%)	Suboptimal control (%)	Median ACT Score (Units)
C	1236	TR	55 (4.4)	7	71.4	18
C	1211	I	N/A	51	52.9	19
C	1411	TR	40 (2.8)	20	40	20.5
C	1023	TR	68 (6.6)	62	54.8	19
C	2000	TR	20 (1)	13	69.2	19
C	2576	TR	24 (0.9)	7	42.9	22
C	967	TR	46 (4.8)	18	61.1	18
I	1345	I	N/A	16	18.8	21
G	898	TR	150 (16.7)	72	43.1	20
C	1145	TR	78 (6.8)	42	42.9	21.5
C	1518	TR	60 (4.0)	15	33.3	21
C	1104	TR	40 (3.6)	8	62.5	18.5
G	888	TR	59 (6.6)	34	44.1	20
C	1256	TR	12 (1.0)	8	62.5	16.5
C	1361	TR	40 (2.9)	23	47.8	20
C	1972	TR	61 (3.1)	47	48.9	20
C	1659	TR	102 (6.1)	37	51.4	19
G	1185	TR	99 (8.4)	53	45.3	20
C	1130	TR	50 (4.4)	23	65.2	18
C	1341	I	N/A	4	50	19.5
C	704	TR	33 (4.7)	34	50	19.5
C	1974	TR	90 (4.6)	57	68.4	17
C	951	TR	70 (7.4)	7	28.6	22
C	898	TR	81 (9.0)	31	35.5	21

* All secondary schools with students between 11 and 18 years of age; ACT; Asthma Control test, C; Comprehensive; I; Independent; G; Grammar

† TR = teacher reported; I = informal

‡ students who completed all ACT questions. N/A; not applicable.

Table 3. Details of non-participating London schools who expressed an interest

School Reference	Type of School*	Total students N	Gender
1	Selective Sixth Form	440	Co-Educational
2	Comprehensive	1437	Girls
3	Comprehensive	550	Co-Educational
4	Comprehensive	1257	Co-Educational
5	Independent	266	Girls
6	Comprehensive	1470	Co-Educational
7	Comprehensive	1079	Girls
8	Comprehensive	850	Boys
9	Comprehensive	1163	Co-Educational
10	Comprehensive	573	Co-Educational
11	Comprehensive	819	Co-Educational
12	Independent	707	Girls
13	Comprehensive	1288	Co-Educational
14	Comprehensive	160	Girls
15	Independent	157	Boys
16	Independent	800	Boys
17	Independent	750	Co-Educational
18	Comprehensive	1250	Girls
19	Comprehensive	1600	Co-Educational

*Selective sixth form = entry examination required; Comprehensive = intake of students not selected using an entry examination; Independent = not dependent on national or local government for finances and governance