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School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review (Review)

Harris KM, Kneale D, Lasserson TJ, McDonald VM, Grigg J, Thomas J

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[Intervention Review]

School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

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ABSTRACT

Background

Asthma is a common respiratory condition in children that is characterised by symptoms including wheeze, shortness of breath, chest tightness, and cough. Children with asthma may be able to manage their condition more effectively by improving inhaler technique, and by recognising and responding to symptoms. Schools offer a potentially supportive environment for delivering interventions aimed at improving self-management skills among children. The educational ethos aligns with skill and knowledge acquisition and makes it easier to reach children with asthma who do not regularly engage with primary care. Given the multi-faceted nature of self-management interventions, there is a need to understand the combination of intervention features that are associated with successful delivery of asthma self-management programmes.

Objectives

This review has two primary objectives.

• To identify the intervention features that are aligned with successful intervention implementation.

• To assess effectiveness of school-based interventions provided to improve asthma self-management among children.

We addressed the first objective by performing qualitative comparative analysis (QCA), a synthesis method described in depth later, of process evaluation studies to identify the combination of intervention components and processes that are aligned with successful intervention implementation.

We pursued the second objective by undertaking meta-analyses of outcomes reported by outcome evaluation studies. We explored the link between how well an intervention is implemented and its effectiveness by using separate models, as well as by undertaking additional subgroup analyses.

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Search methods

We searched the Cochrane Airways Trials Register for randomised studies. To identify eligible process evaluation studies, we searched MEDLINE, Embase, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, the Cochrane Database of Systematic Reviews (CDSR), Web of Knowledge, the Database of Promoting Health Effectiveness Reviews (DoPHER), the Database of Abstracts of Reviews of Effects (DARE), the International Biography of Social Science (IBSS), Bibliomap, Health Technology Assessment (HTA), Applied Social Sciences Index and Abstracts (ASSIA), and Sociological Abstracts (SocAbs). We conducted the latest search on 28 August 2017.

Selection criteria

Participants were school-aged children with asthma who received the intervention in school. Interventions were eligible if their purpose was to help children improve management of their asthma by increasing knowledge, enhancing skills, or changing behaviour. Studies relevant to our first objective could be based on an experimental or quasi-experimental design and could use qualitative or quantitative methods of data collection. For the second objective we included randomised controlled trials (RCTs) where children were allocated individually or in clusters (e.g. classrooms or schools) to self-management interventions or no intervention control.

Data collection and analysis

We used qualitative comparative analysis (QCA) to identify intervention features that lead to successful implementation of asthma self-management interventions. We measured implementation success by reviewing reports of attrition, intervention dosage, and treatment adherence, irrespective of effects of the interventions.

To measure the effects of interventions, we combined data from eligible studies for our primary outcomes: admission to hospital, emergency department (ED) visits, absence from school, and days of restricted activity due to asthma symptoms. Secondary outcomes included unplanned visits to healthcare providers, daytime and night-time symptoms, use of reliever therapies, and health-related quality of life as measured by the Asthma Quality of Life Questionnaire (AQLQ).

Main results

We included 55 studies in the review. Thirty-three studies in 14,174 children provided information for the QCA, and 33 RCTs in 12,623 children measured the effects of interventions. Eleven studies contributed to both the QCA and the analysis of effectiveness. Most studies were conducted in North America in socially disadvantaged populations. High school students were better represented among studies contributing to the QCA than in studies contributing to effectiveness evaluations, which more commonly included younger elementary and junior high school students. The interventions all attempted to improve knowledge of asthma, its triggers, and stressed the importance of regular practitioner review, although there was variation in how they were delivered.

QCA results highlighted the importance of an intervention being theory driven, along with the importance of factors such as parent involvement, child satisfaction, and running the intervention outside the child's own time as drivers of successful implementation.

Compared with no intervention, school-based self-management interventions probably reduce mean hospitalisations by an average of about 0.16 admissions per child over 12 months (SMD -0.19, 95% CI -0.35 to -0.04; 1873 participants; 6 studies, moderate certainty evidence). They may reduce the number of children who visit EDs from 7.5% to 5.4% over 12 months (OR 0.70, 95% CI 0.53 to 0.92; 3883 participants; 13 studies, low certainty evidence), and probably reduce unplanned visits to hospitals or primary care from 26% to 21% at 6 to 9 months (OR 0.74, 95% CI 0.60 to 0.90; 3490 participants; 5 studies, moderate certainty evidence). Self-management interventions probably reduce the number of days of restricted activity by just under half a day over a two-week period (MD 0.38 days 95% CI -0.41 to -0.18; 1852 participants; 3 studies, moderate certainty evidence). Effects of interventions on school absence are uncertain due to the variation between the results of the studies (MD 0.4 fewer school days missed per year with self-management (-1.25 to 0.45; 4609 participants; 10 studies, low certainty evidence). Evidence is insufficient to show whether the requirement for reliever medications is affected by these interventions (OR 0.52, 95% CI 0.15 to 1.81; 437 participants; 2 studies; very low-certainty evidence). Self-management interventions probably improve children's asthma-related quality of life by a small amount (MD 0.36 units higher on the Paediatric AQLQ(95% CI 0.06 to 0.64; 2587 participants; 7 studies, moderate certainty evidence).

Authors' conclusions

School-based asthma self-management interventions probably reduce hospital admission and may slightly reduce ED attendance, although their impact on school attendance could not be measured reliably. They may also reduce the number of days where children experience asthma symptoms, and probably lead to small improvements in asthma-related quality of life. Many of the studies tested

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the intervention in younger children from socially disadvantaged populations. Interventions that had a theoretical framework, engaged parents and were run outside of children's free time were associated with successful implementation.

PLAIN LANGUAGE SUMMARY

Are asthma self-management interventions effective when delivered in schools for children, and how should they be delivered?

Background to the question

Asthma is a common condition among children. Schools are potential sites for developing self-management skills, but evidence that school-based interventions improve asthma control has not been reviewed systematically.

Review question

We sought to address two questions.

• Which parts of school-based asthma self-management interventions are more likely to make these interventions successful?

• What effect do interventions have on children's asthma control, school attendance, and attendance at GP and hospital settings?

Study characteristics

We included 66 studies. We included 33 of these studies to gain a better understanding of the best way to deliver an asthma self-management intervention. We included the other 33 studies to determine whether these interventions are successful in improving children's health and well-being.

Key results

We included 23 studies in quantitative models measuring children's asthma outcomes (an outcome is something you can measure to find out if an intervention worked). Results show that school-based self-management interventions could improve outcomes such as hospitalisations, emergency department visits, and health-related quality of life. Fewer studies reported improved unplanned medical visits or reduced numbers of days on which children could not do their normal activities. Interventions did not reduce school absences, symptoms, or reliever medication use. The more effective interventions were based on theories about how the intervention might work. Researchers found that including parents in the intervention, making sure children were happy with the intervention, and running the intervention during school hours helped increase fidelity.

Certainty of the evidence

Studies that measured whether an intervention worked were usually well designed; however sometimes they were difficult to carry out, and some may not have measured outcomes accurately. Reviewers found that some of the studies conducted to understand how an intervention should be delivered were at risk of bias, and certainty of the evidence was generally lower for these studies.

Take-home message

Evidence suggests that school-based self-management interventions can help children with asthma and can reduce hospital admissions and trips to the emergency department. Study findings suggest that interventions that were based on a theory about how an intervention can be planned and delivered could prove useful in improving children's outcomes, reaching large numbers of children, and keeping dropout rates low, and indicate that those designing interventions should consider factors such as including parents.

This review is current to August 2017.

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SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Effects of school-based asthma interventions compared to usual care for asthma among children and adolescents

Patient or population: asthma among children and adolescents
Setting: primary/elementary schools through to high/senior schools
Intervention: effects of school-based asthma interventions
Comparison: usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with usual care	Risk with effect of school-based asthma interventions				
Exacerbations leading to hospitalisation (hospitalisations) assessed with RCT Follow-up: range 1 week to 12 months		Mean level of hospitalisation at post-treatment in the intervention group was 0.19 standard deviations lower than in the control group (0.35 to 0.04 lower)	-	1873 (6 RCTs)	⊕⊕⊕◯ MODERATE[a]	Meta-analysis based on SMD including data transformed from OR (data on median level from Gerald 2006 not included)
Asthma symptoms leading to emergency hospital visits (ED visits) Follow-up: range 1 week to 12 months	Less than 10% experience ED visit annually		OR 0.70 (0.53 to 0.92)	3883 (13 RCTs)	⊕⊕◯◯ LOW[b]	Data from Gerald 2006 on median visits not combined Assumed risk based on rates over 12 months < 10% based on Horner 2008, McGhan 2010, Velsor-Friedrich 2005 ≥ 10% based on Cicutto 2013, McGhan 2003
	75 per 1000	54 per 1000 (41 to 69)				
	Over 10% experience ED visit annually					
	281 per 1000	215 per 1000 (172 to 264)				

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Unplanned visit to hospital or GP due to asthma symptoms (unplanned medical visits) Follow-up: range 1 week to 12 months	Unplanned visits over 6 to 9 months		OR 0.74 (0.60 to 0.90)	3283 (5 RCTs)	⊕⊕⊕◯ MODERATE[c]	Unplanned visits over 6 to 9 months based on McGhan 2003, Splett 2006; unplanned visits over 12 months based on Cicutto 2013, McGhan 2010
	264 per 1000	210 per 1000 (177 to 244)				
	Unplanned visits over 12 months					
	318 per 1000	257 per 1000 (219 to 296)				
Absence from school Follow-up: range 1 week to 15 months	Mean absence from school was 4.3 school days missed annually	MD 0.399 school days missed annually lower (1.254 lower to 0.456 higher)	-	4609 (10 RCTs)	⊕⊕◯◯ LOW[d]	Meta-analysis based on SMD including data transformed from OR; transformation to mean difference undertaken based on data from Cicutto 2005
Experience of daytime and night-time symptoms - daytime symptoms (daytime symptoms) Follow-up: range 2 months to 12 months	Mean experience of daytime and night-time symptoms - daytime symptoms was 3.3 days experienced in past 2 weeks	MD 0.377 days experienced in past 2 weeks lower (0.828 lower to 0.05 higher)	-	1065 (5 RCTs)	⊕⊕⊕◯ MODERATE[e]	CI for this pooled estimate crossed the line of no effect by a small margin. Original meta-analysis based on SMDs, including transformations from ORs. SMD to MD based on Bruzzese 2011
Use of reliever therapies, e.g. beta$_2$-agonists (reliever therapies) Follow-up: range 1 week to 15 months	Study population		OR 0.52 (0.15 to 1.81)	437 (2 RCTs)	⊕◯◯◯ VERY LOW[f]	
	228 per 1000	133 per 1000 (42 to 349)				

Health-related quality of life Follow-up: range 1 week to 12 months	Mean health-related quality of life was 4.96 Paediatric Asthma Quality of Life Questionnaire points	MD 0.36 Paediatric Asthma Quality of Life Questionnaire points higher (0.06 higher to 0.64 higher)	-	2587 (7 RCTs)	⊕⊕⊕○ MODERATE[g]	Two studies provided information on change in QoL. Both showed positive intervention effects. Risk with usual care based on follow-up scores

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; ED: emergency department; GP: general practitioner; MD: mean difference; OR: odds ratio; QoL: quality of life; RCT: randomised controlled trial; RR: risk ratio; SMD: standardised mean difference

GRADE Working Group grades of evidence.
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[a] Studies with high or unclear risk of bias contribute the least to the overall effect size. Hospitalisations may be due to reasons other than asthma (-1 for indirectness).

[b] Four studies had high risk of bias around allocation concealment; four also had high risk of bias around attrition; many other studies had unclear risks of bias. However, these risks did not appear to inflate the effect size nor systematically influence the effect. A high degree of inconsistency was evident, as measured by heterogeneity statistics in the meta-analysis, which was partially explained by subgroup analyses. A large degree of variation was evident in measurement of the outcome, prompting concerns about indirectness; similarly, wide confidence intervals were detected (0.53 to 0.95). Study results led to concerns that not all ED visits may be due to asthma (-1 for inconsistency; -1 for indirectness).

[c] No guarantee that unplanned medical visits were due to asthma (-1 for indirectness).

[d] School absences could be due to causes other than asthma; heterogeneity statistics suggested a large degree of statistical inconsistency (-1 for indirectness; -1 for inconsistency).

[e] High risk of bias detected in at least one domain for two out of five studies, which accounted for around a third of the pooled effect size. This included high risk of bias suspected for attrition bias in one study (-1 for risk of bias).

[f] Risk of bias deemed high for attrition and reporting bias for one of the two studies included in the meta-analysis; very wide confidence interval; although both studies were consistent in the direction of effect, they showed large differences in the magnitude of effect (-1 for risk of bias; -1 for inconsistency; -1 for imprecision).

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[g]Imprecision was deemed to be serious based on the nature of the outcome; five of the seven studies were deemed to have high risk of bias in at least one domain. This included three studies deemed to have high risk of bias for allocation concealment. However, these did not appear to differentially influence the effect size (-1 for imprecision).

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BACKGROUND

Description of the condition

Asthma is a chronic respiratory condition characterised by bronchoconstriction, airway inflammation, and mucus hypersecretion leading to variable airflow limitation. Resulting symptoms include wheeze, dyspnoea, cough, and tightness in the chest. No single definitive diagnostic 'test' for asthma is available; instead asthma is diagnosed clinically upon assessment of respiratory symptoms and clinical response to inhaled therapy, and review of evidence of reversible airflow limitation or airway hyper-responsiveness - as in BTS 2016 and Levy 2014 - and elevated exhaled breath nitric oxide - as in NICE 2017. Asthma is the most common chronic disease among children (Neuzil 2000; To 2012), with more than a million children in the UK living with this chronic condition (Asthma UK 2013). Many countries report high prevalence rates of childhood asthma. The International Study of Asthma and Allergy in Children (ISAAC) study, for example, found high prevalence in Australasia and the United Kingdom (Asher 2006). Much of the evidence on non-pharmacological interventions derives from North America, where prevalence is among the highest globally, at 21.5% and 16.7% for six- to seven-year-old boys and girls, respectively, and 19.8% and 23.3% among children 13 to 14 years of age (Mallol 2013).

In the UK, children from black and white ethnic backgrounds have higher levels of asthma symptoms compared with children from South Asian backgrounds (Netuveli 2005), although substantial variation in the risk of developing asthma has been found within these broad ethnic groups (Kneale 2010). Successful management of asthma among UK children is associated, in part, with social position and socio-economic status. For example, although South Asian children are at lower risk of asthma, they, along with black children, are at higher risk than white children of admission following asthma complications (Netuveli 2005). Indeed a systematic review of socio-economic status and health outcomes found evidence to suggest that the risk of developing asthma is highest among children in the UK from lower-income families (Spencer 2012). Overall, the UK government estimates that a billion pounds is spent annually through the National Health Service (NHS) on treatment and prevention of asthma among adults and children (Department of Health 2012). Thus population-based interventions that improve asthma control have the potential to generate significant savings for the UK NHS.

Description of the intervention

Globally, a large proportion of people with asthma do not receive adequate self-management education and training in primary care, and in England in 2014, more than a quarter of people (adults and children) living with asthma had not undergone an asthma review in the previous 15 months (HSCIC 2014). Moreover, inadequate knowledge of the condition and patient non-adherence with clinician recommendations for asthma treatment (e.g. overuse of long-acting beta^2 -agonists, under-use of inhaled corticosteroids) may contribute towards poor asthma management among children (Piecoro 2001; Walsh 1999).

Children who experience an asthma exacerbation are at risk of hospitalisation and death (Bush 2017). Of the 65,000 hospitalisations for asthma occurring in 2011-2012 in the UK, more than one-third (38%) occurred in children (aged birth to 14 years); moreover, in an in-depth study of asthma deaths, 14% (28 of 195) of confirmed deaths from asthma in the UK over a year occurred among children and young people 20 years of age and younger (Levy 2014). Effective self-management of asthma could reduce levels of hospitalisation, which may reduce the financial implications of asthma and improve outcomes for children and adults with asthma, while reducing asthma-related deaths in children.

Living with asthma can impact many other child health and social outcomes, and asthma, particularly severe asthma, is associated with a range of developmental, emotional, and behavioural problems (Blackman 2007). Some studies suggest that children with asthma are disadvantaged in terms of their peer relationships, and other studies report that some children with asthma are bullied (Harris 2017; Wildhaber 2012). Moreover, children with asthma are more likely to limit participation in activities as the result of dyspnoea and other asthma-related symptoms (Van Den Bemt 2011).

Children with asthma tend to have poorer school attendance rates than their peers (Rodriguez 2013). For example, one US study reported that children living with asthma miss an average of 1.5 additional days of school annually compared with their peers, and that increased asthma severity was associated with an increase in the number of days absent from school (Moonie 2006). Furthermore, average school days missed masks large heterogeneity in experience, with some children missing many school days as a result of asthma. A school-based survey, conducted by two members of the review team (KH, JG), assessed current levels of asthma control and school attendance in a sample of 766 children with asthma attending London secondary schools (Harris 2017). Overall, 20.9% of London school children self-reported at least one school absence due to asthma over a four-week period. Moreover, children with poor asthma control (n = 350) had greater rates of school absence compared to their peers with good asthma control (32.7% vs 10.9%) (Harris 2017). Fowler 1992 found that grade failure is more frequent among children with asthma.

Self-management consists of educating and enabling children to achieve good control over their own asthma symptoms, thereby preventing future exacerbations (Kotses 2010);self-management is viewed as a cornerstone of asthma treatment and care (Bateman 2008; BTS 2016; GINA 2018). Asthma control refers to the de-

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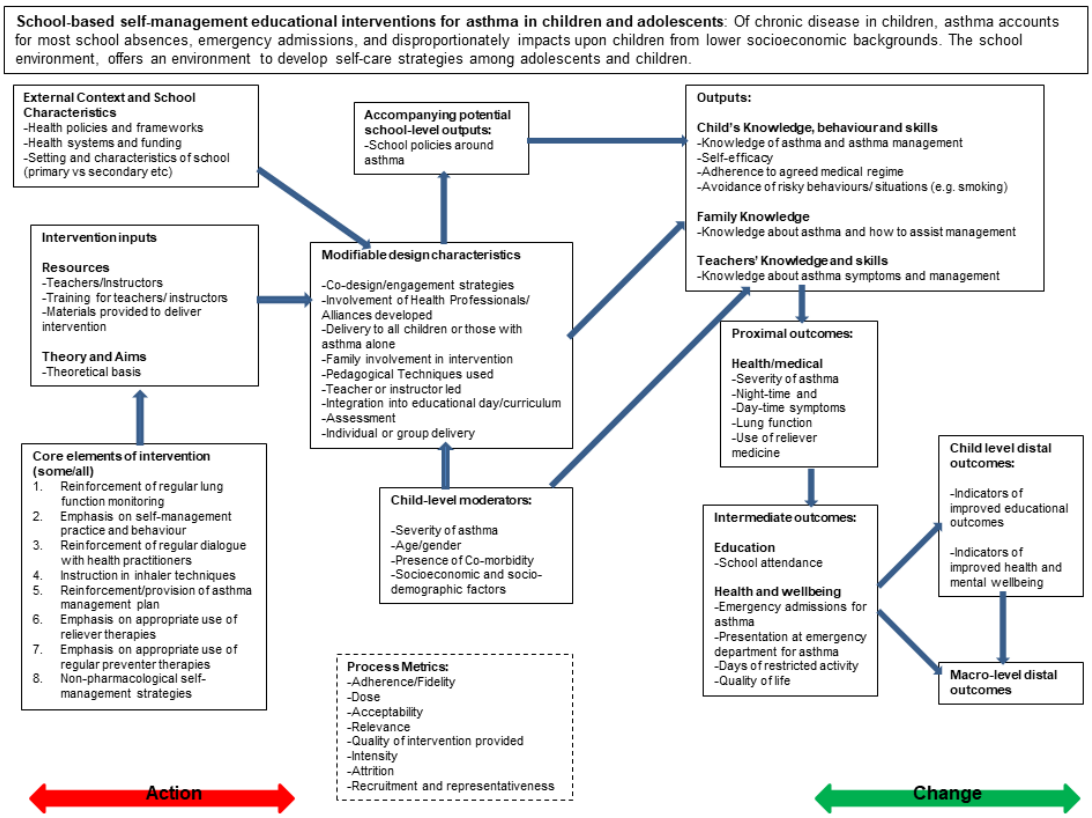
gree to which asthma symptoms can be observed and subsequently improved with treatment (GINA 2018). Well-controlled asthma is associated with reduced daytime and night-time symptoms, decreased long-term morbidity, and diminished risk of life-threatening asthma attacks (Juniper 2006). Asthma control tends to improve with age among children; one study reported excellent or satisfactory control in 38% of children four to six years of age and in 66% of children 13 to 16 years of age (Kuehni 2002).

For chronic respiratory diseases, self-management is defined by the British Thoracic Society (BTS) as "the tasks that individuals must undertake to live with chronic conditions, including have the confidence to deal with medical management, role management and emotional management of their conditions" (BTS 2016). For asthma, successful self-management skills include good inhaler technique and ability to recognise and respond to asthma symptoms. Self-management also encourages an alliance between the physician or healthcare professional and the patient for the purpose of managing asthma (Kotses 2010). For the purposes of the present review, we have included only self-management studies that provided education on asthma symptoms and their avoidance and management, omitting studies that provided education solely on the nature of asthma.

One main indirect cost of childhood asthma is absence from school, and costs of hospitalisation and of asthma medication drive most of the direct costs of this condition (Bahadori 2009). Although delivery of an asthma self-management intervention in schools has the potential to reduce asthma burden, the effectiveness of this approach across various "proximal" (e.g. improvement in asthma symptoms), "intermediate" (e.g. healthcare usage), and "distal" outcomes (e.g. school achievement) remains unclear (Figure 1). Even when interventions are delivered in similar school settings, several factors can influence success, including variation in treatment settings, study populations, and ways in which school-based asthma self-management interventions and intervention components are delivered, in addition to the role of intervention mediators such as changes in school-level policies around asthma or asthma medication (Al Aloola 2014).

Figure 1. Logic model of school-based asthma interventions.



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How the intervention might work

Self-managment works by enabling patients to control their asthma symptoms, thereby preventing future exacerbations and improving their quality of life. Schools are a familiar environment for children's learning, and interventions provided at school have the potential to include large numbers of children with asthma at a single location (Ahmad 2011; Bruzzese 2009; Coffman 2009).

A previous systematic review of self-management interventions delivered in clinic, home, and school environments for children with asthma found that these were positively associated with moderate improvements in lung function, school absenteeism, emergency visits to hospital, and self-efficacy (Guevara 2003). A separate Cochrane Review reported that targeted self-management interventions can lead to reduced hospital admissions among those at risk of hospitalisation (Boyd 2009). Participants included in both reviews were children from birth to 18 years of age with a diagnosis of asthma. Guevara 2003 excluded children with a pulmonary diagnosis other than asthma. Neither review noted participant comorbidities. Other reviews of self-management interventions for children with asthma suggest that educational interventions delivered to children with asthma can be effective; however, these reviews have considered interventions delivered within schools alongside those delivered in other settings, including the clinic and the home (e.g. Smith 2005; Wolf 2002). Indeed Welsh 2011 points to lack of consensus around the optimal setting for asthma interventions. To date, only two systematic reviews have evaluated the evidence for interventions delivered exclusively within schools. These reviews reported a positive impact on school absenteeism but provided less conclusive evidence on the impact on health outcomes such as hospitalisations (Ahmad 2011; Coffman 2009). Notably, both reviews used a narrative approach to synthesis (Ahmad 2011; Coffman 2009). Another review examined outcomes for primary school age children only (Al Aloola 2014). To date, few reviews have included analyses of accompanying "process-level" measures, such as changes in school policy. Pinnock 2015 is one exception. These review authors explored how asthma self-management interventions should be implemented, although they did not focus on school interventions alone. Nevertheless, based on analysis of two studies conducted in schools, they identified high school turnover and lack of parental involvement as challenges to implementation. Analysis of such process factors would further illuminate the modifiable components of interventions that may be most critical in determining the success (or failure) of interventions, and in mapping out the diverse processes undertaken as part of the intervention.

Systematic reviews of self-management interventions in adults with asthma highlight the importance of gaining a deeper understanding of intervention characteristics and implementation processes. For example, Denford 2013 found that active involvement was associated with greater effect size, but that focus on stress management techniques was potentially counterproductive. Previous studies of self-management in children have focused on child-level moderators. Consequently, the effectiveness of different aspects of school-based interventions for children with asthma is currently unclear.

Background to the methods used in this review

In this review, we aim to synthesise the evidence for school-based interventions by addressing asthma self-management, for the first time, using a mixed methods approach. Mixed methods involves synthesising qualitative and process evaluation evidence, as well as quantitative evidence, in an integrated way. Process evaluation studies explore the implementation, receipt, and setting of an intervention. Although "process" and "qualitative" are often mistakenly used interchangeably, data for process evaluation can be both quantitative and qualitative (Oakley 2006). Process evaluations can be used to develop mechanistic theories around how interventions work, although no universally agreed definition is available for what a process evaluation is and which core components it should include.

Investigators in one study defined a process evaluation as evaluating the quality of the intervention and measuring the disparity between the way in which an intervention was intended to be implemented and the way in which it is actually implemented (Shepherd 2010). This focus on evaluating the processes of delivery and the factors "responsible for successful outcomes, implementation of the intervention, and intervention integrity" is also shared elsewhere (Waters 2006). Meanwhile, UK Medical Research Council guidance on how to conduct process evaluations states that core components of process evaluations include (I) clear description (and evaluation) of implementation and processes of implementation; (ii) clear analysis of the mechanism of impact (participant responses to and interactions with the intervention); and (iii) clear description of context and analysis of how contextual factors affect mechanisms and implementation (Moore 2015).

Qualitative comparative analysis (QCA)

Although other reviews have set out to apply a mixed methods approach (albeit applied to other health topics) (Hurley 2013; Husk 2016), we sought to review the literature using both meta-analyses of quantitative studies to assess the effectiveness of interventions and qualitative comparative analysis (QCA) to discern the importance of different configurations of intervention features. QCA has its basis in set-theoretic logic, and is a well-placed method for synthesising data from a small number of studies with complex characteristics. This approach aims to uncover the degree of overlap between a set of studies that are successful in their implementation and sets of studies that share different configurations of intervention characteristics. In pursuing the aim described above, we used a logic model to help structure and synthesise review findings (Figure 1), in accordance with the practices described in previous reviews (Glenton 2013).

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Logic models

Logic models are tools that can be used to evaluate the effectiveness of a programme and/or to guide programme planning and implementation (NHS Scotland 2014). The protocol authors developed a logic model to outline some school-based asthma self-management intervention components that may be influential (Figure 1). We developed the logic model from the outcomes to be included in this review, and we worked backwards, theorising the causal chain necessary to lead to these outcomes. We developed the logic model using published literature and systematic reviews, including existing logic models used in studies and policy documents. Use of a logic model assisted us in identifying the types of data that may need to be captured if we are to gain an understanding of intervention components and implementation processes (Kneale 2015). The underlying idea behind a logic model is that a target or final goal is identified, and the pre-conditions needed to reach this goal are hypothesised as different steps, building up a theorised chain of intervention actions and how they may impact outcomes. The logic model in Figure 1 shows the steps needed to reach the distal (long-term) outcome of improvement in general health, well-being, and educational outcomes among children with asthma; to achieve this long-term outcome, we hypothesise that improvement in more intermediate outcomes such as episodes of healthcare usage and school absences is needed; to achieve improvement in these outcomes, we would expect improvement in asthma symptoms and lung function to be a necessary pre-condition, and, in turn, to improve these, we theorise that children need better knowledge about asthma and improved skill in using inhalers. Changes in children's knowledge and skills follow from exposure to the intervention, although several modifiable intervention design characteristics may cause the intervention to have a differential impact, and may influence the characteristics of children themselves and the context in which the intervention takes place. Each intervention however includes various core elements (reflecting our definition of self-management), as well as a set of resources and theories underlying its delivery. In addition, the logic model recognises that interventions can fail to effect change in children's outcomes because of issues of design or implementation, and a box on 'process metrics' incorporates ways of understanding the success of intervention implementation.

Why it is important to do this review

Educational impacts attributable to asthma are larger among children from lower socio-economic groups and/or ethnic minority groups (Milton 2004), with children from ethnic minorities more likely than others to report asthma-related hospitalisations (Netuveli 2005). Such differentials may, in part, reflect the failure of existing intervention models to deliver asthma self-management training equitably to children across socio-demographic groups. Given that the school environment offers a platform by which children from all socio-economic backgrounds can receive the same asthma self-management interventions, delivery of asthma self-management interventions at this level could reduce inequalities in self-management. Indeed, schools were previously identified as effective sites for the delivery of asthma self-management interventions because the school environment is commonly associated with learning of new skills. Schools also provide access to large numbers of children with asthma, including those who do not have a general practitioner (GP) and those who do not regularly attend GP appointments. However, 'school age' (usually five to 18 years old) spans a wide spectrum of child development stages and consequently represents different teaching needs and various responses to self-management interventions. Therefore, an understanding of the processes of implementation (and their success) is essential for the development of mechanistic theories of how and why interventions work that can be understood in the context of the child's characteristics.

In planning the current review, we placed strong emphasis on documenting and understanding the different processes that occur during school-based asthma self-management interventions. We envisaged that this approach would help us to understand the different mechanisms involved and would allow future trialists to evaluate the generalisability of processes and outcomes described and measured. The focus on delivery of interventions to help children self-manage their own chronic condition is encouraged by advisory groups to UK policy-makers. They view the integration of health and educational (and social care) services as critical in improving the quality of life of children with chronic conditions such as asthma, and in reducing differentials in outcomes such as school attendance (Lewis 2012). This systematic review draws on a mixed methods approach, looking at different sets of literature that evaluate intervention implementation and effectiveness, and using different methods to combine this literature. This approach will provide a rich account of school-based asthma interventions by examining whether these interventions are effective in changing children's outcomes and by discerning how they effect change.

OBJECTIVES

This review has two primary objectives.

- To identify the intervention features that are aligned with successful intervention implementation.
- To assess effectiveness of school-based interventions provided to improve asthma self-management among children.

We addressed the first objective by performing qualitative comparative analysis (QCA), a synthesis method described in depth later, of process evaluation studies to identify the combination of

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intervention components and processes that are aligned with successful intervention implementation.

We pursued the second objective by undertaking meta-analyses of outcomes reported by outcome evaluation studies. We explored the link between how well an intervention is implemented and its effectiveness by using separate models, as well as by undertaking additional subgroup analyses.

METHODS

Criteria for considering studies for this review

Types of studies

We addressed our first objective (to identify intervention components and processes that are aligned with successful intervention implementation) by exploring process evaluation reports. We pursued the second objective (to assess the effectiveness of school-based interventions for improvement of asthma self-management) by examining outcome evaluation reports (i.e. randomised parallel-group design involving individual or cluster randomisation).

Identifying the intervention components and processes aligned with intervention success in process evaluation studies

In this review, we identified process evaluations as involving systematic measurements to determine the extent to which a particular programme was implemented, in keeping with the guidance described above. Measures of implementation were focused on fidelity and specifically on attrition, adherence, and dosage. To capture the breadth of evidence about implementation, we identified a process evaluation study as (I) a study that was a self-defined "process evaluation"; or (ii) a study that included the elements of a process evaluation as defined in a section of an outcome evaluation; or (iii) a study in which researchers integrated process evaluation data within an outcome evaluation but provided within the results measures around processes that were detailed and extractable. Studies not self-identified as process evaluation studies must have contained (I) an assessment of core components (implementation, mechanisms, context); (ii) clear research questions guiding the process evaluation; and (iii) use of recognised evaluation methods (described by Moore 2015). We also included studies with a focus on the presence/development of school asthma policies (as represented in the logic model (Figure 1)); we expanded this to include studies measuring broader school-level commitment. In this way, use of a logic model explicitly impacted study selection decisions (Kneale 2015).

Previous systematic reviews of process evaluation studies have tended to include only process evaluation studies linked to an outcome evaluation (e.g. Murta 2007). In this review, we have linked included process evaluation studies to randomised controlled trials (RCTs) assessing the effectiveness of the intervention; we have also included trials evaluating the implementation of a variety of study designs, provided they met our other inclusion criteria. This allowed us to use process evaluation data for theory development and testing within a mixed method framework.

Publication date and language

We imposed criteria around the date on which studies were published to help ensure that the content of self-management interventions was broadly reflective of today's recommendations. Recommendations around the management of asthma in the UK were first developed in 1990 on the basis of articles that had appeared in *British Medical Journal* and *Archives of Diseases in Childhood,* from 1989 onwards (British Asthma Guidelines 1997); recommendations were developed in the USA around the same time (National Institute of Health 1997). Therefore, we excluded studies that pre-dated the impetus around development of guidelines for the management of asthma, and we included only studies published from 1995 onwards (corresponding with publication of the first Global Initiative for Asthma (GINA) guidelines, which provided a foundation for asthma guidelines globally). We included only studies published in English.

Types of participants

We included school-aged children and young people (five to 18 years old) with asthma. When the intervention included young people and adults (e.g. when provided in colleges with students 16 to 24 years of age), we intended to include these studies only if most participants were 18 years of age or younger (although we observed no such instance). We also included interventions if they incorporated some components that were delivered to peers, teachers, and/or parents and families, although only when they involved at least partial delivery of the intervention to school-aged participants with asthma within school environments. We included studies reporting on interventions among children and young people with intermittent or mild to severe or persistent asthma.

We did not impose criteria regarding the types of schools that we included in our scope, as long as schools represented the physical location where intervention participants usually received most of their education.

Types of interventions

We included asthma self-management interventions delivered at school. Eligible interventions aimed to develop and enhance self-management of asthma among children by achieving the following.

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- Increasing knowledge of asthma self-management.
- Enhancing self-management skills.
- Improving self-management behaviours and practice.

Eligible interventions must have included the active transfer of information around at least one of the aspects of asthma self-management outlined below. However, we recognise that for asthma self-management to be effective, a combination of these must be incorporated into the interventions.

- Reinforcement of regular monitoring of lung function.
- Emphasis on the importance of self-management practice and behaviour.
- Development of a partnership/alliance between patient and primary care/healthcare practitioners (including school nursing staff) for the management of asthma.
- Instruction on inhaler techniques.
- Reinforcement/provision of an individualised written asthma management plan.
- Emphasis on the importance and appropriate use of reliever therapies such as beta^2 -agonists (BTS 2016).
- Emphasis on the importance and appropriate use of regular preventer therapies such as inhaled corticosteroids and combination inhaled corticosteroid and long-acting beta^2 -agonist therapies (BTS 2016).
- Non-pharmacological self-management strategies focused on avoiding or reducing the risk of experiencing asthma or asthma attacks, including lifestyle and behavioural modifications (as set out in BTS 2016).

Interventions that focused only on treating children's asthma in schools, and not on enhancing self-management skills, were not eligible. For example, interventions that provided directly observed therapy but did not seek to actively improve children's self-management skills inside and outside school were not eligible for inclusion. This included studies in which we determined that most of the self-management component of the intervention had not occurred in the school environment. This led to the omission of some studies that otherwise met the inclusion criteria and have been included in previous reviews (e.g. Halterman 2011; Halterman 2012).

Interventions may focus on improving the climate for asthma self-management within schools, for example, by changing school policies around the way that teaching staff may assist in asthma self-management. However, studies that did not also include the development and evaluation of asthma self-management skills and behaviours among children were not eligible. We included self-management interventions if they fit the definition given in the guidelines produced by the British Thoracic Society/Scottish Intercollegiate Guidelines Network, or in the GINA guidelines (BTS 2016; GINA 2018), as described in the Background section. We excluded studies that concentrated on breathing exercise methods (including yoga interventions) if they did not directly focus on the other aspects of self-management listed above.

The intervention could be provided by a trained educator, nurse (including school, practice, or community nurse), doctor or physician, peer, or social worker, and most delivery or access must have been provided on the premises of the school attended by the children. Interventions for which the school setting was not involved in delivery were not eligible for inclusion.

Comparisons

For outcome evaluation studies, comparison groups were restricted to usual care or to a self-management or health intervention with a focus other than asthma (placebo).

For process evaluation studies, a comparison group could have received another asthma intervention, or the study may not have included a comparison group at all; all process evaluation studies must have included other parameters as described above in terms of study population, study setting, and contents of the asthma intervention.

Types of outcome measures

Outcomes for meta-analyses

Our primary outcomes were based on those identified as indicators of good asthma control (BTS 2016), represented as intermediate outcomes in Figure 1. We were also interested in several secondary outcomes (represented as proximal and intermediate outcomes in Figure 1, as well as a measure of acceptability/implementation in withdrawal from the intervention).

Primary outcomes

- Asthma symptoms or exacerbations leading to admission to hospital (children with one or more admissions or high admission rates)
- Asthma symptoms or exacerbations leading to emergency department visits
- Parent-reported absence from school
- Days of restricted activity

Secondary outcomes

- Unplanned visit to hospital or GP due to asthma symptoms
- Experience of daytime and night-time symptoms (*these were differentiated from 'any' symptomatology by stating that symptoms occurred either in the daytime or at night-time)
- Lung function (e.g. forced expiratory volume in one second (FEV_1) in clinic, peak flow at home)
- Use of reliever therapies such as beta^2 -agonists

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- Corticosteroid dosage and/or use of add-on therapies (e.g. long-acting beta^2 -agonists (LABAs), leukotriene receptor antagonists (LTRAs))
- Health-related quality of life (HRQoL) as measured by a validated questionnaire
- Withdrawal from the study

We extracted data for all points at which the outcomes above were measured and pooled data as appropriate.

Outcomes for qualitative comparative analysis (QCA): defining a successful intervention

Qualitative comparative analysis (QCA) as used in this review and described in further detail below, is a method of evidence synthesis that enables understanding of which configurations of intervention components and processes trigger successful outcomes. QCA is predicated upon set theory, and in this context essentially involves exploring the degree of overlap between a set of successfully implemented studies and a set of studies with a particular range of intervention components and processes.

A first step in our use of QCA was deciding how 'successful' implementation could be identified. Currently, no approach has been established for categorising the implementation of an intervention as 'successful' or 'not successful' (Schellenberg 2012). We began by examining aspects of intervention implementation that were related to intervention fidelity as well as evidence around attrition, dosage, and adherence. A literature review of implementation scoring methods for public health interventions - Schellenberg 2012 - included one study that examined the implementation of a complex intervention that included a school component (Rosecrans 2008). Study authors used the following criteria: "process indictors for which standards were set, such as fidelity (e.g. % of minimum foods stocked) or dose received (e.g. % of family pack cards completed and returned), were assigned to categories of implementation as follows: low (0-49%), moderate (50-74%) or high (75-100%)" (Rosecrans 2008; p75). This 75% threshold also corresponds with the 25% attrition rate that is often incorporated within study sample size calculations for public health trials involving children (Berry 2013; Bruzzese 2011; Clark 1986).

A 75% threshold formed the basis of our coding scheme for the outcome, by which 75% was used as a cross-over point for a 'high' or 'successful' implementation score. Implementation reflected reports of attrition, dosage, and adherence. For each of these indicators, we set values by using a blend of direct and transformational assignment (see Table 1), whereby we assigned values to qualitative data and then calibrated all data using transformational assignment. This blended approach was necessary to combine qualitative and quantitative data. To derive an outcome variable that reflected intervention implementation more holistically, we aggregated the three separate indicators into a single outcome variable by adding each separate value and calibrating the summed score. This outcome value reflected the mainstay of the analyses and distinguished our successfully implemented intervention set.

Search methods for identification of studies

Electronic searches

We searched the Cochrane Airways Group Specialised Register (see Appendix 1) for trials, using the strategy presented in Appendix 2, which was developed by the Cochrane Airways Information Specialist (Liz Stovold). We conducted searches in April 2015 and updated them in April 2016. We conducted further searches on 25 August 2017.

We searched the databases below for process evaluations for our qualitative comparative analyses, using the search criteria identified in Appendix 1, although we modified these criteria to account for the different search syntax/parameters used in additional databases (see Appendix 3, Appendix 4, Appendix 5, Appendix 6, and Appendix 7 for example search strategies).

- Database of Promoting Health Effectiveness Reviews (DoPHER).
- Cochrane Database of Systematic Reviews (CDSR).
- Database of Abstracts of Reviews of Effects (DARE).
- The Campbell Library.
- National Institute for Health Research (NIHR) Health Technology Assessment (HTA) Programme website/journals library.
- Health Technology Assessment (HTA) database.

We applied search strategies to a comprehensive search of the following clinical, public health, psychology, and social care databases from 1995 to the present*.

- Allied and Complementary Medicine Database (AMED)
- Applied Social Sciences Index and Abstracts (ASSIA).
- Bibliomap (EPPI-Centre Database of Health Promotion Research).
- ClinicalTrials.gov
- Cochrane Database of Systematic Reviews (CDSR).
- Cochrane Central Register of Controlled Trials (CENTRAL).
- Cumulative Index to Nursing and Allied Health Literature (CINAHL).
- Excerpta Medica dataBASE (EMBASE)
- Health Management Information Consortium (HMIC).
- International Bibliography of the Social Sciences (IBSS).
- National Health Service Economic Evaluation Database (NHS EED).
- PsychInfo.
- PubMed.
- Sociological Abstracts (SocAbs).
- Social Policy and Practice (SPP).
- Social Services Abstracts

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- Web of Knowledge.

*MEDLINE, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, the Allied and Complementary Medicine Database (AMED), and PsycINFO are included within the Cochrane Airways Group Specialised Register search.

Searching other resources

We handsearched Google Scholar, Social Policy Digest (for content up to 2014), and other sources such as the British Thoracic Society and Asthma UK for further studies.

We initially identified integral process evaluations (sibling studies) through backwards and forwards citation searches. As expected, we identified multiple process evaluations for some intervention studies; our strategy also allowed for inclusion of process evaluations without linkage to a trial included for quantitative analyses.

Data collection and analysis

Selection of studies

We piloted criteria for title and abstract screening on a random subset of studies for which the review authors who were involved in screening (DK, KH) took part in moderation exercises; we resolved disagreements by discussion and developed a shared understanding of the inclusion criteria. We achieved an agreement rate exceeding 90% in three consecutive samples before we proceeded to independent screening (DK, KH). We also employed priority screening (text mining) for independent title and abstract screening (Thomas 2011), after achieving a sufficiently high agreement rate, to locate likely included studies more quickly. However, both review authors (DK, KH) screened all abstracts.

We applied inclusion criteria successively to titles and abstracts, and to full reports. We obtained full-text reports when studies appeared to meet the criteria for title and abstract, or when information was insufficient for a decision. For outcome evaluation studies, screening criteria covered populations (children five to 18 years of age), disease status (asthma), interventions (school-based and focused on self-management), comparators (usual care or placebo), study design (randomised controlled trials or cluster randomised controlled trials), date (publication year after 1995), and language (English language). We entered full-text reports into EPPI-Reviewer and reapplied the inclusion criteria (Thomas 2010); we included studies that met these study design criteria (irrespective of the actual outcomes collected). We developed a similar set of inclusion criteria for process evaluation studies covering populations, disease status, interventions, date, and language; additional criteria stipulated that studies must include the core components expected within a process evaluation and must use structured or recognised tools to collect data.

Data extraction and management

Data management

We uploaded records identified by searches to the specialist systematic review software EPPI-Reviewer 4 for duplicate stripping and screening (Thomas 2010). This software recorded the bibliographic details of each study considered in the review, the origins of all studies (including search strings), and reasons for their inclusion or exclusion. We first extracted all data into EPPI-Reviewer 4 and later exported them, as appropriate, into other software for synthesis (RevMan 2014; StataCorp 2013; Thiem 2013).

Extraction and management of data from process evaluation studies

Process evaluation measures - data selection

Overall approach

The primary aim of exploring process evaluations using QCA was to identify the combinations of components and processes undertaken for interventions that were associated with successful intervention implementation. QCA is based on set theory, and, in this review, we explored the extent of overlap between a set of studies with successful implementation (our process outcome) and sets of studies that share combinations of different intervention components and processes. We presented extracted intervention components and processes (equivalent to antecedents and referred to as conditions from hereon in, in line with QCA terminology) as modifiable design characteristics in the logic model (Figure 1).

Extracting data and building the data table: initial data reduction and assignment of values

Two review authors (DK, KH) independently extracted the conditions (process evaluation measures) of interest from eligible studies. We developed an extensive data table of information supporting over 90 conditions for each study. These data represented quantitative indicators (showing the level of presence of a condition (e.g. the proportion of children from an ethnic minority recruited into an intervention)); binary indicators (representing whether or not a condition was present (e.g. study authors reported that the asthma curriculum contained information on lung physiology)); or qualitative statements (e.g. when study authors published quotes illustrative of child satisfaction with the intervention). In accordance with guidance provided by Rihoux and De Meur (Rihoux 2009), we developed a set of rules for assigning values to conditions (Table 1); these rules reflect a mixture of direct and transformational assignment (we have provided further explanation and an example in Appendix 8).

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Reduction of data on conditions

We extracted more data than any QCA model could support - a problem referred to as 'limited diversity in QCA terminology'. Recognising that many of the conditions extracted were binary indicators of constructs related to the same underlying condition, we implemented cluster analyses of linked items (e.g. elements of the curriculum) to create natural groupings and to reduce the number of conditions included in some models (Thomas 2014). We have displayed original and reduced data for these conditions in Table 2. In addition, we used the logic model presented in Figure 1 to guide our analysis, to rationalise and prioritise the conditions entered into models, and to limit the number of conceptually similar conditions that were entered into models.

Reduction of cases

Although cluster analysis reduced the number of conditions examined, we made the decision to focus on cases (studies) that were coded as providing high- or medium-intensity interventions. We did not explicitly mention this in the protocol (therefore it is reported as a deviation), although this approach is congruent with indicators such as attrition and dosage.

Extraction and management of data from outcome evaluation studies (RCTs)

Outcome measures - data extraction

Two review authors (DK, KH) independently extracted study characteristics and numerical outcome data from studies meeting the eligibility criteria of the review. In agreement meetings, review authors resolved discrepancies by discussion; we encountered no disagreements that needed resolution through arbitration by senior members of the review team. When we encountered missing data, we recorded these instances and contacted study authors for further information.

Assessment of risk of bias in included studies

Assessment of risk of bias in included RCTs

We assessed how the following sources of bias may affect the results of an individual study.

- **Sequence generation:** we deemed that studies that used a computer-generated allocation procedure, a random number table, or other recognised low-risk means were at low risk of bias (as advised by the Cochrane tool for assessing risk of bias). We deemed that studies that used items such as clinic visit date or date of birth when the order of treatment group assignment was predictable or open to external influence were at high risk of bias. We described studies for which we were unable to ascertain methods of randomisation and allocation as having unclear risk of bias. Given the potential impact of socio-economic imbalance between cluster sites within the same study, we also considered whether study authors had stratified socio-economic variables.
- **Allocation concealment:** we deemed that studies for which researchers took measures to prevent disclosure of treatment group assignment, such as off-site allocation or allocation by a third party not involved in the study, were at low risk of bias. For cluster randomised studies, an additional consideration was timing of recruitment into the study in relation to assignment.
- **Blinding (performance bias and detection bias):** we deemed that studies for which investigators took measures to ensure that personnel collecting data were unaware of participants' treatment group assignment were at low risk of bias. However, given the nature of the intervention and the difficulty involved in blinding recipients, a degree of performance bias may have impacted some outcomes, particularly patient-reported outcomes, and this was unavoidable.
- **Handling of missing data and attrition:** we deemed that studies for which data sets were complete, or for which reasons for missing data were not related to treatment, were at low risk of bias. When attrition rates were particularly high or imbalanced and unexplained, and only an available case set was presented, we deemed that the study was at high risk of bias. We deemed that studies for which study authors did not report the attrition rate separately for treatment and control groups, and for which we were unable to determine satisfactorily the reasons for withdrawal, were at high risk of bias.
- **Selective reporting:** we restricted assessments of selective reporting to examination of available data related to outcomes included in the 'Summary of findings' table.
- **Other bias:** we examined baseline imbalances in the characteristics of participants (see also the first point around stratification) for potential bias. We also looked for evidence of contamination between intervention and control groups. We restricted sensitivity analysis to primary outcomes of the review, and we derived overall judgements for each study at the outcome level.

Assessment of risk of bias in included process evaluation studies

We assessed the quality of process evaluation studies using elements of two tools. The first tool was developed at the EPPI-Centre to assess the methodological rigour of 'views' studies that aimed to collect information on people's experiences during trials (Harden 2004). This tool considers seven criteria, including (I) whether the study includes an explicit theoretical framework and/or literature review; (ii) clearly stated aims and objectives; (iii) a clear description of context; (iv) a clear description of the sample and how it was recruited; (v) a clear description of methods used to collect and analyse data; (vi) attempts made to establish the reliability or validity of data analysis; and (vii) inclusion of sufficient

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original data to mediate between evidence and interpretation. The second tool, which was developed by the EPPI-Centre to assess the quality of process evaluation data (O'Mara-Eves 2013), assesses (I) methods of data collection; (ii) process evaluation participants as described; (iii) timing of the process evaluation with respect to the intervention; (iv) process evaluation data collection methods; (v) process evaluation data analysis methods; (vi) whether findings were supported by data; (vii) breadth and depth of findings; (viii) the extent to which the process evaluation gave privilege to the views of participants; (ix) reliability of findings; and (x) usefulness of process evaluation. As some of these domains overlap, we combined elements from both tools to assess the quality of process measures. This strategy also covers the main domains that had been set out in the Cochrane Qualitative Methods Group guidance that was current at the time (Hannes 2011).

Assessment of bias in conducting the systematic review

We conducted the review according to the published protocol (Harris 2015), and we reported deviations from it under Differences between protocol and review.

Measures of treatment effect

Continuous data

We planned to calculate mean differences (MDs) when continuous data were measured by the same scale or unit; however, this did not occur for most outcomes (one MD model had been constructed to explore quality of life as an outcome). Instead, when similar outcomes were measured by different scales or units, we used standardised mean differences (SMDs) (Hedges' (adjusted) *g*).

Dichotomous data

For dichotomous data, we calculated odds ratios (ORs), and, when appropriate, we combined results from different trials.

Ordinal data

We planned to analyse ordinal outcomes (such as quality of life scales) as continuous variables; when appropriate thresholds were identified, we analysed these as dichotomous variables.

Count data

We planned to calculate rate ratios for any count data that we encountered that represented the ratio of events experienced between two groups, such as episodes of hospitalisation or absences from school.

Unit of analysis issues

Cluster randomised studies

We included cluster randomised controlled trials in which schools or classes within schools rather than individuals with asthma were the unit of allocation. As variation in response to treatment between clusters may also be influenced by cluster membership, meaning that cluster members' data can no longer be considered independent of one another, we extracted data when study authors had undertaken analysis that properly adjusted for a clustered design. When study authors provided no intracluster correlation coefficient (ICC), we intended to estimate the ICC and the design effect according to methods recommended in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). No study provided a direct estimate of ICC; however, we selected 0.05 based on the ICC estimate used in one of the included papers to calculate the sample size (McCann 2006). We adjusted effect estimates using methods described in Higgins 2011.

Choice of measurement point

For trials that reported outcomes at multiple time points, such as at post-test with longer follow-up, we extracted all data and combined in meta-analyses the follow-up points most consistently reported among trials.

Dealing with missing data

When study characteristics and numerical outcome data were missing from studies, we contacted study authors to request missing information. For quantitative aspects of process evaluations, such as satisfaction or participation data, we applied the same procedure. Recording of the 'missingness' of qualitative data in the process evaluations that we include is more oblique, although we recorded instances in which investigators indicated that the data collected were not reported upon as part of the quality assessment.

Assessment of heterogeneity

We assessed statistical heterogeneity by using the I^2 measure (Higgins 2003). We explored possible sources of variation by conducting prespecified sensitivity and subgroup analyses and performing meta-regression analyses. These included those set out in the protocol (Harris 2015), as well those that we developed from QCAs.

We intended to construct random-effects multi-variate meta-regression models using STATA, which would allow us to model the impact of different covariates simultaneously after first exploring the impact of these potential effect size study-level moderators in bivariate models. However, a relatively small number of studies (our largest meta-analysis model included 13 studies) meant that

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we were unable to extend the modelling in this way without compromising the underlying assumptions.

Assessment of reporting biases

We recorded the number of studies for which we were not able to ascertain the analysis of data related to our primary outcomes. We also recorded the number of studies for which we were not able to extract process measures, and we assessed the breadth and depth of those studies in terms of information on processes. We selected all process evaluation studies conditionally on addressing process-related research questions, although the core process outcomes included within these did not always match our own selected process outcomes (e.g. some studies addressed different recruitment techniques as a central process of interest, although this focus did not match our own focus).

We plotted the distribution of effect sizes for each (outcome) study against study standard errors as a funnel plot for primary outcomes and based our assessment of publication bias on visual inspection (if 10 or more studies contributed to the outcome); we also undertook formal tests for small-study publication bias using Egger's test (Harbord 2009).

Data synthesis

Data synthesis - adopting a mixed methods approach

In the first strand of analyses, we explored which intervention features (components and processes) are associated with successful implementation of an intervention. This first strand involved undertaking qualitative comparative analysis (QCA) to uncover which configurations of these features (known as 'conditions' in QCA terminology) are aligned with successful intervention implementation. The QCA served to generate hypotheses about the importance of different intervention components and processes that were tested in meta-analyses (below). Conditions identified through QCA helped us to identify which conditions matter for implementing an intervention, and structuring the meta-analysis helped us to identify their potential impact on the overall effectiveness of interventions. The possibility that hypotheses were generated and tested on the same dataset was avoided due to very little overlap between studies included in the QCA synthesis and studies included in the meta-analyses.

To examine the effectiveness of school-based asthma self-management interventions in improving children's outcomes, we undertook meta-analyses. We performed subgroup analyses based upon results of the QCA described above.

We undertook the synthesis of process evaluations performed before the RCTs were conducted to remain blinded to the possible impact of specific measures. We further examined the link between implementation and effectiveness by estimating whether interventions defined as 'successful' in terms of their implementation were those with greater effect sizes. These analyses focused on a subgroup of studies adopting diverse designs (as outlined below).

Data synthesis part 1 - using process evaluation studies for qualitative comparative analysis (QCA) of determinant conditions for successful intervention implementation

Qualitative comparative analysis (QCA) is used to identify configurations of conditions associated with successful intervention implementation. QCA takes a study-based approach (accounting for several of the study's observed characteristics simultaneously) rather than a variable-based approach, so that the focus is on different configurations of conditions (Thomas 2014). As this approach is relatively novel to systematic reviews, we have provided further information on the underlying principles and operationalisation of the approach in Appendix 8. The QCA approach used here aimed to generate theories about components 'sufficient' for triggering successful implementation; 'sufficient' relationships signify that an outcome is triggered in the presence of a sufficient condition or a sufficient condition set, but that other pathways to triggering the outcome may also exist. Here the outcome is successful implementation, and conditions are intervention characteristics and processes. In analysing our data, we followed the steps laid out by others (Ragin 2009; Thomas 2014).

- We began by operationalising our data and creating a set of rules on how data should be coded for creating a data table of intervention characteristics (known as 'conditions' in QCA terminology) and the extent to which an intervention was successfully implemented (the outcome in this case). In the section titled Secondary outcomes, we have described the way in which we derived our outcome variable, and in the section titled Data extraction and management, we have described our coding framework for other intervention characteristics of interest. Two review authors (DK, KH) coded data for each study and grouped the information into separate data tables reflecting different domains of an intervention (i.e. conditions): setting and participants (Table 3); recruitment and retention processes (Table 4); curriculum and pedagogical factors (Table 5); modifiable intervention design features (Table 5); and stakeholder involvement (Table 6). We adopted this strategy to avoid 'limited diversity', whereby too many possible combinations of intervention characteristics are unsupported by observed studies.
- We constructed truth tables that move beyond examining individual studies (i.e. one row per study) to examining configurations of conditions. Configurations could be supported by no studies, one study, or multiple studies. Truth tables also show the extent to which a 'set' of studies belonging to a configuration overlap with the outcome set.
- We checked the quality of the truth tables. For each truth table, we considered whether a spread of positive and negative outcomes was triggered; whether configurations were supported by (multiple) cases (especially for configurations triggering a successful outcome); whether some configurations were

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counterintuitive and whether some conditions showed identical patterns; and whether some conditions occurred too infrequently. Our most important check involved whether we observed contradictory configurations when evidence suggested that configurations triggered positive and negative outcomes. When we were unable to resolve these issues according to guidance provided in Thomas 2014, the analysis progressed no further (see Appendix 8).

- We then implemented Boolean minimisation to identify the most logically simple expression of a 'pathway' to a successful outcome. A pathway in this case represents a configuration of conditions that is observed to sufficiently trigger an outcome. This solution is based on observed configurations of conditions only and is known as a 'complex solution'.
- When we detected logical remainders, we incorporated these into further models as 'intermediate solutions' to simplify the solution and maintain its theoretical coherence (see Appendix 8). For intermediate solutions, review authors (DK, KH) set expectations on whether the conditions entered were likely to lead to success.
- A sixth stage involved interpretation, when review authors considered the plausibility of the solution and determined whether conclusions were consistent with evidence obtained from individual cases. We constructed a consolidated model, using evidence from preceding models. We checked the quality of the overall solution to ensure that it did not trigger negation of the outcome; we also assessed the parameters of fit and the validity of simplifying assumptions.

We constructed all QCA models using R and a package developed by Thiem and Dusa (Thiem 2013). We have outlined further details of all steps, as well as the background to the method, in Appendix 8.

Data synthesis part 2 - using RCTs for meta-analyses of effectiveness

We combined data in Review Manager 5.3 (RevMan 2014), and we conducted some analyses and data transformations in STATA (when we encountered cluster randomised trials, we converted our standard errors using EPPI-Reviewer functions (Thomas 2010)). We expected outcomes to be reported as similar units of analysis, although we encountered several variations and used Chinn's formulae for converting effect sizes and standard errors between SMDs and ORs (Chinn 2000), according to direction provided in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). In addition, although we had originally specified daytime and night-time symptoms as a single outcome, we split this into two separate outcomes to maintain conceptual coherence. Occasionally, we could not incorporate some data into the meta-analyses because of methodological difficulties in combining these data (including data based on rank (e.g. median)). Other changes and forms of imputation for missingness included the following: (I) basing the effect size for quality of life from Al-Sheyab 2012 on the P value because of uncertainty regarding the effect size derived from point estimates and the precision provided; (ii) basing effect sizes for Cicutto 2013 on approximations of the numbers of participants in control and treatment groups; and (iii) estimating the numbers in treatment and control arms for Clark 2005 (assuming equal distribution of the overall sample size); we also imputed an OR of 0.996 for a value reported as 1.00 for Clark 2005 for ED visits, so we could combine the information from different models.

Data synthesis part 3: adjunct meta-analyses exploring the link between implementation and effectiveness of school-based asthma self-management interventions

Methods used by review authors for the adjunct meta-analyses followed the same processes as were used for the main meta-analysis (part 2) in terms of the approaches taken in extracting effect sizes and combining data. The difference between analyses is that results of part 3 are based both on RCTs included in the main analyses (part 2) and on studies included in part 1 that allow for calculation of an effect size for school absences and/or emergency department visits. All studies included here must have included a control group and must have allowed for calculation of successful implementation, which we defined in the same way as our QCA analysis (part 2), and represented a combined indicator around attrition, adherence, and dosage.

Rating the certainty of the evidence

The certainty of evidence rating reflects the extent to which we can be confident that results for review outcomes reflect the true effect (Guyatt 2008). We rated the certainty of evidence for our main outcomes using methods developed by the GRADE (Grades of Recommendation, Assessment, Development and Evaluation) Working Group (http://www.gradeworkinggroup.org/publications/JCE_series.htm). We considered the possible impact of each of the following factors on our outcomes of interest.

- Risk of bias.
- Imprecision.
- Inconsistency.
- Indirectness.
- Publication bias.

We attempted to identify a representative control group risk to illustrate the effects of our meta-analysis results in absolute terms. We tabulated GRADE ratings alongside absolute and relative effects in a 'Summary of findings' (SoF) table for the following outcomes.

- Asthma symptoms or exacerbations leading to admission to hospital.
- Asthma symptoms or exacerbations leading to emergency department (ED) visits.

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- Unplanned visit to hospital or GP due to asthma symptoms.
- School absence.
- Experience of daytime symptoms.
- Use of reliever therapies such as beta^2 -agonists.
- (Health-related) quality of life.

We generated the SoF table using the GRADE Guideline Development tool (GDT). We have described elsewhere further analyses undertaken to explore heterogeneity in effect size.

Subgroup analysis and investigation of heterogeneity

We conducted a statistical test for heterogeneity across subgroups using an I^2 statistic. We planned to construct a multi-variate meta-regression model based on our results for different outcomes. However, the small number of included studies precluded this possibility. We undertook prespecified subgroup analyses to investigate heterogeneity on the basis of the following characteristics, which are represented in our logic model as child-level, school-level, and contextual moderators, as well as modifiable design characteristics of the intervention itself, which we identified on the basis of QCA.

- Setting: elementary/primary school versus secondary/high school.
- Age: five to 10 years; 11 to 15 years; 16 years and older.
- Socio-economic level: low or mixed/high/unclear.
- Delivery of intervention: healthcare provider (e.g. health educator, school nurse, other healthcare professional) versus other professional (e.g. teacher, mixture) versus other model of delivery (e.g. peer led).
- Other (prespecified): intervention moderators developed from hypotheses generated through syntheses of process evaluation data including whether the intervention was theory driven, whether parents were actively involved, and the timing of the intervention during the school day. We entered these as single conditions and as groups reflecting configurations.

We measured some indicators, such as socio-economic status, very differently, and we used broad groupings based on income, social class, or other indicators of social position, such as having received means tested benefits.

Sensitivity analysis

We undertook sensitivity analyses on the basis of the following.

- Risk of bias assessment: we included all studies in the primary analysis and restricted included studies to those that were not classed as having high risk of bias for any single domain.
- Fixed-effect modelling.
- Exclusion of cluster study data from outcomes (originally intended when external or imputed ICCs had been used, although this applied to most included cluster RCTs).

We did not plan to apply an equivalent for QCA modelling, although we did conduct robustness checks, including whether solutions predicted negation of the outcome.
We had intended to run sensitivity analyses based on the severity of children's asthma; however, no intervention specifically targeted children at particular levels of asthma severity, and inconsistent and low levels of reporting of asthma severity meant that we did not conduct these analyses. We have reported elsewhere other deviations from the protocol.

RESULTS

Description of studies

We have reported the characteristics of all included studies in the Characteristics of included studies section; Table 7 presents an additional summary of how process evaluations met the review inclusion criteria.

Results of the search

We performed the first search in April 2015, and an updated search in April 2016. We conducted further searches on 25 August 2017. Two members of the review team (KH, DK) conducted the searches for process evaluation studies (see Figure 2). The Cochrane Airways Information Specialist, Liz Stovold, conducted the searches for outcome evaluation studies (see Figure 3). Review team members (KH, DK) performed initial automated checks for duplication using EPPI-Reviewer software during the data screening and extraction process. After de-duplication, we (KH, DK) screened 29,384 titles and abstracts of potential process evaluation studies, facilitated by text mining, as well as 350 title and abstracts for eligibility as outcome evaluations. Following application of inclusion criteria to review of titles and abstracts, KH and DK independently assessed the remaining 1066 full-text process evaluation records and 105 full-text outcome evaluation records for eligibility for inclusion. We included 54 papers, from 33 different studies, for further analysis as process evaluation studies, and 44 papers, from 33 different studies, for further analysis as outcome evaluation studies.

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Figure 2. Process evaluation study flow diagram.

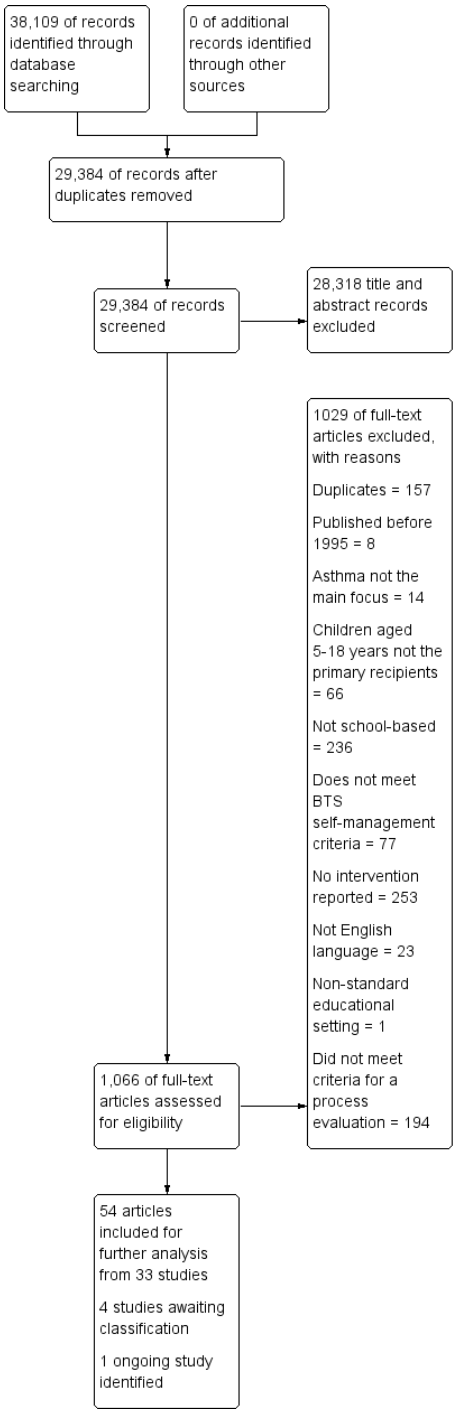

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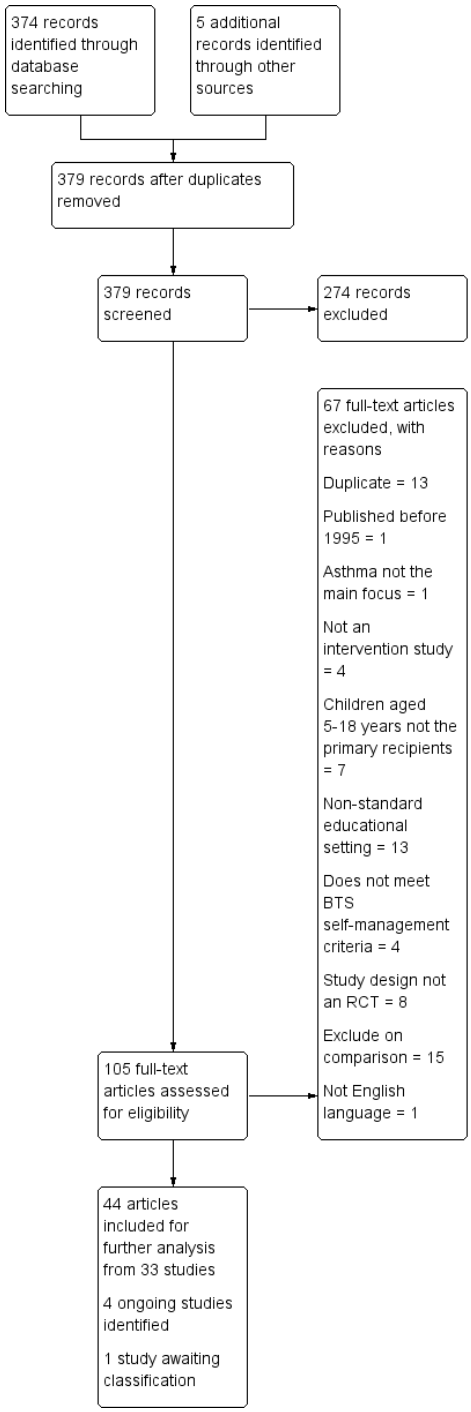
Figure 3. Outcome evaluation study flow diagram.



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We identified several potential additional sources as ongoing studies (n = 4; see Characteristics of ongoing studies) and other studies as awaiting classification (n = 5; see Characteristics of studies awaiting classification).

Included studies

We included in the review 33 process evaluation studies and 33 outcome evaluation studies that met the inclusion criteria. We have described the characteristics of process and outcome evaluation studies separately below. We noted little overlap between the 33 studies included in both sets of studies, with Bruzzese 2004, Bruzzese 2008, Bruzzese 2011, Cicutto 2013, Gerald 2006, Henry 2004, Horner 2015, Howell 2005, Levy 2006, McCann 2006, and Splett 2006 (11/33) common to both sets of studies, although Bruzzese 2004 and McCann 2006 did not contribute data to the meta-analyses.

Characteristics of process evaluation studies

Study population and intervention characteristics

Process evaluations of asthma self-management interventions in schools reported on a diversity of intervention models. Nine studies included evaluations of the effectiveness of Open Airways for Schools (OAS) (American Lung Association 2018), or modifications to this programme (see Table 8). OAS consists of six 40-minute sessions, aimed at groups of children aged eight to 11 who learn about different topics including general information about asthma, how to recognise and manage asthma symptoms, and problem-solving and decision-making about asthma medication. Authors of process evaluation studies described other intervention models (e.g. PowerBreathing (Berg 2004); Staying Healthy-Asthma Responsible and Prepared (SHARP; Kintner 2012); Asthma Self-Management for Adolescents (ASMA; Bruzzese 2004; Bruzzese 2008)), although these were diffuse across studies and were common to no more than two included studies.

Across all studies, investigators taught a diverse curriculum. Although most studies mentioned that the intervention involved developing knowledge and skills around asthma physiology and monitoring and treatment of symptoms, fewer included studies explicitly mentioned that investigators aimed to develop alliances between children/parents and their care provider(s) (Dore-Stites 2007; Gerald 2006; Richmond 2011; Terpstra 2012), and a greater number did involve parents in the intervention in other ways. Most interventions were reliant on trialists, research staff, and others from outside schools to deliver the intervention, although some interventions were primarily delivered, or supported pivotally, by school nurses (Engelke 2013; Langenfeld 2010; Levy 2006; Magzamen 2008; Splett 2006), teachers (Henry 2004; Mujuru 2011; Pike 2011), or children's peers (Magzamen 2008).

Several studies explicitly drew on social cognitive theory (Bruzzese 2008; Bruzzese 2011; Cicutto 2013; Terpstra 2012). Two studies from the same research team drew upon the Health Belief Model (Joseph 2010; Joseph 2013). Other theoretical models featured in only a single study included self-regulation theory (Bruzzese 2004), learning or social learning theory (Berg 2004; Howell 2005), Piaget's pedagogical theory (Crane 2014), Orem's self-care deficit theory (Kouba 2012), attribution theory (Joseph 2013), miscellaneous theoretical concepts that contributed to a theoretical framework (Al-Sheyab 2012a), biopsychosocial theory (Dore-Stites 2007), a transtheoretical model (Joseph 2010), and a functional context model (Lee 2011). A small minority of studies named a theoretical framework that was specific to asthma, with Horner 2015 employing Bruhn's theoretical model of asthma self-management to underpin an intervention (Bruhn 1983), and Kintner 2012 drawing upon an asthma acceptance model (alongside a life course development perspective). These theoretical frameworks also differed in their use and in whether they supported the premise and emphasis of the intervention in a holistic manner, or whether they supported a particular pedagogical technique that was favoured in delivery of the intervention; this distinction was not clear in some studies. Few studies presented a clear logic model or theory of change to describe the underlying conceptual framework (Kneale 2015).

Five studies evaluated implementation of interventions involving delivery of self-management education in part or mainly through electronic games or training provided through computers (Dore-Stites 2007; Howell 2005; Joseph 2010; Joseph 2013; Kouba 2012). In two of these interventions (Joseph 2010; Joseph 2013), the information provided was tailored to children based on their input. In total, nine interventions had components that tailored content towards the needs of an individual child through delivery on a one-to-one basis or through delivery of personalised content (Bruzzese 2004; Bruzzese 2008; Howell 2005; Joseph 2010; Joseph 2013; Langenfeld 2010; Spencer 2000; Splett 2006).

Most studies took place in the USA (29/33 studies); several of these US-based studies explicitly mentioned that the intervention took place in an urban or inner city area, or explicitly made reference to the diverse socio-economic or ethnic background of participants (Berg 2004; Bignall 2015; Brasler 2006; Bruzzese 2004; Bruzzese 2010; Bruzzese 2011; Gerald 2006; Joseph 2010; Joseph 2013; Kouba 2012; Levy 2006; Magzamen 2008; Mickel 2016; Pike 2011; Richmond 2011; Splett 2006); in contrast, just two studies specifically explored implementation in rural areas (Horner 2015; Mujuru 2011). Fewer studies took place in high schools (14 studies) than in junior, middle, or elementary/primary schools (see Table 9).

Time of assessment of process outcome measurements

Twenty-one process evaluation studies collected pre- and post-hoc data. Four studies collected post-hoc data only (Al-Sheyab 2012a; Berg 2004; Bruzzese 2004; Richmond 2011). Several studies collected data immediately after the intervention or within three months of cessation of the intervention (Bignall 2015;

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Bruzzese 2004; Bruzzese 2008; Carpenter 2016; Crane 2014; Gerald 2006; Howell 2005; Jackson 2006; Kintner 2012; Kouba 2012; Magzamen 2008; Mickel 2016; Mujuru 2011; Pike 2011; Spencer 2000; Splett 2006). The longest follow-up data collection period lasted for 12 months post testing (Bruzzese 2011; Cicutto 2013; Horner 2015; Joseph 2010; Joseph 2013; McCann 2006). In a small number of studies, the follow-up duration was unclear (Al-Sheyab 2012a; Dore-Stites 2007; Engelke 2013; Langenfeld 2010; Levy 2006; Richmond 2011; Terpstra 2012).

Measurement of process outcomes

We included 33 process evaluation studies, most of which adopted a quantitative approach to analyses. Process evaluation elements across these studies included thematic analysis of student perceptions, identification of implementation challenges and facilitators, reach of the intervention, and student satisfaction. We have provided further details of inclusion criteria and process evaluation elements for all process evaluation studies in Table 7 The descriptions below refer to all studies included as process evaluation studies, although we included in QCAs only those that we deemed to be of moderate or high intensity (see section on reduction of cases). Similarly, we transformed the data and ratings described below using direct and indirect transformations (see earlier methods).

Attrition

A total of 18 studies provided evidence that attrition was low. Five studies showed substantial attrition (Bruzzese 2004; Gerald 2006; Levy 2006; Magzamen 2008; Richmond 2011), with levels of attrition exceeding 20% and/or reported by trial authors as a substantial challenge.

Adherence to the intervention

A total of 21 studies reported child adherence. 'Child adherence' broadly referred to the extent to which children followed directions of the intervention, for example, in completing homework assignments, undertaking and completing intervention modules, or completing evaluation instruments. Fourteen studies presented evidence that child adherence with the intervention was good. Six studies highlighted evidence that adherence was not problematic among other stakeholders (Bruzzese 2011; Cicutto 2013; Jackson 2006; Joseph 2013; Kintner 2012; Splett 2006). Child adherence was problematic in eight studies (Brasler 2006; Gerald 2006; Howell 2005; Joseph 2010; Kouba 2012; Magzamen 2008; Richmond 2011; Spencer 2000); these judgements were based on reports from trialists and on reports of completion rates of intervention modules and/or completion of evaluation instruments.

Dosage of intervention received

'Dosage' broadly referred to the extent to which children received the intervention as intended, for example, in attending the expected number of sessions. This differed from attrition, in that children could have received a low dosage but may have not permanently dropped out; this also differed from adherence, in that children could have received a low dosage but were otherwise adherent. Participants received the intended dose of the intervention in nine studies (Bignall 2015; Bruzzese 2011; Jackson 2006; Joseph 2013; Kintner 2012; McCann 2006; Mickel 2016; Pike 2011; Terpstra 2012). In one study, researchers noted a dose-response relationship (Kouba 2012). Seven studies reported that the intended dose was not achieved (Brasler 2006; Bruzzese 2008; Gerald 2006; Howell 2005; Joseph 2010; Langenfeld 2010; Magzamen 2008), with substantial numbers not receiving the intended intervention. In one study (Gerald 2006), this finding was based on reports of shortening of sessions. In another study, in which parental involvement was an integral component, study authors reported additional problems with dosage received (Bruzzese 2008). One study comparing an individualised intervention model versus a generic intervention model reported that the individualised model had higher levels of dosage, although both models showed relatively low levels of completion of all modules (Joseph 2010).

Combined indicator of 'successful' implementation

We combined data from process evaluation studies on attrition, adherence, and dosage into a single indicator. We summed scores across the three indicators and calibrated them to fall between zero and one, with 0.5 the point of maximum ambiguity and values over 0.5 indicating partial membership of the successful implementation set, up to a maximum possible value of one, which indicated full membership of the successful implementation set, values under 0.5 indicating more out of than in the set, and a value of 0 indicating full non-membership of the successful implementation set. Eight studies were either fully or strongly within the successful implementation set (Al-Sheyab 2012a; Berg 2004; Bruzzese 2008; Bruzzese 2011; Henry 2004; Joseph 2013; Kintner 2012; Terpstra 2012), and another five studies had scores that were mainly within the successful implementation set (Cicutto 2013; Dore-Stites 2007; Horner 2015; Mujuru 2011; Pike 2011). A further 14 studies provided scores that were ambiguous or low implementation scores (Brasler 2006; Bruzzese 2004; Crane 2014; Engelke 2013; Howell 2005; Gerald 2006; Joseph 2010; Kouba 2012; Langenfeld 2010; Lee 2011; Levy 2006; Magzamen 2008; Spencer 2000; Splett 2006).

Characteristics of outcome evaluation studies (RCTs)

We have included in Table 10 further details of studies that met the criteria for study design, but from which we did not include data in the meta-analysis.

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Study population and intervention characteristics

Most studies took place in the USA (22/33 studies), with fewer taking place in high schools (eight studies) than in junior, middle, or elementary/primary schools (see Table 11). Study reports showed substantial variation in the types of interventions that were trialled, although nine studies included evaluations of the effectiveness of Open Airways for School, or modifications to this programme (see Table 12). Study reports also showed substantial variety in the ways in which asthma self-management interventions were delivered. Children received long programmes of sessions in some interventions, with 16 sessions delivered in two studies (Horner 2008; Horner 2015), and 10 sessions and eight sessions delivered in others (Kintner 2009; Patterson 2005, respectively). In contrast, researchers delivered three interventions in a single group session to children (Gerald 2006; Howell 2005; McCann 2006), although these interventions were supported by other activities including nurse visits or staff training. The number of sessions was not always commensurate with the quantity of content delivered however; for example, the intervention delivered in Atherly 2009 amounted to 4.5 hours of instruction over three sessions, and Horner 2015 delivered 4 hours of content over 16 sessions.

Several studies collected outcome data immediately after the intervention or within three months (Atherly 2009; Bruzzese 2004; Bruzzese 2008; Gerald 2006; Horner 2008; Howell 2005; Kintner 2009; Mosnaim 2011; Patterson 2005; Persaud 1996; Shah 2001; Srof 2012), or they appeared to collect data concurrently with intervention delivery (Splett 2006). The longest period between the end of the intervention and data collection was 36 months in Bartholomew 2006, and 24 months in Clark 2004 and Clark 2010, although for a minority of studies, the length of follow-up was not clear (Levy 2006; Monforte 2012; Pulcini 2007). We included many studies on the basis of study design, although these studies did not contribute to the meta-analyses, as they did not collect data on the outcomes of interest or did not collect these data in an extractable format (see Table 10).

Primary outcomes

Asthma symptoms or exacerbations leading to admission to hospital

Six outcome studies provided data on asthma exacerbations leading to admission to hospital that were combined in meta-analyses (Atherly 2009; Bruzzese 2011; Clark 2005; Horner 2008; Horner 2015; Levy 2006). One study collected information on hospitalisations but did not disaggregate the information by treatment status (Bartholomew 2006), and another study provided disaggregated information on median hospitalisations that could not be combined in meta-analyses (Gerald 2006). Two studies assessed hospitalisations using hospital or school medical records (Gerald 2006; Levy 2006); three studies assessed hospitalisations using parent reports (Clark 2005; Horner 2015; Horner 2008); and two studies used child reports (Atherly 2009; Bruzzese 2011). Of the six studies included in the meta-analyses, most collected outcome data on hospitalisations after a substantial period between receipt of the intervention and assessment of the outcome had elapsed (12 months in the case of Bruzzese 2011; Clark 2005; and Horner 2015; and seven months in the case of Horner 2008); less time had elapsed in the case of Atherly 2009 and Levy 2006, in which assessment took place within three months of receipt of the intervention. Studies in which a longer time had elapsed between intervention and assessment tended to be those with a longer exposure time over which the outcome was measured.

Asthma symptoms or exacerbations leading to emergency department visits

Fifteen outcome evaluation studies collected data on asthma symptoms or exacerbations leading to an emergency department (ED) visit (Atherly 2009; Bartholomew 2006; Bruzzese 2011; Cicutto 2005; Cicutto 2013; Clark 2005; Gerald 2006; Horner 2008; Horner 2015; Howell 2005; Levy 2006; McGhan 2003; McGhan 2010; Persaud 1996; Velsor-Friedrich 2005). However, we did not use data from Bartholomew 2006 because study authors did not disaggregate the data by treatment status, and we could not combine data from Gerald 2006 because of incompatibility in the unit of assessment. Three studies used school or hospital administrative records to assess ED visits, with records provided by the medical hospital (Gerald 2006; Levy 2006; Persaud 1996). Parents were frequently the sources of ED data: one study collected these data using tracking sheets of ED attendance provided by parents (Cicutto 2013); another study collected data through parent interviews (Cicutto 2005); six studies used various parent self-completion questionnaires (Clark 2005; Horner 2015; Horner 2008; Howell 2005; McGhan 2003; McGhan 2010), and one specifically used the Usherwood symptom questionnaire (Bartholomew 2006). One study collected data from children's asthma diaries (Velsor-Friedrich 2005), and others collected data from children's reports (Atherly 2009; Bruzzese 2011).

Of the 13 studies included in the meta-analyses, most collected outcome data on ED visits after a substantial period had elapsed between receipt of the intervention and assessment of the outcome (12 months in the case of Bruzzese 2011, Cicutto 2005, Cicutto 2013, Clark 2005, Horner 2015, McGhan 2003, McGhan 2010; seven months in the case of Horner 2008; and 20 weeks in the case of Persaud 1996); less time had elapsed in the case of Atherly 2009, Howell 2005, and Levy 2006, which performed assessment within three months of receipt of the intervention. As was the case above, studies in which a longer time had elapsed between intervention and assessment were those with a longer exposure time over which the outcome was measured (see Table 11 for full details).

Absence from school

Twelve outcome evaluation studies assessed school absence or attendance (Bartholomew 2006; Bruzzese 2011; Cicutto 2005;

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Cicutto 2013; Clark 2004; Gerald 2006; Gerald 2009; Howell 2005; McGhan 2003; McGhan 2010; Persaud 1996; Splett 2006). Four studies used administrative school records (Bartholomew 2006; Gerald 2006; Persaud 1996; Splett 2006). One study collected school absenteeism data from parents/guardians using tracking sheets (Cicutto 2013), and five studies used parental interviews or questionnaires (Cicutto 2013; Clark 2004; Howell 2005; McGhan 2003; McGhan 2010). In another study, school staff entered absence data into an intervention tracking system (Gerald 2009). Bruzzese 2011 was the only study that collected self-reported absence data directly from children.

Bartholomew 2006 did not present disaggregated information, and we will not consider this study further here. Clark 2004 presented information on effectiveness of the intervention in terms of school absence in the form of a risk difference, which was not combined in the meta-analyses, although researchers showed a significant intervention effect in reducing absences at three months and 12 months.

We included data from 10 studies in meta-analysis models. Six of these studies considered long-term impact of the intervention, with follow-up data from nine months or longer collected and included in the meta-analysis (Bruzzese 2011; Cicutto 2005; Cicutto 2013; Gerald 2009; McGhan 2003; McGhan 2010). However, three studies collected follow-up data after three months or sooner (Persaud 1996; Howell 2005; Splett 2006), and one study provided unclear information on this (Gerald 2006). Differences in the exposure period over which absences were considered ranged from a year in three studies - as in Cicutto 2005, Cicutto 2013, and McGhan 2010 - to two weeks in one study - as in Bruzzese 2011. Three studies considered any instance of recorded absence from school (Cicutto 2013; McGhan 2003; McGhan 2010), and the remaining seven studies measured mean number of days of absence or attendance at school. Most studies included in the meta-analysis collected data on any form of absence, with only Gerald 2009 collecting data on absence related to asthma/respiratory illness.

Days of restricted activity

Three outcome evaluation studies reported days of restricted activity (Bruzzese 2011; Cicutto 2005; Cicutto 2013). One study used parent tracking sheets/diaries to record days of interrupted activity due to asthma (Cicutto 2013), another study used data from parent interviews (Cicutto 2005), and another study collected information directly from children (Bruzzese 2011). We included data from all three studies in the meta-analyses, and all three studies collected data at 12 months' follow-up. Two studies collected data on the mean number of days of restricted activity (Bruzzese 2011; Cicutto 2005), and Cicutto 2013 collected data on any instance of a day of restricted activity.

Secondary outcomes

Unplanned visit to a hospital or GP due to asthma symptoms

Five outcome evaluation studies reported on unplanned visits to a hospital or GP due to asthma symptoms (Bruzzese 2011; Cicutto 2013; McGhan 2003; McGhan 2010; Splett 2006). One study recorded unplanned visits using tracking sheets provided to parents (Cicutto 2013); two studies used a parental questionnaire (McGhan 2003; McGhan 2010); one study collected data directly from children (Bruzzese 2011); and a final study collected information on episodic asthma-related visits to a school-based health facility from administrative data (Splett 2006).

We included data from all five studies in the meta-analyses. One study originally collected information on the mean number of unscheduled visits (Bruzzese 2011), and the remaining studies collected information on any instances of unscheduled visits to a medical provider (not captured in hospitalisation or ED utilisation data (above)). All studies collected data after substantial time had elapsed since the intervention began; this extended to nine to 12 months in four studies (Bruzzese 2011; Cicutto 2013; McGhan 2003; McGhan 2010), and in Splett 2006, longitudinal data collection occurred concurrently alongside delivery of the intervention over a period of six months.

Experience of daytime and night-time symptoms

Nine outcome evaluation studies assessed children's experiences of daytime and night-time symptoms (Atherly 2009; Bruzzese 2008; Bruzzese 2011; Clark 2004; Clark 2010; Howell 2005; McGhan 2003; Shah 2001; Velsor-Friedrich 2005). These studies specifically reported on symptoms occurring during the day or during the night. Data were not combined in meta-analyses for either Clark 2004 or Clark 2010. Clark 2004 collected data on daytime and night-time symptoms as a risk difference, which indicated that the intervention had a positive effect in reducing daytime symptoms for all children but reduced the incidence of night-time symptoms only for children with severe or persistent asthma (yielding a negative effect on night-time symptoms for children with mild asthma). We did not include this in the meta-analyses as it was incompatible with other units of analysis. Meanwhile, Clark 2010 collected information on a *change* in daytime symptoms, which indicated that the intervention had a positive, but non-statistically significant, impact in terms of a drop in daytime symptoms (an effect size was extractable for one of the treatment arms only, although it was not used in meta-analyses because of statistical and conceptual differences between post-test data and changes in post-test outcome data).

Among the seven studies included in the meta-analysis, five studies reported on the incidence of daytime symptoms (Atherly 2009; Bruzzese 2008; Bruzzese 2011; Shah 2001; Velsor-Friedrich 2005), and in the case of Shah 2001, researchers reported the incidence of daytime symptoms specifically occurring within school; four studies reported on night-time awakenings (Bruzzese 2008; Bruzzese 2011; Howell 2005; McGhan 2003), with two studies reporting on both daytime and night-time symptoms (Bruzzese

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2008; Bruzzese 2011). Four studies reported on intervention effects six to 12 months after the intervention (Bruzzese 2011; McGhan 2003; Shah 2001; Velsor-Friedrich 2005), and the remaining three studies included in the meta-analyses information collected from children or parents two to three months post intervention. Similarly, data show a relatively even split between studies reporting on the mean level of asthma symptoms occurring in the daytime/at night-time - Atherly 2009, Bruzzese 2008, Bruzzese 2011, Howell 2005 - and those focused on measuring any reported incidence of daytime/night-time symptoms - McGhan 2003, Shah 2001, and Velsor-Friedrich 2005.

Lung function

Five outcome evaluation studies assessed lung function (Gerald 2009; Horner 2015; Patterson 2005; Shah 2001; Velsor-Friedrich 2005), although studies measured this in different ways. One study assessed lung function using the peak expiratory flow rate (PEFR) and specifically focused on the occurrence of poor readings (red and yellow readings defined as less than 80% of best value) (Gerald 2009). A second study measured spirometry by measuring the percentage predicted change in forced expiratory volume in one second (FEV_1) (Patterson 2005). Shah 2001 reported forced vital capacity (FVC) before use of a bronchodilator. Velsor-Friedrich 2005 measured peak flow increases as a percentage of pretest peak (i.e. change in peak flow); Horner 2015 measured airway inflammation by measuring exhaled nitric oxide as a biomarker of airway inflammation.

Because of conceptual differences in the outcomes collected, we did not combine these in meta-analyses. Table 13 shows that the individual effects extracted exhibited considerable heterogeneity in the direction and magnitude of effect, confirming that meta-analysis was not desirable due to statistical heterogeneity.

Use of reliever therapies such as beta$_2$-agonists

Four outcome evaluation studies assessed use of reliever therapies (Gerald 2009; McGhan 2003; McGhan 2010; Splett 2006). We combined in meta-analyses two studies that reported on the use of rescue medication and short-acting bronchodilators (SABAs), respectively (Gerald 2009; McGhan 2010). The former captured information on instances when rescue medication was used more than twice a week, and the latter measured any instance in which rescue medication was used; these studies sought to measure long-term intervention effects at 12 months - as in McGhan 2010 - and at 15 months - as in Gerald 2009. The remaining two studies measured appropriate use of reliever medication and access to reliever medication, respectively (McGhan 2003; Splett 2006). Because of conceptual differences in the way in which researchers measured use of reliever therapies, we chose not to meta-analyse this information. We have presented information provided by all four studies in Table 13.

Corticosteroid dosage and/or use of add-on therapies

Six studies measured corticosteroid usage and dosage (Bruzzese 2011; Horner 2015; Howell 2005; McGhan 2003; McGhan 2010; Splett 2006). One study measured whether children had access to controller medication while visiting the school health office (Splett 2006). Two studies measured whether children were adhering to guidance provided around the correct use of corticosteroid (Horner 2015; Howell 2005), and three studies measured any reported usage of corticosteroid or controller medication (Bruzzese 2011; McGhan 2003; McGhan 2010). We meta-analysed data from these five studies separately, as adherence was deemed to conceptually differ from reports of usage. Horner 2015 and Howell 2005 included information from children at five months and three months, respectively, in meta-analyses of corticosteroid adherence. All three studies in the second meta-analysis on reported instances of corticosteroid or controller medication usage collected information at nine months or 12 months post intervention. We have presented data from all six studies in Table 13.

Health-related quality of life (HRQoL)

Twelve outcome evaluation studies measured quality of life (Al-Sheyab 2012; Cicutto 2005; Cicutto 2013; Clark 2010; Henry 2004; Horner 2008; Howell 2005; Kintner 2009; McCann 2006; McGhan 2010; Patterson 2005; Shah 2001). McCann 2006, McGhan 2010, and Clark 2010 did not present data in an extractable format (i.e. described data narratively, did not disaggregate data, or did not include the necessary information to extract an effect size); Patterson 2005 measured change in quality of life; and Shah 2001 measured clinically significant improvements (see Table 13). Among the nine studies that calculated an effect size, eight were based on the Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life (see Juniper 1996); Al-Sheyab 2012 used an Arabic version of this questionnaire. Kintner 2009 measured quality of life by reviewing responses to the Participation in Life Activities Scale.

We constructed two sets of meta-analyses for a model measuring changes in quality of life. One of these used SMD to calculate effect sizes; this allowed us to incorporate data from Kintner 2009. We meta-analysed change scores to obtain an MD from the data reported in Patterson 2005 and Shah 2001. Therefore data from six studies were common to both models. Several studies measured quality of life within four months of the intervention (Al-Sheyab 2012; Cicutto 2005; Howell 2005; Kintner 2009; Patterson 2005; Shah 2001), two studies collected data at six to seven months after the intervention (Henry 2004; Horner 2008), and one study collected data 12 months after the intervention (Cicutto 2013).

Withdrawal from the study

Researchers frequently presented withdrawal data, although not always in a format that allowed extraction of data to form an effect size. This often occurred because studies reported overall numbers lost during the study without disaggregating by treat-

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ment arm (Cicutto 2013; Velsor-Friedrich 2005), or because studies reported no losses (Persaud 1996). Fourteen studies provided enough data to allow calculation of an effect size (OR) (Al-Sheyab 2012; Bartholomew 2006; Bruzzese 2008; Bruzzese 2011; Cicutto 2005; Gerald 2009; Horner 2008; Horner 2015; Kintner 2009; Levy 2006; McGhan 2003; McGhan 2010; Patterson 2005; Shah 2001). Few studies reported on active withdrawal processes occurring during the intervention; instead investigators reported on failure to collect children's data at follow-up (collected from children and parents). Researchers collected data at different points between intervention and follow-up, including at four months or less (Al-Sheyab 2012; Bruzzese 2008; Patterson 2005; Shah 2001), at six to seven months (Cicutto 2005; Gerald 2009; Horner 2008; McGhan 2010), and at nine to 12 months (Bruzzese 2011; Horner 2015; Kintner 2009; Levy 2006; McGhan 2003). Duration was unclear in one study (Bartholomew 2006).

Excluded studies

From the title and abstract screening, we excluded 28,318 records because they were clearly outside the remit of the review of process evaluations. Following full-text screening, we excluded another 1029 records, for reasons detailed in the PRISMA diagram (Figure 2).

Based on title and abstract screening, we excluded 274 records as they were outside the remit of the review of outcome evaluation studies. Following full-text screening, we excluded 67 additional records, for reasons detailed in the PRISMA diagram (Figure 3).

Risk of bias in included studies

We have displayed results of the risk of bias assessment for process and outcome evaluation studies in the risk of bias table and graph. We have presented the agreed judgement of two review authors (DK, KH) regarding the risk of bias for each included study as percentages for each bias item in the risk of bias graph (Figure 4; Figure 5).

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Figure 4. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

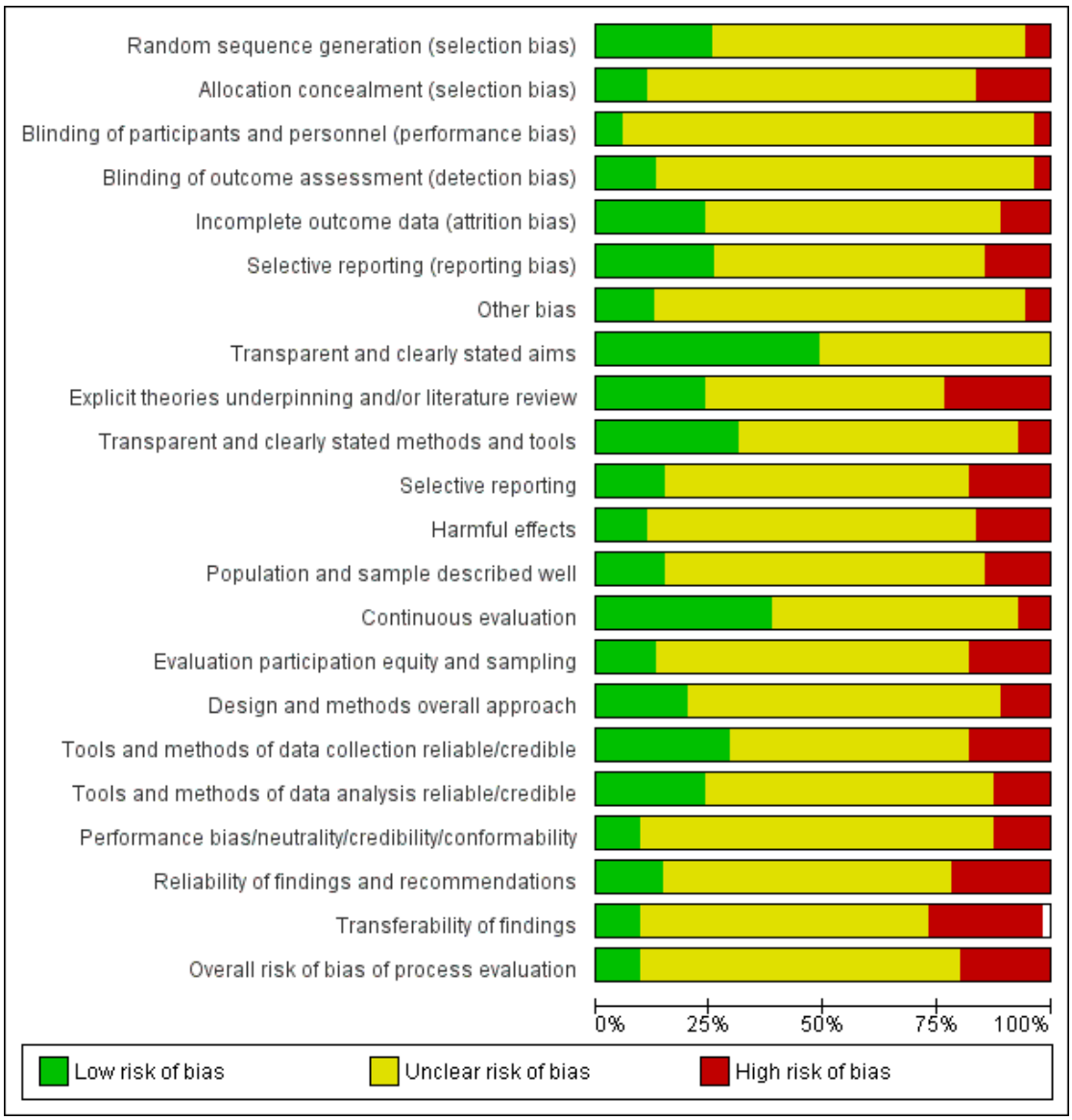

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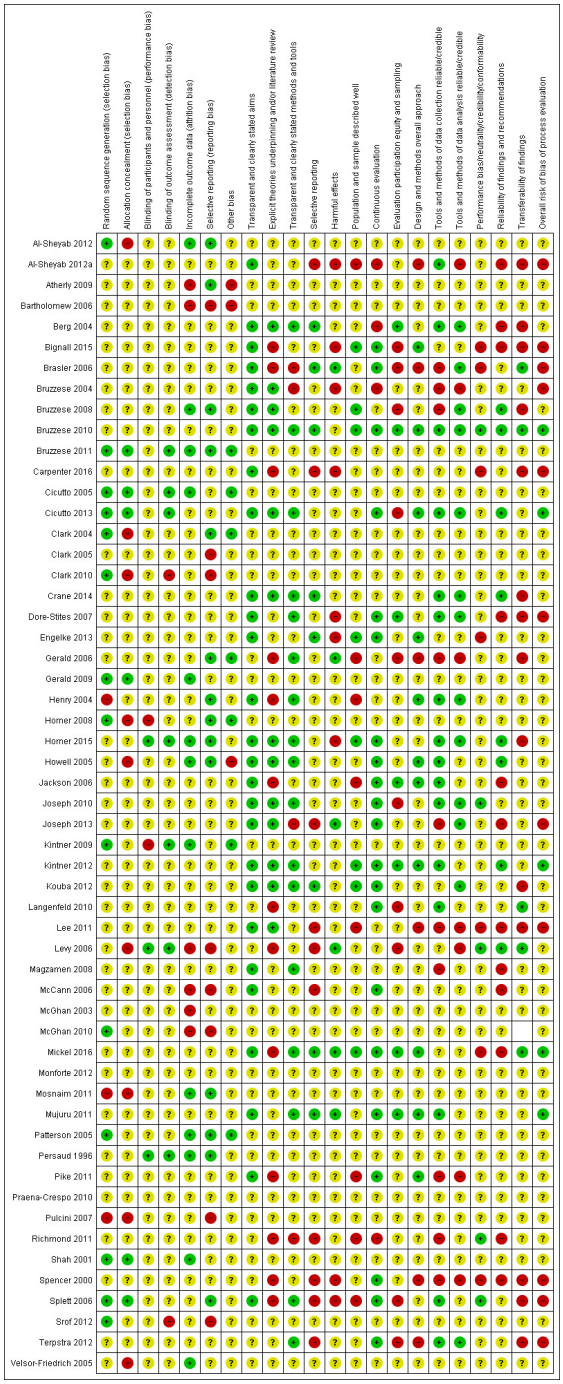
Figure 5. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



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Risk of bias - process evaluation studies

For process evaluation studies, we assessed risk of bias using a combination of two tools. The first tool was developed at the EPPI-Centre (Harden 2004) to assess the methodological rigour of 'views' studies; the second tool, which was developed by the EPPI-Centre to assess the quality of process evaluation data (O'Mara-Eves 2013),

We assessed reporting quality across five indicators.

- Transparent and clearly stated aims (0 high risk of bias, 27 low risk of bias, 6 unclear risk).
- Explicit theories underpinning the intervention (10 high risk of bias, 14 low risk of bias, 9 unclear risk).
- Transparent and clearly stated methods and tools (4 high risk of bias, 17 low risk of bias, 12 unclear risk).
- Selective reporting (10 high risk of bias, 8 low risk of bias, 15 unclear risk).
- Harmful effects (8 high risk of bias, 5 low risk of bias, 20 unclear risk).

We assessed population and selection factors using four indicators.

- Population and sample described well (8 high risk of bias, 8 low risk of bias, 17 unclear risk).
- Continuous evaluation (3 high risk of bias, 8 low risk of bias, 22 unclear risk).
- Evaluation participation equity and sampling (9 high risk of bias, 7 low risk of bias, 17 unclear risk).
- Design and methods overall approach (6 high risk of bias, 10 low risk of bias, 16 unclear risk).

We assessed reliability and transferability of findings using two indicators.

- Reliability of findings and recommendations (11 high risk of bias, 8 low risk of bias, 14 unclear risk).
- Transferability of findings (13 high risk of bias, 5 low risk of bias, 15 unclear risk).

Overall, process evaluation studies consisted of 10 high-risk studies, five low-risk studies, and 18 studies at unclear risk.

Risk of bias - outcome evaluation (RCT) studies

Allocation

We judged 14 outcome evaluation studies to be at low risk of bias for random sequence generation (Al-Sheyab 2012; Bruzzese 2011; Cicutto 2005; Cicutto 2013; Clark 2004; Clark 2010; Gerald 2009; Horner 2008; Kintner 2009; McGhan 2010; Patterson 2005; Shah 2001; Splett 2006; Srof 2012). We judged three to be at high risk (Henry 2004; Mosnaim 2011; Pulcini 2007). We judged the remainder to be at unclear risk. We judged six of these studies to be at low risk of allocation concealment bias (Bruzzese 2011; Cicutto 2005; Cicutto 2013; Gerald 2009; Shah 2001; Splett 2006). We judged nine studies to be at high risk of allocation concealment bias (Clark 2010; Horner 2008; Howell 2005; Kintner 2009; Levy 2006; McGhan 2010; Mosnaim 2011; Pulcini 2007; Velsor-Friedrich 2005).

Blinding

We judged three outcome evaluation studies to be at low risk of bias for blinding of participants and personnel (Cicutto 2013; Horner 2015; Levy 2006). We judged two studies to be at high risk of bias for this component (Horner 2008; Kintner 2009). We judged seven outcome evaluation studies to be at low risk for blinding of outcome assessment (Bruzzese 2011; Cicutto 2005; Cicutto 2013; Horner 2015; Kintner 2009; Levy 2006; Persaud 1996). For two outcome evaluation studies, we determined that risk of bias for blinding of outcome assessment was high (Clark 2010; Srof 2012).

Incomplete outcome data

We judged 13 outcome evaluation studies to be at low risk of bias for incomplete outcome data (Al-Sheyab 2012; Bruzzese 2011; Bruzzese 2008; Cicutto 2005; Gerald 2009; Horner 2015; Howell 2005; Kintner 2009; Mosnaim 2011; Patterson 2005; Persaud 1996; Shah 2001; Velsor-Friedrich 2005). We judged six outcome evaluation studies to be at high risk of bias for incomplete outcome data (Atherly 2009; Bartholomew 2006; Levy 2006; McCann 2006; McGhan 2010; McGhan 2003).

Selective reporting

We judged 14 outcome evaluation studies to be at low risk of bias for selective reporting (Al-Sheyab 2012; Atherly 2009; Bruzzese 2011; Bruzzese 2008; Clark 2004; Gerald 2006; Henry 2004; Horner 2015; Horner 2008; Howell 2005; Mosnaim 2011; Patterson 2005; Persaud 1996; Splett 2006). We judged eight studies to be at high risk of bias for selective reporting (Bartholomew 2006; Clark 2005; Clark 2010; Levy 2006; McCann 2006; McGhan 2010; Pulcini 2007; Srof 2012).

Other potential sources of bias

We judged 13 outcome evaluation studies to be at low risk of bias (Al-Sheyab 2012; Atherly 2009; Bruzzese 2008; Bruzzese 2011; Gerald 2009; Gregory 2000; Horner 2008; Kintner 2009; Patterson 2005; Persaud 1996; Shah 2001; Splett 2006; Velsor-Friedrich 2005), along with seven studies at high risk of bias, for missingness (Bartholomew 2006; Bruzzese 2004; Cicutto 2005; Howell 2005; Levy 2006; McGhan 2010; Praena-Crespo 2010). We judged 15 outcome evaluation studies to be at low risk of bias for baseline imbalance (Bruzzese 2008; Bruzzese 2011; Cicutto 2005; Cicutto 2013; Clark 2004; Gerald 2006; Gerald 2009; Gregory 2000; Horner 2008; Kintner 2009; Levy 2006; McGhan 2010; Splett 2006; Srof 2012; Velsor-Friedrich 2005). We judged six studies to be at high risk for baseline imbalance (Al-Sheyab

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2012; Atherly 2009; Clark 2010; Howell 2005; McCann 2006; McGhan 2003).

We judged 27 outcome evaluation studies to be at low risk for contamination (Al-Sheyab 2012; Atherly 2009; Bartholomew 2006; Bruzzese 2011; Cicutto 2005; Cicutto 2013; Clark 2004; Clark 2005; Clark 2010; Gerald 2006; ; Henry 2004; Horner 2008; Horner 2015; Howell 2005; Kintner 2009; Levy 2006; McCann 2006; McGhan 2003; McGhan 2010; Monforte 2012; Mosnaim 2011; Patterson 2005; Praena-Crespo 2010; Pulcini 2007; Shah 2001; Splett 2006; Velsor-Friedrich 2005), and we determined that five outcome evaluation studies were at high risk (Bruzzese 2004; Bruzzese 2008; Gerald 2009; Persaud 1996; Srof 2012).

Effects of interventions

See: **Summary of findings for the main comparison** Effects of school-based asthma interventions compared to usual care for asthma among children and adolescents

Results of synthesis - part 1: qualitative comparative analysis of determinant conditions for successful intervention implementation

Descriptive results from process evaluation studies on implementation success

Across the 27 included studies, review authors identified eight studies as having high implementation scores for our combined outcome (attrition, adherence, dosage) and classified these studies as mainly or fully included in a set of studies marked as successfully implemented (Al-Sheyab 2012a; Berg 2004; Bruzzese 2008; Bruzzese 2011; Henry 2004; Joseph 2010; Kintner 2012; Terpstra 2012). In contrast, we identified eight studies as having low implementation success scores and as mainly or entirely outside the successfully implemented set of studies (Brasler 2006; Bruzzese 2004; Gerald 2006; Howell 2005; Kouba 2012; Langenfeld 2010; Magzamen 2008; Spencer 2000). Other studies were more ambiguous regarding their implementation success and had high levels of missing data or conflicting results across indicators.

For many studies reporting lower implementation success, we viewed the difficulty of incorporating an intervention into the busy school curriculum and into children's busy schedules as undermining the intervention (Brasler 2006; Bruzzese 2004; Gerald 2006; Howell 2005; Kouba 2012). Additional factors included difficulties in terms of high staff turnover (Gerald 2006); high child turnover and/or chaotic families (Brasler 2006; Howell 2005); and low motivation among children, particularly in the absence of incentives (Magzamen 2008). Similarly, researchers provided a diverse set of explanations for successful implementation, including high levels of school-level commitment (Henry 2004; Kintner 2012); high levels of child and teacher motivation (Al-Sheyab 2012a; Berg 2004); and development of group cohesion (Bruzzese 2008), as well as specific intervention design features, including tailoring of messages to children, as in Bruzzese 2011 and Joseph 2010, and additional communications with parents, as in Terpstra 2012.

In the QCA analyses below, we examine factors that could further explain successful implementation by examining which characteristics are shared among studies that were successfully implemented, and whether these differ from studies that were not successfully implemented.

Summary of results from qualitative comparative analysis

We first explored different domains of implementation separately, before bringing this evidence together in a final model (Table 14). We used this strategy mainly because of the problem of limited diversity, by which observed studies did not support too many possible combinations of intervention characteristics. We found no configurations of characteristics that consistently triggered successful implementation with respect to recruitment and retention, as well as pedagogical factors, although these may be important in other ways for children's outcomes.

In our consolidated model, we prioritised conditions that were included in configurations with high consistency and coverage scores. To facilitate interpretation in the consolidated model, we focused on conditions with a consistent direction. Working from the raw data (Table 15), we created a truth table (Table 16), which showed the extent to which sets of studies with particular configurations of conditions overlapped with a set of studies included in our successful intervention set. Boolean minimisation helped to simplify the solution (Table 17), and we inserted assumptions about logical remainders (configurations with no observed cases) to further simplify the solution (Table 18). After doing this, we observed that four pathways (or configurations of conditions) triggered the outcome, thereby forming our 'solution' (summarised in Table 19).

This solution emphasises the importance of a theory-driven intervention across all settings for successful implementation. Three of these pathways are specific to high schools. Here, the evidence suggests that in addition to the importance of a theory-based intervention, good levels of engagement with parents, high levels of child satisfaction, or running the intervention outside the child's own time can lead to a successfully implemented intervention. A pathway that is not specific to high schools reinforces these findings by showing that being theory-based, fostering high levels of child satisfaction, reporting good levels of parental engagement, and running an intervention outside the child's own time are sufficient conditions for triggering a positive outcome.

As a whole solution, these pathways had a consistency score of 0.862, suggesting that they were sufficient in triggering the outcome. Interventions that are designed with these sets of characteristics are therefore highly likely to be successfully implemented. We also checked whether any of the configurations described also predicted negation of the outcome, but we found no such evi-

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dence. Our coverage score of 0.432, which is modest, suggests that other pathways can also trigger successful implementation, which may be explained by factors not explored in these models. We were not able to incorporate risk of bias judgements directly into the QCA solution.

Based on results of QCAs, we intended to include the following conditions in meta-analyses, either in the form of subgroup analyses or as covariates in meta-regression. We planned to examine these as binary or ordinal variables in meta-analyses; they reflect the single conditions thought to most commonly trigger a successful outcome.

- Type of school: high school; primary/elementary school; junior/middle school; other.
- Theory driven: does the study name a theoretical framework that underpins the intervention design or delivery style?
- Parental engagement: did parents engage or participate in the ways they were expected to?
- Child satisfaction: did at least 75% of children report satisfaction with the intervention, or did study authors report high levels of satisfaction?
- Timing of the intervention: does the intervention interfere with the child's own time (during lunch or after school)?

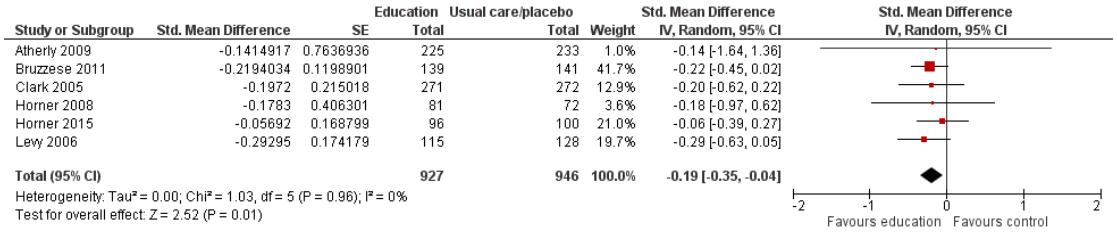
Due to data constraints, we were not able to explore child satisfaction in meta-analyses, as very few studies captured this information, and we operationalised parental engagement as 'parental involvement' - whether or not parents were actively included in the intervention - for similar reasons. We entered the factors beginning "Theory driven", "Parental engagement", and "Timing of the intervention" into subgroup analyses as configurations of conditions in an attempt to replicate the results of the QCA (above). We further explored the link between implementation and outcomes in the next section.

Results of synthesis - part 2: meta-analyses of effectiveness

Primary outcome: asthma symptoms or exacerbations leading to hospitalisation

We extracted effect sizes from seven studies (Atherly 2009; Bruzzese 2011; Clark 2005; Gerald 2006; Horner 2008; Horner 2015; Levy 2006), and we analysed the data from six. Evidence showed that school-based asthma self-management interventions were effective in reducing numbers of hospitalisations among children (standardised mean difference (SMD) -0.19, 95% confidence interval (CI) -0.35 to -0.04; participants = 1873; Figure 6 Analysis 1.1). Effect sizes from all six studies were in the same direction, and I^2 and Q statistic values provided no evidence of statistical heterogeneity. Gerald 2006 presented data on the median number of hospitalisations, which were not compatible with other extracted data, although it is worth noting that the median level of hospitalisation appeared higher for the intervention group than for the control group post intervention.

Figure 6. Forest plot of comparison: 1 School-based asthma interventions vs usual care: outcome: 1.1. Exacerbations leading to hospitalisation.



Given that we found no indication of heterogeneity in these models and the likelihood that these analyses would be underpowered, we did not conduct further subgroup analyses. We considered sensitivity analyses, although the small number of studies included in the models precluded a full analysis. All but one of the studies - Bruzzese 2011 - reported on cluster randomised trials, and half of the studies originally reported on binary outcomes (Atherly 2009; Clark 2010; Horner 2008), although sensitivity analyses on these factors revealed no significant differences in effect size. Egger's test for publication bias suggested no evidence of publication bias (the P value for the bias coefficient stood at 0.626), although the small number of studies meant that the test and observations of the funnel plot (not displayed) were ultimately underpowered.

The small number of included studies precluded a detailed investigation of the way in which risk of bias influenced the effect size

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for this outcome. However, two of the largest studies, which contributed three-fifths of weighting to the pooled effect size, had low or unclear risk of bias across all domains (Bruzzese 2011; Horner 2015), and in the case of Horner 2015, low risk of bias was seen for each domain, apart from blinding of participants and personnel (unclear risk of bias).

Evidence therefore suggests that school-based asthma self-management interventions do reduce the frequency of asthma symptoms and exacerbations requiring hospitalisation among children, with a high level of consistency in the direction and magnitude of effect.

Primary outcome: asthma symptoms or exacerbations leading to emergency department visits

We meta-analysed effect sizes from 13 studies and found clear evidence that school-based asthma self-management interventions were effective in reducing the frequency of ED visits (odds ratio (OR) 0.70, 95% CI 0.53 to 0.92; participants = 3883). Gerald 2006 presented data on the median number of hospitalisations, which were not compatible with other extracted data (full details in Table 13), although the median level of ED visits was observed to be slightly lower for the intervention group than for the control group post intervention.

Heterogeneity in the effects of studies was evident, in terms of both magnitude and direction of effect, with three studies having negligible effect sizes (close to one - Atherly 2009; Clark 2005; Horner 2015) and two studies suggesting a negative intervention effect (McGhan 2003; McGhan 2010); this resulted in an I^2 value of 26%. The number of studies and the level of heterogeneity allowed us to explore potential study characteristics that could help to explain the observed variation.

Subgroup analyses: exacerbations leading to emergency department visits

Subgroup analyses suggested that the heterogeneity shown in Figure 7 - Analysis 1.2 - was not explained by school type (Figure 8), age (Analysis 3.1), or socio-economic status of children and intervention deliverers involved in the intervention (Analysis 4.1; Analysis 5.1).

Figure 7. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.2. Exacerbations leading to emergency department (ED) visits.

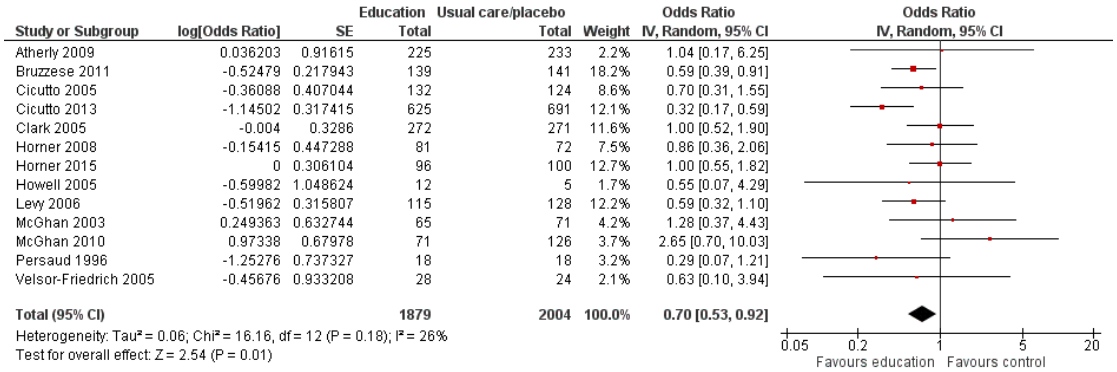

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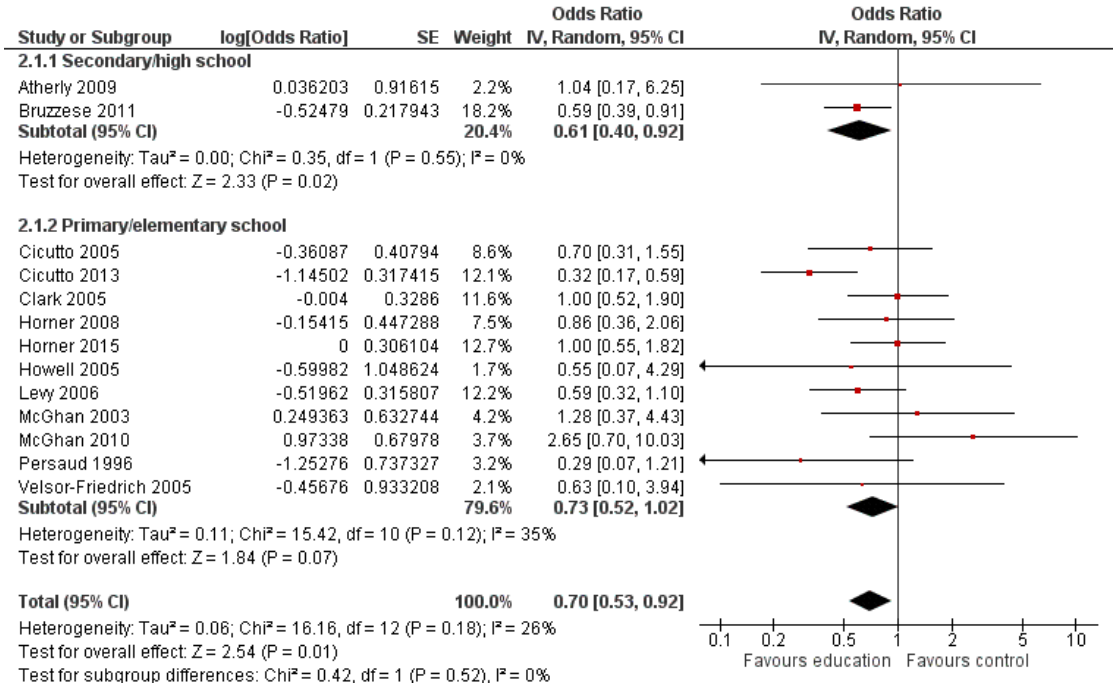
Figure 8. Forest plot of comparison: 2. Effect of school-based asthma interventions vs usual care subgrouped by school type, outcome: 2.1. Exacerbations leading to emergency department (ED) visits.



We employed subgroup analyses to examine whether any of the intervention conditions that consistently predicted successful implementation in earlier QCAs, namely, explicit use of theory (Analysis 6.1), inclusion of parents (Analysis 7.1), or timing of the intervention (Analysis 8.1), also helped to explain any of the observed heterogeneity in effect sizes. However, we found no evidence that these factors helped to explain heterogeneity.

We also constructed a variable that attempted to replicate some of the implicants (combinations of intervention characteristics) identified in QCAs that trigger successful implementation; however, results appeared to contradict the findings of earlier analyses. A subgroup of studies that replicated one of the configurations theorised to trigger successful intervention implementation (five studies that were theory driven, did not take place in children's own time, and did not involve school nurses) had inconclusive effect sizes as a group (OR 0.85, 95% CI 0.47 to 1.52); in contrast, a subgroup of studies that did not replicate a configuration were found to trigger successful intervention implementation in the QCAs (OR 0.67, 95% CI 0.47 to 0.94). We also created a variable based on a count of intervention characteristics found to trigger successful implementation in our earlier QCAs, and we tested these in subgroup analyses. We constructed a variable reflecting a count of three of the conditions generally found to trigger successful implementation (theory driven, not run in children's own time, and parental engagement (assessed by active involvement of parents)), whereby studies could include zero to three of these 'ingredients'. All studies included in the meta-analyses had incorporated at least one of these conditions, and subgroup analyses suggested that the number of components was inversely related to effect size, with studies with one component (three studies; OR 0.56, 95% CI 0.33 to 0.97) or two components (seven studies; OR 0.67, 95% CI 0.49 to 0.94) having lower effect sizes than the three studies that included all three components (OR 1.48, 95% CI 0.65 to 3.40); however, the test for differences between subgroups did not suggest that these differences were significant, and moderate heterogeneity remained within one of the subgroups. Among the latter group of studies, two of the three studies evaluated the effectiveness of the RAP (Roaring Adventures of Puff) intervention (McGhan 2003; McGhan 2010). One of these studies provided evidence of a baseline imbalance that could influence the outcome (McGhan 2003), whereby the proportion of intervention group children who had been admitted to an ED was almost ten percentage points higher in the intervention group (23.7%) than in the control group (14%). The second study provided evidence that the mean number of ED visits was higher post intervention in the control group (McGhan 2010), although study authors did not present full data allowing for extraction of the mean number of visits, and the measure used reflected the odds of reporting ED

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visits.

Sensitivity analyses: exacerbations leading to emergency department visits

We conducted sensitivity analyses to explore the impact of decisions to transform or combine the data. We detected no differences between effect sizes that were originally measured through binary effect sizes (ORs) and those that were originally measured through continuous measures (SMDs). We detected no differences in whether studies assessed intervention effects at 12 months, four to seven months, or within three months (intervals reflecting the spread of studies). All but two studies - Bruzzese 2011 and Persaud 1996 - had randomised children at the school level (cluster RCTs); little evidence suggested that this distinction explained heterogeneity in effect sizes.

In assessing the impact of study quality on effect sizes, we undertook supplementary analyses using meta-regression in STATA, and, due to the limited number of studies, we combined categories of high and unclear risk when assessing the impact of study quality. We classified none of the studies included in the meta-analysis for ED visits as having high risk of bias for random sequence generation, although we deemed that eight studies were at unclear risk. Results of sensitivity analyses provided moderate evidence that studies had high or unclear risk of selection bias with respect to breaches in allocation concealment with significantly different effect sizes (OR 0.86, 95% CI 0.64 to 1.16), compared to the three studies that we deemed to have low risk of bias (OR 0.51, 95% CI 0.33 to 0.78). Finally, evidence showed that studies with low risk of bias with respect to collection of outcome data and blinding of collectors were significantly more effective (OR 0.58, 95% CI 0.41 to 0.81) than the seven studies with unclear or high risk of bias (OR 1.04, 95% CI 0.69 to 1.58). Differences in the risk of bias classification for other domains did not significantly explain heterogeneity in effect sizes between studies. We conducted sensitivity analyses to explore the impact of a random-effects specification on pooled effect size, noting only moderate differences in point estimates between fixed-effect (OR 0.68, 95% CI 0.55 to 0.85) and random-effects models (OR 0.70, 95% CI 0.53 to 0.92); however, the level of heterogeneity (I^2 = 26%) suggested that studies were not measuring a single common effect size, thereby undermining the fixed-effect assumption (and model results).

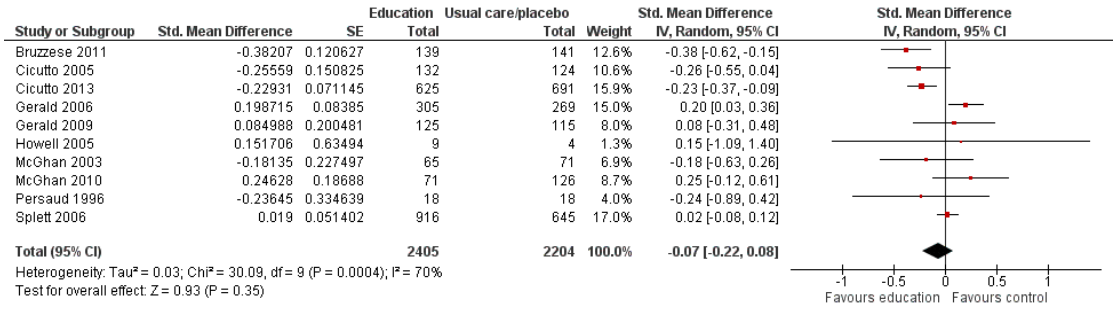
Our investigations into the potential impact of publication bias revealed that neither the funnel plot nor Egger's test was indicative of publication bias (the bias coefficient provided weak evidence that smaller studies differed systematically from studies with larger sample sizes).

Evidence therefore suggests that school-based asthma self-management interventions do reduce the frequency of asthma symptoms and exacerbations requiring emergency care among children, although variation in the magnitude and direction of effect was not explained coherently by planned subgroup analyses.

Primary outcome: absences from school

Ten studies contributed to our meta-analyses of effects of interventions on school absences, although there was uncertainty as to whether school-based self-management interventions had an impact on reducing absences from school (SMD -0.07, 95% CI -0.22 to 0.08; participants = 4609; Analysis 1.3; Figure 9). These studies showed substantial heterogeneity between effect size estimates, with I^2 estimated at 70%. Effect sizes from half of the studies included in the meta-analysis indicated that the intervention had a negative impact in slightly or significantly increasing the number of school absences in the intervention group relative to the control group (Gerald 2006; Gerald 2009; Howell 2005; McGhan 2010; Splett 2006).

Figure 9. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.3. Absence from school.



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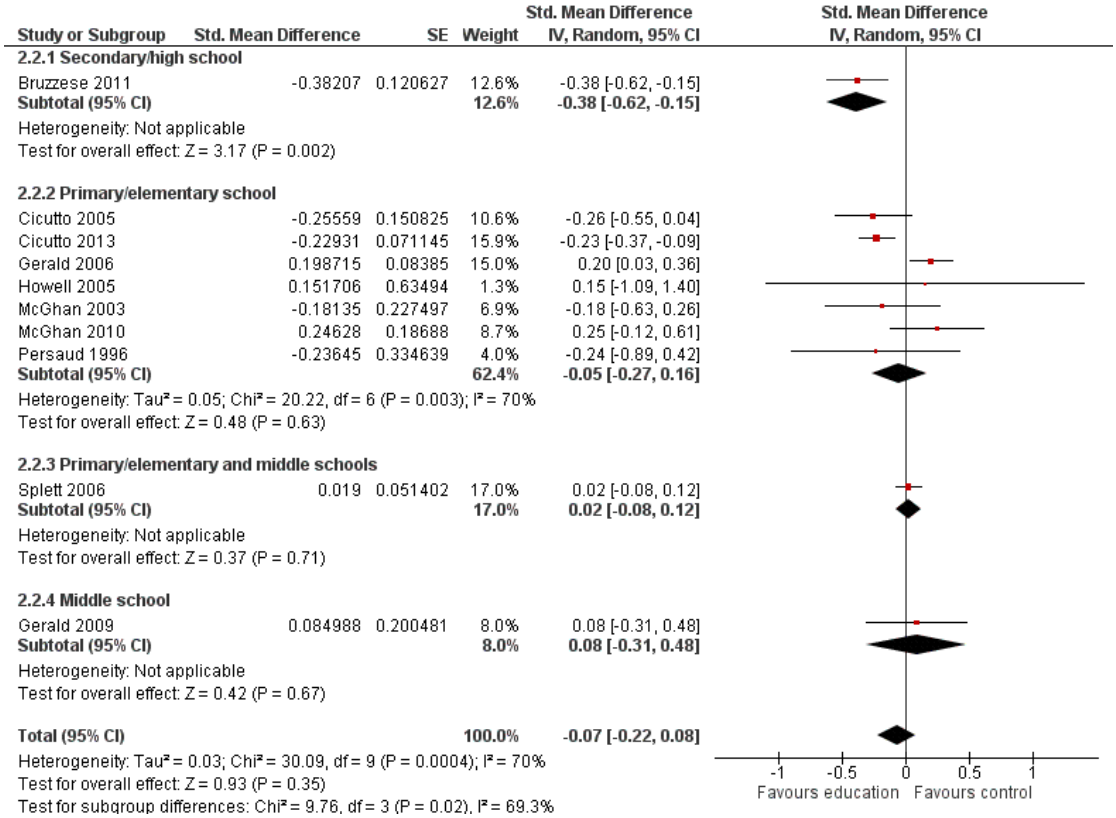
Subgroup analyses: absences from school

We undertook subgroup analyses to explore study-level characteristics that could explain this between-study heterogeneity, although it is worth noting that these analyses were likely to be underpowered and to represent indicative factors that could explain observed differences in the direction and magnitude of effect sizes across studies. The only study included in the meta-analyses that focused on high schools (and consequently older children) was highly effective in reducing school absences (SMD -0.38, 95% CI -0.62 to -0.15) (Bruzzese 2011); this study appeared to drive much of the heterogeneity explained by subgroup analyses examining school type and child age (Figure 10; Analysis 2.2; Analysis 3.2). Studies that included 25% to 50% children from lower socioeconomic backgrounds were significantly more effective in reducing levels of school absence (SMD -0.23, 95% CI -0.36 to -0.09; studies = 2) than studies with greater numbers of children from deprived backgrounds (over 50%) for whom the effect was negligible (SMD 0.01, 95% CI -0.09 to 0.11; 2 studies) and studies in which less than 25% of children were from deprived backgrounds or in which this was unclear, where the pooled effect size indicated negligible effect (SMD -0.02, 95% CI -0.29 to 0.24; 6 studies).

Figure 10. Forest plot of comparison: 2. Effect of school-based asthma interventions vs usual care subgrouped by school type, outcome: 2.2. Absence from school.



Studies that involved existing school staff (teachers or school nurses) in delivery of the intervention were significantly less effective (SMD 0.08, 95% CI -0.08 to 0.24; 3 studies) than studies in which the intervention was mainly delivered and facilitated by stakeholders who were external to the school (SMD -0.17, 95% CI -0.32 to -0.02; 7 studies; Analysis 5.2; Figure 11). Findings of the earlier QCA show that involvement of internal stakeholders within the school in delivery of the intervention did not always lead to successful intervention implementation, but they also show that involving school staff in intervention delivery may be one of a configuration of conditions that trigger successful implemen-

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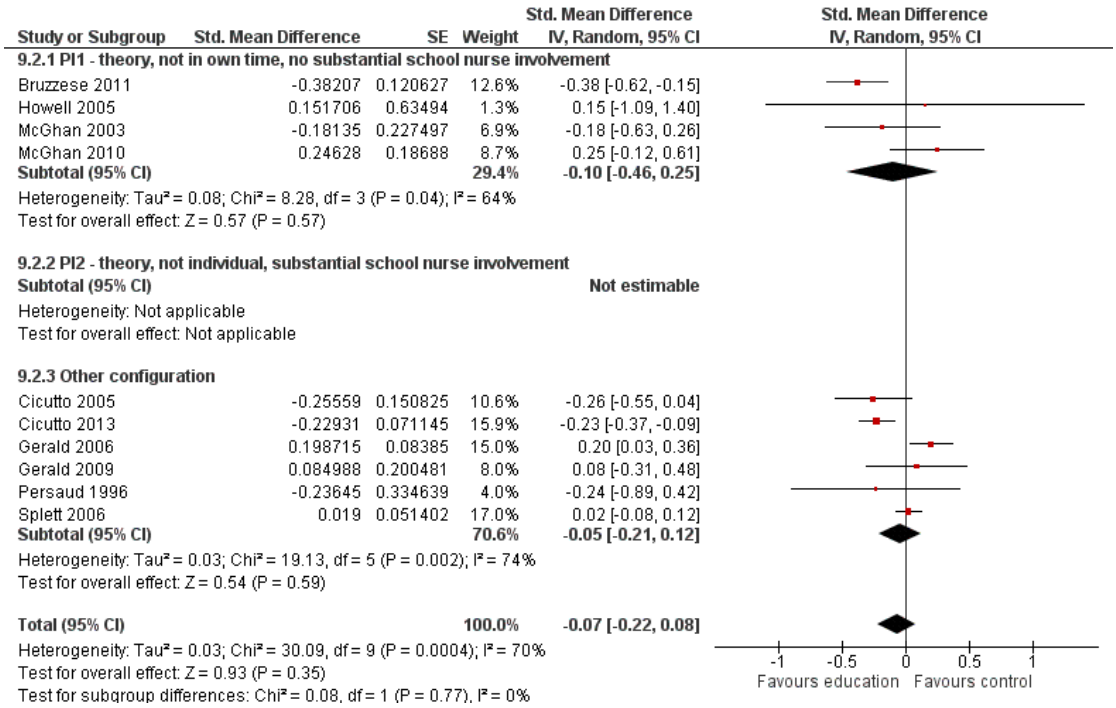
tation, none of which are sufficient alone. Similar processes may occur around their role in reducing the level of school absence.

Figure 11. Forest plot of comparison: 10. Effect of school-based asthma interventions vs usual care subgrouped by configuration of conditions (iI), outcome: 10.3. Absence from school.



We conducted subgroup analyses involving the conditions and configurations found to be sufficient in earlier QCAs to trigger successful implementation. But these findings did not significantly explain the heterogeneity in effect sizes, with two exceptions. Analysis 8.2 provided evidence that interventions that took place during the child's own time had significantly greater impacts in reducing school absence (SMD -0.23, 95% CI -0.36 to -0.11; 2 studies) than those that took place at another point in the school day (SMD -0.01, 95% CI -0.18 to 0.16; 8 studies), although a substantial level of heterogeneity remained among this latter group of studies (I^2 = 62%). We noted strong evidence around the role of theory (Analysis 6.2), whereby studies that reported drawing upon a defined theoretical framework had a significantly more impactful pooled effect size (SMD -0.20, 95% CI -0.36 to -0.04; 6 studies) than studies that did not (SMD 0.08, 95% CI -0.05 to 0.20; 4 studies). Although moderate levels of heterogeneity remained (I^2 = 41% for studies that explicitly drew upon theory and I^2 = 28% for those that did not), and even though interpretation of these results is not straightforward (see discussion), this result indicates that theory-driven studies may achieve better outcomes with respect to this domain.

Sensitivity analyses: absences from school

We conducted sensitivity analyses to explore whether the following factors, reflecting study design or analytical decisions made during the review process, helped to explain heterogeneity in effect size: (I) transformations were made to the original effect size (conversions between ORs and SMDs; Chinn 2000); (ii) cluster RCT or not; (iii) the data collection period; and (iv) the study's risk of bias . We found no evidence to suggest that transformations in effect sizes explained heterogeneity, and no evidence indicated that the unit of randomisation (school vs child) explained variation in effect size. The three studies that collected absence data within three months post intervention (or for which the collection date was unclear) did exhibit a weaker effect in reducing school absences (Gerald 2006; Howell 2005; Persaud 1996), with Gerald 2006 and Howell

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2005 showing a negative intervention impact, although this was not significantly different from studies that assessed absences over the 12 months post intervention. Little evidence suggests that risk of bias influenced the effect size obtained; however, studies that had taken steps to blind assessment of outcomes and to avoid detection bias had a greater impact in reducing school absences (SMD -0.27, 95% CI -0.38 to -0.17; 3 studies) than studies that did not take these steps (SMD -0.07, 95% CI -0.02 to 0.16; 7 studies).

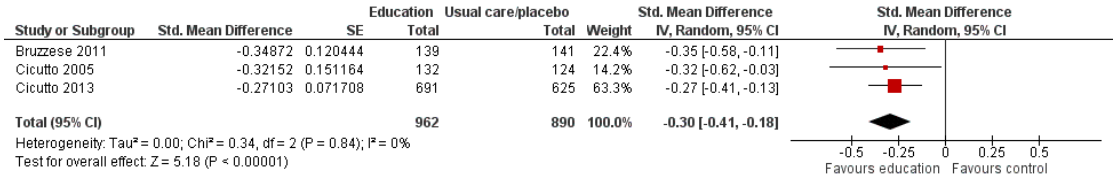
We investigated the potential impact of publication bias by examining a funnel plot and the results of Egger's test. These tests did not provide strong evidence that data were impacted by publication bias (the bias coefficient provided weak evidence that smaller studies differed systematically from studies with larger sample sizes). We examined differences between the fixed-effect model and the random-effects model reported above. The fixed-effect model showed that the pooled point estimate remained similar, but with a less conservative confidence interval (SMD -0.05, 95% CI -0.11 to 0.02). However the level of heterogeneity was substantial (I^2 = 70%), which suggested that these studies were not measuring a single common effect size and thereby undermined the fixed-effect assumption (and model results).

Evidence from the overall pool of studies therefore suggests that school-based asthma self-management interventions did not have an impact in reducing absence from school, although variation in direction and magnitude was substantial. Planned subgroup analyses assisted in identifying particular groups of studies and did, or did not, have a beneficial effect.

Primary outcome: days of restricted activity

Three studies contributed data to our meta-analysis of the impact of school-based asthma self-management interventions in reducing the number of days of restricted activity that children experienced (Bruzzese 2011; Cicutto 2005; Cicutto 2013). These studies provided evidence that the intervention mode could reduce the number of days of restricted activity experienced (SMD -0.30, 95% CI -0.41 to -0.18; 1852 participants; 3 studies; Analysis 1.4), albeit based on a limited number of studies, two of which evaluated the same intervention design (the Roaring Adventures of Puff) (Cicutto 2005; Cicutto 2013). All three studies provided relatively consistent evidence around the direction and magnitude of effect (I^2 = 0%). Reporting on the results of subgroup analyses is not meaningful in the presence of low heterogeneity and small numbers of studies, and many sensitivity analyses could not be conducted for the same reason, although it is worth noting that we rated none of the included studies as having high risk of bias for any domain assessed for the outcome evaluation risk of bias tool (Figure 12).

Figure 12. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.4. Days of restricted activity.



Secondary outcome: unplanned visits to a medical provider

From a meta-analysis of five studies (Analysis 1.5), evidence shows that school-based asthma self-management interventions did reduce the number of unplanned or unscheduled visits to a medical provider (OR 0.74, 95% CI 0.60 to 0.90; 3490 participants; 5 studies). Despite inconsistency in the magnitude (and direction) of effect in the case of McGhan 2003, which indicated a small negative intervention impact, the meta-analysis provided little evidence of statistical heterogeneity (I^2 = 0%). As was the case above, the small number of studies and the absence of heterogeneity did not support meaningful investigation of subgroup analyses, nor the opportunity to undertake a full assessment of some of the assumptions made in pooling the data (see Table 13 for further details on the derivation of effect sizes). Similarly, we were not able to assess the potential impact of publication bias. Two studies contributed almost 75% towards the pooled effect size (Bruzzese 2011; Cicutto 2013), and we rated neither study as having high risk of bias in any domain (Figure 13).

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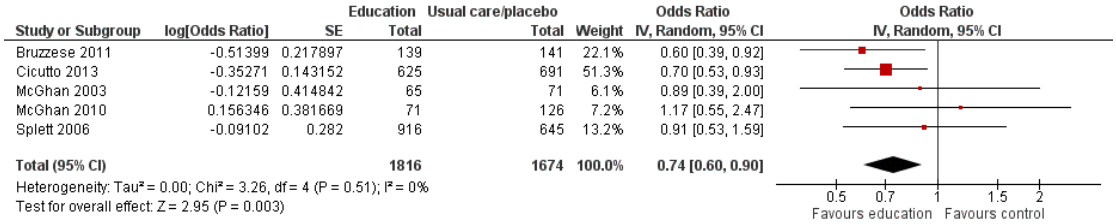
Figure 13. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.5. Unplanned visit to hospital or GP due to asthma symptoms.

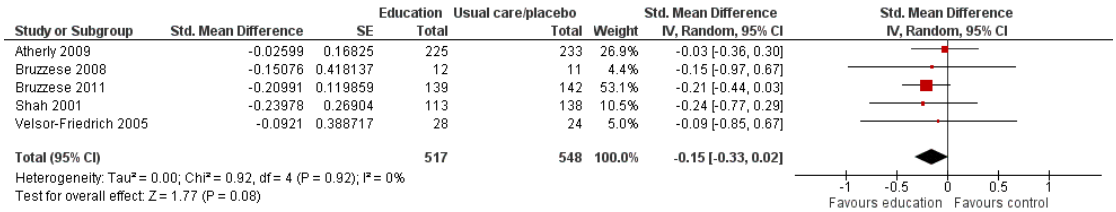


Secondary outcome: experience of daytime and night-time symptoms

As described in the section on Included studies, trialists adopted different strategies in measuring the impact of interventions on children's daytime and night-time symptoms. We constructed separate models of meta-analysis for studies reporting on daytime symptoms (Analysis 1.6) and night-time symptoms (Analysis 1.7), although some variation remained in the way in which symptom data were collected (Table 13).

Uncertainty surrounded the question of whether school-based self-management interventions reduced the level of daytime symptoms that children experienced (SMD -0.15, 95% CI -0.32 to 0.02; I^2 = 0%; 1065 participants; 5 studies), with the confidence interval just crossing the line of no effect (zero). However, study reports show consistency in the direction of effects (Figure 14). Even greater uncertainty surrounded whether self-management interventions in schools reduced the level of night-time symptoms reported by children in random effects meta-analysis (SMD -0.18, 95% CI -0.52 to 0.15; I^2 = 40%; 459 participants; 4 studies), with two studies providing weak evidence that night-time symptoms actually increased among children receiving school-based asthma self-management interventions. We performed sensitivity analyses using a fixed-effect model, with the pooled effect size across the four studies indicating that night-time symptoms decreased (SMD -0.26, 95% CI -0.46 to -0.06; 4 studies), although given the inconsistency in the direction of effect, the underlying assumptions of the fixed-effect model cannot be substantiated, and the random-effects model may provide a more realistic estimate of intervention effects on night-time symptoms.

Figure 14. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.6. Experience of daytime and night-time symptoms - daytime symptoms.



Reporting on the results of subgroup analyses was not meaningful with the few included studies; other sensitivity analyses could not be conducted for the same reason. One study that measured change in daytime symptoms showed a weak effect of the intervention in lowering the level of daytime symptoms (see Table 13) (Clark 2010).

Secondary outcome: lung function

We extracted outcomes measuring trial impacts on lung function from five studies, although we did not combine these data in meta-analyses due to conceptual (and statistical) heterogeneity. We have presented these outcomes in full in Table 13.

Secondary outcome: use of reliever therapies

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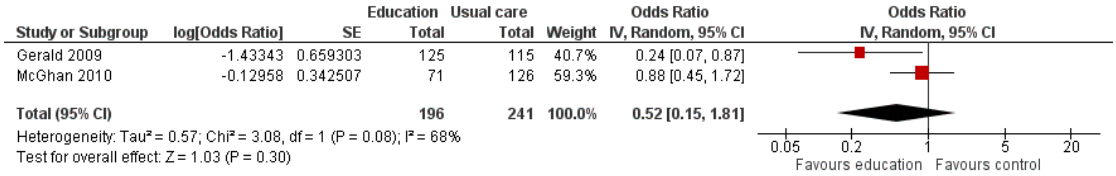
Four studies reported on the use of reliever therapies among children who had received self-management interventions in school (Table 13), and we included effect sizes from two studies with clinical and conceptual equivalence in a random-effects meta-analysis (Figure 15; Analysis 1.8). The pooled result provided uncertain evidence on the impact of the intervention on children's use of reliever therapies (OR 0.52, 95% CI 0.15 to 1.81; 437 participants; 2 studies). The level of heterogeneity between studies was substantial (I^2 = 68%), although both were somewhat consistent in the direction of effect, indicating lower odds of (frequent) reliever therapy usage. One study had low or unclear risk of bias across all domains considered (Gerald 2009), and we judged McGhan 2010 to have high risk of bias in terms of attrition bias and selective reporting.

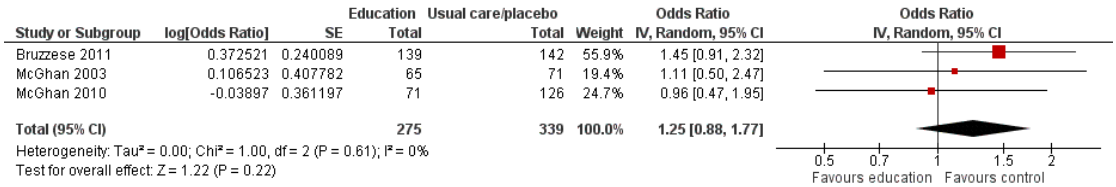
Figure 15. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.8. Use of reliever therapies, e.g. beta 2 -agonists.



Secondary outcome: corticosteroid dosage and use of add-on therapies

We found unclear evidence on the impact of interventions on children's use of corticosteroids and add-on therapies (OR 1.25, 95% CI 0.88 to 1.77; 614 participants; 3 studies; Figure 16; Analysis 1.9). We noted no evidence of statistical heterogeneity between these study impacts on corticosteroid usage (I^2 = 0%), and as reporting on the results of subgroup analyses is not meaningful with low heterogeneity and few studies, we could not conduct other sensitivity analyses for the same reason. We deemed one study included in the model to have low risk of bias for all domains except blinding of participants and personnel, for which we deemed the risk to be unclear (Bruzzese 2011); we deemed the other two studies to have high risk of bias in one and two domains (McGhan 2003; McGhan 2010), respectively, with both deemed to have high risk of attrition bias from incomplete and unexplained dropouts at outcome data collection.

Figure 16. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.9. Corticosteroid dosage and/or use of add-on therapies (usage of).



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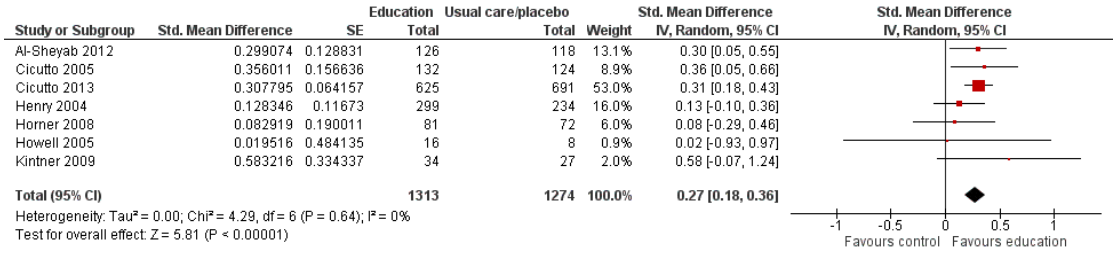
We included two studies reporting appropriate usage of corticosteroids and add-on therapies. Although the direction of findings differed substantially between studies, resulting in considerably high levels of heterogeneity (I^2 = 87%), we did not estimate a pooled effect size (Analysis 1.10).

Secondary outcome: health-related quality of life

Nine studies provided data on the effectiveness of school-based self-management interventions in improving children's quality of life. Because of conceptual differences in the way in which the outcome was measured, one meta-analysis of seven studies explored intervention impacts on quality of life measures assessed through standardised mean differences using mainly the Paediatric Asthma Quality of Life Questionnaire (PAQLQ) (Figure 17; Analysis 1.11), and provided evidence of effectiveness (SMD 0.27, 95% CI 0.18 to 0.36; 2587 participants; 7 studies). This model provided no evidence of statistical heterogeneity in effectiveness (I^2 = 0%), with all studies providing estimates of positive improvements, although these were not all statistically significant in all studies. The low level of heterogeneity and the few included studies meant that conducting subgroup analyses was not appropriate. We deemed that five of the seven studies included in the meta-analysis were at high risk of bias in at least one domain (Al-Sheyab 2012; Henry 2004; Horner 2008; Howell 2005; Kintner 2009), although the two studies with low or unclear risk of bias in all domains contributed over 60% of the weighted effect size (Cicutto 2005; Cicutto 2013). Explorations of the funnel plot and Egger's test were underpowered, and publication bias could not be adequately tested.

Figure 17. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.11. Health-related quality of life (SMD).



A second meta-analysis involving eight studies also provided evidence that children in intervention groups had higher HRQoL than children in control groups (MD 0.35, 95% CI 0.06 to 0.64; 2950 participants; 8 studies) based on PAQLQ results at follow-up (Analysis 1.12). The mean difference, while again indicating that the impact did not cross the threshold of no effect, fell below 0.5 - the threshold considered to indicate a clinically significant change in HRQoL on this scale. Heterogeneity among studies was considerably high (I^2 = 81%). One study in particular had relatively high levels of baseline imbalance, and a sensitivity analysis removing this value resulted in a lower point estimate but much lower levels of heterogeneity (MD 0.21, 95% CI 0.07 to 0.36; I^2 = 24%) (Al-Sheyab 2012). We included this same study in Analysis 1.11, although we used different data to obtain an effect size (P value and sample size). We did not further explore heterogeneity because included studies were few and, similarly, explorations of the funnel plot and Egger's test were underpowered; therefore, we could not adequately assess publication bias. We deemed that four of the studies included in Analysis 1.12 were at high risk of bias in at least one domain. A further sensitivity analysis involving constructing a fixed-effect model yielded a similar point estimate (MD 0.32, 95% CI 0.21 to 0.43; I^2 = 81%; 8 studies), although the considerably high level of heterogeneity indicates that this is not a suitable analytical framework.

Despite the additional study included in Analysis 1.12, we consider the results from Analysis 1.11 to be more reliable because of the considerably high heterogeneity observed in the model for MD and the insufficient number of studies to fully explore drivers of this heterogeneity.

Therefore, evidence suggests that school-based asthma self-management interventions do improve children's quality of life, although this finding may not reach a point of clinically significant improvement. Although all studies provided an indication of a positive beneficial effect, variation in the size of the effect was substantial.

Secondary outcome: withdrawal from the study

Meta-analysis provided no evidence that participation in the inter-

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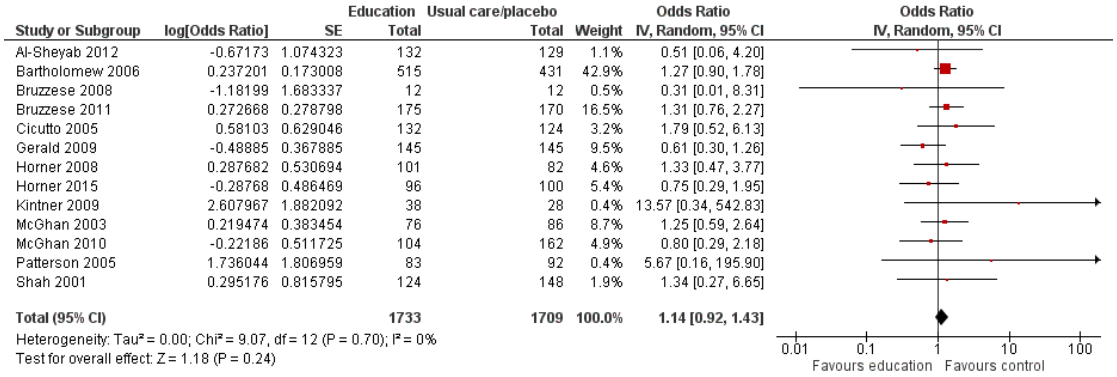
vention was linked to withdrawal from the study (OR 1.14, 95% CI 0.92 to 1.43; 3442 participants; 13 studies; Figure 18; Analysis 1.13). We detected no substantial statistical heterogeneity (I^2 = 0%), although some qualitative differences were apparent between studies that reported very low levels of withdrawal among those receiving treatment relative to those in control groups (Bruzzese 2008), and relative to those with very high levels of withdrawal (Kintner 2009; Patterson 2005); in neither case would the level of withdrawal be described as problematic (not exceeding 25% of participants), and the stark relative effect was driven by very small sample sizes in some studies (Bruzzese 2008; Kintner 2009).

Figure 18. Forest plot of comparison: 1. Effect of school-based asthma interventions vs usual care, outcome: 1.13. Withdrawal from the study.



Despite the low level of heterogeneity, we have presented subgroup analyses because of the link between this outcome and the QCAs presented earlier. When we replicated one set of configurations in the subgroup analysis to mirror QCA findings (Analysis 9.3), we found weak/uncertain evidence to suggest that studies that used theory, while avoiding running the intervention in children's own time and having no substantial school staff involvement, were less likely to have children drop out before outcomes were assessed (OR 0.88, 95% CI 0.55 to 1.40; 4 studies) when compared with studies with other configurations of conditions (OR 1.23, 95% CI 0.95 to 1.58; 8 studies). We also found no evidence that withdrawal from the intervention was associated with school type (Figure 19).

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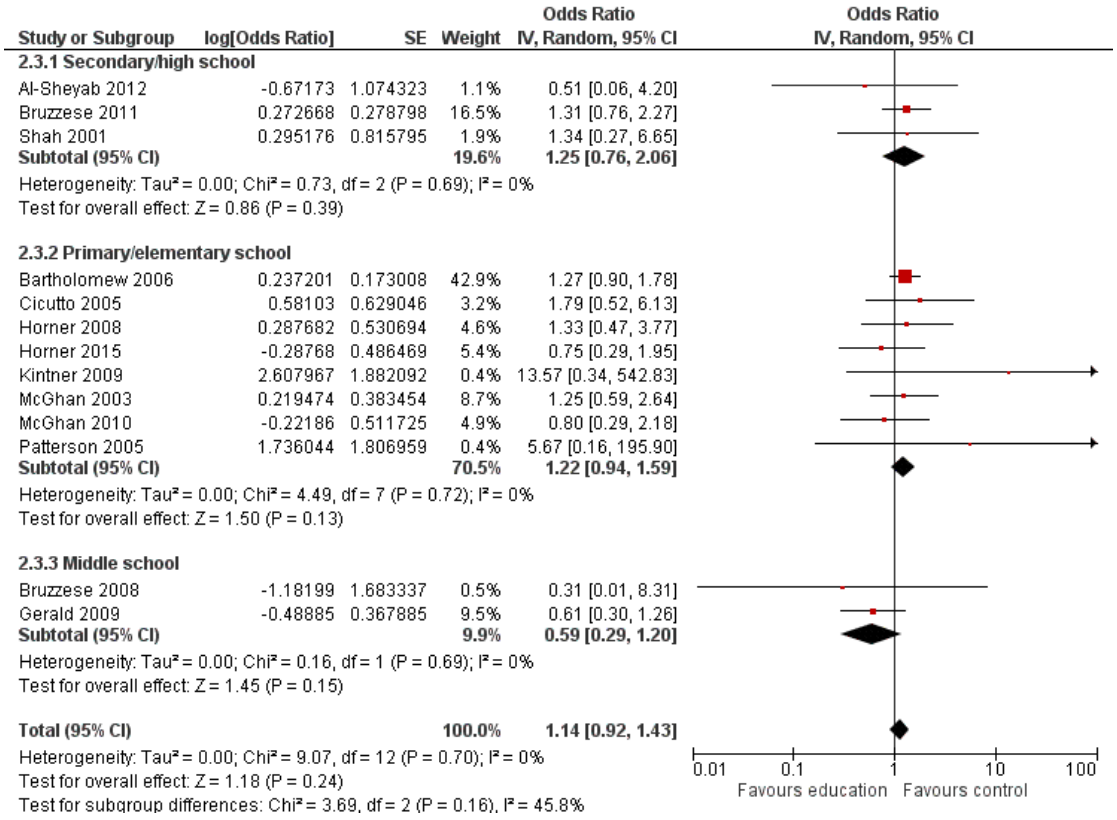
Figure 19. Forest plot of comparison: 2. Effect of school-based asthma interventions vs usual care subgrouped by school type, outcome: 2.3. Withdrawal from the study.



Subgroup analyses seeking to reveal patterns of heterogeneity in the odds of withdrawal did not show that timing of assessment, unit of randomisation (cluster vs individually randomised trials), or risk of bias explained patterns of withdrawal. This included risk of attrition bias assessments, although the meta-analysis explored differential patterns of attrition and did not account for instances in which both intervention and control groups had high levels of attrition (as was the case when risk of attrition bias was assessed). We found no evidence to show that publication bias was an issue in terms of withdrawal data. Because of the low level of statistical heterogeneity, fixed-effect and random-effects specifications for the meta-analyses were equivalent, with one study accounting for 46% of the weighting; we classified this study as having high risk of bias in three domains and unclear risk of bias in the remaining four domains (Bartholomew 2006).

Results of synthesis - part 3: adjunct meta-analyses exploring the link between implementation and effectiveness of school-based asthma self-management interventions

We conducted adjunct meta-analyses to explore whether interventions that were deemed successful in terms of implementation were also deemed successful in terms of their effectiveness (see Figure 2), using a subset of studies contained within the process evaluations. For inclusion in these analyses, we considered studies that included a control group; however studies could have employed randomisation or quasi-experimental methods, and control group children could have received an alternative intervention that might have included an asthma component.

Because of conceptual and methodological differences in study design, these studies provide indicative evidence only pertaining to the impact of self-management interventions on children's asthma outcomes, but they help us to establish links between implementation factors and asthma outcomes. Researchers defined successful implementation the same way it was defined in our QCA, and this represented a combined indicator around attrition, adherence, and dosage. We considered two outcomes - ED visits and school absences - when we found sufficient studies to form a meta-anal-

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ysis. Both models included effect sizes from seven studies, with five studies in each appearing in earlier meta-analyses (with studies considered as process and outcome evaluation studies (Bruzzese 2011; Cicutto 2013; Horner 2015; Howell 2005; Levy 2006)), and two studies in each meta-analysis included as process evaluation studies only (Joseph 2010; Joseph 2013).

Meta-analysis of ED visits shows that the included interventions were successful in reducing the number of ED visits (Figure 20; Analysis 11.1), but with a high I^2 value (52%) signalling substantial levels of heterogeneity. Subgroup analyses, based on implementation scores, indicated that studies classified as successfully implemented had a greater impact in reducing ED visits (SMD -0.26, 95% CI -0.48 to -0.04; 4 studies) than studies that were not as successful (SMD -0.09, 95% CI -0.28 to 0.10; 3 studies), although this difference was not statistically significant (P value for subgroup differences = 0.26). Meta-analysis of the impact of self-management interventions provided uncertain evidence that these interventions were successful in reducing children's absences from school (SMD -0.12, 95% CI -0.28 to 0.04; 7 studies). However, subgroup analyses based on the combined implementation score indicate that studies that were successfully implemented had significantly higher effect sizes (SMD -0.28, 95% CI -0.39 to -0.18; 3 studies) than those that were not successfully implemented (SMD 0.04, 95% CI -0.09 to 0.18; Figure 21).

Figure 20. Forest plot of comparison: 11. Adjunct analyses - impact of Implementation on selected outcomes, outcome: 11.1. Exacerbations leading to emergency department (ED) visits.

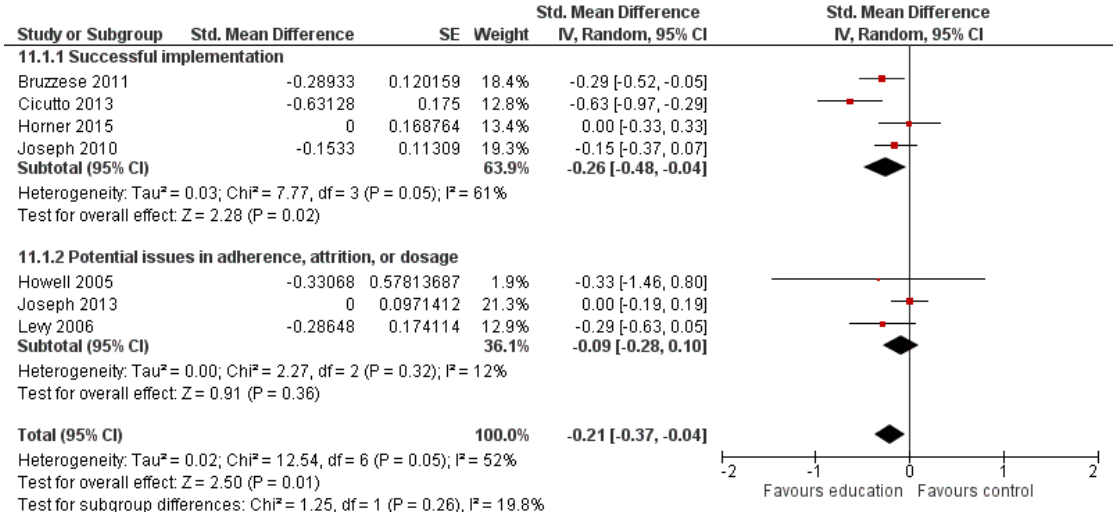

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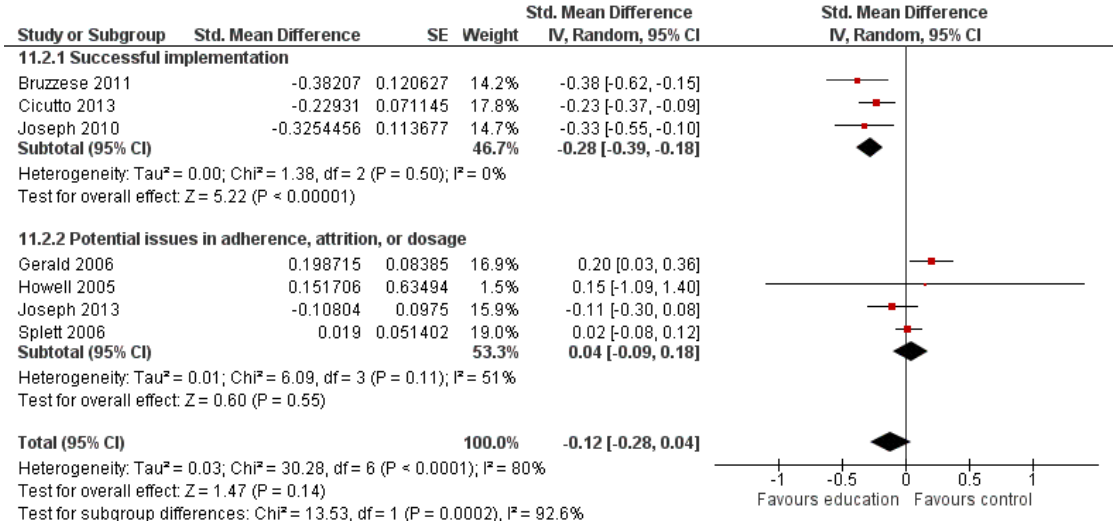
Figure 21. Forest plot of comparison: 11. Adjunct analyses - impact of Implementation on selected outcomes, outcome: 11.2. Absence from school.



In both models, had the focus been restricted to well-implemented studies only, the conclusions would have changed, and these studies would have provided evidence that school-based asthma self-management interventions were effective in reducing these outcomes. Although restricted to selected outcomes and a subset of studies, these models help to illuminate the links between successful implementation and intervention effectiveness, and provide justification for meta-analyses based on earlier QCAs to test emerging hypotheses.

Part 4: update of the logic model

Figure 22 presents an updated logic model. This is a graphical depiction of synthesised evidence showing that school-based asthma interventions have a positive impact in reducing healthcare usage, improving quality of life (albeit not at a clinically meaningful level), and reducing days of restricted activity (shaded green). These were termed 'intermediate outcomes' in our original model (Figure 1), although some of the pathways through which these improvements are achieved remain poorly understood, particularly around proximal outcomes including lung function and daytime/night-time symptoms (shaded blue and grey). We found evidence of a link between successful implementation (through results presented in part 3) and improved outcomes, although Figure 22 shows that other factors around the intervention design may directly lead to improvement in 'intermediate' outcomes. Of these, being theory driven is likely to be the most important element leading to successful implementation, and later, successfully improving children's outcomes, although the logic model shows that other conditions are likely to be important in certain circumstances.

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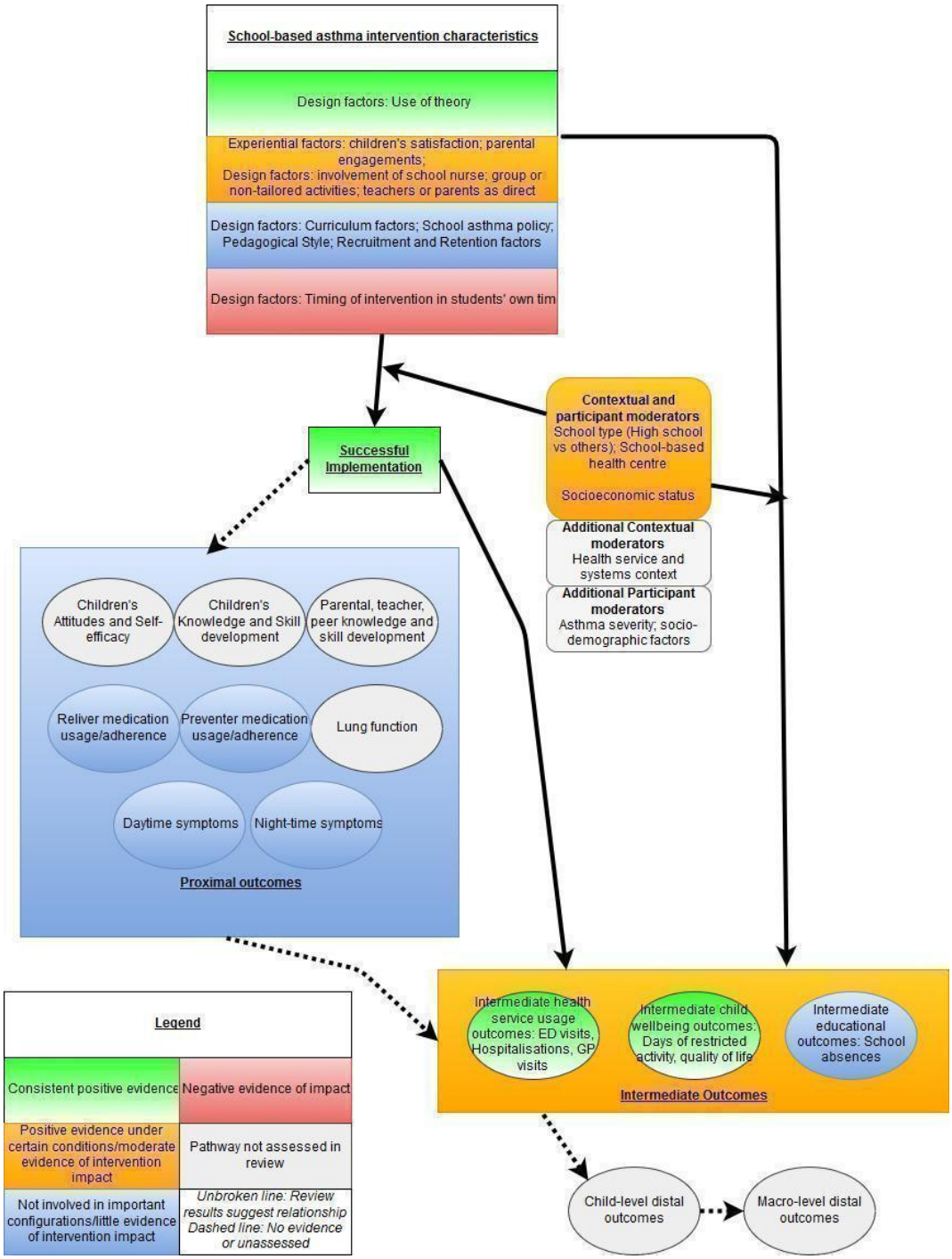
Figure 22.



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Use of QCA alongside meta-analysis has helped to disentangle the ways that school-based asthma interventions 'work' to a certain extent. The logic model helps to show the strength of evidence for many parts of the causal chain but also shows gaps in evidence on which future reviewers may focus their efforts (boxes shaded grey in Figure 22), including (I) establishing which proximal outcomes are important elements of the causal chain between intervention and intermediate outcomes; (ii) improving understanding of the role of contextual and participant characteristics; and (iii) examining distal characteristics and stability of improved outcomes.

DISCUSSION

Summary of main results

Summary and further description of qualitative comparative analysis (QCA) results

One of the most consistently positive conditions that appeared in configurations triggering a successfully run intervention was a named theoretical framework described as underpinning the intervention (Table 20). However, a diverse set of theoretical standpoints were represented (see Description of studies), and we are unable to attribute a successful intervention to a single conceptual or theoretical framework. Merely the use of named or explicitly expressed theory, in conjunction with other conditions, led to better implementation. These configurations also included interventions not run in children's own time, good levels of engagement from parents and satisfaction from children reported, and some configurations specific to high schools. It is not clear whether the theories used to underpin an intervention were equally suitable, and we were not able to ascertain how the theoretical framework was used to shape or inform different stages of the intervention.

We found that good levels of engagement from parents and positive experiences among children, in combination with other conditions, were sufficient conditions for a successful intervention. Positive parental engagement reflected high levels of co-operation in providing information to trialists, as noted by study authors (Dore-Stites 2007; Joseph 2013), or more active forms of engagement, including co-operation with home or school visits (Engelke 2013; Howell 2005), attendance at seminars (Bruzzese 2008), or telephone appointments received from the trialists (Engelke 2013). In contrast, a different set of studies reported difficulties in engaging parents to provide consent (when consent was actively sought) or to assist with data collection (Berg 2004; Gerald 2006; Terpstra 2012); difficulties in participation (Brasler 2006; Cicutto 2013; Kintner 2012; Kouba 2012; Levy 2006); or problems with adherence or behaviour change (Mujuru 2011). Children's satisfaction was found to be a sufficient condition for successful implementation (in combination with other conditions) and was collected in eight included studies, with four studies providing evidence that most children were satisfied through qualitative statements based on children's other stakeholders' perceptions (Al-Sheyab 2012a; Brasler 2006; Bruzzese 2004; Howell 2005), and four studies providing evidence based on quantitative data (Berg 2004; Bruzzese 2008; Dore-Stites 2007; Kintner 2012). None of the studies included in the QCAs reported low levels of child satisfaction, although one study (not included in the QCAs), which provided a low-intensity intervention, did report low levels, with low levels of satisfaction (64% and 67%) for some indicators (Jackson 2006).

With respect to school nurse involvement, the presence and involvement of school nurses in interventions appear to be instrumental in triggering a successful intervention under certain conditions when children are not engaged in personalised or tailored interventions. Finally, the timing of interventions was important in triggering successful interventions, with interventions that did not interrupt children's own time triggering successful implementation in two different configurations.

No single condition appeared in isolation as a trigger for successful implementation. This highlights the complexity of triggering a successful intervention, as well as the utility of the QCA approach in capturing complex causal recipes. This finding is further supported by modest levels of coverage of any pathway.

Summary of outcome evaluation results

Results from meta-analyses show that school-based self-management interventions led to small average improvements in several important outcomes, including hospitalisations (six studies), emergency department (ED) visits (13 studies), and health-related quality of life (seven studies). A smaller number of studies contributed to meta-analyses suggesting positive results for unplanned medical visits (five studies) and days of restricted activity (three studies). Effects on school absences, symptoms, and use of medication were also small, although our certainty for these outcomes was low or very low and confidence intervals included small or no effect. The effect on withdrawals suggested similar levels of attrition between intervention and control conditions.

The original logic model and the updated logic model show that evidence for effectiveness of the intervention was stronger than for urgent care contact and quality of life than for symptoms (Figure 1; Figure 22, respectively). We did not measure distal outcomes (e.g. academic achievement). This is likely a partial reflection of heterogeneity in measurement approach in terms of lung function and daytime and night-time symptoms.

Researchers observed the most prominent intervention impacts

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for outcomes involving healthcare usage. Although conceptually relatively homogeneous, they were measured in several different ways, prompting us to undertake several transformations to facilitate meta-analysis. The magnitude of effect sizes for hospitalisations, ED visits, and other instances of unplanned healthcare usage was similarly small across all three outcomes when considered in absolute terms. However, this indicates that intervention effect can also reach across children's healthcare pathways to include both primary and secondary episodes of care. In contrast, it was anticipated that a greater effect would be evident for school absences than was apparent in our review. However, heterogeneity was substantial in meta-analyses of school absence (I^2 = 70%), and additional subgroup analyses suggest that the way in which the intervention was implemented may have had a substantial impact on this outcome.

Effects of the intervention were relatively consistent across outcomes, with the exception of school absences and ED visits. Most planned investigations of heterogeneity were generally uninformative or inconclusive in explaining variation in our results. Indications suggest that both school type and age of the child may help to explain some between-study heterogeneity in models for school absence, with the intervention exerting a greater impact on older children in high schools, although this result was primarily driven by a single study (Bruzzese 2011). Two studies suggested that interventions with moderate to high numbers of children from lower socio-economic backgrounds (between 25% and 50% of children) resulted in fewer school absences for intervention children (Cicutto 2013; McGhan 2003), although the relationship between the proportion of children from a lower socio-economic background and effect size was not linear. We found generally mixed evidence around the impact of including parents. Based on subgroup analyses, interventions that did include parents appeared to confer no additional benefit compared with those that did not. Similarly, meta-analyses provided contrasting evidence as to whether involvement of school nurses had a positive impact on children's outcomes.

Contribution of a mixed methods approach

The mixed methods approach adopted here allowed us to (I) understand design and implementation processes associated with more successful implementation of school-based self-management interventions; (ii) develop judicious and theory-driven hypotheses for testing in subsequent meta-analyses with covariates that reflected configurations of study conditions as well as single conditions; and (ii) explore the links between successful implementation and intervention outcomes.

Adjunct analyses showed links between intervention implementation and more impactful interventions, although the strength of these relationships differed for Analysis 11.1 and Analysis 11.2. Analysis of ED visits did not rule out differential effects between subgroups. We classified implementation of the intervention as successful in four studies. Study authors reported lower levels of ED visits with the intervention, and this finding was consistent with results for subgroups of studies that classified interventions as not successful. However, the result was inconclusive for studies that did not implement the intervention successfully. In the case of school absence, evidence shows greater impact of studies that were well implemented versus those that were not successfully implemented. This held when we restricted our focus to direct comparison of interventions (five studies) versus usual care.

Meta-analyses based on the findings of earlier QCAs, which assessed the impact of school-based asthma self-management interventions in lowering levels of school absence, also show that individual conditions that were frequently part of configurations that triggered successful intervention implementation explained some of the between-study heterogeneity. Notably, studies that were theory driven had greater impact on reducing school absences than those that were not, with the confidence interval for the subgroup of studies that explicitly used theory clearly within the boundaries of an effective intervention.

Further meta-analyses suggesting that interventions that did not involve existing school staff in a substantial delivery or facilitating role were those that achieved greater levels of impact in lowering school absence. This corresponds with QCA findings that involvement of school staff could be counterproductive in certain configurations. Well-implemented interventions that are supported by theory and can be implemented independently of existing school staff appear to be sufficient for lowering levels of school absence in these analyses.

Translating evidence into practice

The financial implications of asthma treatment and care for healthcare systems are significant; costs up to £1 billion per year are reported in the UK. A formal economic evaluation would be needed to determine how the reduction in healthcare use observed in this review impacts the financial burden on healthcare systems incurred by managing asthma. Although a similar reduction in school absence has not been established in this review, subgroup analyses developed on the basis of earlier QCAs identified study-level characteristics associated with substantial reductions in absence, most notably interventions explicitly using theory.

In terms of the design of interventions, the importance of theory was emphasised in QCA results and was given further limited support by some of the subgroup analyses conducted as part of the meta-analyses. However, it is not clear if the use of theory in interventions is a marker of the quality of the interventions and the experience of researchers, or is more integral to intervention success and provides an anchor for trialists to return to and actively draw upon. Based on QCA results, when trialists take steps to measure levels of child satisfaction (including levels of enjoyment and fulfilment from activities), this is reflected in delivery of a successful intervention. The presence and involvement of school

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nurses appear to be instrumental in successful implementation of the intervention under certain conditions, particularly when children are not engaged in personalised or tailored interventions.

Overall completeness and applicability of evidence

Most of the included studies were conducted in the USA, specifically in inner city areas with large numbers of children from ethnic minority backgrounds and/or lower-income households; very few of the included studies came from the UK or Europe. Although we anticipated that broader contextual factors around health policy and access to health care are likely to shape the design and implementation of the intervention (see logic model in Figure 22), we have not synthesised the impact of these contextual factors.

The US focus of studies may have differing implications for the transferability of interventions. The nature of healthcare delivery and the large number of people without adequate healthcare coverage could mean that the intervention has a greater impact in US settings, particularly among lower-income populations with substantial levels of underdiagnosis and low levels of access to appropriate medication plans. Several interventions (e.g. those of Bruzzese 2011 and Gerald 2009) were developed precisely on the basis of this rationale, focusing on low-income groups or ethnic minority groups with inadequate access to health care, and selected schools as the delivery site because of the universality of education (as opposed to health care) in these settings. The implications for transferability could mean that weaker effect sizes are achieved in settings with better healthcare coverage, higher rates of diagnosis, and greater equality in access to medication (e.g. in settings such as the UK, where health care is universally free at the point of delivery). In contrast, many of the findings around intervention implementation are likely to be universal across several settings because of the relative universality of the way in which children attend schools, for example, better implementation when the intervention takes place outside children's own time.

Many outcomes with stronger evidence of an intervention effect were those commonly experienced by children with relatively severe asthma. For example, in Atherly 2009, when an intervention was implemented in high schools among children with mild to severe asthma, around 3% of children had been hospitalised for asthma at baseline, and less than 10% had visited an ED. Values suggesting that unplanned secondary healthcare utilisation is relatively rare among children with asthma are also observed in prevalence studies, for example, in Harris 2017, which examined asthma patterns in London high schools.

Many of the studies included in the QCA and in the meta-analyses were conducted as cluster randomised controlled trials (RCTs); however few of these studies described the impact of this clustering effect either quantitatively or qualitatively. It is likely that conducting school-level randomisation is an important consideration in terms of the feasibility of the study and serves as a step toward prevention of contamination of treatment impact, although the opportunity to explore implementation and impact of school-level designs is not taken up by many trialists. This means that we are unable to comment on the generalisability of study findings with regards to school cultures.

High schools were better represented among studies included as process evaluations than among those included as outcome evaluations. Whether this is a reflection of the challenge of implementing RCT designs in high schools compared to primary schools was not directly addressed by the studies included in this review, although distinct configurations of conditions that triggered successful interventions were identified in QCAs for high schools and/or older children. Meta-analyses revealed little 'qualitative' impact of conducting interventions in high schools rather than in other types of schools for most outcomes except school absences, although this assertion is based on inclusion of few high schools in subgroup analyses and low heterogeneity for many healthcare usage outcomes.

Many studies did not report on the outcomes specified in the protocol for this review and encountered further issues with the incompatibility of some reported effect sizes. In fact, any of the meta-analyses performed (the largest including 13 studies) provided only a partial account of the total number of studies included. Some models, especially subgroup analyses, may have been effectively underpowered. Future systematic reviewers exploring public health interventions may wish to explicitly include a narrative synthesis of all studies in terms of study design, which may examine both the nature of the intervention, the types of outcomes collected, and the impact of interventions on these outcomes, including graphical representations (Thomson 2013), for a more complete account and understanding of the impact and feasibility of the model.

Finally, because we excluded studies that delivered similar interventions in different settings, we do not know the added value of running an intervention in a school compared with running an intervention in a hospital or community setting. What is clear, however, is that schools provide access to large numbers of children with asthma, including those who do not regularly attend appointments with their medical provider; therefore the school environment can be considered an important third space for delivery of interventions that can improve both children's outcomes and healthcare usage. This review has shown that school-based self-management interventions are effective in improving several outcomes for children with asthma, and that those who design future interventions should consider a number of configurations, including instructor, theory, and time of day, in their design. The outcomes of this review will directly inform the development of a school-based self-management intervention for children with asthma in London secondary schools.

Certainty of the evidence

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The 'Summary of findings' table highlights our reasons for downgrading the certainty of evidence for the main outcomes of interest in this review, with process evaluations considered separately below. We noted issues in the execution of all studies, although the impact of risk of bias differed across outcomes. We deemed that several studies had high or unclear risk of bias, although these results did not appear to inflate the effect size relative to that provided by low-risk studies, and in most cases they did not influence the direction of effect. Studies that we deemed to have unclear or high risk of bias may nevertheless have contributed to decisions to downgrade the certainty of evidence through other factors, including directness of outcome measurements. For example, school absences were measured in a variety of ways, and not all approaches were specific to asthma-related school absences.

We deemed the certainty of evidence to be moderate for four outcomes delineated in the 'Summary of findings' table: hospitalisation, unplanned medical visits, quality of life, and symptoms. Each of these outcomes showed positive intervention effects (or effects that were very close to being classed as positive effects in the case of daytime symptoms). For two of the outcomes reported in the 'Summary of findings' table, we deemed that the certainty of evidence was low (school absences and ED visits), and we found evidence certainty to be very low for a further outcome on medication usage. Again, indirectness and unexplained heterogeneity were the main drivers for downgrading of evidence.

Additional considerations not necessarily captured in the 'Summary of findings' table should be considered when quality of the evidence is examined. First, we decided to include in our analyses some cluster RCTs with relatively low numbers of clusters. Although these studies tended to be comparatively small by their nature and therefore did not contribute greatly to pooled effect sizes, there remains the possibility that the intervention effects are slightly exaggerated compared to those of individually randomised trials or large cluster RCTs (see also the section on bias below). Nevertheless, this risk should be balanced against the potential bias introduced by overlooking information from such (smaller) trials. Similarly, effect sizes were harmonised for most outcomes, with the most substantial transformations involving conversion between standardised mean differences (SMDs) and odds ratios (ORs) to develop a common metric; although this appeared to have minimal impact, and different effect sizes tended to be consistent in direction/impact regardless of original measurement (see Analysis 12.1 through to Analysis 12.27), this is further evidence of indirectness in outcome measures, which is an indicator of lower-certainty evidence.

In contrast, we judged the quality of the process evaluation literature to be almost uniformly poor, with many studies having high or unclear risk of bias across several domains. This is likely due to various factors but most plausibly is a reflection of previous lack of guidance around the conduct of process evaluations, as well as difficulty in identifying process evaluations in the literature; there remains a methodological gap in terms of tools to report on and help in identifying process evaluations (as opposed to guidance on conducting process evaluations (Moore 2015)). This review included process evaluation studies that were integrated with outcome evaluation studies, that were presented as separate sections, or that could be considered stand-alone evaluations. The tool used to measure risk of bias in process evaluation studies was an amalgamation of two tools used in reviews of process evaluation studies and resulted in a comprehensive assessment (O'Mara-Eves 2013; Shepherd 2010). We deemed only four studies to have low risk of bias in most domains (Bruzzese 2011; Kintner 2012; Kouba 2012; Mujuru 2011). Of these, only Kintner 2012 could be considered a stand-alone evaluation, with Mujuru 2011 including defined sections evaluating processes, and Bruzzese 2011 and Kouba 2012 presenting process evaluation data that were more integrated. We classified the latter two studies as process evaluations due to their exploration of process-related questions using recognised tools and exploration of context and potential mechanisms. The main weakness of the process evaluation studies included is that they lacked breadth and had considered only a single process of importance in-depth. The impact of these poor quality studies on the QCA is difficult to ascertain, although absence of richer and broader process data may have been a factor as to why we were able to explain only a relatively modest amount of successful implementation via QCA models. A commonly occurring risk of bias among the included process evaluation studies is that the tools and methods of collecting and analysing data were not always deemed to be reliable or credible.

Potential biases in the review process

Current evidence around the introduction of potential bias through restrictions on publication language is mixed, with some recent studies finding no systematic bias in effect size estimates when languages other than English were excluded (Morrison 2012), although many remain concerned that the results of ineffective trials will be submitted to local (non-English language) journals, leading to the potential for language restrictions and systematic bias (Guyatt 2011). We assessed a potential impact of this restriction by conducting explorations of the impact of publication bias. Imposing a language restriction may also have influenced results of the synthesis of process evaluation data, and may impede the generalisability of results to individuals of non-English speaking cultures, although we were not able to explore the impact of this decision in this review.

We encountered the following limitations in the review process.

- **Potential measurement error:** we noted variation in the way in which many outcomes were measured, for example, lung function and school absences. Although no 'gold standard' is available for measuring school absences, lack of continuity across studies may reduce the validity of findings. Further, data for both school attendances and healthcare use may be subject to substantial measurement error, for example, we cannot say for

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certain that all school absences and healthcare visits that were recorded were specifically due to asthma, or were authorised by either the school or the medical centre. Similarly, measurement error may be a factor with some of the covariates used in subgroup analyses, for example, socio-economic status (SES) can be measured in different ways - through stated household income or evidence of free school meals - although it was not possible to further explore these differences in measurement in the present review.

- **Effect size transformations:** this review sought to include comprehensive trial data within meta-analytical models, while maintaining construct validity across effect sizes. This often necessitated transforming the data to ensure statistical compatibility, following recommendations within the *Cochrane Handbook for Systematic Reviews of Interventions*, and undertaking Chinn's transformation (Chinn 2000). Although we have attempted to ensure transparency in fully presenting disaggregated effect sizes alongside those that have been consolidated, and despite sensitivity analyses conducted to ensure the validity of findings, there is potential for these analyses themselves to be confounded, and underlying assumptions around the transformation of effect sizes may not hold with further interrogation. For example, to facilitate transformations, we combined data on SMDs and ORs, although the skewness usually associated with data such as hospitalisations, for example, may not have been fully accounted for in the transformation. This is an important limitation, but it needs to be balanced against research wastage and information lost by excluding studies that use different approaches in measuring outcomes. Encountering such diverse data reinforces our recommendation below for development of a core outcome set.
- **Potentially underpowered analyses and treatment of heterogeneity:** we included few studies in many of the meta-analysis models, and for random-effects models, the models themselves may have been underpowered (Jackson 2017). In addition, when heterogeneity was encountered, the low number of studies meant either that subgroup analyses were unsuitable, or that the subgroups themselves included few studies. We deemed that planned meta-regression analyses were not suitable for any of the outcomes. Furthermore, unlike many other systematic reviews, we did not present all planned subgroup analyses when we encountered a low number of studies (under 10) and/or a low level of heterogeneity; in this respect, several deviations from the protocol occurred. However, we have greater confidence in the results of subgroup analyses because of our judicious use of these methods.
- **Identification of process evaluation studies:** identification of process evaluations was a challenge in this review. Although guidance is available to assist trialists in conducting a process evaluation (Moore 2015), this did not necessarily aid in the identification of process evaluation studies from a systematic review perspective. All process evaluation studies included an examination of a given process (or processes) and implementation outcome(s) of interest, as well as their relationship to context (in this case, the immediate context of the schools). However, this group spanned a range of studies - from those that were self-described process evaluations, to those with defined process evaluation sections, to those that included process evaluation data embedded within other evaluation data. Although we developed an inclusive strategy around identification of process evaluation studies, there remains the possibility that some trialists may not have considered their own study as fulfilling the remit of a process evaluation. In addition, although guidance for process evaluations states that they can adopt a range of methods for data collection (Moore 2015), unlike other recent reviews (Dickson 2016), many of the studies that we included did not draw upon robust qualitative methods of data collection, which in turn may have limited our understanding of some of the issues surrounding implementation. Consequently, we deemed there remained greater scope within several of the included studies to explore the way in which the school context, and particularly the broader health service context, influenced delivery of the intervention, and we graded much of the process evaluation information as having high risk of bias because of this weakness. This review highlights the need for greater support for review authors in identifying process evaluation studies. In the current review, our original logic model was instrumental in helping to identify the processes and process metrics of interest and informed the selection of studies (Figure 1); in the absence of clearer guidance in this area, the use of logic models may represent an important step in helping review authors to draw criteria around which processes should be considered in a process evaluation.
- **Harmful effects:** some studies reported negative intervention impacts among children, such as increased levels of ED visits. Such negative effects may reflect the content of self-management information delivered to children, which may, for example, have recommended greater contact with healthcare providers when experiencing exacerbations (although such detail was not reported in studies), in which case an increase in ED visits could be viewed as a positive. A narrative approach to synthesis of outcome evaluations data could lead to a more nuanced understanding.
- **Alternative explanations:** many other factors might also have influenced review results. For example, although these are school-based asthma self-management interventions, few, if any, of the studies considered seasonality of asthma exacerbations and their relationship within the school year. Another Cochrane Review considered the issue of seasonality and showed that seasonal omalizumab treatment between four and six weeks before children return to school might reduce the number of asthma exacerbations seen in autumn (Pike 2018); however the effect of this on outcomes such as asthma control remains unclear.

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- **Low number of clusters:** some of the cluster RCTs included in this review randomised only a small number of schools. Although it is universally agreed that randomising one cluster per arm would entirely conflate the randomisation/intervention and clustering effect, there is less agreement on the minimum number of clusters needed for a study to qualify as a cluster RCT (one source recommends four clusters per arm). Studies involving a low number of clusters are generally indicative of a small trial and often contribute only sparse data to any one model. Sensitivity analyses for studies with a low number of clusters per arm were conducted (two or three clusters per arm: Al-Sheyab 2012; Howell 2005; Kintner 2012; Shah 2001; Velsor-Friedrich 2005). Results were generally inconclusive and inclusion/exclusion of these studies in models did not qualitatively change results of meta-analyses, with the exception of Al-Sheyab 2012 in one quality of life model. These studies may be particularly prone to baseline imbalances, as well as to issues involving introduction of bias, and their inclusion does represent a potential source of bias.

Agreements and disagreements with other studies or reviews

This review is one of the first of its kind to employ a mixed study and mixed methods approach to understanding how school-based asthma self-management interventions work, and whether they are effective. It is also the first to undertake quantitative synthesis of studies seeking to develop children's asthma self-management skills in the school environment. Direct comparisons are challenging, but a number of similar reviews have focused on different settings, different study designs, or use of different synthesis methods, which allows us to understand results in the context of other evidence.

Pinnock 2015 is one of few reviews that have explored how asthma self-management interventions should be implemented. Review authors focused on a range of settings and age groups and addressed a targeted question around whether interventions primarily targeted at patients, professionals, or the organisation, or explicitly targeting all three levels simultaneously, were differentially effective in changing outcomes, or in changing process measures. They found that complex interventions that explicitly address patient education, professional training, and organisational commitment were associated with improvements in process measures, markers of asthma control, and reduced use of unscheduled health care. Their conclusions that 'individually, the separate components (professional, patient, organisation) of comprehensive self-management support do not appear to be sufficient consistently to improve outcomes in asthma' (p14) are congruent with our own findings from QCA synthesis, which emphasised that no single condition was necessary and sufficient to trigger successful implementation outside a configuration of conditions.

An earlier Cochrane Review explored the effectiveness of self-management education interventions for children aged two to 18 with asthma across a range of settings between 1980 and 2002 (Wolf 2002). Review findings were similar to the findings of this review, with data suggestive of moderate reductions in ED visits and in days of restricted activity. This earlier review also found evidence that self-management education led to a small reduction in school absences, and review authors were able to ascertain a small impact on lung function. It is unclear to what extent the discrepancy in settings, age groups, or inclusion criteria for studies on date would drive the discrepancy in school absence, or another factor. In contrast to the promising results observed for night-time symptoms in the previous review (Wolf 2002), our review did not find evidence that the intervention made a positive impact, although this was consistent with the findings of a later review that narratively summarised study results (Coffman 2009).

Subsequent reviews include Al Aloola 2014, which focused on primary schools and used a narrative approach to synthesise data. Review authors concluded that most studies were suggestive of positive effects, but as was the case in the present review, they were critical of the measurement of outcomes, which varied greatly among included studies. They also highlighted lack of detail in the descriptions provided for intervention content and processes, which is consistent with the outcome evaluations included here. Ahmad 2011 also took a narrative approach to synthesising outcome data from studies that involved school nurses, but nevertheless concluded that results indicated that a decrease in school absences could be expected, but that results for reductions in ED visits and hospital admissions were less certain, in contrast to the results provided here. Coffman 2009 also undertook a narrative descriptive synthesis of the effectiveness of a school-based approach, although review authors concluded that there was heterogeneity in the direction and/or magnitude of effect on quality of life, symptom days, night-time symptoms, and school absences, which largely corroborates the findings of the present review. Finally, a more recent review included school-based self-management interventions provided across a diffuse set of studies with regards to design (Carvalho 2016). These review authors also took a narrative approach when synthesising study results, and again showed an overall trend suggestive of heterogeneity in magnitude and direction of effect across a range of outcomes.

This systematic review makes a contribution to the literature by providing the first meta-analyses of asthma self-management interventions focused in schools, and it provides evidence of the effectiveness of this approach in reducing healthcare usage. Methodologically, this is also one of the first Cochrane Reviews to employ a mixed methods approach in synthesising evidence. This mixed methods approach helped to show that although intervention as a whole did not appear to be effective in reducing school absences, interventions that were drawing upon theory were effective in improving school absences.

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AUTHORS' CONCLUSIONS

Implications for practice

School-based asthma self-management interventions probably reduce hospitalisations and improve symptoms (moderate-certainty evidence), may lower emergency department (ED) attendance (low-certainty evidence), and may decrease children's unplanned and urgent healthcare visits (low-certainty evidence). Their impact on school absence varied between studies (low-certainty evidence), and probably lead to small improvements in quality of life (moderate-certainty evidence). The effects of these interventions on the requirement for reliever medication are uncertain.

Hospitalisation was reduced by an average of about 0.16 admissions per child over a 12-month period. The proportion of children attending the ED was reduced from 75 per 1000 children to 54 per 1000 children over the course of a year. Similar results were observed for unplanned medical visits. For health policy-makers, the results highlight that schools may be an effective location for delivering asthma self-management interventions to potentially large numbers of children, although formal cost-effectiveness analysis is needed to determine how reductions in healthcare usage affect financial burden on health systems. Many of the included studies tested the intervention among financially deprived populations, and judging the applicability of the results to more socially diverse populations is difficult.

The mixed methods design of this review has revealed important features of interventions that are of particular interest to educational practitioners and teachers. Variation in school absences may be driven by the results from a subset of explicitly theory-driven interventions that achieved modest decreases. Trialists may wish to take account of this when designing interventions that they intend to evaluate. Our process evaluation shows that when trialists are concerned about the level of child satisfaction (including levels of enjoyment and fulfilment from activities), and when they take steps to measure levels of satisfaction, this is reflected in the delivery of a successfully implemented intervention.

Implications for research

The evidence presented in this review for school-based asthma self-management interventions varies in degrees of certainty across the outcomes of interest. The updated logic model summarises where evidence has been identified but also highlights where uncertainties remain (Figure 22). In particular, the mechanisms that link participation in a school-based asthma intervention with achievement of these relatively distal outcomes remain undefined. Many analyses of intermediary outcomes provided inconclusive evidence (e.g. analyses reported asthma symptoms (Analysis 1.6; Analysis 1.7); data were insufficient for inclusion in meta-analyses (e.g. lung function data (see Table 13)). In other cases, these outcomes were not included in our protocol. For example, although knowledge was not explicitly measured, we can hypothesise that knowledge and skill development are essential components for changes in self-management and therefore changes in healthcare usage. The current review also did not assess these, and overall, many of the intermediary stages and accompanying changes in healthcare service usage between receipt of the intervention and behaviour change remain unidentified, signalling some of the pathways for future research.

Evaluation of healthcare usage in future studies would help to establish whether the intervention effect transfers to other settings. Researchers providing data on ED visits observed heterogeneity in the magnitude and direction of effect across studies. Research conducted specifically to determine when and how the intervention might increase attendance as observed for a subset of studies would help to explain the variation in direction of effect. For example, although baseline imbalances may be a contributory factor in explaining negative or negligible impacts for some studies implementing the "Roaring Adventures of Puff" manualised intervention in certain settings (McGhan 2003; McGhan 2010), further targeted analyses may reveal the context and mechanisms that explain its effectiveness in others (Cicutto 2005; Cicutto 2013).

This review identified a heterogeneous group of process evaluation studies that were often of low quality and did not present a broad or deep understanding of the processes undertaken and the mechanisms of action reflective of the complexity of the intervention. The quality of the process evaluation literature has been criticised previously (Oakley 2006), and this is relevant when one seeks to understand the causal chains of actions occurring within public health interventions such as school-based asthma self-management interventions. Although guidance on the conduct of process evaluation studies is available (Moore 2015), this review highlights that many trialists do not adequately assess the implementation and context of their interventions. It is notable that only a third of included studies contributed to both sets of syntheses conducted in our review. Enhancing understanding of the barriers preventing conduct and publication of process evaluations is a priority for future research. Systematic reviews would benefit from the development of a tool or checklist that can be used to help identify process evaluation studies during screening and/or to better design searches for relevant studies.

The largest meta-analysis includes 13 of the 33 RCTs identified in this review. The need for a more standardised approach to evaluating key asthma outcomes is clear based on this finding. Approaches to developing core outcome sets for clinical trials are increasingly common (Williamson 2012). Some work has been undertaken to consider which domains should be captured in trials involving children with asthma (Sinha 2012). Our review shows that many studies, including those recently published, continue to capture diffuse outcomes that may have little clinical value and/or policy resonance. Further development, refinement, and implementation of a core outcome set for this intervention model would be welcome and would facilitate future reviews, which could include

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information not only on which domains should be captured, but also on how this information should be measured.

Subgroup analyses suggest that intervention effects were generally consistent across different types of schools (high/senior vs primary/elementary schools) for outcomes for which we were able to explore differences in effect size. However, further studies within high/senior schools are needed to extend the applicability of the evidence base to children older than those recruited to many of the studies to date. These results should also be considered in light of results from process evaluations, which suggest that the distinction between high/senior school and other types of schools may be important from an implementation perspective, necessitating a modified approach to the design and running of school-based asthma self-management interventions.

Although this review has shown that schools can provide an effective setting for self-management interventions that reduce healthcare usage, we have not been able to explore the optimal setting. This would be a natural direction for future primary research studies and systematic reviews. In addition, although the intervention aim and the setting were the same in all studies included here, interventions have differed substantially. Future reviews should explore whether differences in outcomes are observed across different modes of asthma intervention, and should examine the comparative effectiveness of different programmes (e.g. Open Airways for Schools). Review authors could provide a better understanding of the links between intervention input and more distal outcomes, and this may prove valuable for public health decision-makers. The feasibility of such research is contingent on emergence of a more mature evidence base for this type of intervention in terms of the number of available studies, as well as improvements in collection of standardised outcomes and reporting of processes undertaken and implemented.

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* *Indicates the major publication for the study*

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Al-Sheyab 2012

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** study was conducted in 4 public high schools in the Irbid region of northern Jordan - 2 schools randomised to intervention arm and 2 to control arm **Period:** dates in which study was conducted - intervention and subsequent data collection - not clear
Participants	**Eligible sample frame:** 261 pupils found to be eligible **Randomised:** 261 pupils randomised at the school level: 132 to the treatment group and 129 to the control group **Completed (intervention):** 244 pupils completed the trial **Inclusion criteria:** students were eligible for participation in the study if they had reported wheezing in the last 12 months as identified by the Arabic version of the ISAAC written questionnaire; were physically and cognitively capable of completing the survey; were able to read and converse in both Arabic and English; and regularly attended school classes **Exclusion criteria:** students with other diseases that could affect quality of life measures or who were concurrently involved in another health-related study were not eligible **Baseline characteristics** **Age of children:** exact age not given; all children in years 8, 9, and 10 (usually 12 to 15 years old) **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** 113 female participants (43.3%); note intervention and control took place in single-sex schools (1 of each in treatment and control arms) **Asthma status:** 184 students (70.5%) had a formal asthma diagnosis; 87 students (33.3%) reported use of reliever medication; and 57 students (21.8%) reported use of preventer medication
Interventions	**Intervention:** bilingual health workers trained peer leaders from year 11 to deliver 3 Triple-A lessons. The content of Triple-A is not described here, but typical topics in Triple-A include basic information on asthma, its triggers, and management; and barriers to optimal asthma management, including risk-taking behaviours such as smoking (see earlier description of Triple A provided in Gibson 1998) **Control:** not clearly stated (usual care) **Intensity:** target asthmatic students received 3 lessons from peer leaders (year 11 students) **Instructor:** peers **Theoretical framework:** theories involving self-efficacy underpinned the intervention **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported

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Outcomes	**Extractable outcomes were collected for:** Health-related quality of life (measured through the Paediatric Asthma Quality of Life Questionnaire) Withdrawal
Notes	This intervention tests a model of asthma self-management education developed elsewhere, although modifications to the intervention are not fully described Considered as a process evaluation but excluded as did not seek to address process evaluation research questions **Funding source: J**ordan University of Science and Technology (Irbid, Jordon) and Nursing Council

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Low risk - closed-envelope technique used to select initial schools that were stratified by gender
Allocation concealment (selection bias)	High risk	Closed envelope, although no further details were provided and only a small number of schools (4) were involved, potentially compromising the concealment of allocation
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No further details were given around blinding of personnel and participants
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No further details were given around blinding of outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low levels of attrition, roughly spread across intervention and control arms
Selective reporting (reporting bias)	Low risk	All stated outcomes were reported upon
Other bias	Unclear risk	Missingness - low risk - low levels of missingness Baseline imbalance - high risk - differences in asthma reliever therapies at baseline between groups Risk of contamination - low - school-based randomisation minimises the potential for contamination between intervention and control groups

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Al-Sheyab 2012 (*Continued*)

Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Al-Sheyab 2012a

Methods	**Included as process evaluation** **Intervention study design:** non-experimental design with post-test only evaluation of feasibility among intervention groups **Unit of allocation:** N/A **Process evaluation methods:** surveys and focus groups among key stakeholders
Participants	**Setting:** a private girl's high school in Jordan **Age of children:** students in years 7 to 11 received the intervention delivered by children in years 10 and 11

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	Child characteristics (BME/SES): no information **Asthma status:** no information **Intervention recipients:** children only
Interventions	**School type:** high school (private girl's high school) **Intervention description:** study authors report that the Adolescent Asthma Action (Triple A) programme uses a 3-step cascade process from senior to junior students to deliver asthma education and has well-developed resources, including standardised training manuals, educational videos, asthma-related models and devices, and first aid kits. Trained health workers provide initial training for peer leaders and facilitate the steps of the programme. Programme content covers management of asthma exacerbations, resisting pressure to smoke, and asthma medication and triggers. Programme delivery occurs through interactive teaching and learning activities, including role-play and group discussion, all of which are said to be more effective than traditional didactic education for adolescents **Control description:** N/A - feasibility study with no control group **Theoretical framework:** study authors report that Triple A is grounded in universally applicable theoretical concepts including peer leadership, self-efficacy, and empowerment, suggesting its potential for use in different cultural contexts
Outcomes	**Core processes evaluated (child level):** the intervention explores child satisfaction in-depth, with the intervention ostensibly implemented as intended
Notes	**Process evaluation category:** stand-alone; core process questions were central **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** featured but not sufficiently; unclear about the extent to which children were able to express negative views of the intervention **Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A

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Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly reported
Explicit theories underpinning and/or literature review	Unclear risk	Literature was sufficient to support the direction of the intervention, but a specific theory was not named to provide evidence of a sound theoretical basis
Transparent and clearly stated methods and tools	Unclear risk	Data collection methods and tools were reported; however data analysis methods are unclear
Selective reporting	High risk	Absence of outcome data (e.g. asthma-related emergencies) directly related to the aims of the programme
Harmful effects	High risk	No evidence that any harmful effects were considered
Population and sample described well	High risk	Difficulty in distinguishing between numbers involved in the intervention and numbers involved in the process evaluation
Continuous evaluation	High risk	Data collected only post intervention
Evaluation participation equity and sampling	Unclear risk	Although the voice of young people was given prominence, it is unclear whether intervention sessions required school lessons to be moved, and how teachers felt about this
Design and methods overall approach	High risk	Description of research design and methods was limited, particularly with regards to the analysis, as study authors stated that this was beyond the scope of the study
Tools and methods of data collection reliable/credible	Low risk	Instruments used were suitable for the study and have been implemented elsewhere
Tools and methods of data analysis reliable/credible	High risk	Study authors did not report on an analytical framework and did not describe the methods used for data analysis
Performance bias/neutrality/credibility/conformability	Unclear risk	Unclear whether this was addressed during the study

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Al-Sheyab 2012a (*Continued*)

Reliability of findings and recommendations	High risk	Study authors considered this to be a feasibility study, and the paper suggests that it was conducted successfully. However, the data presented do not support this in all instances
Transferability of findings	High risk	Study authors acknowledged that findings were limited in transferability, as the sample was derived from a single private girl's school, where English was not studied extensively
Overall risk of bias of process evaluation	High risk	This study had many unclear or high risk of bias classifications

Atherly 2009

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT **Setting:** junior high and high schools **Period:** 2003-2004 school year
Participants	**Eligible sample frame:** not reported **Randomised:** numbers for these data are disaggregated. The study included 524 children: 458 children randomised at the school level: 225 to the intervention group; and 233 to the control group **Completed (intervention):** 458 **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** mean age, 13.9 in the intervention group; 13.4 in the control group **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** 46.6% female in the intervention group; 50.7% female in the control group **Asthma status:** asthmatic children only
Interventions	**Intervention:** the Power Breathing programme focused on education about asthma, asthma control strategies, and psychosocial concerns **Control:** not reported **Intensity:** three 90-minute educational sessions **Instructor:** teachers and school nurses were involved in the intervention; however their role is unclear **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported

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Outcomes	**Extractable outcomes were collected for:** Exacerbations leading to admission to hospital Asthma symptoms leading to an emergency hospital visit Experience of daytime and night-time symptoms
Notes	Study presented an economic evaluation of the intervention Considered for inclusion as a process evaluation but not deemed to fulfil the criteria of a process evaluation **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No detail provided on random assignment procedures "The schools were then randomly assigned to the intervention or control group"
Allocation concealment (selection bias)	Unclear risk	Not addressed by study authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	High risk	Although attrition was relatively low overall, the study did not provide details of the spread of attrition across arms and was deemed at high risk of bias "The study included 524 adolescents in grades 6-12 from middle and high schools. Surveys were administered at baseline, immediately postintervention and three months post-intervention. A total of 458 children completed all surveys, including 225 in the intervention group and 233 in the control group"
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting
Other bias	High risk	Missingness - low risk - besides attrition, no additional missing data were reported Baseline imbalance - high risk - indications showed poorer asthma control at baseline

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		in the control group (e.g. higher level of ED visits) Risk of contamination - low - randomisation occurred at a school level
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

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Bartholomew 2006

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** study was conducted across inner city elementary schools in Texas, USA. All schools from a single district were invited to participate, with 84 agreeing to participate. 60 schools were selected because two-thirds of students were in receipt of free school meals **Period:** study conducted and data collected from 1997 to 2000
Participants	**Eligible sample frame:** 982 pupils eligible and consented **Randomised:** 946 pupils randomised at school level: 515 into treatment group and 431 into control group **Completed (intervention):** 503 pupils were available at follow-up; 16 had actively withdrawn, 325 were lost to follow-up, and 102 had graduated **Inclusion criteria:** not clearly stated - case detection procedure implemented to discover asthmatic students **Exclusion criteria:** not clearly stated at child level (school-level criteria included that schools would have two-thirds of pupils in receipt of free school meals) **Baseline characteristics** **Age of children:** based on reports from 88.3% of pupils: mean age 7.7 years **Ethnicity:** based on reports from 88.3% of pupils: 45% of children were African American, 51% Hispanic, 3% Caucasian, and 1% from other ethnic groups **Socio-economic status:** most students were from households with incomes < $20,000 per year; 28% reported incomes < $9999 **Gender:** based on reports from 88.3% of pupils: 400 girls (47.9%) and 435 boys (52.1%) **Asthma status:** indicators of asthma severity not provided
Interventions	**Intervention:** multi-component intervention involving direct delivery to children, care providers, and parents/guardians. Children received self-management education through the "Watch, Discover, Think, and Act" interactive computer programme, which was based on National Institutes of Health guidelines and pedagogical and self-management theories. Children participated in the intervention for approximately 1 year, during which time they played the computer game and their parents received training materials on managing asthma. School nurses received training to improve communication with community primary care providers and to encourage greater monitoring of children's asthma status. Children with persistent asthma in 15 schools received an enhanced intervention, which involved meetings with a project physician to develop an Asthma Action Plan and receipt of a month's supply of medication, with the plan sent to the child's community primary care provider. Researchers also assessed the quality of the school environment with regards to asthma triggers in intervention schools and communicated these findings with recommendations to schools **Control:** not clearly stated (usual care) **Intensity:** not clearly described: children were involved in the intervention over the course of a year, and all children completed all levels of the intervention computer programme, although patterns and intensity of usage were not described **Instructor:** main standardised instruction provided through a computer programme; other components involved school nurses **Theoretical framework:** a logic model was provided and the computer programme was

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	reported as being based on social cognitive theory **Parental engagement:** not reported directly. Problems reported in gaining consent: "only about 64% of parents returned case detection surveys, and about half of the families of children with probable asthma agreed to participate in the study" **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	Withdrawal from study
Notes	Several primary outcomes of interest were collected but were not disaggregated by treatment status (exacerbations leading to admission to hospital and absence from school) or were not presented in the results (asthma symptoms leading to emergency department visits) Also considered for possible inclusion as a process evaluation - while the study purports to include a process evaluation section, this was not deemed to include the core components of a process evaluation (i.e. at least a partial focus on implementation outcomes and the relationship with context) **Funding source:** National Heart, Lung, and Blood Institute, National Institutes of Health

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No information was provided on how randomisation occurred, except schools were randomly assigned to treatment and control groups
Allocation concealment (selection bias)	Unclear risk	No information was provided on how allocation of schools occurred, except that schools were randomly assigned to treatment and control groups Also little detail on how schools were additionally allocated to enhanced intervention: in 15 schools, an enhanced intervention allowed children and their parents to meet with a project physician, develop an asthma action plan, and receive a 1-month supply of medication; the project physician then followed up with the child's community physician
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No measures to limit performance and detection biases were described (not considered by trial authors)

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Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No measures to blind outcome assessment were described (not considered by trial authors)
Incomplete outcome data (attrition bias) All outcomes	High risk	Very high levels of attrition were noted in both outcome and control groups: 43% in control and 49.5% in treatment at post test. Some evidence provided by study authors indicated that "attrition did not create any significant group differences in the variables measured in the study sample"
Selective reporting (reporting bias)	High risk	Some outcomes were not reported or results were not disaggregated by intervention and control (e.g. levels of hospitalisation)
Other bias	High risk	Missingness - children were not tracked from school to school because of problems with treatment and control group migration. Around 10% of children had missing data at baseline or were not considered to have "usable data", and no imputation strategies were described Baseline imbalance - no data on baseline demographic characteristics were given to illuminate the split between control and intervention groups. No differences between groups were found in health status variables, school performance, attendance, or levels of environmental allergens in schools Risk of contamination - low - randomisation occurred at the school level
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A

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Bartholomew 2006 (*Continued*)

Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Berg 2004

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, post test **Unit of allocation:** not reported **Process evaluation methods:** descriptive/bivariate (surveys), thematic/grounded theory
Participants	**Country:** USA **Age of children:** 15 to 18 years **Child characteristics (BME/SES):** 46.2% were of African American ethnicity. The sample was 69.2% female; SES information was not reported **Asthma status:** asthmatic only **Intervention recipients:** children only
Interventions	**School type:** intervention was implemented in 1 high school **Intervention description:** the Power Breathing programme consisted of educational sessions in which the children met as a group and were instructed on aspects of asthma management, including triggers, symptoms, and causes **Control description:** not reported **Theoretical framework:** intervention was grounded in social learning theory
Outcomes	**Core processes evaluated (child level):** attrition and adherence were not problematic; information on dosage was not reported
Notes	**Process evaluation category:** integrated **Breadth and depth:** neither broad nor deep

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	Voice of children given prominence: sufficient coverage **Funding source:** intramural grant from the University of California, Los Angeles, School of Nursing

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly reported
Explicit theories underpinning and/or literature review	Low risk	Theoretical framework guiding the intervention was described as social learning theory
Transparent and clearly stated methods and tools	Low risk	Process of collecting data and the tools used were well described
Selective reporting	Low risk	All results of the intervention appear to be documented
Harmful effects	Unclear risk	Unclear how much difficulty was involved in engaging with parents
Population and sample described well	Unclear risk	Population was generally described well; however the severity of asthma among participants was not reported
Continuous evaluation	High risk	Data were collected only post intervention

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Berg 2004 (*Continued*)

Evaluation participation equity and sampling	Low risk	All students who participated in the pilot were also included in the process evaluation
Design and methods overall approach	Unclear risk	Some of the indicators in Table 3 are unconvincing
Tools and methods of data collection reliable/credible	Low risk	Tools and methods used for data collection were reported on
Tools and methods of data analysis reliable/credible	Low risk	Methods of data analysis were appropriate for the data
Performance bias/neutrality/credibility/conformability	Unclear risk	Unclear what effect negative cases had on outcomes. Analysis of those who consented vs those who did not would have been helpful
Reliability of findings and recommendations	High risk	Sample size was too small to allow for too much endorsement of study findings
Transferability of findings	High risk	Small sample size limits the transferability of findings. The profile of participating students is noticeably different from the profile of the school overall
Overall risk of bias of process evaluation	Unclear risk	Not much evidence to determine low risk; however evidence is sufficient for a process evaluation of a feasibility study

Bignall 2015

Methods	**Included as process evaluation** **Intervention study design:** randomised controlled trial **Unit of allocation:** child **Process evaluation methods:** descriptive/bivariate (quantitative), descriptive (qualitative)
Participants	**Setting:** single high school in a midwestern city in the USA **Age of children:** 12 to 17 years (mean age, 15.47 years) **Child characteristics (BME/SES):** African American **Asthma status:** asthmatic only **Intervention recipients:** children
Interventions	**School type:** high school **Intervention description:** 2 short instructional sessions for children on relaxation/breathing retraining techniques. Participants completed 2 in-person visits spaced 1 month apart and were given a copy of the script and a CD with breathing retraining techniques to help them practise at home

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	Control description: participants in the control group received 30 minutes of standard asthma education **Theoretical framework:** no specific framework was named (although supporting literature around breathing exercises was provided)
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** named section(s) on processes included **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** featured but not sufficiently **Note:** not included as outcome evaluation because control received asthma education **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	No named theoretical framework was presented
Transparent and clearly stated methods and tools	Unclear risk	Although methods and tools were clearly described, it is unclear who delivered the intervention. However, tools used and the content of interviews were well described
Selective reporting	Unclear risk	Interviews may have been underreported

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Bignall 2015 (*Continued*)

Harmful effects	High risk	Not much scope for harmful effects, such as impact of disruption of the intervention, to be studied
Population and sample described well	Low risk	The most relevant characteristics of the sample were captured
Continuous evaluation	Low risk	Data were collected before and after the intervention
Evaluation participation equity and sampling	High risk	Only child-level data were collected
Design and methods overall approach	Low risk	Two sets of data were provided
Tools and methods of data collection reliable/credible	Unclear risk	Difficult to establish whether these were reliable, as they were interviews
Tools and methods of data analysis reliable/credible	Unclear risk	Analysis of quantitative data was comprehensive. However, treatment/analysis of qualitative data was unclear
Performance bias/neutrality/credibility/conformability	High risk	Because of the way in which qualitative interviews were conducted, risk of performance bias was increased
Reliability of findings and recommendations	High risk	Study included a small sample, and target numbers for the study were not achieved. Presentation of qualitative data was limited
Transferability of findings	High risk	Study authors did consider transferability of findings; however analysis of qualitative data was absent
Overall risk of bias of process evaluation	High risk	Some data were collected well; however treatment of qualitative data reveals high risk of bias

Brasler 2006

Methods	**Included as process evaluation** **Intervention study design:** single-group pre-post design **Unit of allocation:** N/A **Process evaluation methods:** descriptive analysis of outcome and process factors
Participants	**Setting:** conducted in 12 culturally and socio-economically diverse junior and middle schools in school districts in Anchorage, Alaska (AK), and Kansas City (KC) suburbs **Age of children:** 11 to 13 years

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	Child characteristics (BME/SES): 29% of children in Anchorage and 48% in Kansas City were African American, Asian, or Native American. An average of 27% of children across both sites were eligible for free school meals **Asthma status:** asthmatic only **Intervention recipients:** children only
Interventions	**School type:** junior/middle **Intervention description:** PBP: "the program, designed for adolescents aged 11-19, covers asthma basics and management, addresses adolescents' social and lifestyle concerns, and encourages them to take control of their asthma". It is a manualised program developed by the Asthma and Allergy Foundation of America **Control description:** N/A **Theoretical framework:** no single theoretical framework was named
Outcomes	**Core processes evaluated (child level):** mainly attrition, dosage, adherence
Notes	**Process evaluation category:** named section **Breadth and depth:** breadth not depth - a broad range of processes explored on a superficial level **Voice of children given prominence:** not featured - data collected from children did not allow the voice of children to be heard **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated

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Brasler 2006 (*Continued*)

Explicit theories underpinning and/or literature review	High risk	No evidence of a named theoretical framework
Transparent and clearly stated methods and tools	High risk	Most of the content was based on reflective note taking
Selective reporting	Low risk	Notes reflected low levels of initial co-operation
Harmful effects	Low risk	Although elements of the intervention did not match the plan, study authors have discussed these
Population and sample described well	Unclear risk	Some detail was absent, for example, ethnicity and SES data were not well described
Continuous evaluation	Low risk	Data were collected before and after the intervention
Evaluation participation equity and sampling	High risk	This was a multi-component intervention, but the 'voices' of teachers, nurses, and parents were absent
Design and methods overall approach	High risk	Tools that were used were unstructured
Tools and methods of data collection reliable/credible	High risk	Tools used were unstructured, thus reducing reliability
Tools and methods of data analysis reliable/credible	Low risk	Analysis of the data was fair
Performance bias/neutrality/credibility/conformability	High risk	Study authors did not consider performance bias
Reliability of findings and recommendations	Unclear risk	Tools used to collect these data were not clearly described, although the conclusions drawn appear to match the data presented
Transferability of findings	Low risk	Process evaluation findings were regarded as transferable; the extent to which evidence of effectiveness was transferable across sites is unclear
Overall risk of bias of process evaluation	High risk	Unstructured data collection methods were used for process evaluation

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Bruzzese 2004

Methods	**Included as process evaluation and outcome evaluation** **Intervention study design:** randomised controlled trial with the child selected as the unit of allocation **Setting:** children were recruited from 2 inner city public high schools **Period:** not reported
Participants	**Eligible sample frame:** 65 students were eligible; 45 were randomised to intervention or control group **Randomised:** 45 students were randomised: 23 to the intervention group and 22 to the delayed-treatment control group across the 2 schools **Completed (intervention):** 100% of children in the intervention group received workshop 1; 91% received workshop 2; 61% of children in the intervention group received workshop 3, as time did not permit a make-up session **Inclusion criteria:** students with persistent asthma symptoms, at least 3 days a week or 3 nights a month **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** students in 9th and 10th grades **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** not reported **Asthma status:** asthmatic students only
Interventions	**School type:** high school **Intervention description:** Open Airways for Schools, academic detailing **Control description:** usual care/nothing **Theoretical framework:** self-regulation theory **Intervention:** students received the ASMA programme, in which students were taught how to manage their asthma to prevent symptoms and improve quality of life. One goal of ASMA is to help students incorporate asthma management strategies into their self-identity. Continued medical education was also offered to students' medical providers **Intensity:** intervention was delivered over an 8-week period, comprising 3 workshops spaced 2 to 3 weeks apart **Instructor:** intervention was delivered by a trained health educator **Parental engagement:** not reported **Child satisfaction:** most students found the sessions helpful; however a third confirmed that they may or may not participate again **Timing of intervention in school day:** every attempt was made to meet with students during their free time
Outcomes	**Extractable outcomes were collected for:** none **Core processes/outcomes evaluated (child level):** attrition, adherence
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** sufficient coverage **Funding source:** Speakers' fund for public health
Risk of bias	

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Bruzzese 2004 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Only detail provided was that students were randomly assigned to treatment or control groups
Allocation concealment (selection bias)	Unclear risk	No details were provided except that students were randomly assigned to treatment or control groups
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Methods used for blinding were not described
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Methods used for blinding were not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Low levels of post-test outcomes collected: 14 students who attended group workshop #3 - 64% of all treatment students - completed an evaluation of the programme
Selective reporting (reporting bias)	Unclear risk	No data from the control group were presented. The procedure followed for control group students is unclear
Other bias	Unclear risk	Baseline data were not reported, so we are unable to determine if any imbalances existed at baseline
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Theory guiding the intervention was provided as self-regulation theory
Transparent and clearly stated methods and tools	High risk	Tools used for data collection were inferred, as opposed to being stated
Selective reporting	Unclear risk	Outcomes that study authors intended to measure are unclear; therefore we are unable to say whether evidence shows selective reporting
Harmful effects	High risk	No provision was made for harmful effects

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Bruzzese 2004 (*Continued*)

Population and sample described well	Unclear risk	Some aspects of the sample were described in sufficient detail; however no information was provided on ethnicity, SES, or asthma severity among participants
Continuous evaluation	High risk	Study authors did not capture the people who dropped out
Evaluation participation equity and sampling	Unclear risk	Not reported by study authors
Design and methods overall approach	Unclear risk	Little information was given about the methods used
Tools and methods of data collection reliable/credible	High risk	Small sample size suggests that different approaches to analysis and collection should have been used
Tools and methods of data analysis reliable/credible	High risk	Small sample size suggests that different approaches to analysis and collection should have been used
Performance bias/neutrality/credibility/conformability	Unclear risk	Not reported by study authors
Reliability of findings and recommendations	Unclear risk	Not reported by study authors
Transferability of findings	Unclear risk	Some of the lessons learnt around timetabling were transferable; however study authors did not assess transferability
Overall risk of bias of process evaluation	High risk	Points around sampling and absence of continuous evaluation contribute to high risk of bias

Bruzzese 2008

Methods	**Included as outcome evaluation and process evaluation** **Study design:** parallel-group design with families selected as the unit of randomisation **Setting:** study recruited children and their families from one middle school in New York City, New York, USA **Period:** dates on which study was conducted - intervention and subsequent data collection - not clear; follow-up data collected 2 months post intervention
Participants	**Eligible sample frame:** 78 pupils found to be eligible; 24 agreed to participate **Randomised:** 24 students randomised (at the student/family level): 12 each in control and intervention groups

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	Completed (intervention): 12 students and 10 caregivers in the treatment group, and 11 students and 8 caregivers in the control group, completed immediate follow-up **Inclusion criteria:** after completing a case detection survey, eligible students were identified as having had "an asthma diagnosis from a medical provider, and over the past 12 months exhibited asthma symptoms an average of three times per month and used asthma medication" **Exclusion criteria:** families were excluded if "(1) the child had a co-morbid disease that affects lung functioning or highly specialized developmental or learning needs, (2) the child and/or the caregiver did not speak English, or (3) the caregiver and child did not live together" **Baseline characteristics** **Age of children:** mean age, 12.8 years (grades 6 to 8) **Ethnicity:** child ethnicity described as Hispanic (41%); White, not of Hispanic origin (17%); African American, not of Hispanic origin (8%); and other (34%) **Socio-economic status:** employment status of participating caregivers (but socio-economic circumstances of family) presented. Unemployed (8%); employed part-time (21%); employed full-time (71%). Data on highest educational level completed by caregiver were also presented, with 66% having post-compulsory education **Gender:** males accounted for 13 of the child participants (54%), and females for 11 of the participants (46%) **Asthma status:** direct information on severity not presented
Interventions	**School type:** junior/middle **Intervention description:** OAS, ASMA, caregiver education **Control description:** usual care/nothing **Theoretical framework:** social cognitive theory and cognitive-behavioural therapy **Intervention:** implemented "Asthma: It's a Family Affair!" intervention. "Intervention students received six group sessions on prevention and management of asthma. Lesson topics included: (1) information and feelings about asthma; (2) asthma medication; (3) prevention and management of asthma symptoms; (4) problem-solving and coping with negative feelings about asthma; and (5) communicating about asthma to peers and teachers, relaxation exercises, and healthy behaviours, including smoking refusal skills and avoiding exposure to secondhand smoke". The sixth session included a comprehensive review designed to reinforce key messages and to enhance students' confidence in managing their asthma. Curriculum was based on existing materials from Coping with Asthma at Home and at School, OAS, and ASMA. Caregivers participated in five 90-minute group sessions held once per week intended to support the child's autonomy and development of asthma self-management skills **Control:** no treatment (usual care) **Intensity:** children received 6 lessons on a weekly basis **Instructor:** children's sessions were delivered by a developmental psychologist **Theoretical framework:** integration of 4 psychological theories: social cognition theory, cognitive-behavioural theory, and 2 forms of family systems theory (parenting styles and behavioural family systems theory) **Parental engagement:** low attrition among caregivers and high levels of satisfaction **Child satisfaction:** high levels of satisfaction: "All students reported that the intervention gave them a better understanding of asthma, and 91% reported that the handouts helped them understand the topics discussed. Many reported that the best aspect of the program was 'talking about my asthma'"

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	Timing of intervention in school day: not reported
Outcomes	**Extractable outcomes were collected for:** Experience of daytime and night-time symptoms Withdrawal from the study **Core processes/outcomes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** named section **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No information on how randomisation occurred
Allocation concealment (selection bias)	Unclear risk	No information on how allocation was concealed
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No information; blinding was not assessed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No information; blinding was not assessed by study authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few participants dropped out (1 out of 12 students in the control group)
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting
Other bias	Unclear risk	Missingness - low risk - no evidence of missing indicators Baseline imbalance - low risk - no evidence of systematic differences in baseline characteristics Contamination - high - randomisation was by family
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Intervention development was guided by social cognitive theory and cognitive-behavioural therapy

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Bruzzese 2008 (*Continued*)

Transparent and clearly stated methods and tools	Unclear risk	Medium bias - tools were poorly described
Selective reporting	Unclear risk	As data collection tools were not that well stated, it is difficult to assess whether results show any evidence of selective reporting
Harmful effects	Unclear risk	Not considered by trial authors
Population and sample described well	Low risk	Population and sample were well described
Continuous evaluation	Unclear risk	Data were collected before and after the intervention; however the level of participation was low
Evaluation participation equity and sampling	High risk	Little evidence of evaluation from children
Design and methods overall approach	Unclear risk	Unclear how data were collected
Tools and methods of data collection reliable/credible	High risk	Unclear whether tools used had been validated
Tools and methods of data analysis reliable/credible	Low risk	Analysis appears to reflect the data
Performance bias/neutrality/credibility/conformability	Unclear risk	Unclear whether this was given consideration
Reliability of findings and recommendations	Low risk	Reliability of findings clear; conclusions justified
Transferability of findings	High risk	No consideration given to transferability of findings
Overall risk of bias of process evaluation	Unclear risk	Medium bias

Bruzzese 2010

Methods	**Included as outcome evaluation and process evaluation** **Intervention study design:** RCT, parallel group, randomised at the child level **Setting:** 25 public schools in New York City **Period:** intervention was conducted over 4 years
Participants	**Eligible sample frame:** 393 students were eligible; 288 completed the 12-month follow-up **Randomised:** 393 students were randomised; numbers of students in intervention and control groups not reported

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Bruzzese 2010 (*Continued*)

	Completed (intervention): 288 students completed the 12-month follow-up **Inclusion criteria:** students with persistent asthma and their caregivers **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 14 to 16 **Child characteristics (BME/SES):** 45.51% Hispanic; 75% of students on free school meals **Asthma status:** asthmatic only **Intervention recipients:** children only
Interventions	**School type:** high school **Intervention description:** ASMA, academic detailing **Control description:** usual care/nothing **Theoretical framework:** social cognitive theory **Intervention:** a family affair programme. Students in the intervention group attended 6 workshops to empower them to manage their asthma; their parents attended training group workshops to teach childrearing skills that support their child's growing autonomy and need to manage their asthma **Intensity:** children attended 6 workshops, and parents/caregivers attended 5 **Instructor:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Withdrawal **Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** integrated **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** featured but not sufficiently **Funding source:** National Heart, Lung, and Blood Institute; NYC Speakers' Fund

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported by study authors
Allocation concealment (selection bias)	Unclear risk	Not reported by study authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Abstract only; no information on blinding presented
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Abstract only; no information on blinding presented

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Bruzzese 2010 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Abstract only; no information on blinding presented
Selective reporting (reporting bias)	Unclear risk	Abstract only; no information on blinding presented
Other bias	Unclear risk	Abstract only; no information on blinding presented
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Social cognitive theory guided development of the intervention
Transparent and clearly stated methods and tools	Low risk	Methods and tools used were clearly described
Selective reporting	Low risk	All collected data were reported on
Harmful effects	Unclear risk	Medium bias - some harmful effects around differential reach can be inferred
Population and sample described well	Low risk	Sufficient data were included to provide a depiction of context
Continuous evaluation	Low risk	Two rounds of follow-up were described for outcomes
Evaluation participation equity and sampling	Low risk	Available data with adjustments for main baseline imbalances could serve as confounders
Design and methods overall approach	Low risk	Administrative and survey data were collected at multiple points
Tools and methods of data collection reliable/credible	Low risk	Validated tools were used
Tools and methods of data analysis reliable/credible	Low risk	Credible analysis - zip regression modelling was employed to address skewness
Performance bias/neutrality/credibility/conformability	Low risk	Blinding was explicitly mentioned
Reliability of findings and recommendations	Low risk	No issues were reported

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Bruzzese 2010 (*Continued*)

Transferability of findings	Low risk	Study authors have considered this; however their findings have comparatively low transferability "We are also unable to extrapolate study results to other populations of high school students with asthma (e.g. white suburban adolescents with mild asthma) because we limited enrolment to minority youth with moderate to severe persistent asthma"
Overall risk of bias of process evaluation	Low risk	Within the narrow confines of the data, this is a well-conducted study

Bruzzese 2011

Methods	**Included as outcome evaluation** **Intervention study design:** randomised controlled trial parallel group **Setting:** conducted at 5 participating high schools in New York, USA **Period:** study enrolment took place over 4 consecutive school years from 2001 to 2004
Participants	**Eligible sample frame:** 261 pupils found to be eligible **Randomised:** 345 students randomised: 175 to intervention group and 170 to control group **Completed (intervention):** 139 (79.4%) in the intervention group completed follow-up, as did 142 (83.5%) in the control group **Inclusion criteria:** 9th and 10th graders with moderate to severe persistent asthma who were taking medication prescribed by a medical provider in the last 12 months **Exclusion criteria:** none stated **Baseline characteristics** **Age of children:** mean age, 15.10 years **Ethnicity:** 45.5% Hispanic/Latino/a or Hispanic American; 37.7% African American/African or Caribbean American/Caribbean; 11.6% mixed ethnicity; 5.2% other ethnicity **Socio-economic status:** not reported **Gender:** 29.6% male; 70.4% female Asthma status: 68.70% moderate persistent asthma, 31.30% severe persistent asthma. No information on SES
Interventions	**Intervention:** ASMA consisted of 2 components: (I) an 8-week intensive programme for students, and (ii) academic detailing for adolescents' medical providers. Student intervention consisted of three 45- to 60-minute group sessions, and individual tailored coaching sessions held at least once per week for 5 weeks. Sessions were delivered by trained health educators during the school day. Students were taught asthma management skills and ways to cope with asthma, and were encouraged to see their medical provider for clinical evaluation and treatment (see Bruzzese 2004 for a full outline of ASMA content) **Control:** wait-list control (usual care) **Intensity:** three 45- to 60-minute group sessions for children over 8 weeks and individual tailored coaching sessions once a week for 5 weeks

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	Instructor: health educators **Theoretical framework:** ASMA described as grounded in social cognitive theory **Parental engagement:** not reported **Child satisfaction:** not reported **Timing:** unclear but at some point during the school day
Outcomes	**Extractable outcomes were collected for:** Exacerbations leading to hospital admission Asthma symptoms leading to emergency hospital visits Absence from school Days of restricted activity Unplanned GP or hospital visit due to asthma Experience of daytime and night-time symptoms Corticosteroid dosage Withdrawal
Notes	**Funding source:** National Heart, Lung, and Blood Institute; NYC Speakers' Fund

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Study authors reported: "Within each stratum, we randomised students to control or intervention using computerized randomisation lists generated in advance by the data manager who concealed them until randomisation"
Allocation concealment (selection bias)	Low risk	Randomisation lists were generated in advance by the data manager, who concealed them until randomisation
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Interviewers were blind to group assignment. Whether participants were blinded is unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Interviewers were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No differences were noted between the 2 groups - incomplete data were unlikely to affect outcomes
Selective reporting (reporting bias)	Low risk	All outcomes were reported
Other bias	Low risk	Missingness - low risk - appears that more participants who did not drop out submit-

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		ted their data Baseline imbalance - low risk - intervention and control groups were relatively evenly matched in characteristics Risk of contamination - low - informal interviews with control participants regarding their contact with other students in the programme suggest that contamination did not occur
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

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Carpenter 2016

Methods	**Included as process evaluation** **Intervention study design:** study design was quasi-experimental, with pre-post follow-up and no control **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate
Participants	**Country:** USA **Age of children:** 25 children 7 to 17 years old were recruited **Child characteristics (BME/SES):** sample comprised 72% non-Hispanic white children **Asthma status:** asthmatic children only **Intervention recipients:** children and nurses
Interventions	**School type:** intervention was delivered at 7 different schools, consisting of high schools, junior/middle schools, and primary/elementary schools **Intervention description:** the intervention consisted of 2 sessions for children. Children were asked to watch a tailored video and to demonstrate their inhaler technique before and after the video. One month later, at the second session, children demonstrated their inhaler technique again to the school nurse and were allowed to watch the video again **Control description:** N/A **Theoretical framework:** not reported
Outcomes	**Core processes evaluated (child level):** adherence
Notes	**Process evaluation category:** named section **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** sufficient coverage **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A

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Carpenter 2016 (*Continued*)

Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	No theoretical framework was presented to inform the intervention
Transparent and clearly stated methods and tools	Unclear risk	Medium bias - content and conduct of the focus group were not presented
Selective reporting	High risk	Study authors provided some example quotations; however it is unclear how themes were derived
Harmful effects	High risk	The premise of the intervention could be considered harmful, as the information that was collected should be provided only by demographically equivalent people. However, this was not explored in depth
Population and sample described well	Unclear risk	The reach of this study is unclear; very little information on the sample was presented
Continuous evaluation	Unclear risk	Not reported by study authors
Evaluation participation equity and sampling	Unclear risk	Some information was collected from different actors; however information was not collected to the same degree of robustness as for other participants
Design and methods overall approach	Unclear risk	Medium bias - premise of the intervention is suspect, and approach needs to be grounded in providing information around a need - but this info is lacking
Tools and methods of data collection reliable/credible	Unclear risk	The focus of the intervention is not reflected strongly enough in the data collected
Tools and methods of data analysis reliable/credible	Unclear risk	No information was provided on how data were collected in the focus group, so whether data analysis methods used were appropriate is not clear
Performance bias/neutrality/credibility/conformability	High risk	No evidence indicates whether concerns were addressed during the data collection process

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Carpenter 2016 (*Continued*)

Reliability of findings and recommendations	Unclear risk	Although data were presented, how data were collected remains unclear
Transferability of findings	High risk	No evidence indicates this; the premise of the intervention makes a large focus on transferability very important
Overall risk of bias of process evaluation	High risk	The premise of the intervention was not explored

Cicutto 2005

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** study was conducted across 26 elementary schools in a suburb of Toronto (Canada) **Period:** dates on which the study was conducted - including intervention and subsequent data collection - not clear; intervention and data collection was conducted over the period of a year
Participants	**Eligible sample frame:** 40 elementary schools were randomly selected from a pool of 147 potential elementary schools for inclusion in the Toronto area. Parents and children were invited to participate, and eligibility was assessed (see below). Based on the information returned, 26 schools had sufficient numbers of pupils (more than 7 pupils per school) to allow the trial to go ahead. In total, 297 eligible pupils were identified across the 26 schools **Randomised:** 256 pupils randomised at the school level: 132 to the treatment group and 124 to the control group **Completed (intervention):** 248 pupils remained at the 6-month data collection point: 130 treatment group children and 118 control group children. 239 children completed the intervention: 121 in the treatment and 118 in the control group **Inclusion criteria:** students were eligible for participation if they were reported as (I) having physician-diagnosed asthma, (ii) having used an asthma medication (i.e. bronchodilator and/or anti-inflammatory agents) for breathing difficulties, and (iii) having experienced asthma symptoms 3 or more times in the past year. Students had to meet all 3 criteria to be eligible **Exclusion criteria:** children were excluded from the study if they had a second (major) chronic illness with a pulmonary component (e.g. cystic fibrosis) **Baseline characteristics** **Age of children:** mean age, 8.6 years across treatment and control groups **Ethnicity:** not reported **Socio-economic status:** indicative evidence that none of the children were from low-income families: "The average income of the parent/guardian who participated in the study was approximately $53,000.00 (Canadian dollars) with a range of $20,500.00 to $200,000.00. In Canada, low-income families earn $19,000.00 per year" **Gender:** treatment group: 58.3% male, 41.7% female; control group: 59.6% male, 40.4% female

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	Asthma status: At baseline, according to parental report: Treatment group: 68.2% of children had mild asthma, 20.4% had moderate asthma, 5.4% had severe asthma; Control group: 69.5% of children had mild asthma; 23.4% had moderate asthma; 7.3% had severe asthma
Interventions	**Intervention:** children in treatment group received "Roaring Adventures of Puff" (RAP) intervention. This consisted of 6 sessions that included: "(1) getting to know each other, goal setting, use of a peak flowmeter, and diary monitoring; (2) trigger identification, control, and avoidance, and basic pathophysiology; (3) medications and the proper use of inhalers; (4) symptom recognition and action plan use; (5) lifestyle, exercise, and managing an asthma episode; and (6) sharing asthma information with teachers and parents". Parents were invited to attend the final session and were encouraged to take part in assisting with children's homework **Control:** usual care **Intensity:** children attended 6 sessions 50 to 60 minutes in length that were held once a week over 6 consecutive weeks **Instructor:** asthma educator **Theoretical framework:** theories involving social cognitive theory and self-regulation underpinned the intervention **Parental engagement:** reported as low - < 20% of children had a parent who attended the final session **Child satisfaction:** not reported **Timing of intervention in school day:** sessions took place over the lunch period
Outcomes	**Extractable outcomes were collected for:** Exacerbations leading to hospital admission Asthma symptoms leading to emergency hospital visits Absence from school Days of restricted activity
Notes	Considered for process evaluation but not deemed to address implementation questions nor to provide any in-depth study of implementation processes **Funding source:** Change Foundation

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation was centrally controlled by a computerised randomisation programme
Allocation concealment (selection bias)	Low risk	Randomisation was centrally controlled by a computerised randomisation programme
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors

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Cicutto 2005 (*Continued*)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessors and participants were blinded to group assignment
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low levels of attrition/dropout with outcome data collected from 93% of students, who were randomised
Selective reporting (reporting bias)	Unclear risk	Not all outcomes were fully reported, but they were described narratively in some places
Other bias	Low risk	Missingness - unclear risk - intention-to-treat analyses were implemented, although the extent of missingness (as opposed to attrition) is unclear Baseline imbalance - low risk - demographic and asthma-related characteristics were similar between the 2 study groups and did not demonstrate statistically significant differences Risk of contamination - low - allocation was provided at the school level
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A

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Cicutto 2005 (*Continued*)

Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Cicutto 2013

Methods	**Included as process evaluation and outcome evaluation** **Intervention study design:** cluster RCT **Setting:** 170 primary/elementary schools from 5 public health units across Ontario, Canada **Period:** not reported
Participants	**Eligible sample frame:** 180 schools were eligible and 170 schools were randomised (85 in each arm). 2502 families were eligible and 1316 were enrolled **Randomised:** 1316 participants were enrolled **Completed (intervention):** 1172 completed the study; 144 children withdrew, representing an 11% withdrawal rate **Inclusion criteria:** parental report of physician-diagnosed asthma, use of asthma medications, asthma symptoms at least 3 times in the past year, enrolment in grades 1 through 5 at school, ability to speak English, no other chronic conditions that could mimic asthma **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 8 years old **Ethnicity:** not reported **Socio-economic status:** 26.4% of children had a mother who did not have a high school diploma **Gender:** the sample comprised 57.4% males; 58.4% of control children and 56.6% of intervention children were male **Asthma status:** asthmatic only
Interventions	**School type:** primary/elementary **Intervention description:** Roaring Adventures of Puff **Control description:** usual care/nothing **Theoretical framework:** social cognitive theory **Intervention:** workshops included goal setting and self-monitoring, trigger identification, control and avoidance, basic pathophysiology, medication and proper inhaler use, symptom recognition and the asthma action plan, lifestyle and exercise, managing an asthma exacerbation, and showcasing learning with teachers and parents. The interven-

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	tion used interactive techniques to educate the children. Make-up sessions were available for those who missed a class **Intensity:** children attended six 45-minute sessions **Instructor:** public health nurses **Parental engagement:** difficulty in getting parents/guardians involved **Child satisfaction:** not reported **Timing of intervention in school day:** lunchtime
Outcomes	**Extractable outcomes collected for:** Asthma symptoms leading to emergency hospital visits Parent-reported absence from school Days of restricted activity Unplanned visit to hospital or GP due to asthma symptoms Health-related quality of life Withdrawal **Core processes evaluated (child level):** attrition
Notes	**Process evaluation category:** stand-alone and Integrated (2 papers) **Breadth and depth:** breadth - not depth **Voice of children given prominence:** not featured **Funding source:** Ontario Ministry of Health and Long Term Care

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random sequence: of the 180 schools, 170 schools with the largest numbers of students with asthma were randomised to intervention or control groups through a computer-generated table of random numbers
Allocation concealment (selection bias)	Low risk	Central allocation indicated: of the 180 schools, 170 schools with the largest numbers of students with asthma were randomised to intervention or control groups through a computer-generated table of random numbers
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not clear whether measures were taken and whether this would have influenced the outcome
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Study authors reported: "Data collectors were blinded to group assignment. A post survey of data collectors revealed that blinding was successful. Data collectors became unblinded to group assignment for 9% of

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		participating families, which occurred during the data collection interviews with parents/guardians"
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Attrition data were presented, although data were not disaggregated by treatment status
Selective reporting (reporting bias)	Unclear risk	Absence of clear numbers hinders interpretation of some data
Other bias	Unclear risk	Missingness - high risk - evidence of unexplained missing data in Table 2 Baseline imbalance - low risk - study authors reported: "Randomisation was successful in that comparison of baseline variables for the control and experimental groups suggested they were similar or balanced before the intervention" Risk of contamination - low - unit of randomisation was at the school level, reducing the threat of contamination
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Intervention development was informed by social cognitive theory
Transparent and clearly stated methods and tools	Low risk	Tools and methods were clearly reported
Selective reporting	Unclear risk	Unclear how this was addressed
Harmful effects	Unclear risk	Study authors did report on low parental engagement; however they offered no explanation as to why all treatment schools did not adopt the policy
Population and sample described well	Unclear risk	Individual schools were not described sufficiently
Continuous evaluation	Low risk	Policy development was monitored early on; 2 sets of data were collected after baseline
Evaluation participation equity and sampling	High risk	Stakeholders were not directly involved
Design and methods overall approach	Low risk	Pre-post assessment data were collected

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Cicutto 2013 (*Continued*)

Tools and methods of data collection reliable/credible	Low risk	Study authors used validated data collection tools
Tools and methods of data analysis reliable/credible	Low risk	Data analysis methods used were suitable for the data
Performance bias/neutrality/credibility/conformability	Unclear risk	Blinding was attempted but was not always successful
Reliability of findings and recommendations	Low risk	Clearly reported by study authors. Findings appear to be reliable
Transferability of findings	Unclear risk	Not explored
Overall risk of bias of process evaluation	Low risk	Important indicators, for example, design methods and continuous evaluation, were at low risk

Clark 2004

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** study was conducted at 14 public high schools in Detroit, Michigan, USA. Seven schools (416 children) were assigned to the treatment arm, and 7 schools (419 children) to the control group **Period:** dates on which study was conducted - intervention and subsequent data collection - were not clear; follow-up data were collected 2 years after baseline
Participants	**Eligible sample frame:** following a case detection survey, 1217 children were identified as eligible and 835 parents provided consent for their child to participate **Randomised:** 835 pupils randomised at the school level: 416 to the treatment group and 419 to the control group **Completed (intervention):** unclear; 674 parents participated in follow-up survey 2 years later, but this was not disaggregated and completion figures were not provided **Inclusion criteria:** students were eligible for participation in the study if they had: " (1) a physician's diagnosis of asthma and active symptoms, or a diagnosis and received a prescription for asthma medications in the previous year; or (2) no physician's diagnosis, but reported presence of three or more of seven asthma symptoms in the past year, or reported either of two exercise-related asthma symptoms with frequency of three times or more, in the past year" **Exclusion criteria:** no additional exclusion criteria reported **Baseline characteristics** **Age of children:** all children were in grades 2 through 5; 93% were between 7 years and 10 years of age **Ethnicity:** 98% of children were African American **Socio-economic status:** schools were located in areas of high poverty. Almost half of students (45%) were from families with annual income under $15,000

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	Gender: no gender breakdown was provided **Asthma status:** 236 students had mild persistent asthma (28.3%), 128 had moderate asthma (15.3%), and 40 had severe asthma (4.7%)
Interventions	**Intervention** This was a comprehensive programme of asthma self-management targeted at children, caregivers, and the wider school: "The program elements were as follows: (1) OAS disease management training for children adapted to local needs (for example, related to smoking among elementary school-aged children), which included handouts and homework assignments involving parents; (2) 'Environmental Detective', two classroom sessions for classmates to enhance their understanding of factors that may influence respiratory health in general, and to help them develop empathy for children with asthma in particular; (3) orientation to asthma and control strategies for school principals and counsellors; (4) briefings and building walk-throughs for custodial personnel regarding potential environmental triggers to asthma symptoms and practical means of remediation; (5) school fairs for children and their caretakers, including asthma care question-and-answer sessions for the adults; (6) written communication on behalf of the family with the child's clinician providing information about the school program, encouraging completion of an asthma action plan for the child, and requesting provision of a copy to the school" **Control:** wait-list control (usual care) **Intensity:** target students received OAS training (which usually consists of 6*60-minute sessions) as well as 2 additional classroom sessions through the 'environmental detective' component **Instructor:** not reported **Theoretical framework:** not explicitly described **Parental engagement:** not reported in detail, although elements of the programme reported as having been "completed with reasonable success", except the element that involved written communication with the child's physician **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	Selected outcomes were extracted but were not combined in meta-analyses due to incompatibility of unit of analysis (risk difference) between this study and others
Notes	Absence from school and experience of daytime and night-time symptoms were collected in the study, but sample sizes disaggregated by study arm that could allow for extraction and inclusion in meta-analysis were not included **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Schools were randomly assigned via a random numbers table to receive the programme (7 schools and 416 children) or to be assigned to a wait-list control group (7 schools and 419 children)

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Allocation concealment (selection bias)	High risk	Use of pre-defined random number table potentially compromised allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No information was provided on blinding; this was not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No information was provided on blinding; this was not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear - full information on attrition was not presented
Selective reporting (reporting bias)	Low risk	No evidence indicated selective reporting (although the unit of analysis was incompatible for the meta-analytical framework implemented)
Other bias	Low risk	Missingness - unclear - information on missing data was not provided Baseline imbalance - low risk - no differences in characteristics of intervention and control groups were described Risk of contamination - low - schools were the unit of randomisation, providing low risk of contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A

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Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Clark 2005

Methods	**Included as outcome evaluation** **Intervention study design:** clustered parallel-group randomised controlled trial with schools selected as the unit of randomisation; "schools similar in size and student body within the same district were randomly assigned to either the intervention or control group" **Setting:** study was conducted at 21 elementary schools in 1 agricultural area and 1 industrial area of Beijing, China **Period:** not clear **Length:** dates on which study was conducted - intervention and subsequent data collection - not clear
Participants	**Eligible sample frame:** 9040 parents of children surveyed in case detection survey, with 8724 returning a questionnaire, revealing 639 children with a diagnosis of asthma **Randomised:** 639 children randomised according to their school (note numbers of children in intervention and control groups were not provided) **Completed (intervention):** unclear; 543 parents of children returned follow-up questionnaire a year after start (note numbers of children in intervention and control groups were not provided) **Inclusion criteria:** children eligible if they had "(1) three or more of seven asthma symptoms reported in the past year; (2) one or more of two exercise symptoms reported three times or more in the past year; and (3) a physician's diagnosis of asthma, with any symptoms reported or medication prescribed in the past year" **Exclusion criteria:** not directly reported **Baseline characteristics** **Age of children:** all 7 to 11 years of age **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** not reported **Asthma status:** mixed severity: "29% of the children were classified as having mild (20%) or moderate persistent asthma (9%) and 71% as having mild intermittent asthma. No

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	severe persistent asthma was noted"
Interventions	**Intervention:** based on Open Airways for Schools (OAS) model. The OAS programme manual and teaching materials were translated into Chinese and adapted for specifics related to the Beijing idiom. Some changes were made, but researchers reported that the substantial focus of the programme was not modified. Topics covered included "basic information/feelings about asthma, recognising and managing asthma symptoms, solving problems with medicines, deciding severity of symptoms, finding and controlling asthma triggers, staying healthy and doing well at school" **Control:** not clearly stated (usual care) **Intensity:** 5 sessions over a 5-week period, each lasting approximately 25 minutes. Sessions were split according to children's age/grade **Instructor:** teachers provided the programme in schools and were trained in advance **Theoretical Framework:** social cognitive theory, especially principles of self-regulation **Parental engagement:** no info **Child satisfaction:** no info **Timing:** children met for the programme at the end of the class day
Outcomes	**Extractable outcome data collected for:** Exacerbations leading to hospital admission Asthma symptoms leading to emergency hospital visits
Notes	Unclear how many participants were included in intervention and control groups Quality of life and withdrawal data collected but not extractable from the information presented **Funding source:** Thrasher Fund Award

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No additional information was provided to support a judgement
Allocation concealment (selection bias)	Unclear risk	No additional information was provided to support a judgement
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No additional information was provided to support a judgement
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No additional information was provided to support a judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No information was provided to support a judgement. Around 100 children dropped out of the intervention (although the spread of these children across treat-

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		ment arms remains unclear)
Selective reporting (reporting bias)	High risk	Many outcomes could not be extracted in full for meta-analyses
Other bias	Unclear risk	Missingness - unclear risk - additional reports of missingness were not described by study authors Baseline imbalance - unclear risk - this was not addressed by study authors Risk of contamination - low - schools were the unit of randomisation, lowering the risk of contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A

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Overall risk of bias of process evaluation	Unclear risk	N/A

Clark 2010

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** study was conducted at 19 middle schools in Detroit, Michigan, USA. Seven schools were randomised to one of the treatment arms, 6 schools to another treatment arm, and 6 schools to a control arm **Period:** this was a 5-year study with a 2-year enrolment period starting in 2003
Participants	**Eligible sample frame:** through a case detection survey, 1292 students were identified as probably having asthma (and eligible for the intervention) **Randomised:** students randomised at the school level - 468 pupils in one treatment arm, 416 in a second treatment arm, and 408 in a control arm **Completed (intervention):** data from 921 pupils were collected at 12-month follow-up; disaggregated numbers by trial arm were not reported **Inclusion criteria:** students were eligible for participation in the study if they met the "definition of probable asthma as well as levels of severity based on NAEPP guidelines" **Exclusion criteria:** no further criteria reported **Baseline characteristics** **Age of children:** mean age, 11.6 years across all 3 trial arms **Ethnicity:** 93% of children involved in the study were African American; this varied between 90% and 98% across trial arms **Socio-economic status:** a large proportion of children were from low-income households - 48% of all children (44% to 50% across different arms) were from households with annual income under $15,000 per annum **Gender:** 48% of children were female (ranging from 46% to 50% across different trial arms) **Asthma status:** indicators of asthma severity at baseline included 58% of children (caregivers) reporting obtaining prescriptions for asthma medications in the past year and 52% reporting persistent night-time asthma
Interventions	**Intervention:** trial included 2 treatment arms and 1 control arm. Both treatment arms tested the effectiveness of different forms of Open Airways for Schools (OAS): **Treatment arm 1:** adapted form of OAS delivered as a 6- to 7-lesson curriculum including interactive problem-solving activities appropriate for groups of pre-teens. Topics included (I) basic information and feelings about asthma; (ii) facts about asthma medicines and their use (emphasising partnership with the physician); (iii) how to make good decisions about activities; (iv) how to manage an asthma attack at home or school, deciding when to go to the doctor, and making the doctor visit more effective; (v) how to keep yourself healthy, including smoking avoidance; and (vi) personal characteristics, actions, and environmental factors that lead to successful asthma control. Groups of pre-teens met during school hours for approximately 1½ hours each week for 6 weeks. Take-home assignments and handout materials for parents were provided at each session **Treatment arm 2:** included the adapted OAS above and a peer education component. Peer leaders were sought from the general population of eighth grade students and were

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	trained by project staff to provide 3 asthma awareness lessons to seventh grade students. Two to three peer leaders were trained as a team. Peer leaders developed skits and game shows as part of training to impart an important message about asthma. Teams of peer leaders taught the 3 asthma awareness lessons to seventh grade students. Participants discussed a video, played games demonstrating and testing asthma knowledge, and discussed barriers to self-management. Finally, younger students voted on key messages to communicate to sixth grade schoolmates. In step 3, with help from peer leaders, project staff, and a teacher, seventh grade students translated asthma messages into skits, songs, and dramas, and performed these for an assembly of sixth grade students. All 3 steps focused on enabling students to understand and support their classmates with asthma **Control:** treatment not described (usual care) **Intensity:** students in treatment group 1 received 6 lessons; students in treatment group 2 received the same 6 lessons and additional input that differed depending on school grade **Instructor:** OAS sessions were led by graduate students and community leaders who were trained in programme methods and approach; in treatment arm 2, some components may have been delivered directly by peers **Theoretical framework:** not explicitly discussed **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** described as during school day (not after school) , but exact timing not reported
Outcomes	Data on daytime and night-time symptoms were extracted
Notes	Health-related quality of life and experience of daytime and night-time symptoms were collected, but data needed for extraction and inclusion in meta-analysis were not presented Considered as a process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation) **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Schools were stratified by geographical location and disease prevalence to ensure homogeneity across groups. Within each of the resulting 4 strata, schools were randomised via a table of random numbers
Allocation concealment (selection bias)	High risk	Potential for concealment to be breached through open random numbers table
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear which measures were taken to ensure blinding of participants

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Blinding of outcome assessment (detection bias) All outcomes	High risk	Likely any blinding of interviewers would have been breached through data collection methods: data were collected from school records and through face-to-face interviews with students at each school
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Missing data and attrition did occur - but impacts were said to have been attenuated through multiple imputations
Selective reporting (reporting bias)	High risk	Risk of selective reporting was high, as outcomes were not reported in full and we were not able to extract several outcomes of interest
Other bias	Unclear risk	Missingness - unclear risk - missingness was present, but multiple imputations were implemented and impact is unknown Baseline imbalance - high risk - at baseline, despite randomisation, one intervention arm had lower grades than controls. This may impact responsiveness to the intervention Risk of contamination - low - schools were the unit of analysis
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A

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Clark 2010 (*Continued*)

Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Crane 2014

Methods	**Included as process evaluation** **Intervention study design:** study design was quasi-experimental. Pre-post follow-up was provided **Unit of allocation:** school **Process evaluation methods:** quantitative: survey/questionnaire
Participants	**Country:** USA **Age of children:** 8 to 12 years old **Child characteristics (BME/SES):** not reported **Asthma status:** asthmatic only **Intervention recipients:** 45 children; 49% male
Interventions	**School type:** 1 Tulsa-area elementary school **Intervention description:** modification of Open Airways for Schools (OAS). Children received 10 sessions lasting 20 minutes over a lunch period. Six education topics from the original OAS programme were taught, and students received handouts from the original programme **Control description:** Open Airways for Schools (OAS) (standard) **Theoretical framework:** based on Piaget's educational theory
Outcomes	**Core processes evaluated (child level):** attrition, dosage
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** depth - not breadth **Voice of children given prominence:** featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

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Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Based on the educational theory of Jean Piaget
Transparent and clearly stated methods and tools	Low risk	Methods and tools were well described
Selective reporting	Low risk	What was purported to be measured was included in the report
Harmful effects	Unclear risk	Harmful effects were discussed, for example, time-tabling issues and conflicts. However, harmful effects were not collected by structured means
Population and sample described well	Unclear risk	Information around asthma burden and ethnicity was not collected
Continuous evaluation	Unclear risk	Only 1 drop out was reported; however relevant data were not collected
Evaluation participation equity and sampling	Unclear risk	Not all stakeholders were included in the evaluation
Design and methods overall approach	Unclear risk	This was reported, but not a lot of information was provided

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Crane 2014 (*Continued*)

Tools and methods of data collection reliable/credible	Low risk	All data collection methods and tools were reliable
Tools and methods of data analysis reliable/credible	Low risk	Data analysis methods were credible for the data
Performance bias/neutrality/credibility/conformability	Unclear risk	Unclear how confidentiality was maintained
Reliability of findings and recommendations	Low risk	Findings of the process evaluation were sufficiently supported by the data
Transferability of findings	High risk	Small sample size makes it difficult for findings to be transferable
Overall risk of bias of process evaluation	Unclear risk	The narrow confines of the focus probably account for medium risk when viewed as a 'process evaluation'

Dore-Stites 2007

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group intervention examining change pre-post intervention **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate (hypothesis testing)
Participants	**Setting:** 5 elementary schools in the Detroit area, USA **Age of children:** 5 to 10 years (mean age, 9.1 years) **Child characteristics (BME/SES):** 39% African American, 14% Hispanic, and 18% mixed ethnicity children; 34.6% were from low-income families (< USD20,000 per annum) **Asthma status:** asthmatic only **Intervention recipients:** children and parents
Interventions	**School type:** primary/elementary **Intervention description:** treatment consisted of 3 components: a computer-based educational game (Asthma: Quest for the Code), home activities, and caregiver information. The computer game included modules on: Lung Physiology; Symptom Recognition; Trigger Recognition; Peak Flow Meter Usage; Appropriate Use of Long-Term and Reliever Medication; Correct Usage of Common Asthma Medication; and Effect of Asthma Medications on Lungs. The study author reports: "The self-directed activities spanned from 10 to 20 minutes per session and were presented to participants individually during their school day. Modules were embedded within a larger, multiphase game and advancement to the next level occurred contingent upon answering quiz questions correctly. Children completed one or two modules per session dependent upon progression through each section and academic schedule. At a minimum, an individual participant could complete all activities in Asthma: Quest for the Code in approximately 1.25 hours

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	although typically children utilised the CD-ROM for approximately 20 minutes once per week over the course of eight to nine weeks for an approximate total time of 2.5 hours in instruction" **Control description:** N/A **Theoretical framework:** not 1 overarching theory utilised, but the study draws upon several theoretical standpoints
Outcomes	**Core processes evaluated (child level):** attrition
Notes	**Process evaluation category:** integrated **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** sufficient coverage **Funding source:** Blue Cross Blue Shield Foundation

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated and were related to exploring feasibility
Explicit theories underpinning and/or literature review	Unclear risk	Sufficent literature was provided to support the study, drawing upon several theoretical standpoints
Transparent and clearly stated methods and tools	Low risk	Methods and tools were clearly stated

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Dore-Stites 2007 (*Continued*)

Selective reporting	Unclear risk	Parental engagement was a key component of the study but was deemed to have not been reported in full
Harmful effects	High risk	Not fully addressed - implementation data on the support needed to get children to play the game were lacking
Population and sample described well	Unclear risk	Caregiver demographics were not reported in full
Continuous evaluation	Low risk	A pre-post design was utilised
Evaluation participation equity and sampling	Low risk	All participants involved in the programme had the opportunity to participate in the evaluation
Design and methods overall approach	Unclear risk	This was reported; however not much information was provided
Tools and methods of data collection reliable/credible	Low risk	Tools that were used were well described and were recognised tools
Tools and methods of data analysis reliable/credible	Low risk	Analytical plan seems to be appropriate for the data; however it is unclear how (or if) the hierarchical nature of the data was accounted for
Performance bias/neutrality/credibility/conformability	Unclear risk	Not addressed by the study author
Reliability of findings and recommendations	High risk	The study sample was very small, reducing the reliability of study findings
Transferability of findings	High risk	Transferability of findings is unclear; however given the small sample size, transferability of study findings should be limited
Overall risk of bias of process evaluation	High risk	Data regarding dosage and adherence are limited. Moreover, the small sample size compromised the study as a whole

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Engelke 2013

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, pre-post, no control **Unit of allocation:** N/A **Process evaluation methods:** bivariate analysis
Participants	**Country:** USA **Age of children:** 143 children in grades 1 to 12 **Child characteristics (BME/SES):** 40.6% of children were Caucasian; 50.3% were male; 63.6% received Medicaid **Asthma status:** asthmatic only **Intervention recipients:** children, teachers, parents, nurses
Interventions	**School type:** 303 schools, including junior/middle, primary/elementary, and high schools, from 24 school districts participated **Intervention description:** interventions were divided into 5 categories, including direct care, student education/counselling, parent/family education, teacher/staff education, and healthcare co-ordination. After initial assessment, the nurse chose an individual goal for each student **Control description:** N/A **Theoretical framework:** case management theory
Outcomes	**Core processes evaluated (child level):** not reported
Notes	**Process evaluation category:** named section **Breadth and depth:** depth - not breadth **Voice of children given prominence:** not featured **Funding source:** Kate B. Reynolds Charitable Trust

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A

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Engelke 2013 (*Continued*)

Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Unclear risk	Literature around case management was provided; however the actual theory remains unclear
Transparent and clearly stated methods and tools	Unclear risk	Instruments used are not entirely clear, for example, scoring and analysis tools
Selective reporting	Low risk	All outcomes were reported on satisfactorily
Harmful effects	High risk	Any negative effects of the intervention on the nurse workload were not addressed
Population and sample described well	Low risk	Study population was adequately described
Continuous evaluation	Low risk	Pre-post assessment findings were reported
Evaluation participation equity and sampling	Unclear risk	Voice of the children was not included in the evaluation
Design and methods overall approach	Low risk	Parent and nurse reports were collected twice
Tools and methods of data collection reliable/credible	Unclear risk	It is unclear if the analytical method or the tool itself was reliable
Tools and methods of data analysis reliable/credible	Unclear risk	It is unclear if the analytical method or the tool itself was reliable
Performance bias/neutrality/credibility/conformability	High risk	No steps were taken to reduce this
Reliability of findings and recommendations	Unclear risk	Multi-variate analysis was not used
Transferability of findings	Unclear risk	School factors are unclear, for example, what kinds of schools were used and what types of findings were obtained
Overall risk of bias of process evaluation	Unclear risk	Because many classifications were unclear, it is difficult to categorise this trial; however as a process evaluation, this is not a bad study

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Gerald 2006

Methods	**Included as outcome evaluation and process evaluation** **Study design:** parallel-group design. The study was split across cohorts, and schools within cohorts were randomised **Setting:** the study was conducted at 54 elementary schools in Birmingham, Alabama, USA **Period:** the intervention was implemented over 3 years, with 1 cohort receiving the intervention each year
Participants	**Eligible sample frame:** 736 were enrolled into the study **Randomised:** 736 pupils enrolled, but unclear how many were included in each arm **Completed (intervention):** not reported **Inclusion criteria:** children identified by the case detection procedure as having previously diagnosed asthma or suspected asthma **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** elementary school age - grades 1 to 4 (even split) **Ethnicity:** 97% black ethnicity **Socio-economic status:** not reported. **Gender:** 56% and 52% of participants were male in intervention and control groups, respectively **Asthma status:** not reported
Interventions	**Intervention:** the intervention consisted of 3 separate educational programmes and medical management for children with asthma: asthma education for school faculty and staff (Managing Asthma: A Guide for Schools), for the general student body (Asthma Awareness: A Curriculum for the Elementary School Classroom), and for students with asthma (Open Airways for Schools). Education was provided for school faculty and staff at an in-service meeting. Asthma awareness classes were provided to all children at each elementary school. Content was modified slightly for children younger than age 8 **Control:** delayed intervention, but usual care at the time of data collection **Intensity**: the Open Airways for Schools programme consists of six 40-minute sessions **Instructor:** in the first cohort, teachers were trained to deliver sessions. In the second cohort, classes were taught by study personnel **Theoretical framework:** not reported **Parental engagement:** parental satisfaction was low. Parents either did not attend scheduled visits or did not return completed questionnaires **Child satisfaction:** not reported **Timing of intervention in school day:** during physical education periods
Outcomes	**Core processes evaluated:** attrition, dosage, adherence **Extractable outcomes were collected for:** Exacerbations leading to admission to hospital Asthma symptoms leading to an emergency hospital visit Parent-reported absence from school
Notes	**Process evaluation category:** named section(s)/integrated within the study **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** not featured directly **Funding source:** National Heart, Lung, and Blood Institute

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Gerald 2006 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	How schools were randomised was not described
Allocation concealment (selection bias)	Unclear risk	Not addressed by study authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Attrition was evident but was not fully disaggregated
Selective reporting (reporting bias)	Low risk	No evidence shows selective reporting
Other bias	Low risk	Misssingness - unclear risk - unclear the extent to which missing data were due to attrition or to additional survey non-response Baseline imbalance - low risk - both arms were balanced on characteristics of importance Risk of contamination - low - schools were the unit of randomisation
Transparent and clearly stated aims	Unclear risk	Medium bias - study aims are not explicitly clear
Explicit theories underpinning and/or literature review	High risk	No theoretical framework was presented
Transparent and clearly stated methods and tools	Low risk	Methods were clearly reported
Selective reporting	Unclear risk	Many aspects did not match the plan, although the tools used to collect this information were not entirely structured
Harmful effects	Low risk	Difficulty in maintaining fidelity was discussed
Population and sample described well	High risk	Unclear how many dropped out of intervention and treatment groups

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Gerald 2006 (*Continued*)

Continuous evaluation	Unclear risk	Medium bias - use of administrative records lowered the risk of bias
Evaluation participation equity and sampling	High risk	The voices of children, parents, and teachers were not included in the evaluation
Design and methods overall approach	High risk	Many of the methods used did not capture key process data
Tools and methods of data collection reliable/credible	High risk	Study authors reported on the high level of measurement error
Tools and methods of data analysis reliable/credible	High risk	No adjustment was made for missing data
Performance bias/neutrality/credibility/conformability	Unclear risk	The degree of neutrality is not clear
Reliability of findings and recommendations	Unclear risk	A lot of variation in implementation is evident
Transferability of findings	High risk	The quality of the study is not high enough to support the claim that this style of intervention does work in inner city schools
Overall risk of bias of process evaluation	Unclear risk	Use of unstructured tools to collect process data means that the risk of bias is not entirely clear

Gerald 2009

Methods	**Included as outcome evaluation** **Study design:** parallel-group design, with a 2-group randomised longitudinal design, randomised by the child **Setting:** USA **Period:** baseline data collection occurred from October 2005 to December 2006. Children were randomised in January 2006. The study comprised a longitudinal design with 15-month follow-up. Follow-up data were collected from January 2006 to December 2006
Participants	**Eligible sample frame:** 290 children were randomised **Randomised:** 290 children were randomised - 145 in each arm **Completed (intervention):** 240 (83%) **Inclusion criteria:** children were eligible if they had physician-diagnosed persistent asthma requiring daily controller medication, they attended one of the 36 participating schools, and they were able to use a dry powder inhaler and a peak flow meter **Exclusion criteria:** not reported **Baseline characteristics**

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	Age of children: mean age, 11.0 years **Ethnicity:** 91% black ethnicity **Socio-economic status:** not reported. **Gender:** 57% male; 43% female in total **Asthma status:** mixed levels of severity - 15% mild persistent asthma, 79% moderate persistent asthma, 6% severe persistent asthma
Interventions	**Intervention:** children were given 20 minutes of asthma education, including discussion about avoidance of triggers. Children in the supervised therapy group also received supervision from study staff each day on the use of inhaled corticosteroids. If a child was observed using the inhaler incorrectly, staff provided education with the aid of a placebo inhaler **Control:** usual care **Intensity**: a single education session for 20 minutes; multiple supervisions for the intervention group **Instructor:** study personnel **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Parent-reported absence from school Lung function Use of reliever therapies Withdrawal
Notes	This paper did not provide much detail; however the study was previously reported in a separate paper (Gerald 2009) Considered for process evaluation: implementation data were not considered to have been collected via structured or recognised tools **Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Study authors reported: "a random sequence of treatment codes, stratified by school system, was generated using the SAS System (Version 9.1, Cary, North Carolina) by the statistician"
Allocation concealment (selection bias)	Low risk	Centrally generated: study authors reported: "a random sequence of treatment codes, stratified by school system, was generated using the SAS System (Version 9.1, Cary, North Carolina) by the statistician"

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Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No measures were described as implemented around blinding
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No measures were described as implemented around blinding
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors described: "79.3% completion rate in the control group and 86% completion rate in the intervention group. Reasons and details provided"
Selective reporting (reporting bias)	Unclear risk	No evidence shows selective reporting
Other bias	Unclear risk	Missingness - low risk - all those who were followed up submitted information Baseline imbalance - low risk - no significant differences between groups were found in baseline demographic characteristics or asthma symptom Risk of contamination - high - children were the unit of randomisation; children with different treatment allocations were present in the same school
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A

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Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Henry 2004

Methods	**Included as outcome evaluation and process evaluation** **Study design:** clustered parallel-group design **Setting:** secondary schools in Newcastle, New South Wales, Australia **Period:** baseline data were collected between February and March 1993. Follow-up data were collected between August and October 1993. Follow-up questionnaires were sent to the heads of participating schools in 1999 **Process evaluation methods:** descriptive/bivariate
Participants	**Eligible sample frame:** 33 schools were eligible for participation, with a total of 4475 year 8 students, 23% of whom had current asthma. In total, 76.7% of all eligible students and 82.7% of students recruited into th initial phase contributed to data analysis **Randomised:** not reported **Completed (intervention):** not reported **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** year 8 students were eligible; adolescents aged 13 to 14 years were targeted **Ethnicity:** numbers were not reported; however schools included a predominantly Caucasian population **Socio-economic status:** not reported. **Gender:** males represented 52.4% of intervention students with matched data and 52.9% of control adolescents **Asthma status:** not reported
Interventions	**Intervention:** intervention schools received a 3-lesson package about asthma designed to be taught within the Personal Development/Health/Physical Education (PD/ H/PE) strand of the school curriculum. Each school was invited to send a delegate to learn the curriculum and was provided with the Living With Asthma teaching kit **Control:** usual care **Intensity:** 3 lessons; however the duration of these lessons was not reported **Instructor:** in some schools, teachers who attended the training seminar delivered the lessons; in other schools, teachers trained their colleagues

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	Theoretical framework: not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** taught within the Personal Development/ Health/Physical Education strand of the school curriculum
Outcomes	**Core processes evaluated (child level):** adherence (long-term) **Extractable outcomes were collected for:** Health-related quality of life (HRQoL)
Notes	**Process evaluation category:** integrated **Breadth and depth:** depth - not breadth **Voice of children given prominence:** featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Method of stratification is unclear: schools were randomised to control or intervention, with an attempt to obtain similar demographic mixes in the 2 groups
Allocation concealment (selection bias)	Unclear risk	Not addressed by study authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Attrition data for asthmatic children were not provided in full
Selective reporting (reporting bias)	Low risk	All data were reported by study authors
Other bias	Unclear risk	Missingness - unclear risk - missing data are apparent with no explanation provided Baseline imbalance - unclear risk - this was not addressed by study authors Risk of contamination - low - risk of contamination was low due to the study design
Transparent and clearly stated aims	Low risk	Study aims were clearly stated

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Henry 2004 (*Continued*)

Explicit theories underpinning and/or literature review	High risk	No theoretical framework and very little supporting literature were provided
Transparent and clearly stated methods and tools	Low risk	Study aims were clearly stated
Selective reporting	Unclear risk	Medium bias - problems with linking surveys were experienced (pre-post intervention)
Harmful effects	Unclear risk	How this was addressed is unclear. In particular, this might not have been beneficial for many children
Population and sample described well	High risk	Level of baseline imbalance was not reported
Continuous evaluation	Unclear risk	Pre-post assessment data were used for the majority, but an element of continuous evaluation was included in the school policy analysis
Evaluation participation equity and sampling	Unclear risk	Moderate evidence shows that the voice of children was reflected adequately
Design and methods overall approach	Low risk	Design and methods were appropriate for this study
Tools and methods of data collection reliable/credible	Low risk	Data collection tools used were credible and reliable
Tools and methods of data analysis reliable/credible	Low risk	Analysis of quantitative data was reliable
Performance bias/neutrality/credibility/conformability	Unclear risk	No evidence shows how confidentiality was maintained
Reliability of findings and recommendations	Unclear risk	Level of baseline imbalance is unclear
Transferability of findings	Unclear risk	Transferability was not assessed by study authors
Overall risk of bias of process evaluation	Unclear risk	Some aspects of study design and study characteristics were not explained fully

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Horner 2008

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** elementary schools in the USA; 10 treatment and 8 attention control schools **Period:** each of the participating school districts participated for 1 academic year, and the whole project spanned 2003 to 2006 academic years. Analysis occurred over 12 weeks of the academic year from study enrolment to 6 weeks post intervention
Participants	**Eligible sample frame:** 541 families of children were invited to participate **Randomised:** 183 pupils were randomised: 101 into treatment group and 82 into control group **Completed (intervention):** 163 pupils completed the trial **Inclusion criteria:** students were eligible for participation in the study if they had doctor-diagnosed asthma, had experienced asthma symptoms in the previous 12 months, had no other significant comorbidity that would preclude participation in classes, spoke either English or Spanish, and were enrolled in grades 2 to 5 **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** mean age, 8.78 years **Ethnicity:** within the sample, 47% were Mexican American, 30% white, 22% African American, and 1% other **Socio-economic status:** not reported **Gender:** 108 male; 75 female **Asthma status:** not reported
Interventions	**Intervention:** the curriculum presented a 7-step asthma self-management plan **Control:** the attention-control group mirrored the treatment group and received education on health promotion topics appropriate for children **Intensity:** 16 sessions, each for 15 minutes **Instructor:** 18 lay health educators **Theoretical framework:** the asthma health education model that informed the study was adapted from Bruhn's theoretical model of asthma management **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** lunch breaks
Outcomes	**Extractable outcomes were collected for:** Hospitalisation Withdrawal
Notes	**Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Study authors reported: "schools were randomised through a simple coin toss at a summer meeting held with elementary

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		school principals"
Allocation concealment (selection bias)	High risk	Risk that concealment of allocation was breached
Blinding of participants and personnel (performance bias) All outcomes	High risk	Study authors reported: "Because the participants could not be blinded to their treatment condition, this information was disclosed to parents during this first telephone call"
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not assessed by study authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Missing outcome data roughly balanced across intervention and control groups, with similar reasons for missingness and study authors reporting: "Comparing baseline scores of those who dropped out of the study with those who were retained (i.e. completers) showed no significant differences in terms of demographic or study variables"
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting
Other bias	Low risk	Missingness - low risk - strategies implemented for missingness (which accounted for less than 10% of the sample) described as follows: "Missing items were handled by substituting the participant's mean score for the missed item in those cases where fewer than 10% of the items were missing for a scale. In this study, there were no instances of more than 10% of missed items for a scale" Baseline imbalance - low risk - comparing groups at baseline on study measures revealed no significant differences between groups except for asthma severity, which was greater in the treatment group Risk of contamination - low - schools were the unit of randomisation, lowering the potential for contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A

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Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Horner 2015

Methods	**Included as outcome evaluation and process evaluation** **Intervention study design:** cluster parallel-group design, with schools selected as unit of randomisation, using a stratified design according to school characteristics **Setting:** 33 elementary schools in 5 rural Texas, USA, districts participated in the study **Period:** dates on which study was conducted - intervention and subsequent data collection - not clear; data were collected over a 12-month period
Participants	**Eligible sample frame:** a total of 292 children were enrolled **Randomised:** a total of 292 children were enrolled and were randomised to 1 of 3 groups; information from 2 groups of interest provided here. 96 children were randomised to the school-based intervention group and 100 children to the attention control group **Completed (intervention):** 84 children completed the intervention and attention control **Inclusion criteria:** children were eligible if they had doctor-diagnosed asthma, had

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	experienced asthma symptoms in the previous 12 months, and could speak either English or Spanish **Exclusion criteria:** no significant comorbidity that would preclude participation in classes **Baseline characteristics** **Age of children (based on completers):** mean age, 8.8 years **Ethnicity (based on completers):** treatment: 22.9% white, 55.2% Hispanic, 21.9% African American; control: 11.3% white, 60.8% Hispanic, 27.8% African American **Socio-economic status (based on completers):** 31.2% defined as lower SES group in intervention group and 29.8% in control group **Gender (based on completers):** treatment: 55.2% male, 44.6% female; control: 76.0% male, 24.0% female **Asthma status:** mixed levels of asthma severity; similar levels between treatment and control groups when measured on the Severity of Chronic Asthma Scale
Interventions	**Intervention:** the "Asthma Plan for Kids" curriculum, specifically designed for children in rural areas, was provided to the intervention group as group instruction. Topics within the curriculum included: "(1) identifying lung function, asthma warning signs, symptoms, and triggers; (2) learning skills to manage symptoms, including peak expiratory flow score interpretation, communication with adults, medication use, and inhaler technique; (3) evaluating asthma symptoms and the effectiveness of management; and (4) discussing how to safely keep active during physical activity and sports" **Control:** an equivalent attention control was provided. This mirrored the structure of the school-based intervention but differed in providing a non-asthma-based curriculum. The content consisted of topics on general health information identified by school nurses as useful, including handwashing, nutrition, brushing teeth, and exercising **Intensity:** 15-minute lessons spread over 16 sessions that took place within a 5-week period **Instructor:** trained lay health educators **Theoretical framework:** Bruhn's theoretical model of asthma self-management **Parental engagement:** not reported **Child satisfaction:** not reported **Timing:** sessions held during lunchtime (15-minute blocks)
Outcomes	**Quantitative outcomes** Extractable outcomes were collected for: Exacerbations leading to hospital admission Asthma symptoms leading to emergency hospital visits Withdrawal **Core processes evaluated (child level):** attrition, adherence
Notes	This study compared the treatment (a school-based intervention) group vs an attention control group; also compared the school-based intervention vs the same intervention provided at an asthma day camp (although these data are not extracted here) Data were collected on office visits, but unclear whether office visits were restricted to community primary care providers or included specialist consultations **Additional measures of process evaluation quality** **Process evaluation category:** integrated within outcome evaluation **Breadth and depth:** neither broad nor deep

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	Voice of children given prominence: featured but not sufficiently **Funding source:** National Institutes of Health; Nursing Research; National Heart, Lung, and Blood Institute

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not addressed in full by study authors: actual method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Not addressed by study authors
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Evidence shows that steps were taken to ensure blinding
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Study authors reported: "Data were collected 4 times over the 12-month study during home visits, scheduled at times convenient to the families, by RAs who were blind to group assignment"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported: "A total of 292 children were enrolled and 257 completed the 12-month study (87.7% retention). There were no significant baseline differences in age, gender, race/ethnicity, SES, language spoken by parents, or asthma severity between the children who completed the study and those who dropped out"
Selective reporting (reporting bias)	Low risk	All collected outcomes apparently reported in full
Other bias	Unclear risk	Missingness - unclear risk - no evidence of additional missing data Baseline imbalance - unclear risk - children in the control group were more likely to be male; the impact that this could have on study outcomes is unclear Risk of contamination - low - schools were the unit of randomisation, lowering the risk of contamination
Transparent and clearly stated aims	Low risk	Study aims were clearly stated

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Horner 2015 (*Continued*)

Explicit theories underpinning and/or literature review	Low risk	Intervention was guided by Bruhn's theoretical model of asthma self-management
Transparent and clearly stated methods and tools	Low risk	Study methods were clearly stated
Selective reporting	Unclear risk	A limited set of data was presented for the process evaluation
Harmful effects	High risk	Only a few negative outcomes were considered
Population and sample described well	Low risk	Study sample was well described
Continuous evaluation	Low risk	Data were collected at several time points
Evaluation participation equity and sampling	Unclear risk	Not many stakeholders were involved in the evaluation
Design and methods overall approach	Unclear risk	This is unclear, as risk of bias for outcome evaluation was low; however risk of bias for process evaluation was high
Tools and methods of data collection reliable/credible	Low risk	Tools used for data collection were credible
Tools and methods of data analysis reliable/credible	Low risk	Data analysis methods were appropriate for the data
Performance bias/neutrality/credibility/conformability	Unclear risk	Credible findings focused mainly on outcomes
Reliability of findings and recommendations	Low risk	Findings are transparent
Transferability of findings	High risk	Some factors around transferability were assessed, for example, reach and attrition; however no other factors were assessed
Overall risk of bias of process evaluation	Unclear risk	As an outcome evaluation, few concerns are evident; as a process evaluation, this study is questionable

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Howell 2005

Methods	**Included as outcome evaluation and process evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** 4 elementary schools in Syracuse City, New York, USA **Period:** conducted December 2003 to January 2004; subsequent data collected through September 2004 **Process evaluation methods:** descriptive/bivariate
Participants	**Eligible sample frame:** 40 families found to be eligible and 30 consented, with 5 others unable to participate before randomisation **Randomised:** 25 families (children and caregiver), with 16 selected into the intervention group and 9 into the control group **Completed (intervention):** no reports of permanent attrition **Inclusion criteria:** target child was between 8 and 11 years of age and was in third to fifth grade with a diagnosis of asthma and prescribed daily medications for asthma as reported by nurse and/or parent **Exclusion criteria:** coexisting chronic illness that required daily medication (e.g. insulin-dependent diabetes) **Baseline characteristics** **Age of children:** mean age, 9 years 7 months; range, 8 to 11 years **Ethnicity:** 75% of children were African American **Socio-economic status:** unclear **Gender:** 63% male **Asthma status:** all children had a record of asthma, although study authors did not describe asthma severity
Interventions	**School type:** primary/elementary **Intervention description:** children in the intervention condition received four 30-minute sessions on the "Quest for the Code" computer game at their school. The computer game included modules on Lung Physiology; Symptom Recognition; Trigger Recognition; Peak Flow Meter Usage; Appropriate Use of Long-Term and Reliever Medication; Correct Usage of Common Asthma Medication; and Effect of Asthma Medications on Lungs. The child's primary caregiver participated in a medication routine interview in the home and received a 1-time home visit at which a medication routine plan was developed **Control description:** usual care/no additional intervention **Theoretical framework:** learning theory principles and behaviour modification
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** named section **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** the voice of children was featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

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Random sequence generation (selection bias)	Unclear risk	Information not given: this study was a pretest, intervention, post-test, follow-up (PPF) RCT with random assignment based on school site
Allocation concealment (selection bias)	High risk	Information not given; few students were randomised and concealment may have been breached
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed in the study
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed in the study
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low risk - low levels of attrition are reported in the study
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting
Other bias	High risk	Missingness - high risk - small sample and evidence of missingness for some indicators Baseline imbalance - high risk - described in the introduction as imbalanced Risk of contamination - low - randomisation occurred at a school level
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Intervention was informed by learning theory principles and behaviour modification
Transparent and clearly stated methods and tools	Low risk	Study included a broad-ranging description of tools implemented at different time points
Selective reporting	Unclear risk	Some statements from parents are impenetrable; other statements describe kids enjoying the intervention but are not entirely clear on how this feedback was obtained
Harmful effects	Unclear risk	Study methods do not highlight the possibility of negative effects
Population and sample described well	Unclear risk	Only basic demographic information was included

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Howell 2005 (*Continued*)

Continuous evaluation	Low risk	Not continuous; however 3 time points were considered
Evaluation participation equity and sampling	Unclear risk	Information was collected from parents and children only
Design and methods overall approach	Low risk	This was an RCT but with dedicated attention to feasibility
Tools and methods of data collection reliable/credible	Low risk	Validated measures were used
Tools and methods of data analysis reliable/credible	Unclear risk	Small study sample precludes usefulness of confounding data
Performance bias/neutrality/credibility/conformability	Unclear risk	Process was limited
Reliability of findings and recommendations	Low risk	How the data relate to study findings is clear
Transferability of findings	Unclear risk	Study sample was too small, so transferability is limited
Overall risk of bias of process evaluation	Unclear risk	Small sample compromises much of the information provided in this study

Jackson 2006

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental design with pre-post follow-up and no control group **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate analysis methods
Participants	**Country:** USA **Age of children:** this study recruited 943 third grade students, aged 8 to 9 years **Child characteristics (BME/SES):** not reported **Asthma status:** asthmatic and non-asthmatic children **Intervention recipients:** children only
Interventions	**School type:** public and private elementary schools in Chicago **Intervention description:** children completed a 1-hour asthma education programme entitled "The lion who couldn't roar". Teachers were encouraged to attend the workshop **Control description:** N/A **Theoretical framework:** not reported

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Jackson 2006 (*Continued*)

Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence	
Notes	**Process evaluation category:** integrated **Breadth and depth:** breadth - not depth **Voice of children given prominence:** sufficient coverage **Funding source:** Midwestern University and Majestic Steel Erections	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	No evidence of a theoretical framework guiding intervention development
Transparent and clearly stated methods and tools	Unclear risk	Some detail provided; however information is limited
Selective reporting	Unclear risk	Unclear whether selective reporting was considered, but most aspects of the data collected were presented; they are not entirely interpretable
Harmful effects	Unclear risk	Most aspects of the data collected were presented; they are not entirely interpretable

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Jackson 2006 (*Continued*)

Population and sample described well	High risk	No demographic information about the children was provided
Continuous evaluation	Low risk	Appropriate for intensity of the intervention
Evaluation participation equity and sampling	Low risk	Relevant stakeholders were included in the evaluation
Design and methods overall approach	Low risk	Appropriate for intensity of the intervention
Tools and methods of data collection reliable/credible	Low risk	Tools used were appropriate and well described
Tools and methods of data analysis reliable/credible	Unclear risk	Presentation of data collection methods and analysis is difficult to follow
Performance bias/neutrality/credibility/conformability	Unclear risk	Data are unclear
Reliability of findings and recommendations	High risk	No evidence from the intervention data that findings are reliable
Transferability of findings	Unclear risk	No exploration of how the impact of study findings differed by school
Overall risk of bias of process evaluation	Unclear risk	Data are unclear

Joseph 2010

Methods	**Included as process evaluation** **Intervention study design:** parallel-group randomised controlled trial **Unit of allocation:** child **Process evaluation methods:** survey based, including multi-variate analyses of outcomes
Participants	**Setting:** 6 high schools in Detroit, Michigan, USA **Age of children:** mean age, 15.3 years **Child characteristics (BME/SES):** 97% of students were African American; 52% were eligible for federal school lunch programmes **Asthma status:** asthmatic only; severity unclear **Intervention recipients:** children only
Interventions	**School type:** high schools **Intervention description:** tailored computer programme (Puff City): the web-based programme focuses on 3 core behaviours, namely, controller medication adherence, rescue inhaler availability, and smoking cessation/reduction, and consists of 4 consecutive educational computer sessions that make use of both normative ("compared with other

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	students") and ipsative ("compared with your last session") feedback. Messages are voiced over to accommodate low literacy. Participant-specific information necessary for tailoring is obtained at baseline and during the 4 sessions **Control description:** students randomised to the control group were directed to existing generic asthma websites **Theoretical framework:** not 1 single framework was named, but theories around content were mentioned
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** stand-alone and integrated (2 papers) **Breadth and depth:** breadth and depth **Voice of children given prominence:** featured but not sufficiently **Note:** study is not included as an outcome evaluation because the comparison group received asthma education (this study evaluated the added impact of providing tailored messaging) **Funding source:** National Heart, Lung, and Blood Institute, National Institutes of Health

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Each paper includes clearly stated aims
Explicit theories underpinning and/or literature review	Low risk	Not a single theory, but some aspects of learning are grounded in pedagogical techniques

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Transparent and clearly stated methods and tools	Low risk	All methods were clearly stated
Selective reporting	Unclear risk	Data were apparently collected at different time points, but only follow-up data were presented. Otherwise no evidence indicates that data collected were not presented
Harmful effects	Unclear risk	Some consideration of negative factors in the design - e.g. access to the referral co-ordinator. However, whether the analysis fully accounts for this is unclear
Population and sample described well	Unclear risk	Characteristics of the population were generally described well - but ambiguities between papers that ostensibly describe the same study population surround the numbers involved
Continuous evaluation	Low risk	Data were collected at different time points, but only follow-up data were presented
Evaluation participation equity and sampling	High risk	High level of non-participation is a matter of concern
Design and methods overall approach	Unclear risk	Evaluation took into account multiple time points (all data were not necessarily presented): however data from multiple stakeholders were not collected
Tools and methods of data collection reliable/credible	Low risk	Tools and methods used were reliable
Tools and methods of data analysis reliable/credible	Low risk	Analysis was straightforward, in part because of the relatively straightforward research design
Performance bias/neutrality/credibility/conformability	Low risk	One of the papers explicitly addressed negative cases
Reliability of findings and recommendations	Unclear risk	Taken together, the 3 papers associated with this study present an accurate description of the processes undertaken, but numerous children did not participate and no clear explanation for this was provided
Transferability of findings	Unclear risk	Study authors did not address transferability, but the data are rich enough for explo-

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Joseph 2010 (*Continued*)

		ration of contextual factors, etc. No explanation is provided as to why so many children did not participate
Overall risk of bias of process evaluation	Unclear risk	This study was well conducted in most respects, but it is unclear why so many children failed to participate

Joseph 2013

Methods	**Included as process evaluation** **Intervention study design:** parallel-group randomised controlled trial **Unit of allocation:** child **Process evaluation methods:** survey based, including multi-variate analyses of outcomes
Participants	**Setting:** 6 high schools in Detroit, Michigan, USA **Age of children:** mean age, 15.6 years **Child characteristics (BME/SES):** 98% African American; 74% of children were in receipt of free or reduced price school meals **Asthma status:** asthmatic only; severity unclear **Intervention recipients:** children only
Interventions	**School type:** high school **Intervention description:** this is an adapted version of a tailored computer programme (Puff City) that was tested in Joseph 2010. Puff City focusses on 3 behaviours: controller medication adherence, keeping an inhaler nearby, and smoking reduction or cessation. This new intervention included new submodules designed to target teens with characteristics shown to be associated with lack of behaviour change in the previous trial, and who exhibited no change after 1 or more sessions. Students were provided 4 sessions in total **Control description:** controls received 4 sessions of generic asthma education to match the experience of students in the treatment group **Theoretical framework:** Puff City uses tailoring to apply behavioural theory. Also includes Health Belief Model, Attribution Theory, and motivational interviewing
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** stand-alone and integrated (2 papers) **Breadth and depth:** breadth and depth **Voice of children given prominence:** featured but not sufficiently **Note:** study is not included as an outcome evaluation because the comparison group received asthma education (this study evaluated the added impact of providing tailored messaging) **Funding source:** National Institutes of Health; National Heart, Lung, and Blood Institute
Risk of bias	

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Joseph 2013 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Behavioural theory informed the intervention
Transparent and clearly stated methods and tools	High risk	Information collected from caregivers is unclear
Selective reporting	High risk	Data were collected from caregivers, but study authors did not state what these data included
Harmful effects	Low risk	Subgroup analyses of the impact of potential risk group were undertaken
Population and sample described well	Unclear risk	More could have been done to describe caregivers
Continuous evaluation	Low risk	Pre-post assignment data were collected
Evaluation participation equity and sampling	Unclear risk	Data collected are unclear
Design and methods overall approach	Unclear risk	Data were collected but were not presented; a clear outline of the research design was not presented

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Joseph 2013 (*Continued*)

Tools and methods of data collection reliable/credible	High risk	Information collected from caregivers is unclear
Tools and methods of data analysis reliable/credible	Low risk	Data presented were analysed in a straightforward way
Performance bias/neutrality/credibility/conformability	Unclear risk	Steps taken to address this are unclear
Reliability of findings and recommendations	High risk	Very low proportion of eligible students took part, so reliability of study findings was compromised
Transferability of findings	Unclear risk	Subgroup analyses were conducted; however study authors did not address transferability of findings, and the high level of non-response does impede data transferability
Overall risk of bias of process evaluation	High risk	Data collected were not presented clearly; high level of non-participation impinges on ability to generalise, even to the population in question

Kintner 2009

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design, with schools selected as the unit of randomisation **Setting:** 5 schools in a south-central Michigan school district **Period:** dates from recruitment to data collection spanned from September 2006 to June 2007
Participants	**Eligible sample frame:** 85 pupils found to be eligible **Randomised:** 66 pupils randomised at the school level: 38 to treatment group and 28 to control group **Completed (intervention):** 59 pupils completed the trial (7 dropped out of the intervention group) **Inclusion criteria:** student eligibility criteria included (a) diagnosis of asthma, (b) availability to participate in scheduled classes or make-up sessions, and (c) verbal and written assent to participate **Exclusion criteria:** student's expressed unwillingness to participate, lack of consent from parent or legal guardian **Baseline characteristics** **Age of children:** 9 to 12 years of age, with mean age, approximately 10.5 years **Ethnicity:** 32% African American; 15% mixed race; 11% other; 3% Hispanic **Socio-economic status:** unclear: mean score > 50 on Nam-Powers Socioeconomic Status Scale

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	Gender: overall, 52% of participants were male **Asthma status:** unclear: mean score on the Severity of Illness Scale was > 5.8 for intervention and control groups
Interventions	**Intervention:** study evaluated the SHARP programme (Staying Healthy - Asthma Responsible and Prepared). Study authors describe that 'the SHARP programme was integrated into the schools as a teaching module. Students met for 50-minute sessions delivered once a week for 10 weeks from January through March. Students worked through the 100-page SHARP workbook, which was designed to be colourful, entertaining, educational, and developmentally appropriate, as well as diverse with regards to gender, race, and culture. The programme was incorporated into the existing curriculum as an elective course through inclusion of spelling words, math problems, reading and writing assignments, discussions, demonstrations, and hands-on learning activities from biology, psychology, and sociology. To support SHARP students, caregivers and others participated in a 3-hour information sharing programme **Control:** not clearly stated (usual care) **Intensity:** targeted asthmatic students received 10 sessions in total **Instructor:** unclear (potentially teachers, although not clear) **Theoretical framework:** a lifespan development perspective guided this study and served as the framework for development of the Acceptance of Asthma Model. Cognitive, behavioural, and psychosocial needs of students with asthma were addressed to foster acceptance of asthma by increasing long-term responsibility for maintaining and promoting health, and for preventing complications **Parental engagement:** caregivers were involved, but level of engagement is unclear **Child satisfaction:** not reported **Timing of intervention in school day:** integrated into class time
Outcomes	**Extractable outcomes were collected for:** Health-related quality of life (study authors described participation in activities as a measure of quality of life) Withdrawal
Notes	Considered as a process evaluation but did not include the core components of a process evaluation, with process data collected via use of structured tools **Funding source:** National Institutes of Health and Staying Healthy - Asthma Responsible and Prepared, National Institute of Nursing Research (Primary); National Heart, Lung, and Blood Institute; National Institute of Allergy & Infectious Diseases; National Institute of Child Health & Human Development

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was computer-generated following Time 1 data collection
Allocation concealment (selection bias)	Unclear risk	Unclear; few schools were allocated

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Blinding of participants and personnel (performance bias) All outcomes	High risk	Interveners and participants were not blinded to randomisation after schools were designated to treatment and control groups
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Evaluators were instructed to not assume or ask the randomisation status of participants. Participants were requested to not disclose randomisation status to evaluators
Incomplete outcome data (attrition bias) All outcomes	Low risk	Relatively low levels of attrition; baseline characteristics of those who dropped out of the intervention group did not differ from characteristics of those who completed post-intervention assessment
Selective reporting (reporting bias)	Unclear risk	A large body of data was collected; data were aggregated into various scores, hindering their interpretation and use within meta-analyses
Other bias	Low risk	Missingness - low risk - baseline characteristics of those who dropped out of the intervention group did not differ from characteristics of those who completed post-intervention assessment Baseline imbalance - low risk - baseline group imbalance was addressed by adjusting for baseline values of outcomes in the analyses Risk of contamination - low - schools were the unit of randomisation
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A

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Kintner 2009 (*Continued*)

Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Kintner 2012

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, pre-post, no control **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate
Participants	**Country:** USA **Age of children:** sixth and seventh grades **Child characteristics (BME/SES):** 53.6% African American; 35.7% lower SES **Asthma status:** asthmatic only **Intervention recipients:** students, members of their social network
Interventions	**School type:** high school **Intervention description:** SHARP, community coalition component **Control description:** N/A **Theoretical framework:** asthma model and lifespan development perspective
Outcomes	**Core processes evaluated (child level):** dosage, adherence
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** breadth and depth **Voice of children given prominence:** sufficient coverage **Funding source:** not reported
Risk of bias	

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Kintner 2012 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	A theoretical framework was clearly presented
Transparent and clearly stated methods and tools	Low risk	Methods were well described
Selective reporting	Unclear risk	Not all indicators were fully reported, for example, asthma severity
Harmful effects	Unclear risk	These effects were not presented by study authors but can be inferred
Population and sample described well	Low risk	Participant demographics were clearly described
Continuous evaluation	Low risk	Pre-post assignment assessment of data was provided
Evaluation participation equity and sampling	Low risk	All relevant stakeholders were apparently involved in the evaluation
Design and methods overall approach	Low risk	Data were collected from multiple sources and at multiple time points

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Kintner 2012 (*Continued*)

Tools and methods of data collection reliable/credible	Low risk	Tools and methods were well described
Tools and methods of data analysis reliable/credible	Unclear risk	Not everything was presented in full
Performance bias/neutrality/credibility/conformability	Unclear risk	These were not fully addressed; only a few steps appear to have been taken to minimise the possibility of performance bias
Reliability of findings and recommendations	Low risk	How findings came about is clearly shown by study data
Transferability of findings	Unclear risk	Study authors did not focus on what might need to be changed to scale up. Some measures (e.g. individual interviews with dyads) are not transferable, although it is not clear if study authors shared this view
Overall risk of bias of process evaluation	Low risk	This is a good example of a process evaluation study

Kouba 2012

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group study examining change pre-post intervention **Unit of allocation:** N/A **Process evaluation methods:** descriptive and bivariate methods of analyses of survey-based data (as well as administrative records)
Participants	**Setting:** 2 urban high schools in the USA **Age of children:** ninth through 12th grade; average age was 15.9 years **Child characteristics (BME/SES):** 92% African American, 4% Hispanic, 4% mixed ethnicity. Combined median family income ranged from USD30,000 to USD39,000 **Asthma status:** asthmatic only; 66% of children were deemed to have control of their asthma at baseline according to ACT tests **Intervention recipients:** children only (targeted overweight/obese children)
Interventions	**School type:** 2 high schools **Intervention description:** I Can Control Asthma and Nutrition Now (ICAN): the ICAN programme was developed as an adaptation of an existing intervention and is composed of 3 elements: (I) asthma education; (ii) coping skills training; and (iii) nurse practitioner-reinforcement visits. In this study, 60% of students were overweight or obese. Because of concerns about the increasing prevalence of both youth asthma and obesity, study authors added a nutrition component to the intervention, so that the intervention could address these comorbidities. The ICAN programme is thus composed of 4 elements: (I) asthma education, (ii) nutrition education synthesised with CST,

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	targeting obesity prevention and management, (iii) reinforcement visits with a registered nurse (RN) and a dietetic intern, and (iv) a family information meeting **Control description:** N/A **Theoretical framework:** Orem's self-care deficit theory (SCDT)
Outcomes	**Core processes evaluated (child level):** attrition, dosage
Notes	**Process evaluation category:** integrated within outcome evaluation **Breadth and depth:** depth - not breadth **Voice of children given prominence:** voice and views of children not featured **Funding source:** Loyola University Chicago Niehoff School of Nursing

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Orem's self-care deficit theory guided the intervention
Transparent and clearly stated methods and tools	Low risk	Methods and tools were fully described
Selective reporting	Low risk	All planned outcomes were reported on
Harmful effects	Unclear risk	Generalisability was not considered. Some of the challenges of working with obese kids who are not adherent were not reported

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Kouba 2012 (*Continued*)

Population and sample described well	Low risk	Population demographics were clearly described
Continuous evaluation	Low risk	Two follow-ups post intervention
Evaluation participation equity and sampling	Unclear risk	No evidence of satisfaction evaluation and no child perspectives given
Design and methods overall approach	Unclear risk	Everything required for a good process evaluation was not captured
Tools and methods of data collection reliable/credible	Unclear risk	Nothing suggests that this study was at high risk of bias; however no study steps were described
Tools and methods of data analysis reliable/credible	Low risk	All methods of data analysis are appropriate for the study
Performance bias/neutrality/credibility/conformability	Unclear risk	Not much evidence of this; however analysis was carried out by research associates under the supervision of the statistician
Reliability of findings and recommendations	Unclear risk	This included a small sample, and the voice of children did not feature prominently
Transferability of findings	High risk	Small sample size limits the transferability of findings
Overall risk of bias of process evaluation	Unclear risk	As a process evaluation, this study was limited, and the breadth of the study in including nutrition alongside asthma education was not evaluated

Langenfeld 2010

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, pre-post, with no control **Unit of allocation:** N/A **Process evaluation methods:** bivariate analysis methods
Participants	**Country:** USA **Age of children:** students from grades 3, 4, and 5 were enrolled. All students were between 5 and 10 years old **Child characteristics (BME/SES):** 63% African American; large number of students were eligible for a free, or reduced price, lunch **Asthma status:** asthmatic only **Intervention recipients:** children and teachers

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Interventions	**School type:** 286 students from 12 elementary schools **Intervention description:** children participated in the OAS programme, consisting of six 40-minute education sessions on asthma and asthma management. Children and staff also participated in the asthma programme, developed through case management strategies. This included 5 core components, including case management for specific children selected by the school nurse, and staff development and education about asthma **Control description:** N/A **Theoretical framework:** not reported
Outcomes	**Core processes evaluated (child level):** dosage
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** depth - not breadth **Voice of children given prominence:** not featured **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Unclear risk	Study aims can be inferred by the reader but were not clearly stated
Explicit theories underpinning and/or literature review	High risk	No theoretical framework was provided, and very little supporting literature is available

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Transparent and clearly stated methods and tools	Unclear risk	Methods described are relatively transparent, but some ambiguity remains
Selective reporting	Unclear risk	This paper did not claim to present outcomes but focused on whether the right people received the right intervention
Harmful effects	Unclear risk	Harmful effects in terms of recruitment were definitely addressed, but other harmful effects were not considered
Population and sample described well	Unclear risk	Study population and sample were generally well described, but school demographics were not reported
Continuous evaluation	Low risk	Pre-post assessment was conducted
Evaluation participation equity and sampling	High risk	Nurse voice and student voices were obfuscated
Design and methods overall approach	Unclear risk	Not clearly described by study authors
Tools and methods of data collection reliable/credible	Low risk	Tools used for data collection were appropriate for the data
Tools and methods of data analysis reliable/credible	Unclear risk	No in-depth analysis was provided; insights gained from nurse interviews are unclear
Performance bias/neutrality/credibility/conformability	Unclear risk	Premise of the paper involves thinking about the robustness of certain processes, but it is unclear who conducted the analysis
Reliability of findings and recommendations	Unclear risk	This paper clearly presented one point, but obscurity surrounds nurses' ratings
Transferability of findings	Low risk	Evidence is sufficient that the main thrust of the paper is transferable
Overall risk of bias of process evaluation	Unclear risk	As a process evaluation, its low breadth introduces high risk of bias to this trial, but in evaluating a single process, this is a really good trial

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Lee 2011

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group intervention examining change pre-post intervention **Unit of allocation:** N/A **Process evaluation methods:** qualitative and quantitative data collection; descriptive/bivariate, thematic/grounded theory, narrative data analysis
Participants	**Setting:** selected schools (67 schools) in Cleveland Metropolitan School District **Age of children:** 8 to 11 years old **Child characteristics (BME/SES):** no information **Asthma status:** asthmatic only **Intervention recipients:** children only
Interventions	**School type:** primary/elementary **Intervention description:** Open Airways for Schools (also testing the feasibility of undergraduate nursing students as instructors). The study author described that "the curriculum consists of six 40-minute group lessons held during the school day. These lessons use group discussion, stories, role-playing, and games to help the children understand more about asthma and to engage them more in the empowerment of managing their disease. The topics that are included in the program are basic information about asthma, recognizing and managing asthma symptoms, using medication, avoiding asthma triggers, getting enough exercise, and doing well in school. Each lesson focuses on one of the above topics with a review of previous information for enforcement of the skills and knowledge learned. The overall goals of the program are to (a) improve asthma self-management skills, (b) decrease asthma emergencies, (c) raise awareness among parents/guardians, and (d) promote broader asthma management coordination among physicians, parents, and schools" **Control description:** N/A **Theoretical framework:** functional context approach
Outcomes	**Core processes evaluated (child level):** explored some indicators of adherence
Notes	**Process evaluation category:** integrated within outcome evaluation **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A

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Lee 2011 (*Continued*)

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Low risk	Functional context approach guided development of the intervention
Transparent and clearly stated methods and tools	Unclear risk	In terms of the outcome evaluation and information collected from children, lack of transparency surrounds the sample frame and tools
Selective reporting	High risk	Many instruments were not presented
Harmful effects	Unclear risk	Some elements that could be negative were included, but nothing from the children is included
Population and sample described well	High risk	Not much information was included on participants, and some details of the children were not described. More information was provided about the schools themselves
Continuous evaluation	Unclear risk	Pre-post assessment, but post hoc only for nurses
Evaluation participation equity and sampling	Unclear risk	Nothing from the teachers was reported
Design and methods overall approach	High risk	Structured data about implementation - e.g. attrition, adherence - are insufficient
Tools and methods of data collection reliable/credible	High risk	Lack of transparency is evident among the methods used to assess child outcomes
Tools and methods of data analysis reliable/credible	High risk	Quantitative data were not analysed fully - e.g. lack of subgroup analyses

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Lee 2011 (*Continued*)

Performance bias/neutrality/credibility/conformability	High risk	How aspects around neutrality were addressed is unclear
Reliability of findings and recommendations	High risk	Study design did not support the research question - results from different instructors were not compared
Transferability of findings	High risk	Generalisability was not explicitly considered in enough detail
Overall risk of bias of process evaluation	High risk	Study has several limitations, including reporting bias and lack of transparency

Levy 2006

Methods	**Included as outcome evaluation and process evaluation** **Intervention study design:** cluster parallel-group RCT with schools selected as unit of randomisation, based on a stratified design according to school characteristics **Setting:** 14 elementary schools in Memphis, Tennessee, USA, school district participated in the study **Period:** study was conducted over 2 school years between 1999 and 2001
Participants	**Eligible sample frame:** see below **Randomised (based on year 1):** 14 schools randomised. In 8 treatment group schools, 115 students participated, and in 6 usual care schools, 128 students participated. This represented a consent rate of 48% for both groups of students, whose parents reported asthma on the student's registration form **Completed (intervention) (based on year 1):** in the treatment group, 90 (78.3%) parents completed both pre- and post-test surveys; in the usual care group, 72 (56.3%) parents participated in post-test surveys **Inclusion criteria:** children 6 to 10 years of age with a diagnosis of asthma reported on school health forms and whose parents provided consent (see above) **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 6 to 10 years of age; further breakdown not provided **Ethnicity (based on year 1):** 97% of children in the treatment group and 99% of children in the control group were African American **Socio-economic status:** (based on year 1): 81% of students in the treatment group and 85% in the control group were in receipt of TennCare health insurance (a state-specific version of Medicare) **Gender (based on year 1):** treatment: 58% male, 42% female; control: 57% male, 53% female **Asthma status:** not reported directly
Interventions	**Intervention:** the intervention consisted of the following: "(1) education (delivery of the Open Airways curriculum to students in a weekly group setting at school), (2) weekly monitoring of students' health status (following up on absences and symptoms with students, families, and teachers), and (3) coordination of care (contacting students, family

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	members, school personnel, and medical providers to facilitate disease management and mitigate environmental triggers at school and at home)" The intervention aimed to introduce the following principles of self-management: "(1) periodic physiologic assessment and monitoring of asthma symptoms, (2) appropriate use of medications, (3) patient education, and (4) control of factors contributing to asthma severity" **Control:** usual care **Intensity:** weekly group sessions and weekly individual sessions; "nurse case managers met with students weekly from October through May to teach and coach students on asthma knowledge and treatment techniques" **Instructor:** school-based nurses **Theoretical framework:** not directly reported **Parental engagement:** difficulties reported; low levels of consent and high levels of attrition at post-test survey **Child satisfaction:** not reported **Timing of intervention:** during school day; exact time unclear
Outcomes	**Extractable outcomes were collected for:** Exacerbations leading to hospital admission Asthma symptoms leading to emergency hospital visits Withdrawal **Core processes outcomes evaluated (child level):** attrition
Notes	**Notes for outcome evaluation:** only data for year 1 used, as year 2 data not collected through randomised study design **Additional measures of process evaluation quality** **Process evaluation category:** integrated **Breadth and depth:** breadth - not depth **Voice of children given prominence:** not featured **Funding source:** Tennessee Department of Health

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No information on method of randomisation was provided
Allocation concealment (selection bias)	High risk	Study author description suggests that allocation concealment was broken: "although schools were matched on demographic variables, a greater number of schools were randomised to intervention status than usual care because of staffing considerations and the school district's request for intervention in as many schools as possible"

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Blinding of participants and personnel (performance bias) All outcomes	Low risk	Some measures were taken to ensure blinding of personnel
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Clear that blinding was implemented for several outcomes based on study author's description of staff being blinded to students' experimental condition in dealing with abstracted medical data from computerised hospital records
Incomplete outcome data (attrition bias) All outcomes	High risk	Study authors reported a differential loss to follow-up: "there was a 24% loss in follow-up with intervention parents and a 44% dropout rate with usual care parents"
Selective reporting (reporting bias)	High risk	High risk, as study authors tended to report in passing or incompletely outcomes that were not significantly different
Other bias	Unclear risk	Missingness - high risk - evidence shows substantial missing data, as study authors described that "in the usual care parent group, only 72 of the possible 128 parents participated in the posttest surveys, and considerable data were missing". How this affected outcomes is unclear Baseline imbalance - low risk - no evidence shows a baseline imbalance in the characteristics of children Risk of contamination - low - randomisation took place by school, thereby lowering the risk of contamination
Transparent and clearly stated aims	Unclear risk	Medium bias - aims were inferred
Explicit theories underpinning and/or literature review	High risk	No theory and not much literature were provided
Transparent and clearly stated methods and tools	Unclear risk	These data were not clearly reported by study authors
Selective reporting	High risk	Some outcomes were not fully reported (outcomes as opposed to processes)
Harmful effects	Low risk	Study authors did consider harmful effects and paid attention to harmful processes or implementation problems

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Levy 2006 (*Continued*)

Population and sample described well	Unclear risk	Medium bias - some conflation between year 1 and year 2 populations is evident
Continuous evaluation	Unclear risk	Medium bias - pre-post for most of the process evaluation
Evaluation participation equity and sampling	High risk	No input from children or teachers and no satisfaction data were reported
Design and methods overall approach	Unclear risk	Data were collected at multiple time points and from different sources; but they were not very well reported
Tools and methods of data collection reliable/credible	Unclear risk	Lack of transparency surrounds some aspects, so it is difficult to categorise this risk of bias appropriately
Tools and methods of data analysis reliable/credible	High risk	Lack of disaggregated data and the bivariate nature of the data mean that this study is likely at high risk of bias
Performance bias/neutrality/credibility/conformability	Low risk	Study authors attempted to introduce rigour and provided a full outline of the caveats. Staff who were blinded to students' experimental condition abstracted medical data from computerised hospital records
Reliability of findings and recommendations	Low risk	How conclusions were reached based on the data is clear
Transferability of findings	Low risk	Study findings are transferable to the wider population
Overall risk of bias of process evaluation	Unclear risk	Bivariate nature of this study makes it have high risk of bias

Magzamen 2008

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group intervention examining change pre-post intervention **Unit of allocation:** N/A **Process evaluation methods:** survey based using descriptive/bivariate analyses. Some regression analyses reported controlling for previous baseline observations
Participants	**Setting:** 15 schools in Oakland, California, USA **Age of children:** 11 to 16 years of age (although more than 80% were 11 to 12 years

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	old) **Child characteristics (BME/SES):** ethnicity of children is unclear (although intervention took place in a diverse catchment area). Socio-economic status of children unclear, although intervention took place within a deprived school system **Asthma status:** asthmatic only (diagnosed asthma) **Intervention recipients:** children only
Interventions	**School type:** junior/middle schools and high schools **Intervention description:** study authors presented results from Kickin' Asthma, described as "a 4-session curriculum developed jointly by experts, nurses and peer educators and delivered over a 3-year period. Kickin' Asthma is similar structurally to Open Airways for Schools, a curriculum designed for children at the elementary school level but with more advanced topics and learning modalities more suitable for adolescents' level of cognition and awareness. The 4 Kickin' Asthma sessions were each taught by a specialist nurse, about 50 minutes in length, and were spaced 1 week apart. The 4 sessions covered (1) lung physiology and asthma basics; (2) triggers, symptoms, and warning signs; (3) medication; and (4) emergencies, problem solving, and review. Each session has optional modules for skits, games, videos, and role-playing scenarios and allowed certain modules to be taught by either the health educator or peer educators. Customized letters were sent home to the parents or guardians of all Kickin' Asthma participants that described the curriculum along with the specific health needs and goals of each student as assessed by the nurse educator" **Control description:** N/A (no control) **Theoretical framework:** no information
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** stand-alone and named section (2 papers) **Breadth and depth:** depth - not breadth **Voice of children given prominence:** not featured **Funding source:** Centers for Disease Control and Prevention Controlling Asthma in American Cities Project

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A

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Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Unclear risk	Some supporting literature was provided, but no theoretical framework was stated
Transparent and clearly stated methods and tools	Low risk	Lots of details about the tools used and how the study was conducted were provided
Selective reporting	Unclear risk	Data were collected individually and were presented ecologically
Harmful effects	Unclear risk	Harmful impacts - particularly around equity and gathering a range of stakeholder views - were not considered
Population and sample described well	Unclear risk	Data on SES and ethnicity are missing
Continuous evaluation	Unclear risk	Data that support different cohorts were provided, but whether they were analysed continuously (i.e. whether data were analysed and used to make any necessary changes to the programme) remains unclear
Evaluation participation equity and sampling	Unclear risk	Equitable sampling was described, along with a low response rate; data were not collected from all stakeholders involved
Design and methods overall approach	Unclear risk	Only one source of evidence was provided; however this is disaggregated across different cohorts
Tools and methods of data collection reliable/credible	High risk	Very low response rates suggest that methods of data collection used are unreliable
Tools and methods of data analysis reliable/credible	Unclear risk	Two sets of analyses were conducted - ecological and individual. Insights gained by using both sets remain unclear
Performance bias/neutrality/credibility/conformability	Unclear risk	Study authors did not describe steps taken to minimise performance bias. Negative outcomes are discussed, as is delivery of the

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Magzamen 2008 (*Continued*)

		intervention by nurses vs researchers. Confidentiality/anonymity is not discussed
Reliability of findings and recommendations	High risk	Study authors reported low rates of response to the surveys used
Transferability of findings	Unclear risk	This was not assessed by study authors, but the information provided is rich enough to assess transferability
Overall risk of bias of process evaluation	Unclear risk	As an impact study, issues are evident, but as a process evaluation, data provided are useful

McCann 2006

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT with schools selected as the unit of randomisation **Setting:** primary/junior schools in the south of England; 24 schools randomised (with one dropout); 12 treatment schools and 11 control schools included **Period:** 2000 to 2001. Outcomes were collected 6 months before and after the intervention
Participants	**Eligible sample frame:** 361 children and their parents were invited to participate **Randomised:** 219 children and their parents agreed to participate. 113 pupils at 12 schools were in the control group; 106 pupils at 12 schools were in the intervention group **Completed (intervention):** 1 school withdrew, resulting in 6 children withdrawing. 20 children withdrew because they moved out the area. Unclear whether these children came from the intervention group or the control group **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 7 to 9 years of age **Ethnicity:** not reported **Socio-economic status:** 25% of pupils in the control group and 15% of those in the intervention group were socially deprived **Gender:** 97 females and 122 males: 50 females and 56 males in the intervention group, 47 females and 66 males in the control group **Asthma status:** asthmatic and non-asthmatic children were included, and selected outcomes for asthmatic children were presented separately
Interventions	**School type:** 24 primary schools **Intervention description:** intervention workshops focused on a description of the respiratory condition, consistent with the national science curriculum. Role-play between a teacher and a school nurse demonstrated what it was like to have asthma, and how one can help a friend who is coughing and struggling to breathe **Control description:** children in the control group took part in a workshop about the

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	respiratory system and how the body defends itself against infection; however asthma was not mentioned during the workshop **Theoretical framework:** not reported **Intensity:** one 45-minute workshop **Instructor:** school nurse **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of the intervention in the school day:** not reported
Outcomes	**Extractable outcomes were not collected** **Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** integrated **Breadth and depth:** depth - not breadth **Voice of children given prominence:** featured but not sufficiently **Note:** extractable outcomes were not collected for meta-analysis; this study described a low-intensity single-session intervention and was not included in QCAs **Funding source:** National Health Service Research and Development Grant

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	This was not addressed by study authors, who described that "Pairs of schools were matched on demographic characteristics and randomly assigned within pairs"
Allocation concealment (selection bias)	Unclear risk	This was not addressed by study authors, who described that "Pairs of schools were matched on demographic characteristics and randomly assigned within pairs"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	This was not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	This was not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	High risk	Attrition was not disaggregated; 219 parents of children with asthma agreed their children could participate, of whom 193 (88.1%) completed the study
Selective reporting (reporting bias)	High risk	Full attendance data were not presented; full data for other outcomes also were not presented

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Other bias	Unclear risk	Missingness - unclear risk - this is not fully described by study authors Baseline imbalance - high risk - differences were apparent (e.g. the control group was twice as likely to report both parents smoking); these were accounted for only in some analyses Risk of contamination - unclear - schools were the unit of randomisation
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Unclear risk	Some literature was provided to support a whole school approach, but no theory was named
Transparent and clearly stated methods and tools	Unclear risk	Tools used are not clear, and it is not clear whether they were validated
Selective reporting	High risk	Although the direction of the result was presented in some cases, actual data were not presented, meaning that they are not extractable
Harmful effects	Unclear risk	Some subgroup analyses were undertaken, but not always with justification
Population and sample described well	Unclear risk	Whether the population consists of all children or only asthmatic children is not always clear
Continuous evaluation	Low risk	Pre-post assessment was conducted
Evaluation participation equity and sampling	Unclear risk	This was not clearly reported by study authors
Design and methods overall approach	Unclear risk	Data were collected from multiple stakeholders, but they were not collected continuously
Tools and methods of data collection reliable/credible	Unclear risk	Not much information about the questionnaires used was presented
Tools and methods of data analysis reliable/credible	Unclear risk	It appears that analysis of the data was conducted sensibly, but it is unclear what happened in the light of results presented

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McCann 2006 (*Continued*)

Performance bias/neutrality/credibility/conformability	Unclear risk	This was not addressed by study authors
Reliability of findings and recommendations	High risk	Data were not presented in full, and study authors reported statistical significance, rather than presenting effect sizes
Transferability of findings	Unclear risk	This was not explicitly considered, but processes of implementation were described in full (simple intervention in some ways)
Overall risk of bias of process evaluation	Unclear risk	Adherence and attrition data are not fully applicable in a single-session intervention, and issues surround the disaggregation of outcome data between asthmatic and non-asthmatic children

McGhan 2003

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT, with schools selected as the unit of randomisation **Setting:** 18 elementary schools in Edmonton, Canada **Period:** dates on which study was conducted - intervention and subsequent data collection - are not clear (post-test data collection took place 9 months after the intervention)
Participants	**Eligible sample frame:** eligibility based on school and parent assent and asthma status - 162 children found to be eligible across 18 schools **Randomised:** 162 pupils were randomised at the school level: 76 to the treatment group and 86 to the control group **Completed (intervention):** 136 pupils completed the trial **Inclusion criteria:** Study authors stated: "the target population was children with asthma ages 7-12 years; however, other ages were included if the parent and child were interested in participating. Criteria for selection included: (1) a diagnosis of asthma by a physician, (2) informed consent from the parent/guardian, (3) ability to speak English, and (4) no previous participation in RAP" **Exclusion criteria:** no additional exclusion criteria described **Baseline characteristics** **Age of children:** wide age range, with children 5 to 13 years old participating (most were 8 to 10 years of age) **Ethnicity:** approximately 77.8% of children were white **Socio-economic status:** unclear **Gender:** approximately 59.2% of participants were male **Asthma status:** approximately 66.6% of children were deemed to have mild asthma, and 6.3% were deemed to have severe asthma

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Interventions	**Intervention:** involved testing the effectiveness of "Roaring Adventures of Puff" (RAP) . Study authors describe that "using the 30 page manual, the instructors taught six 60-minute sessions: (1) getting to know each other, goal setting, use of a peak flow meter, diary monitoring; (2) trigger identification, control and avoidance, basic pathophysiology; (3) medications and proper use of inhalers; (4) symptom recognition and action plan; (5) lifestyle, exercise, managing an asthma episode; and (6) sharing this information with teachers and parents. Parents and teachers in the intervention schools were invited to participate in a RAP parent/teacher asthma awareness event at the school" **Control:** not clearly stated (usual care) **Intensity:** asthmatic students received 6*60-minute lessons **Instructor:** nursing and pharmacy students were asked to be RAP instructors **Theoretical framework:** social cognitive theory **Parental engagement:** it was intended that parents would be involved, although parent and teacher attendance ranged from 10% to 80% **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Outcomes were extracted for:** Asthma symptoms leading to emergency hospital visits Parent-reported absence from school Unplanned GP or hospital visit due to asthma Experience of daytime and night-time symptoms Withdrawal
Notes	**Considered for process evaluation:** did not meet the definition of a process evaluation **Funding source:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	This is not addressed by study authors, who describe: "the study compared children with asthma in randomly assigned intervention schools with those in control schools"
Allocation concealment (selection bias)	Unclear risk	This is not addressed by study authors, who describe: "the study compared children with asthma in randomly assigned intervention schools with those in control schools"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors

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Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	High risk	Twenty-six families (16%) dropped out of the study; indications show that children who dropped out had substantially different characteristics from children who remained engaged: "the dropouts were significantly less likely to have reported seasonal asthma and unscheduled doctor visits in the last year"
Selective reporting (reporting bias)	Unclear risk	No evidence shows selective reporting
Other bias	Unclear risk	Missingness - unclear risk - information on missing data was not provided in detail Baseline imbalance - high risk - the intervention group was more likely to have received previous education on asthma, which is likely to have influenced response to the intervention Risk of contamination - low - unit of randomisation was schools
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A

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Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

McGhan 2010

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design **Setting:** elementary schools in Edmonton, Canada **Period:** not reported
Participants	**Eligible sample frame:** all schools in Edmonton were eligible; an estimated 646 students from the 18 participating schools were eligible **Randomised:** 162 pupils from 18 schools: 76 pupils in the intervention group and 86 in the control group **Completed (intervention):** 136 pupils: 65 in the intervention group and 71 in the control group **Inclusion criteria:** the target population was children 7 to 12 years of age with asthma. Pupils were eligible if they had received a diagnosis of asthma from their doctor and informed consent from their parent/guardian, were able to speak Eglish, and had not previously participated in Roaring Adventures of Puff (RAP) **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 5 to 10 years of age; 27.6% in the intervention group and 23.3% in the control group were 5 to 7 years old, and 61.8% in the intervention group and 57% in the control group were 8 to 10 years old **Ethnicity:** 81.6% of children in the intervention group and 74.4% of children in the control group were Caucasian **Socio-economic status:** not reported; however 26.8% of children in the intervention group and 36.4% in the control group had a father who achieved education grade 12 or less **Gender:** males represented 55.3% of intervention students and 62.8% of control students **Asthma status:** mixed levels of severity: 62.7% of intervention children and 66.7% of control children had mild asthma; 29.3% of intervention children and 28.6% of control children had moderate asthma; 8% of intervention children and 4.8% of control children had severe asthma

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Interventions	**Intervention:** parents and teachers in intervention schools were invited to participate in a RAP asthma awareness event at school. Parents and children in the intervention schools received information letters to share with their doctors, including suggested guidelines for a written action plan to be used at home and school. Doctors also received a summary letter from the RAP instructor at the end of the programme **Control:** usual care **Intensity:** six 60-minute sessions **Instructor:** third year nursing and pharmacy students were RAP instructors under the guidance of their supervisor **Theoretical framework:** social cognitive theory informed the intervention **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Asthma symptoms leading to emergency hospital visit Parent-reported absence from school Unplanned visit to hospital or GP due to asthma symptoms Experience of daytime and night-time symptoms Withdrawal
Notes	**Considered for process evaluation:** did not meet the definition of a process evaluation **Funding source:** Alberta Heritage Foundation for Medical Research - Health Research Fund

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Schools were randomly assigned to RAP educational intervention or usual care (control group) via a random numbers table
Allocation concealment (selection bias)	Unclear risk	Selection of schools is unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	High risk	Over one-quarter of children dropped out; no reasons were provided
Selective reporting (reporting bias)	High risk	Measures of variance were not presented, hindering extraction of some outcomes

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Other bias	Unclear risk	Missingness - unclear risk - no descriptions of missingness were provided Baseline imbalance - low risk - no differences between intervention and control arms are apparent Risk of contamination - low - randomisation at the school level
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

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Mickel 2016

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group intervention with change pre-post intervention examined **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate, descriptive qualitative analysis
Participants	**Setting:** 7 schools in an urban Midwest school district **Age of children:** mean age, 9.3 years **Child characteristics (BME/SES):** 63.6% of children were African American; 13.3% Hispanic; 20.2% white. Backgrounds of individual children were not presented, although schools were recruited from districts in low-income areas **Asthma status:** asthmatic and non-asthmatic children were included, with asthma diagnosed in approximately half of the 348 children **Intervention recipients:** children only
Interventions	**School type:** primary/elementary **Intervention description:** study authors described an intervention (Iggy and the Inhalers (Iggy)). Iggy is an asthma education video, poster, comic book, sticker, and trading card programme for children between the ages of 7 and 12 years. Iggy education takes place over 1 session lasting approximately 30 minutes. Sessions include a brief welcome (2 minutes), the Iggy video (11 minutes), and interactive discussion based on posters (7 minutes). Each pre- and post-test worksheet takes approximately 5 minutes to complete. Children then take home trading cards, stickers, and comic books to share with their parents **Control description:** N/A **Theoretical framework:** no information
Outcomes	**Core processes evaluated (child level):** attrition (to post-test)
Notes	**Process evaluation category:** named section **Breadth and depth:** breadth and depth **Voice of children given prominence:** sufficient coverage **Funding source:** Wisconsin State Asthma Coalition mini-grant

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias)	Unclear risk	N/A

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Mickel 2016 (*Continued*)

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	Some literature was provided, but no theoretical framework was presented
Transparent and clearly stated methods and tools	Low risk	Study approach was well described
Selective reporting	Low risk	No evidence shows selective reporting, as negative comments were presented
Harmful effects	Low risk	Negative responses from children were presented and discussed
Population and sample described well	Low risk	Demographic information was provided
Continuous evaluation	Low risk	Pre-post assessment was conducted
Evaluation participation equity and sampling	Low risk	Parent, nurse, and child responses were collected
Design and methods overall approach	Low risk	Short intervention - data were collected at multiple time points
Tools and methods of data collection reliable/credible	Unclear risk	Description of qualitative data is limited
Tools and methods of data analysis reliable/credible	Unclear risk	How themes were developed remains unclear
Performance bias/neutrality/credibility/conformability	High risk	These aspects were not considered, and programme staff collected qualitative data
Reliability of findings and recommendations	High risk	Some of the claims around sustained impact were based on a 1-month post-test
Transferability of findings	Low risk	Enough data were provided for assessment of the relevance of challenges

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Mickel 2016 (*Continued*)

Overall risk of bias of process evaluation	Low risk	Overall low risk, although some reservations around reporting of study design and analysis of qualitative aspects remain

Monforte 2012

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT **Setting:** 8 urban public elementary schools **Period:** not reported
Participants	**Eligible sample frame:** 22 schools were eligible and 4 participated; unclear how many students were eligible **Randomised:** 49 intervention students and 41 control students - between 32% and 64% of eligible students across schools **Completed (intervention):** 49 students in the intervention group and 41 students in the control group **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 90 children in grades 3 to 6 **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** not reported **Asthma status:** asthma only
Interventions	**Intervention:** children were enrolled in the OAS programme; however no further information was provided **Control:** not reported **Intensity:** not reported **Instructor:** not reported **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Health-related quality of life
Notes	This study was presented as an abstract only **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

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Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A

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Monforte 2012 (*Continued*)

Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Mosnaim 2011

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT **Setting:** elementary schools in Chicago **Period:** not reported
Participants	**Eligible sample frame:** not reported **Randomised:** 344 pupils within the youth group (275 in the intervention group and 69 in the control group) and 192 within the teen group (141 in the intervention group and 51 in the control group) participated. 25 youth classes (19 intervention groups and 6 control groups) and 16 teen classes (11 intervention group and 5 control groups) from 26 schools participated **Completed (intervention):** not reported **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** youths and teens 5 to 15 years old. Median age was 10 for the youth group and 13 for the treatment group **Ethnicity:** 65.5% in the youth intervention group were African American; 11.6% were Hispanic; and 22.3% were other. In the teen intervention group, 85.1% were African American, 7.1% were Hispanic, and 7.1% were other **Socio-economic status:** not reported, but study author described participants as predominantly low income **Gender:** females represented 43% of participants. In the youth intervention group, 41.5% were female; in the teen intervention group, 48.2% were female **Asthma status:** not reported
Interventions	**Intervention:** certified asthma educators provided 1-to-1 training on spacer technique, peak flow meter use, and use of an asthma action plan. The teen programme also addressed tobacco avoidance, asthma-related peer pressure, and asthma self-management skills **Control:** usual care **Intensity:** four 45-minute sessions conducted in school on 4 consecutive days **Instructor:** certified asthma educators **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not explicitly reported, but sessions were scheduled at times with the least impact on instruction, as determined by each school

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Mosnaim 2011 (*Continued*)

Outcomes	**Extractable outcomes were collected for:** None
Notes	**Considered for process evaluation:** study did not include the core components of a process evaluation **Funding source:** Abbott Laboratories Unrestricted Grant

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Potential breach of randomisation schedule through systematic bias in selection of schools for the control group: "The allocation scheme first determined whether an eligible school could accommodate the intervention schedule. Those that could not were automatically assigned to the control group, whereas those that could were subject to the 3:1 randomisation scheme"
Allocation concealment (selection bias)	High risk	Potential breach of randomisation schedule through systematic bias in selection of schools for the control group: "The allocation scheme first determined whether an eligible school could accommodate the intervention schedule. Those that could not were automatically assigned to the control group, whereas those that could were subject to the 3:1 randomisation scheme"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Relatively low levels of missing data; study authors state that this had no impact on the outcome: "Approximately 15% of the participants overall were missing posttest scores (39 youth and 44 teen participants) . Based on feedback from our trained educators as to the source of the absenteeism, we concluded that these missing data were missing at random and did not merit use of data imputation methods"

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Mosnaim 2011 (*Continued*)

Selective reporting (reporting bias)	Low risk	No evidence of indicators measured but not reported. However, indicators that were not included in our protocol were collected
Other bias	Unclear risk	Missingness - unclear risk - missing data but no imputation strategy - study authors stated that it was not necessary to implement imputation strategies Baseline imbalance - unclear risk - some ethnic and gender differences at baseline but impact on outcomes unclear; no differences in asthma knowledge at baseline Risk of contamination - low - unit of randomisation was the school, lowering the risk of contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A

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Mosnaim 2011 (*Continued*)

Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Mujuru 2011

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental design, pre-post follow-up, no control **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate analysis methods
Participants	**Country:** USA **Age of children:** 18 students in grades 3 to 5 **Child characteristics (BME/SES):** 39% of students were in receipt of Medicaid. Ethnicity data were not reported **Asthma status:** asthmatic only **Intervention recipients:** children and parents
Interventions	**School type:** 1 elementary school **Intervention description:** study used the OAS programme to provide educational workshops in schools **Control description:** N/A **Theoretical framework:** not reported
Outcomes	**Core processes evaluated (child level):** attrition
Notes	**Process evaluation category:** integrated **Breadth and depth:** breadth and depth **Voice of children given prominence:** featured but not sufficiently **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A

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Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	Unclear risk	A named theory is not present, but supporting literature was presented
Transparent and clearly stated methods and tools	Low risk	Data collection tools were reasonably well described
Selective reporting	Low risk	Negative aspects of the intervention were reported
Harmful effects	Low risk	Low parental engagement and compliance were reported
Population and sample described well	Unclear risk	Some expected fields, for example, ethnicity, were not reported
Continuous evaluation	Low risk	Pre-post assessment was conducted; however post follow-up engagement was low
Evaluation participation equity and sampling	Low risk	Parents were involved, but little information was received from teachers or instructors
Design and methods overall approach	Low risk	The overall design and methods were well described and suitable for the study
Tools and methods of data collection reliable/credible	Low risk	Tools used for data collection were reported fully
Tools and methods of data analysis reliable/credible	Unclear risk	The validity of the parental survey is unclear. This survey contained a 32-item questionnaire designed by investigators as based on a review of published medical literature
Performance bias/neutrality/credibility/conformability	Unclear risk	Some aspects were covered, but not all aspects were reported on
Reliability of findings and recommendations	Unclear risk	Some process outcomes might be generalisable, but study authors themselves suggest

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		that the "sample size was too small to generalise the results to a larger population"
Transferability of findings	Unclear risk	Some process outcomes might be generalisable, but study authors themselves suggest that the "sample size was too small to generalise the results to a larger population"
Overall risk of bias of process evaluation	Low risk	No factors were considered high risk

Patterson 2005

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design, with schools as the unit of randomisation **Setting:** primary schools in Belfast, Northern Ireland **Period:** participating schools entered the trial between September 2002 and September 2003. Preliminary assessment through to follow-up assessment took 31 weeks
Participants	**Eligible sample frame:** 102 eligible children in intervention schools and 126 eligible children in control schools **Randomised:** 84 eligible children in intervention schools and 92 eligible children in control schools **Completed (intervention):** 99 children in intervention schools and 92 children in control schools **Inclusion criteria:** children were eligible if they were between 7 and 11 years of age and had received a diagnosis of asthma **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** mean age, 9.01 years in the intervention group and 8.99 years in the control group **Ethnicity:** not reported **Socio-economic status:** 32% of children in the intervention group and 22% of children in the control group were eligible for free school meals **Gender:** males represented 45% of the intervention group and 58% of the control group **Asthma status:** not reported
Interventions	**Intervention:** each session began with brief reinforcement of previous training and ended with session feedback. The SCAMP club workbook used during sessions was given to children at prize giving, along with the child-held asthma care pathway record and action plan **Control:** control group received the same intervention after a 16-week interval **Intensity:** weekly sessions for 8 weeks **Instructor:** school nurse and a health visitor **Theoretical framework:** study was informed by the Predisposing, Reinforcing, and Enabling Causes in Educational Diagnosis and Evaluation (PRECEDE) model **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** intervention was designed to be delivered at

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	lunchtime
Outcomes	**Extractable outcomes were collected for:** Days of restricted activity Lung function Health-related quality of life Withdrawal
Notes	**Considered for process evaluation:** study did not contain core components of a process evaluation **Funding source:** South and East Belfast Health and Social Services Trust, Primary Care and Development Fund, Eastern Health and Social Services Board, Department of Child Health, Queen's University Belfast

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	In each pair, the toss of a coin was used to randomise schools to immediate or delayed intervention
Allocation concealment (selection bias)	Unclear risk	Given that allocation was done within pairs of schools, allocation concealment might have been breached
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Very low levels of attrition (2/83 in the intervention group)
Selective reporting (reporting bias)	Low risk	No indication that outcomes were collected and not reported upon
Other bias	Low risk	Missingness - low risk - no missing data among those who did not drop out Baseline imbalance - unclear risk - some differences are apparent; not clear if these differences would significantly alter response to the intervention Risk of contamination - low - schools were the unit of randomisation

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Patterson 2005 (*Continued*)

Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Persaud 1996

Methods	**Included as outcome evaluation** **Study design:** parallel-group design with children selected as the unit of randomisation **Setting:** study was conducted in Galveston, Texas, USA, across children in 10 schools **Period:** the intervention was conducted between September and December 1992
Participants	**Eligible sample frame:** 60 pupils found to be eligible; 43 were contacted and 36 agreed to participate **Randomised:** 36 children were randomised, with 18 each selected into intervention and control arms

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	Completed (intervention): no students were described as having dropped out **Inclusion criteria:** children 8 to 12 years of age with a diagnosis of asthma (several prior episodes of airway obstruction, clinical response to bronchodilator, and absence of other pulmonary disease) **Exclusion criteria:** no additional exclusion criteria provided **Baseline characteristics** **Age of children:** mean age, 10.2 years **Ethnicity:** 69% of children were African American **Socio-economic status:** 69% of children were from families in receipt of Medicaid **Gender:** 64% of children were male **Asthma status:** 44% of children had mild asthma, 50% had moderately severe asthma, and 6% had severe asthma
Interventions	**Intervention:** study authors described that "intervention subjects received individualized, weekly, 20-min education sessions with the school nurse for 8 weeks. Each child had a personal peak flow meter in the school health office to use during teaching sessions. At each visit, the school nurse reviewed the asthma diary with the student and discussed progress, symptoms, and ability to take appropriate measures to control asthma. At each visit, the child demonstrated proper use of inhaled medications and the peak flow meter. The school nurses recorded each student's weekly progress on a checklist in the teaching manual" **Control:** usual care **Intensity:** target asthmatic students received 3 lessons from peer leaders (year 11 students) **Instructor:** school nurses **Theoretical framework:** no overarching theory named **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Emergency department visits Absences from school
Notes	**Considered for process evaluation:** study did not include the core components of a process evaluation, and process data were collected with the use of structured tools **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No further information beyond this: students within each school were randomly assigned to intervention or control groups
Allocation concealment (selection bias)	Unclear risk	No further information beyond this: students within each school were randomly assigned to intervention or control groups

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Blinding of participants and personnel (performance bias) All outcomes	Low risk	All primary care providers were blinded as to assignment to treatment or control groups; primary care providers collected most of these data
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All primary care providers were blinded as to assignment to treatment or control groups; primary care providers collected most of these data
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition was reported among the 36 children
Selective reporting (reporting bias)	Low risk	Selective reporting was evident and outcomes were extracted
Other bias	Unclear risk	Missingness - low risk - no apparent missing data Baseline imbalance - unclear risk - control group had lived with asthma for longer, which could inflate the impact of the intervention Risk of contamination - high - students were randomised within schools; this could lead to contamination across groups
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A

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Persaud 1996 (*Continued*)

Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Pike 2011

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, pre-post, control groups **Unit of allocation:** children in 15 classes were provided with the intervention (data available for 10), and 4 additional classrooms served as controls; 167 children were in the intervention group and 69 were in the control group **Process evaluation methods:** survey data were collected with descriptive/bivariate analyses of data
Participants	**Setting:** elementary schools in a district in St Louis, Missouri, USA **Age of children:** 9 to 11 years of age (based on grade) **Child characteristics (BME/SES):** 81% of control group and 69% of intervention group were African American; 78% of intervention group and 86% of control group were receiving free school meals **Asthma status:** asthmatic and non-asthmatic (mixed class; this is a core feature of the intervention so as not to disrupt normal school functioning) **Intervention recipients:** children and teachers
Interventions	**School type:** primary/elementary **Intervention description:** a curriculum was developed for teachers that contained 15 lesson plans created or adapted from various existing sources and aligned with existing standards for communication arts, science, mathematics, and health. Intervention classroom teachers were asked to teach 7 of the 15 lesson plans, including 3 specific lesson plans chosen by the investigators (which included information on asthma basics, signs and symptoms, triggers, and use of a peak flow metre); the remaining 4 lesson plans were self-selected by the teacher **Control description:** usual care/no additional asthma education **Theoretical framework:** no information
Outcomes	**Core processes evaluated (child level):** dosage
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** depth - not breadth **Voice of children given prominence:** not featured

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	Funding source: not reported	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	No theory was named and little literature was presented
Transparent and clearly stated methods and tools	Unclear risk	Some tools or aspects of tools were not clearly explained, for example, asthma knowledge
Selective reporting	Unclear risk	A full account of what was collected for assessment was not presented; some aspects were not reported - e.g. the teacher focus group
Harmful effects	Unclear risk	How study authors accounted for this remains unclear
Population and sample described well	High risk	Some demographic characteristics, particularly the asthma status of children, were not explained well
Continuous evaluation	Low risk	Pre-post assessment was included

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Pike 2011 (*Continued*)

Evaluation participation equity and sampling	Unclear risk	Sample information was collected from several stakeholders
Design and methods overall approach	Low risk	Multiple sources of evidence were used
Tools and methods of data collection reliable/credible	High risk	How asthma knowledge was measured remains unclear
Tools and methods of data analysis reliable/credible	High risk	No way to assess this without seeing a full output - e.g. of the focus group
Performance bias/neutrality/credibility/conformability	Unclear risk	Some blinding was undertaken
Reliability of findings and recommendations	Unclear risk	Whether this was an effective intervention is not clear, as the information was not presented fully
Transferability of findings	Unclear risk	Study authors explained how the curriculum was developed, so transferability is low for part of this study - but not enough information was provided in other sections
Overall risk of bias of process evaluation	Unclear risk	This is a good study of teachers, but study authors did not provide a lot of other information

Praena-Crespo 2010

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group RCT **Setting:** 16 high schools **Period:** baseline data were collected between November and December 2008
Participants	**Eligible sample frame:** 16 high schools (4090 children) **Randomised:** 15 high schools (3827 children) **Completed (intervention):** 15 high schools (3550 children) **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 13 and 14 years of age **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** mixed **Asthma status:** asthmatic and non-asthmatic children

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Interventions	**Intervention:** children received an asthma programme, but no details were provided **Control:** not reported **Intensity:** 3 lessons **Instructor:** teachers **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** during personal development/health/physical education
Outcomes	**Extractable outcomes were collected for:** None
Notes	This study was reported as an abstract only **Funding source:** not reported

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	This study was presented as an abstract only. The abstract states that schools were randomised but does not describe how this was done
Allocation concealment (selection bias)	Unclear risk	This study was presented as an abstract only. The abstract states that schools were randomised but does not describe how this was done
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed in the abstract
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed in the abstract
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Questionnaires were returned by 3827/4090 students (279 with asthma) at baseline and by 3550 at follow-up (261 with asthma)
Selective reporting (reporting bias)	Unclear risk	Not addressed in the abstract
Other bias	Unclear risk	Missing data - high risk - many forms were not returned and data were not disaggregated Baseline imbalances - not addressed in the

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Praena-Crespo 2010 (*Continued*)

		abstract Risk of contamination - low - schools were the unit of allocation
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

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Pulcini 2007

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design, with schools as the unit of randomisation **Setting:** middle schools in Massachusetts, USA **Period:** number of AAPs received was recorded by the school nurse in the fall of 2005 and was reported as a total number in early 2006 at the end of data collection
Participants	**Eligible sample frame:** not reported **Randomised:** 40 students from 4 school districts - 20 students in each group **Completed (intervention):** not reported **Inclusion criteria:** children were eligible if they had received a diagnosis of asthma with medications ordered at school, had no current asthma action plan on file, were from English-speaking families, did not have any developmental disorders, and had a regular primary care provider or asthma specialist **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** not reported, but children in grades 6 to 8 were recruited **Ethnicity:** not reported **Socioeconomic status:** not reported **Gender:** not reported **Asthma status:** not reported
Interventions	**Intervention:** each student was given a peak flow meter and was educated on the correct technique for measuring lung function. Peak flow was measured for 2 weeks and scores were recorded. All scores were sent to the physician along with a request for an asthma action plan **Control:** school nurses in the control group continued to follow their standard procedure of requesting an AAP via the student's parents **Intensity:** peak flow measured and recorded on a daily basis for 2 weeks **Instructor:** school nurse **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** None
Notes	AAPs are important but are not a part of the outcomes in this review, so they cannot be extracted **Funding source:** National Association of School Nurses Research Grant

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Not specified, and low numbers randomised: each school district participating in the study was required to have at least 2 middle schools, which were randomly as-

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		signed to experimental or control groups
Allocation concealment (selection bias)	High risk	Not specified, and low numbers randomised: each school district participating in the study was required to have at least 2 middle schools, which were randomly assigned to experimental or control groups
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not addressed by study authors
Selective reporting (reporting bias)	High risk	Peak flow data were collected but were not published in full
Other bias	Unclear risk	Missingness - unclear risk - not all data were published Baseline imbalance - unclear risk - not addressed in the study Risk of contamination - low - allocation was done on a school basis
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A

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Pulcini 2007 (*Continued*)

Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Richmond 2011

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental, post follow-up only, no control **Unit of allocation:** N/A **Process evaluation methods:** descriptive/bivariate analysis methods
Participants	**Country:** USA **Age of children:** elementary school age was reported, but no further details were given **Child characteristics (BME/SES):** almost 100% of students were African American; approximately 80% received free or reduced price lunch **Asthma status:** asthmatic only **Intervention recipients:** children only
Interventions	**School type:** 14 elementary schools across 3 school districts **Intervention description:** breathe your best was implemented in the schools. Students were encouraged to received an asthma action plan from their healthcare provider and to collect prescriptions from the pharmacy. Students were also advised to give their action plans and medications to their school nurse at the beginning of the school year **Control description:** N/A **Theoretical framework:** not reported
Outcomes	**Core processes evaluated (child level):** attrition, adherence
Notes	**Process evaluation category:** stand-alone **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** not featured **Funding source:** not reported
Risk of bias	

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Richmond 2011 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Unclear risk	Study report shows some confusion over the purpose of the study
Explicit theories underpinning and/or literature review	High risk	No literature was provided; no named theory guided the intervention
Transparent and clearly stated methods and tools	High risk	How the random sample was selected is not clear
Selective reporting	High risk	Information discussed in the interviews is not clear - no schedule
Harmful effects	Unclear risk	This is inferred by the reader - impact on nurses if implemented across the board
Population and sample described well	High risk	Age and gender were missing, as were the demographic characteristics of asthmatic kids
Continuous evaluation	High risk	Post hoc evaluation only - particularly worrisome, as the intervention failed in the first year but continued into the second year
Evaluation participation equity and sampling	Unclear risk	Parents were interviewed and some information was collected from school nurses

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Richmond 2011 (*Continued*)

Design and methods overall approach	Unclear risk	Interviews with parents seem to be the most important element; these were covered adequately
Tools and methods of data collection reliable/credible	High risk	Tools used were not presented (i.e. interview schedule)
Tools and methods of data analysis reliable/credible	Unclear risk	Only descriptive/narrative analysis reported
Performance bias/neutrality/credibility/conformability	Low risk	Attention was given to negative cases and non-participation was investigated
Reliability of findings and recommendations	High risk	Quantity of data collected was unclear; not easy to ascertain whether there was more to be understood here
Transferability of findings	Unclear risk	Results show lack of understanding of the degree to which age and school factors played a part - much more remained to be said about this
Overall risk of bias of process evaluation	Unclear risk	Risk of bias not very high because of the nature of the messages and the simple methods employed; however reporting errors occurred

Shah 2001

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design **Setting:** high schools in Tamworth, rural New South Wales, Australia **Period:** pupils were recruited in February 1998 and completed the study in October 1998 - 3 months after the intervention was completed
Participants	**Eligible sample frame:** 325 pupils **Randomised:** 272 pupils: 148 in the control group and 124 in the intervention group **Completed (intervention):** 251 pupils; 138 in the control group and 113 in the intervention group **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 118 pupils in year 7; 133 pupils in year 10 **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** 62% to 68% female in the intervention group; 44% to 48% female in the control group **Asthma status:** 69% to 80% had received an asthma diagnosis

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Interventions	**Intervention:** the intervention involved a 3-step approach to educating and empowering students with asthma. In step 1, students learnt how to educate their peers about asthma and its management using games, videos, worksheets, and discussions as teaching tools. In step 2, peer leaders conducted three 45-mnute health lessons for year 10 classes at school. In step 3, year 10 students developed and presented to year 7 students key messages learnt in the lessons **Control:** wait-list control group received usual care during data collection **Intensity:** in step 1, volunteers from year 11 were trained as asthma peers during a 6-hour workshop. In step 2, three 45-minute sessions were taught. No information was recorded on length and intensity in step 3 **Instructor:** peers **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Experience of daytime and night-time symptoms Lung function Health-related quality of life Withdrawal
Notes	School absence data were collected as median values but were not reported in full **Funding source:** Commonwealth Department of Health and Aged Care and Asthma NSW

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Concealed random allocation was performed by study author (who was not involved in administration of the study), using a random number generator and the closed envelope technique
Allocation concealment (selection bias)	Low risk	Concealed random allocation was performed by PGG (who was not involved in administration of the study), using a random number generator and the closed envelope technique
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors

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Incomplete outcome data (attrition bias) All outcomes	Low risk	Low levels of attrition: 272 participated in baseline testing; matched data at baseline and after the intervention were available for 251 students
Selective reporting (reporting bias)	Unclear risk	No direct evidence, although median number of days missed was collected and could not be combined in the meta-analysis
Other bias	Unclear risk	Missingness - low risk - missing data described as uncommon and occurred owing to misclassification, students changing schools or being absent on the day of testing, or failure to complete the questionnaire Baseline imbalance - unclear risk - differences between groups, although it is unclear if these are significant for the outcome Risk of contamination - low - schools were the unit of randomisation, thereby lowering risk of contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A

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Shah 2001 (*Continued*)

Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

Spencer 2000

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental single-group intervention examining change pre-post intervention **Unit of allocation:** N/A **Process evaluation methods:** survey-based methods with descriptive/bivariate analyses of results
Participants	**Setting:** the study included 40 schools from 8 school districts throughout New York State, USA **Age of children:** wide range of ages, with children 6 to 13 years old **Child characteristics (BME/SES):** 36% of children were receiving free or reduced price lunch **Asthma status:** asthmatic only **Intervention recipients:** children and parents
Interventions	**School type:** primary/elementary **Intervention description:** Open Airways for Schools (OAS) described by study authors as consisting of "six weekly (40-minute) hands-on sessions for the children, one or two sessions for the children's parents, and a graduation ceremony for both parents and children. The children's portion of the program covered such areas as: (I) basic information and feelings about asthma; (ii) recognizing and managing asthma symptoms; (iii) solving problems with medicines and deciding how bad symptoms are; (iv) finding and controlling asthma triggers; (v) getting enough exercise; and (vi) doing well at school. The parents' program briefly covered content similar to the children's sessions. Parents also received letters that familiarized them with the children's classroom content" **Control description:** N/A **Theoretical framework:** no information
Outcomes	**Core processes evaluated (child level):** adherence
Notes	**Process evaluation category:** integrated **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** not featured **Funding source:** not reported
Risk of bias	

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Spencer 2000 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A
Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Unclear risk	Aims of OAS were clearly stated, but aims of the study were not explained
Explicit theories underpinning and/or literature review	High risk	No literature or theoretical framework was provided
Transparent and clearly stated methods and tools	Unclear risk	Not much detail provided on tools for parents and nurses
Selective reporting	High risk	Not everything was reported; instruments were poorly reported
Harmful effects	High risk	No evidence of provision for measuring harmful effects
Population and sample described well	Unclear risk	No information about asthma severity
Continuous evaluation	Low risk	Pre-post assessment was implemented
Evaluation participation equity and sampling	Unclear risk	How almost half the sample of kids dropped out remains unclear
Design and methods overall approach	High risk	Limited detail on design and methods was provided; problems with internal validity were noted

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Spencer 2000 (*Continued*)

Tools and methods of data collection reliable/credible	High risk	Not all tools were clearly described
Tools and methods of data analysis reliable/credible	High risk	No indication that clustering was accounted for; not enough information (mean cluster size) was provided to estimate this
Performance bias/neutrality/credibility/conformability	High risk	No attempt at blinding was presented
Reliability of findings and recommendations	High risk	This study was not reported well enough to warrant that findings were reliable
Transferability of findings	High risk	Details about context were lacking, making the findings difficult to transfer
Overall risk of bias of process evaluation	High risk	Issues surround the tools and methods used to collect study data

Splett 2006

Methods	**Included as outcome evaluation and process evaluation** **Study design:** clustered parallel-group design, randomised at the school level **Setting:** K-8 schools in Minneapolis, Minnesota, USA **Period:** in 2000 and 2001, the HLAI was implemented in schools and was tested for effectiveness; in 2001 and 2002, the HLAI was expanded to all K-8 schools
Participants	**Eligible sample frame:** not reported; however 700 students with asthma were required in each group to detect a positive change in attendance **Randomised:** 916 in intervention schools and 645 in control schools **Completed (intervention):** not reported **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** not reported **Ethnicity:** 66% were African American, 6% were Hispanic, 5% were American-Indian, and 20% were white **Socio-economic status:** 73% of participants were eligible for free or reduced price lunches **Gender:** males represented 58% of participants **Asthma status:** not reported
Interventions	**Intervention:** in participating schools, licensed school nurses, licensed practical nurses, and health service assistants received coaching and reinforcement by asthma resource nurses. Clinics also received training on NIH guidelines and guidance on implementing standards of care for asthma. Study authors reported: "staff followed 'Core Components of Asthma Management in the School Health Office' (Core Components), including case

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	identification, nursing care procedures, care coordination, emergency care, and student education, to provide more systematic and consistent care to students with asthma and improve communication with school staff, parents, and health care providers", although further details of the student education component were not provided **Control:** usual care **Intensity:** not reported **Instructor:** school nurse **Theoretical framework:** not reported **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** not reported
Outcomes	**Extractable outcomes were collected for:** Absence from school Unplanned visit to hospital or GP due to asthma symptoms **Core processes evaluated (child level):** no information (other outcomes considered around sustainability)
Notes	This study conducted an ecological analysis **Process evaluation category:** stand-alone, named section (2 papers) **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** not featured **Funding source:** Member Organisations of the Healthy Learners Board, Controlling Asthma in American Cities Grant

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Study authors reported: "A random sequence of treatment codes, stratified by school system, was generated using the SAS System (Version 9.1, Cary, North Carolina) by the statistician"
Allocation concealment (selection bias)	Low risk	Centrally allocated: study authors reported: "A random sequence of treatment codes, stratified by school system, was generated using the SAS System (Version 9.1, Cary, North Carolina) by the statistician"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No measures were described as implemented around blinding
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No measures were described as implemented around blinding

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Splett 2006 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No direct reports describe attrition
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting was found
Other bias	Unclear risk	Missingness - low risk - all those who were followed up submitted information Baseline imbalance - low risk - no evidence of baseline imbalances between intervention and control groups Risk of contamination - high - children were the unit of randomisation; potential was present for children with different treatment allocations to share materials/information, etc
Transparent and clearly stated aims	Low risk	Study aims were clearly stated
Explicit theories underpinning and/or literature review	High risk	No theoretical framework or supporting literature was provided
Transparent and clearly stated methods and tools	Low risk	Methods and tools were clearly stated
Selective reporting	High risk	A focus group is mentioned in the DuPlessis paper, but whether this occurred before or after or during the intervention is not clear. In addition, relevant results were not presented
Harmful effects	High risk	Very broad study; harmful effects were not directly considered
Population and sample described well	High risk	Some information is missing, including age of participants
Continuous evaluation	Low risk	Process evaluation data were apparently collected throughout
Evaluation participation equity and sampling	High risk	No information was collected from nurses
Design and methods overall approach	Unclear risk	Some core elements are missing
Tools and methods of data collection reliable/credible	Low risk	Based on administrative records - straightforward constructs

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Splett 2006 (*Continued*)

Tools and methods of data analysis reliable/credible	Unclear risk	Lack of age data makes it difficult to interpret some outcomes, although the models include controls for age
Performance bias/neutrality/credibility/conformability	Low risk	As based on administrative records, little reason was provided to assign anything but low risk of bias
Reliability of findings and recommendations	Unclear risk	Reliability of findings was compromised by the K-12 age group
Transferability of findings	High risk	Details are lacking, and standardisation introduced difficulties related to transferability - particularly the wide age range
Overall risk of bias of process evaluation	High risk	Details around the ages of children and other key factors that could influence outcomes are lacking

Srof 2012

Methods	**Included as outcome evaluation** **Study design:** parallel-group design, randomised at the child level **Setting:** high schools in midwestern America **Period:** not reported, but post-test data were collected 6 weeks after the intervention was completed
Participants	**Eligible sample frame:** 299 students with asthma across the 3 participating high schools **Randomised:** 39 students: 21 in the intervention group and 18 in the control group **Completed (intervention):** 39 students **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Baseline characteristics** **Age of children:** 14 to 18 years of age; average age was 15.67 years **Ethnicity:** not reported **Socio-economic status:** not reported **Gender:** the intervention group comprised 10 males and 11 females **Asthma status:** not reported
Interventions	**Intervention:** each morning for 2 weeks, the PI and the CNS assisted students to complete asthma diary entries. Students in the intervention group also received 5 coping skills training sessions **Control:** usual care **Intensity:** sessions ranged from 40 minutes to 60 minutes in duration and were conducted over a period of 5 weeks **Instructor:** principal investigator (PI) **Theoretical framework:** Health Promotion Model (HPM) informed development of the intervention

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	Parental engagement: not reported **Child satisfaction:** not reported **Timing of intervention in school day:** sessions took place during the reserved study or resource period time block of the school day
Outcomes	**Extractable outcomes were collected for:** None
Notes	Only some of the data in this study were reported, indicating evidence of possible selective reporting Considered for process evaluation but did not include expected required components **Funding source:** American Lung Association of Metropolitan Chicago, Nu Omicron Chapter of Sigma Theta Tau International, Pedipress Fulfillment Center, Respironics: HealthScan and Allergy Products

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Names of participating students were placed in an envelope and were drawn for random assignment to treatment and control groups within each school
Allocation concealment (selection bias)	Unclear risk	Unclear whether closed envelope technique was used and whether allocation could be concealed
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors
Blinding of outcome assessment (detection bias) All outcomes	High risk	Lack of blinding was cited as a disadvantage of the study
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not addressed in full by study authors
Selective reporting (reporting bias)	High risk	Evidence of some selective reporting; outcomes were not reported consistently throughout
Other bias	Unclear risk	Missingness - unclear risk - not addressed in full by study authors Baseline imbalance - low risk - no differences noted between groups on any of the baseline variables, as would be expected following random assignment

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Srof 2012 (*Continued*)

		Risk of contamination - high - children were randomised within schools, raising the risk of contamination
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A
Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

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Terpstra 2012

Methods	**Included as process evaluation** **Intervention study design:** quasi-experimental design, pre-post follow-up, control group **Unit of allocation:** school **Process evaluation methods:** multi-variate analysis
Participants	**Country:** USA **Age of children:** mean age, 12.52 in the intervention group and 12.10 in the control group **Child characteristics (BME/SES):** 44% of intervention children and 56% of control group children were Latino; average annual income was less than $20,000 **Asthma status:** asthmatic only **Intervention recipients:** children and parents
Interventions	**School type:** 2 middle schools **Intervention description:** children received skills training addressing topics such as how to use a peak flow meter. These sessions took place over 6 weeks. Parents received a newsletter that was centred on an important theme identified during the research **Control description:** equivalent intervention in which children received the intervention but parents did not receive the newsletter **Theoretical framework:** social cognitive theory
Outcomes	**Core processes evaluated (child level):** attrition, dosage, adherence
Notes	**Process evaluation category:** integrated **Breadth and depth:** neither broad nor deep **Voice of children given prominence:** not featured **Funding source:** American Lung Association

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	N/A
Allocation concealment (selection bias)	Unclear risk	N/A
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	N/A
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	N/A
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	N/A

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Selective reporting (reporting bias)	Unclear risk	N/A
Other bias	Unclear risk	N/A
Transparent and clearly stated aims	Unclear risk	Study aims were not clearly stated
Explicit theories underpinning and/or literature review	Unclear risk	Some theory and supporting literature were provided, but why a newsletter was used was not explained
Transparent and clearly stated methods and tools	Low risk	All tools were clearly described
Selective reporting	High risk	This was not considered - particularly the absence of measures showing whether people did receive the newsletter Also, as acknowledged by study authors, not only caregivers received the newsletter
Harmful effects	Unclear risk	This was not recorded, and the paper included no information on child outcomes
Population and sample described well	Unclear risk	School characteristics were poorly described
Continuous evaluation	Low risk	Pre-post assessment was carried out
Evaluation participation equity and sampling	High risk	No child input was included
Design and methods overall approach	High risk	Low breadth of scope was evident, for example, not all stakeholders and not all outcomes were reported
Tools and methods of data collection reliable/credible	Low risk	Tools used for data collection were appropriate for the data
Tools and methods of data analysis reliable/credible	Low risk	How conclusions were reached is clearly explained
Performance bias/neutrality/credibility/conformability	Unclear risk	Absence of 'other' stakeholders who received the newsletter might reduce credibility; absence of any child outcomes certainly does reduce credibility
Reliability of findings and recommendations	Unclear risk	Intervention did not work

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Terpstra 2012 (*Continued*)

Transferability of findings	High risk	Information provided is not rich enough to support a similar study
Overall risk of bias of process evaluation	High risk	Intervention was unsuccessful

Velsor-Friedrich 2005

Methods	**Included as outcome evaluation** **Study design:** clustered parallel-group design with schools selected as the unit of randomisation **Setting:** 4 inner city elementary schools in the USA **Period:** dates on which study was conducted - intervention and subsequent data collection - are not clear. Outcomes were collected from children immediately after they participated in the school-based asthma intervention programme (2 weeks) and at 5 and 12 months
Participants	**Eligible sample frame:** 73 met inclusion criteria guidelines and were enrolled in the study **Randomised:** 73 pupils were randomised at the school level, although distribution between groups is unclear **Completed (intervention):** a total of 52 students were included in the final analysis: 28 students in the treatment group and 24 in the control group **Inclusion criteria:** children for whom a physician had diagnosed asthma, or who had demonstrated asthma-related symptoms and frequent asthma-related emergency department visits or hospital admissions **Exclusion criteria:** no additional exclusion criteria **Baseline characteristics** **Age of children:** mean age of children in the treatment group was 10.2 years; mean age of children in the control group was 9.9 years **Ethnicity:** all children were African American **Socio-economic status:** unclear **Gender:** the sample of completers was evenly split in terms of sex: 26 females and 26 males **Asthma status:** children who received a diagnosis were 8 to 13 years old (mean age, 10 years of age)
Interventions	**Intervention:** 2-part intervention First part consisted of Open Airways for School (OAS) as described by study authors: "the purposes of the Open Airways Program are to: (a) empower children with asthma by teaching them how to prevent asthma episodes and emergencies; and (b) to help schools control asthma by creating partnerships in asthma care with school personnel, school nurses, physicians, and families. The program consists of six 45-minute sessions offered once per week in which small groups of children learn new asthma management skills. The session topics include: (a) basic information about asthma; (b) how to recognize and respond to asthma symptoms; (c) using asthma medication and deciding when to seek help; (d) how to keep physically active; (e) identifying and controlling triggers to minimize asthma symptoms; and (f) handling problems related to asthma and school. The curriculum incorporates an interactive teaching approach utilizing group discussion,

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	stories, games, and role-play to promote children's active involvement in the learning process" Second part of the intervention consisted of nurse practitioner visits, which consisted of the following: "5 monthly visits with the NP at the school-based health clinic. These follow-up visits were initiated after the students completed the asthma educational program. During the visits, the nurse assessed the student's asthma health, including auscultation of breath sounds, assessment of current medication use and availability, and history of symptoms, visits to the emergency department, and hospitalizations. Students were asked to demonstrate skills such as medication administration and peak flow meter techniques. The nurse included age-appropriate asthma education information (from the Open Airways curriculum) as deemed necessary to reinforce and/or increase asthma knowledge" **Control:** wait-list control; the control group received the intervention after evaluation **Intensity**: 6 group-based lessons plus individual nurse practitioner session **Instructor:** principal Investigator for the first part, and nurse practitioner for the second part **Theoretical framework:** Orem's Self-Care Deficit Theory of Nursing served as the guiding framework for this study **Parental engagement:** not reported **Child satisfaction:** not reported **Timing of intervention in school day:** unclear
Outcomes	**Extractable outcomes were collected for:** Emergency department visits Daytime and night-time symptoms Lung function
Notes	Considered as a process evaluation, but study did not seek to address process evaluation/ implementation research questions and did not include sufficient process data **Funding source:** National Institute of Nursing Research, Loyola University Research Award, Respironics Corporation

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Unclear - not described in the study: the 4 schools were randomly assigned to treatment or comparison groups
Allocation concealment (selection bias)	High risk	Not described in the study but potentially high, given the low number of randomised schools and study authors' description of study design
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not addressed by study authors

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Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not addressed by study authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low risk posed by attrition - only 3 students dropped out
Selective reporting (reporting bias)	Unclear risk	Unclear - some data have high levels of variance
Other bias	Unclear risk	Missingness - unclear risk - not addressed by study authors Baseline imbalance - low risk - not described by study authors as problematic Risk of contamination - low - schools (low number) were the unit of randomisation
Transparent and clearly stated aims	Unclear risk	N/A
Explicit theories underpinning and/or literature review	Unclear risk	N/A
Transparent and clearly stated methods and tools	Unclear risk	N/A
Selective reporting	Unclear risk	N/A
Harmful effects	Unclear risk	N/A
Population and sample described well	Unclear risk	N/A
Continuous evaluation	Unclear risk	N/A
Evaluation participation equity and sampling	Unclear risk	N/A
Design and methods overall approach	Unclear risk	N/A
Tools and methods of data collection reliable/credible	Unclear risk	N/A
Tools and methods of data analysis reliable/credible	Unclear risk	N/A
Performance bias/neutrality/credibility/conformability	Unclear risk	N/A
Reliability of findings and recommendations	Unclear risk	N/A

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Transferability of findings	Unclear risk	N/A
Overall risk of bias of process evaluation	Unclear risk	N/A

AAP: Asthma Action Plan.
ACT: Asthma Control Test.
ASMA: Asthma Self-Management for Adolescents.
BME: black and minority ethnicity.
CNS: clinical nurse specialist.
CST: Corticosteroids.
ED: emergency department.
GP: general practitioner.
HLAI: Health Learners Asthma Initiative.
HPM: Health Promotion Model.
HRQoL: health-related quality of life.
ICAN: I Can Control Asthma and Nutrition Now.
ISACC: International Study of Asthma and Allergies in Childhood.
N/A: not applicable.
NAEPP: National Asthma Education and Prevention Program.
NHLBI: National Heart, Lung, and Blood Institute.
OAS: Open Airways for Schools.
PBP: Power Breathing Program.
PD/H/PE: personal development/health/physical education.
PI: principal investigator.
PPF: pre-test/post-test/follow-up.
PRECEDE: Predisposing, Reinforcing, and Enabling Causes in Educational Diagnosis and Evaluation.
RAP: Roaring Adventures of Puff.
RCT: randomised controlled trial.
SCDT: self-care deficit theory.
SES: socio-economic status.
SHARP: Staying Healthy - Asthma Responsible & Prepared.
Triple A: Adolescent Asthma Action.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Akasawa 2016	Considered for process evaluation: not published in the English language
Al Aloola 2017	Considered for process evaluation: core processes not available; educational programme for teachers - child data not collected
Al-Sheyab 2015	Considered for outcome evaluation: excluded on comparison (tested effects of TAJ-Plus vs TAJ)

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Alreshidi 2015	Considered for process evaluation: excluded as did not include implementation research questions
Anderson 2004	Considered for process evaluation: excluded as did not reflect a school setting - school specifically designed for children with chronic disease
Ando 2016	Considered for process evaluation: core processes not evaluated
Arnold 2012	Considered for process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
An kan-Ayy ld z 2016	Considered for process evaluation: not school based; clinical settings
Augustin 2003	Considered for outcome evaluation: excluded on comparison: intervention group received weekly workshops for 6 weeks, control group was given standard educational materials on asthma management Considered for process evaluation: did not include implementation research questions (did not meet the criteria for a process evaluation)
Becker 2003	Considered for outcome evaluation: not school based
Bignall 2015a	Considered for outcome evaluation: excluded, as comparison received an intervention (intervention group (20 minutes breathing retraining plus education) or control group (20 minutes standard education))
Bollinger 2010	Considered for process evaluation: included only information on cost-effectiveness, not information on implementation
Bowen 2013	Considered for outcome evaluation: not school based Considered for process evaluation: did not contain core components of a process evaluation; did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
Brooten 2008	Considered for process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
Bruzzese 2001	Considered for process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
Bruzzese 2006	Considered for outcome evaluation: excluded, as focussed on family-level self-management, rather than child-level self-management
Bruzzese 2011a	Considered for outcome evaluation: unclear whether asthmatic students (with diagnosed asthma) were included Considered for process evaluation: in addition to the above, did not represent a study of implementation using recognised tools
Burgess 2017	Considered for process evaluation: did not address process questions
Burkhart 2003	Considered for outcome evaluation: large number of children under 5 were included (mean age, < 5)

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Bush 2014	Considered for outcome evaluation: not an intervention study (observational design) Considered for process evaluation: no information to suggest that evaluating processes of implementation formed a key part of the intervention
Butz 2005	Considered for outcome evaluation: excluded on comparison: usual care not provided to comparison group Considered for process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
Carpenter 2016b	Considered for process evaluation: not school-based; school not instrumental for delivery
Cheung 2015	Considered for process evaluation: excluded, as provided a detailed description of planned intervention but not of implementation
Chini 2011	Considered for process evaluation: did not contain core components of a process evaluation
Christiansen 1997	Considered for process evaluation: did not include implementation research questions nor in-depth process or contextual information (did not meet the criteria for a process evaluation)
Clark 1986	Considered for outcome evaluation: published before cutoff point
Clark 2003	Considered for outcome evaluation: duplicate (on manual screening)
Coté 1997	Considered for outcome evaluation: not school based
De Godoi 2016	Considered for process evaluation: not solely about asthma
de Greef, 2017	Considered for process evaluation: not an intervention study
DePue 2007	Considered for process evaluation: limited process data were presented, although they were not deemed to be collected via recognised tools nor reported by standardised means
Eakin 2012	Considered for outcome evaluation: large number of children under 5 years of age (mean age, < 5)
Evans 2001	Considered as a process evaluation study and an outcome evaluation study
Fernandes 2006	Considered for outcome evaluation: large number of participants outside the 5- to 18-year-old target age range
Francis 2001	Considered for process evaluation: not deemed to have included the core components of a process evaluation via structured tools
Gardida 2002	Considered for outcome evaluation: not published in the English language
Gerald 2016	Considered for process evaluation: not an intervention study

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(*Continued*)

Gibson 1998	Considered for outcome evaluation: schools were not randomised, and inclusion of only 2 schools means that intervention and randomisation effects would conflate if schools were randomised Considered for process evaluation: did not contain the core components of a process evaluation
Grad 2009	Considered for process evaluation: not deemed to have included the core components of a process evaluation via structured tools
Greenberg 2010	Considered for process evaluation: focus of the study was long-term impact on student health, not implementation. Focus group data were collected, although these data were not presented
Greer 2009	Considered for process evaluation and outcome evaluation: focus on improving knowledge about asthma among children without asthma
Gregory 2000	Considered for outcome evaluation: excluded on the basis of study design. Only 2 sites randomised - 1 school in each arm. Any intervention effect was conflated with school effect Considered for process evaluation: was deemed to not address implementation research questions
Halterman 2004	Considered for outcome evaluation: excluded - deemed to not include a sufficient component of self-management
Halterman 2011	Considered for outcome evaluation: excluded - delivered in part at school and in part in the home - included a substantial home component; not possible to disentangle which part may be driving any change
Halterman 2011a	Considered for outcome evaluation: excluded, as comparison received asthma care Considered for process evaluation: stand-alone process evaluation identified but focused on an allied part of the trial that was not school based
Halterman 2012	Considered for outcome evaluation: excluded, as comparison received asthma care Considered for process evaluation: deemed to not include the core components of a process evaluation using structured tools
Hemate 2012	Considered for process evaluation: did not contain the core components of a process evaluation
Hill 1991	Considered for outcome evaluation: excluded, as the intervention did not foster self-management skills
Horner 1998	Considered for outcome evaluation: excluded - study not designed as an RCT Considered for process evaluation: deemed to not include the core components of a process evaluation using structured tools
Horner 2003	Considered for outcome evaluation: study design was non-experimental
Hughes	Considered for process evaluation: although some satisfaction data were collected, the study did not include the core components of a process evaluation; process data were collected using structured tools
Johnson 2016	Considered for process evaluation: not school based; clinical settings only

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Jones 2005	Considered for process evaluation: school site was not judged to be instrumental for delivery of the intervention; sites external to school were also used for intervention delivery
Joseph 2004	Considered for outcome evaluation: not school based
Joseph 2007	Considered for outcome evaluation (along with linked papers): excluded, as comparison included asthma education Note: included in process evaluation
Joseph 2013a	Considered for outcome evaluation (along with linked papers): excluded, as comparison included asthma education Note: included in process evaluation
Kaufman 2011	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Kenny 2016	Considered for process evaluation: not school based
Khan 2014	Considered for outcome evaluation: excluded, as not school based
Khoshnavay 2013	Considered for process evaluation: received from study author; did not include core components of a process evaluation; process data were collected using structured tools
Kintner 2015	Considered for outcome evaluation: excluded on comparison as the control group received alternative asthma education Considered for process evaluation: did not contain the core components of a process evaluation
Knight 2005	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Krishna 2006	Considered for outcome evaluation: deemed as not school based
Lakupoch 2017	Considered for process evaluation: not school based
Lewis 2005	Considered for outcome evaluation: study as designed included no randomisation
Li 2017	Considered for process evaluation: did not address process evaluation research questions
Liao 2006	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; included home visit components
Lin 2017	Considered for process evaluation: school setting not central for delivery
Lipman 2017	Considered for process evaluation: did not address process evaluation research questions
Loman 2017	Considered for process evaluation: did not address process evaluation research questions centrally

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Louisias 2016	Considered for process evaluation: did not address process questions
Lu 2017	Considered for process evaluation: did not include core components of process evaluation
Lurie 2001	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; some data on stakeholder perceptions were collected, but study did not address implementation research questions
Lwebuga-Mukasa 2002	Considered for process evaluation: study did not include the core components of a process evaluation
Maa 2010	Considered for process evaluation: did not contain core components of a process evaluation
MacPherson 2011	Considered for process evaluation: did not contain core components of a process evaluation
Mangan 2006	Considered for process evaluation: did not contain core components of a process evaluation
Marabini 2002	Considered for outcome evaluation: not focussed on children (mean age, approximately 50)
McClure 2008	Considered for process evaluation: did not fall into the category of self-management (supported management through observation)
McElmurry 1999	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; included home visit components
McEwen 1998	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; included home visit components
McLaughlin 2006	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Meng 2000	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Meurer 1999	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Millard 2003	Considered for outcome and process evaluation: not focussed on self-management; educational activities were aimed at parents; study did not contain the core components of a process evaluation
Mitchell 2017	Considered for process evaluation: core processes not available
Morphew 2013	Considered for process evaluation: presented an economic evaluation - not a process evaluation
Morphew 2017	Considered for process evaluation: core processes not available
Morton 2017	Considered for process evaluation: not reliant on schools for delivery

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Mosnaim 2017	Considered for process evaluation: not an intervention study
NCT00217776	Considered for outcome evaluation: not an intervention study (trial protocol)
Neuharth-Pritchett 2016	Considered for process evaluation: not focussed on children; focussed exclusively on training educators
Nuss 2016	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Otim 2015	Considered for process evaluation: presented an economic evaluation - not a process evaluation
Patel 2007	Considered for process evaluation: presented an outcome and economic evaluation - not a process evaluation
Peers 2017	Considered for process evaluation: did not include core processes
Pender-Phaneuf 2016	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Perry 2000	Considered for outcome evaluation: study not considered to be an RCT
Petrie 2010	Considered for process evaluation: study did not evaluate processes
Quaranta 2012	Considered for process evaluation: study did not report on implementation processes
Quaranta 2015	Considered for process evaluation: study did not involve an intervention
Rasberry 2014	Considered for process evaluation: study did not report on implementation processes
Raun 2017	Considered for process evaluation: correlational analysis
Rhee 2012	Considered for process evaluation: presented an outcome and economic evaluation - not a process evaluation
Richterová 2016	Considered for process evaluation: not published in the English language
Rodriguez-Martinez 2017	Considered for process evaluation: focussed on an economic evaluation
Sabla 2017	Considered for process evaluation: did not contain core components of a process evaluation - focused on evaluating the validity of teaching materials
Salisbury 2002	Considered for outcome evaluation: excluded, as comparison group received additional intervention beyond usual care Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools
Scherer 2016	Considered for process evaluation: not focussed on self-management among children

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Schlueter 2011	Considered for process evaluation: study implementation focussed on parental smoke reduction
Schneider 1997	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; some processes and context were described but were not evaluated
Schuller 2015	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; some processes and context were described but were not evaluated
Scott 2006	Considered for process evaluation: did not allow for implementation processes to be evaluated; only 6 students were included, precluding assessment of core components of a school-based asthma intervention
Scott 2008	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; unclear if school was not instrumental in delivery of the intervention
Scott 2011	Considered for process evaluation: study did not include the core components of a process evaluation; process data were collected using structured tools; unclear if school was not instrumental in delivery of the intervention
Shanovich 2009	Considered for outcome evaluation: study was not judged to be an RCT
Sharek 2002	Considered for outcome evaluation: study was not school based
Shaw 2005	Considered for process evaluation: study did not include the core components of a process evaluation (reported that process evaluation was conducted but did not report the findings)
Shaw 2016	Considered for process evaluation: not school based
Shegog 2001	Considered for outcome evaluation: delivery of the intervention not contingent on schools (not school based)
Shelef 2016	Considered for process evaluation: described development of study protocol, not implementation
Staudt 2015	Considered for process evaluation: study did not include the core components of a process evaluation
Suwannakeeree 2016	Considered for process evaluation: study did not include the core components of a process evaluation; included diaries for symptom monitoring alone
Szefler 2016	Considered for process evaluation: not an intervention study
Szefler 2017	Considered for process evaluation: core aspects of the process evaluation were not addressed
Tate 2009	Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include process data

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Terpstra 2012a	Considered for outcome evaluation: excluded on comparison, as trial tested added impact on additional engagement with caregivers in an established intervention Note: included as a process evaluation
Thornton 2016	Considered for process evaluation: school not instrumental for delivery; main components delivered at home
Urrutia-Pereira 2017	Considered for process evaluation: core aspects of process evaluation not addressed
Valery 2007	Considered for outcome evaluation: intervention not school based
Velsor-Friedrich 2004	Considered for outcome evaluation: no randomisation described (not an RCT) Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include process data
Velsor-Friedrich 2012	Considered for outcome evaluation: excluded on comparison (study compared alternative asthma interventions) Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include process data
Volerman 2017	Considered for process evaluation: core aspects of process evaluation not addressed
Walter 2016	Considered for process evaluation: review in progress; not an intervention study
Walton 2004	Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include sufficient process data
Webber 2005	Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include sufficient process data
Weng 2007	Considered for outcome evaluation: study not deemed to be an RCT
Wensley 2004	Considered for outcome evaluation: not a school-based intervention
Whitman 1985	Considered for outcome evaluation: published before cutoff date
Willeboordse 2016	Considered for process evaluation: school not instrumental in delivery
Wilson 2008	Considered for process evaluation: did not contain the core components expected in a process evaluation; focussed on implementation at a school district level rather than among students and within schools
Wyatt 2008	Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include sufficient process data
Wyatt 2013	Considered for process evaluation: study provided in-depth description of the process of developing content but not implementation; study therefore did not seek to address process evaluation/implementation research questions

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Yawn 2000	Considered for outcome evaluation: not focussed on asthmatic children; study did not report on outcomes for asthmatic children separately from non-asthmatic children Considered for process evaluation: study did not seek to address process evaluation/implementation research questions and did not include sufficient process data
Yoshida 2011	Considered for process evaluation: study was not an intervention study
Young 2001	Considered for process evaluation: some implementation notes included, but study did not seek to address process evaluation/implementation research questions using structured tools
Zografos 2007	Considered for process evaluation: study did not seek to address process evaluation/implementation research questions using structured tools

RCT: randomised controlled trial.
TAJ: XXX.

Characteristics of studies awaiting assessment *[ordered by study ID]*

Liptzin 2016a

Methods	Pre-post study
Participants	Children with asthma across a wide age range
Interventions	Step-Up Asthma Program, applying National Asthma Education and Prevention Program-National Heart, Lung, and Blood Institute guidelines for evidence-based programmes for children with asthma
Outcomes	Number of asthma action plans; access to medication; asthma knowledge; asthma exacerbations
Notes	Status as process evaluation to be classified

McCallum 2017

Methods	Pre-post study
Participants	Participants in high schools with large numbers of Indigenous Australian children; not all children were known to be asthmatic
Interventions	Peer-led, school-based educational programme called the Asthma and Smoking Prevention Project (ASPP); split focus between asthma and smoking prevention
Outcomes	Lung function and wheezing; smoking status

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McCallum 2017 (*Continued*)

Notes	Status as process evaluation to be classified

Praena-Crespo 2017

Methods	Cluster randomised parallel-group trial
Participants	Students engaging in physical activity lessons, including approximately 10% with asthma
Interventions	Asthma, Sport, and Health (ASAH) programme taught by physical activity teachers
Outcomes	Quality of life and asthma knowledge
Notes	Status as outcome evaluation to be classified; results for quality of life not expected to change conclusions

Reznik 2016

Methods	Cluster randomised parallel-group trial
Participants	Children with asthma in primary schools
Interventions	School-wide asthma awareness event; facilitated collaboration with child's primary care provider, classroom-based physical activity, and asthma education for families and school personnel
Outcomes	Symptom-free days, medication adherence, and physical activity levels
Notes	Status as outcome evaluation to be classified

Warren 2016

Methods	Pre-post evaluation design
Participants	Children with asthma in high schools
Interventions	Student Asthma Research Team (START), engaged high school youth in a Photovoice investigation of factors impacting asthma
Outcomes	Asthma knowledge and lung function
Notes	Status as process evaluation to be classified

ASAH: Asthma, Sport, and Health programme.
ASPP: Asthma and Smoking Prevention Project.
START: Student Asthma Research Team.

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Characteristics of ongoing studies *[ordered by study ID]*

Halterman 2017

Trial name or title	Development of School-Based Asthma Management Programs in Rochester, New York: Presented in Honor of Dr Robert Haggerty
Methods	Randomised trial
Participants	Children with asthma
Interventions	Telemedicine intervention
Outcomes	Symptom days
Starting date	Unclear
Contact information	Jill Halterman; jill_halterman@urmc.rochester.edu
Notes	

Lemanske 2016

Trial name or title	School-Based Asthma Management Program (SAMPRO)
Methods	Study design unclear
Participants	Children with asthma and numerous stakeholders
Interventions	Multi-component intervention
Outcomes	Unclear
Starting date	Unclear
Contact information	Robert F. Lemanske, Jr, MD; rfl@medicine.wisc.edu
Notes	Description of establishment published in cited reference

NCT03032744

Trial name or title	Project IMPACT in Schools to Prevent Asthma Symptoms
Methods	Randomised trial
Participants	60 students 6 to 16 years of age
Interventions	Project IMPACT is a school-based health centre intervention programme that institutes guideline-based long-term asthma care and provides supervised administration with daily preventive asthma medications to improve

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NCT03032744 (*Continued*)

	asthma symptoms and lung function, reduce emergency visits, and decrease missed days of school among children from communities with health disparities
Outcomes	Asthma Symptoms; ACT score; Lung function; Missed days of school; Decrease in ED/urgent care visits; Hospitalisations; Oral/parenteral steroid use
Starting date	January 2017
Contact information	Lucy C Holmes, MD; lholmes@upa.chob.edu
Notes	

Perry 2015

Trial name or title	Breath Connection
Methods	Clustered parallel-group RCT
Participants	Children 7 to 14 years of age, with a median age of 9.6 years
Interventions	Study used the Breath Connection programme to provide asthma education via telemedicine to rural children with asthma, their caregivers, and school nurses
Outcomes	Lung function; Use of reliever therapies
Starting date	Unclear
Contact information	
Notes	This study is available as an abstract only and describes ongoing recruitment; study author was contacted for further information

Phipatanakul 2017

Trial name or title	The School Inner-City Asthma Intervention Study
Methods	Randomised, blinded, sham-controlled intervention trial
Participants	Plan to enrol 300 students with asthma from multiple classrooms in 40 northeastern inner city elementary schools
Interventions	School environmental intervention
Outcomes	Asthma symptoms
Starting date	Unclear

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Phipatanakul 2017 (*Continued*)

Contact information	Boston Children's Hospital
Notes	

ACT: XXX.
ED: emergency department.
RCT: randomised controlled trial.
SAMPRO: School-Based Asthma Management Program.

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DATA AND ANALYSES

Comparison 1. Effects of school-based asthma interventions vs usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to hospitalisation	6	1873	Std. Mean Difference (Random, 95% CI)	-0.19 [-0.35, -0.04]
2 Exacerbations leading to emergency department (ED) visits	13	3883	Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
3 Absence from school	10	4609	Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
4 Days of restricted activity	3	1852	Std. Mean Difference (Random, 95% CI)	-0.30 [-0.41, -0.18]
5 Unplanned visit to hospital or GP due to asthma symptoms	5	3490	Odds Ratio (Random, 95% CI)	0.74 [0.60, 0.90]
6 Experience of daytime and night-time symptoms - daytime symptoms	5	1065	Std. Mean Difference (Random, 95% CI)	-0.15 [-0.33, 0.02]
7 Experience of daytime and night-time symptoms - night-time symptoms	4	459	Std. Mean Difference (Random, 95% CI)	-0.18 [-0.52, 0.15]
8 Use of reliever therapies, e.g. beta$_2$ -agonists	2	437	Odds Ratio (Random, 95% CI)	0.52 [0.15, 1.81]
9 Corticosteroid dosage and/or use of add-on therapies (usage of)	3	614	Odds Ratio (Random, 95% CI)	1.25 [0.88, 1.77]
10 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of)	2		Std. Mean Difference (Random, 95% CI)	Totals not selected
11 Health-related quality of life (SMD)	7	2587	Std. Mean Difference (Random, 95% CI)	0.27 [0.18, 0.36]
12 Health-related quality of life (MD)	8	2950	Mean Difference (IV, Random, 95% CI)	0.35 [0.06, 0.64]
13 Withdrawal from the study	13	3442	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]

Comparison 2. Effects of school-based asthma interventions vs usual care subgrouped by school type

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Secondary/high school	2		Odds Ratio (Random, 95% CI)	0.61 [0.40, 0.92]
1.2 Primary/elementary school	11		Odds Ratio (Random, 95% CI)	0.73 [0.52, 1.02]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]

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2.1 Secondary/high school	1	Std. Mean Difference (Random, 95% CI)	-0.38 [-0.62, -0.15]
2.2 Primary/elementary school	7	Std. Mean Difference (Random, 95% CI)	-0.05 [-0.27, 0.16]
2.3 Primary/elementary and middle schools	1	Std. Mean Difference (Random, 95% CI)	0.02 [-0.08, 0.12]
2.4 Middle school	1	Std. Mean Difference (Random, 95% CI)	0.08 [-0.31, 0.48]
3 Withdrawal from the study	13	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Secondary/high school	3	Odds Ratio (Random, 95% CI)	1.25 [0.76, 2.06]
3.2 Primary/elementary school	8	Odds Ratio (Random, 95% CI)	1.22 [0.94, 1.59]
3.3 Middle school	2	Odds Ratio (Random, 95% CI)	0.59 [0.29, 1.20]

Comparison 3. Effects of school-based asthma interventions vs usual care subgrouped by age of children

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Aged 11 to 15, 16 to 18	1		Odds Ratio (Random, 95% CI)	0.59 [0.39, 0.91]
1.2 Aged 11 to 15	1		Odds Ratio (Random, 95% CI)	1.04 [0.17, 6.25]
1.3 Aged 5 to 10, 11 to 15	2		Odds Ratio (Random, 95% CI)	0.64 [0.15, 2.76]
1.4 Aged 5 to 10	9		Odds Ratio (Random, 95% CI)	0.74 [0.51, 1.06]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 Aged 11 to 15, 16 to 18	1		Std. Mean Difference (Random, 95% CI)	-0.38 [-0.62, -0.15]
2.2 Aged 5 to 10, 11 to 15	4		Std. Mean Difference (Random, 95% CI)	0.03 [-0.06, 0.13]
2.3 Aged 5 to 10	5		Std. Mean Difference (Random, 95% CI)	-0.09 [-0.34, 0.16]
3 Withdrawal from the study	13		Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Aged 11 to 15, 16 to 18	1		Odds Ratio (Random, 95% CI)	1.31 [0.76, 2.27]
3.2 Aged 11 to 15	3		Odds Ratio (Random, 95% CI)	0.82 [0.25, 2.67]
3.3 Aged 5 to 10, 11 to 15	4		Odds Ratio (Random, 95% CI)	1.08 [0.48, 2.43]
3.4 Aged 5 to 10	5		Odds Ratio (Random, 95% CI)	1.19 [0.90, 1.58]

Comparison 4. Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Low SES over 50%	2		Odds Ratio (Random, 95% CI)	0.53 [0.30, 0.94]
1.2 Low SES over 25%	3		Odds Ratio (Random, 95% CI)	0.69 [0.28, 1.69]
1.3 Unclear or not low SES	8		Odds Ratio (Random, 95% CI)	0.76 [0.57, 1.01]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]

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2.1 Low SES over 50%	2	Std. Mean Difference (Random, 95% CI)	0.01 [-0.09, 0.11]
2.2 Low SES over 25%	2	Std. Mean Difference (Random, 95% CI)	-0.23 [-0.36, -0.09]
2.3 Unclear or not low SES	6	Std. Mean Difference (Random, 95% CI)	-0.02 [-0.28, 0.24]
3 Withdrawal from the study	13	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Low SES over 50%	1	Odds Ratio (Random, 95% CI)	1.27 [0.90, 1.78]
3.2 Low SES over 25%	4	Odds Ratio (Random, 95% CI)	1.16 [0.61, 2.23]
3.3 Unclear or not low SES	8	Odds Ratio (Random, 95% CI)	1.03 [0.73, 1.45]

Comparison 5. Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Teachers involved in delivery (with or without school nurses)	2		Odds Ratio (Random, 95% CI)	1.00 [0.55, 1.83]
1.2 School nurses alone involved in delivery	1		Odds Ratio (Random, 95% CI)	0.29 [0.07, 1.21]
1.3 Existing school staff not involved in delivery	10		Odds Ratio (Random, 95% CI)	0.69 [0.51, 0.94]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 School nurses or teachers involved in delivery	3		Std. Mean Difference (Random, 95% CI)	0.08 [-0.08, 0.24]
2.2 Existing school staff not involved in delivery	7		Std. Mean Difference (Random, 95% CI)	-0.16 [-0.32, -0.00]
3 Withdrawal from the study	13		Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 School nurses involved in delivery	1		Odds Ratio (Random, 95% CI)	5.67 [0.16, 195.90]
3.2 Existing school staff not involved in delivery	12		Odds Ratio (Random, 95% CI)	1.14 [0.91, 1.42]

Comparison 6. Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Theoretical framework utilised explicitly	10		Odds Ratio (Random, 95% CI)	0.75 [0.54, 1.04]
1.2 Use of theory not explicit	3		Odds Ratio (Random, 95% CI)	0.56 [0.33, 0.97]

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2 Absence from school	10	Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 Theoretical framework utilised explicitly	6	Std. Mean Difference (Random, 95% CI)	-0.19 [-0.35, -0.03]
2.2 Use of theory not explicit	4	Std. Mean Difference (Random, 95% CI)	0.08 [-0.05, 0.20]
3 Withdrawal from the study	13	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Theoretical framework utilised explicitly	12	Odds Ratio (Random, 95% CI)	1.22 [0.97, 1.54]
3.2 Use of theory not explicit	1	Odds Ratio (Random, 95% CI)	0.61 [0.30, 1.26]

Comparison 7. Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Parents actively included	8		Odds Ratio (Random, 95% CI)	0.82 [0.53, 1.25]
1.2 Not included/unclear	5		Odds Ratio (Random, 95% CI)	0.58 [0.42, 0.81]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 Parents actively included	7		Std. Mean Difference (Random, 95% CI)	-0.02 [-0.23, 0.18]
2.2 Not included/unclear	3		Std. Mean Difference (Random, 95% CI)	-0.18 [-0.50, 0.15]
3 Withdrawal from the study	13		Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Parents actively included	9		Odds Ratio (Random, 95% CI)	1.21 [0.93, 1.58]
3.2 Not included/unclear	4		Odds Ratio (Random, 95% CI)	0.97 [0.62, 1.53]

Comparison 8. Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 Intervention mainly delivered during students' free time	5		Odds Ratio (Random, 95% CI)	0.71 [0.45, 1.13]
1.2 Intervention took place during school day (exact time unclear or variable)	8		Odds Ratio (Random, 95% CI)	0.67 [0.48, 0.92]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 Intervention mainly delivered during students' free time	2		Std. Mean Difference (Random, 95% CI)	-0.23 [-0.36, -0.11]

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2.2 Intervention took place during school day (exact time unclear or variable)	8	Std. Mean Difference (Random, 95% CI)	-0.01 [-0.17, 0.16]
3 Withdrawal from the study	13	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 Intervention took place during class time	1	Odds Ratio (Random, 95% CI)	13.57 [0.34, 542.83]
3.2 Intervention mainly delivered during students' free time	4	Odds Ratio (Random, 95% CI)	1.19 [0.65, 2.16]
3.3 Intervention took place during school day (exact time unclear or variable)	8	Odds Ratio (Random, 95% CI)	1.13 [0.89, 1.43]

Comparison 9. Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 PI1 - theory, not in own time, no substantial school nurse involvement	5		Odds Ratio (Random, 95% CI)	0.85 [0.47, 1.52]
1.2 PI2 - theory, not individual, substantial school nurse involvement	0		Odds Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
1.3 Other configuration	8		Odds Ratio (Random, 95% CI)	0.67 [0.47, 0.94]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 PI1 - theory, not in own time, no substantial school nurse involvement	4		Std. Mean Difference (Random, 95% CI)	-0.10 [-0.46, 0.25]
2.2 PI2 - theory, not individual, substantial school nurse involvement	0		Std. Mean Difference (Random, 95% CI)	0.0 [0.0, 0.0]
2.3 Other configuration	6		Std. Mean Difference (Random, 95% CI)	-0.05 [-0.21, 0.12]
3 Withdrawal from the study	13		Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 PI1 - theory, not in own time, no substantial school nurse involvement	4		Odds Ratio (Random, 95% CI)	0.88 [0.55, 1.40]
3.2 PI2 - theory, not individual, substantial school nurse involvement	1		Odds Ratio (Random, 95% CI)	5.67 [0.16, 195.90]
3.3 Other configuration	8		Odds Ratio (Random, 95% CI)	1.23 [0.95, 1.58]

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Comparison 10. Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	13		Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
1.1 No conditions	0		Odds Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
1.2 One condition	3		Odds Ratio (Random, 95% CI)	0.56 [0.33, 0.97]
1.3 Two conditions	7		Odds Ratio (Random, 95% CI)	0.67 [0.49, 0.94]
1.4 Three conditions	3		Odds Ratio (Random, 95% CI)	1.48 [0.65, 3.40]
2 Absence from school	10		Std. Mean Difference (Random, 95% CI)	-0.07 [-0.22, 0.08]
2.1 No conditions	0		Std. Mean Difference (Random, 95% CI)	0.0 [0.0, 0.0]
2.2 One condition	3		Std. Mean Difference (Random, 95% CI)	0.02 [-0.08, 0.11]
2.3 Two conditions	4		Std. Mean Difference (Random, 95% CI)	-0.16 [-0.43, 0.11]
2.4 Three conditions	3		Std. Mean Difference (Random, 95% CI)	0.07 [-0.22, 0.37]
3 Withdrawal from the study	13		Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]
3.1 No conditions	0		Odds Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
3.2 One condition	1		Odds Ratio (Random, 95% CI)	0.61 [0.30, 1.26]
3.3 Two conditions	7		Odds Ratio (Random, 95% CI)	1.22 [0.83, 1.80]
3.4 Three conditions	5		Odds Ratio (Random, 95% CI)	1.22 [0.91, 1.64]

Comparison 11. Adjunct analyses - impact of Implementation on selected outcomes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department (ED) visits	7		Std. Mean Difference (Random, 95% CI)	-0.21 [-0.37, -0.04]
1.1 Successful implementation	4		Std. Mean Difference (Random, 95% CI)	-0.26 [-0.48, -0.04]
1.2 Potential issues in adherence, attrition, or dosage	3		Std. Mean Difference (Random, 95% CI)	-0.09 [-0.28, 0.10]
2 Absence from school	7		Std. Mean Difference (Random, 95% CI)	-0.12 [-0.28, 0.04]
2.1 Successful implementation	3		Std. Mean Difference (Random, 95% CI)	-0.28 [-0.39, -0.18]
2.2 Potential issues in adherence, attrition, or dosage	4		Std. Mean Difference (Random, 95% CI)	0.04 [-0.09, 0.18]

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Comparison 12. Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to hospitalisation - standardised mean difference	3	719	Std. Mean Difference (Random, 95% CI)	-0.20 [-0.36, -0.03]
2 Exacerbations leading to hospitalisation - odds ratio	3	1154	Odds Ratio (Random, 95% CI)	0.71 [0.37, 1.36]
3 Exacerbations leading to hospitalisation - harmonised effect sizes	6	1873	Std. Mean Difference (Random, 95% CI)	-0.19 [-0.35, -0.04]
4 Exacerbations leading to emergency department (ED) visits - standardised mean difference	4	736	Std. Mean Difference (Random, 95% CI)	-0.22 [-0.38, -0.05]
5 Exacerbations leading to emergency department (ED) visits - odds ratio	9	3147	Odds Ratio (Random, 95% CI)	0.74 [0.47, 1.16]
6 Exacerbations leading to emergency department (ED) visits - harmonised effect sizes	13	3883	Odds Ratio (Random, 95% CI)	0.70 [0.53, 0.92]
7 Absence from school - standardised mean difference	6	2720	Std. Mean Difference (Random, 95% CI)	-0.10 [-0.30, 0.11]
8 Absence from school - odds ratio	4	1889	Odds Ratio (Random, 95% CI)	0.91 [0.59, 1.42]
9 Absence from school - harmonised effect sizes	10	4609	Std. Mean Difference (Random, 95% CI)	-0.08 [-0.22, 0.07]
10 Days of restricted activity - standardised mean difference	2	536	Std. Mean Difference (Random, 95% CI)	-0.34 [-0.52, -0.15]
11 Days of restricted activity - odds ratio	1		Odds Ratio (Random, 95% CI)	Subtotals only
12 Days of restricted activity - harmonised effect sizes	3	1852	Std. Mean Difference (Random, 95% CI)	-0.30 [-0.41, -0.18]
13 Experience of daytime and night-time symptoms - daytime symptoms - standardised mean difference	3	762	Std. Mean Difference (Random, 95% CI)	-0.15 [-0.33, 0.04]
14 Experience of daytime and night-time symptoms - daytime symptoms - odds ratio	2	303	Odds Ratio (Random, 95% CI)	0.71 [0.32, 1.55]
15 Experience of daytime and night-time symptoms - daytime symptoms - harmonised effect sizes	5	1065	Std. Mean Difference (Random, 95% CI)	-0.15 [-0.32, 0.02]
16 Experience of daytime and night-time symptoms - night-time symptoms - standardised mean difference	3	323	Std. Mean Difference (Random, 95% CI)	-0.36 [-0.58, -0.14]

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17 Experience of daytime and night-time symptoms - night-time symptoms - odds ratio	1	136	Odds Ratio (Random, 95% CI)	1.24 [0.56, 2.72]
18 Experience of daytime and night-time symptoms - night-time symptoms - harmonised effect sizes	4		Std. Mean Difference (Random, 95% CI)	-0.18 [-0.52, 0.15]
19 Use of reliever therapies, e.g. beta$_2$ -agonists - odds ratio	2	437	Odds Ratio (Random, 95% CI)	0.52 [0.15, 1.81]
20 Corticosteroid dosage and/or use of add-on therapies (usage of)	3	614	Odds Ratio (Random, 95% CI)	1.25 [0.88, 1.79]
21 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of)	2		Std. Mean Difference (Random, 95% CI)	Totals not selected
22 Health-related quality of life - standardised mean difference	7	2502	Std. Mean Difference (Random, 95% CI)	0.27 [0.18, 0.36]
23 Health-related quality of life (MD)	8	2950	Mean Difference (IV, Random, 95% CI)	0.35 [0.06, 0.64]
24 Unplanned visit to hospital or GP due to asthma symptoms - standardised mean difference	1	280	Std. Mean Difference (Random, 95% CI)	-0.28 [-0.52, -0.05]
25 Unplanned visit to hospital or GP due to asthma symptoms - odds ratio	4	1316	Odds Ratio (Random, 95% CI)	0.78 [0.62, 0.98]
26 Unplanned visit to hospital or GP due to asthma symptoms - harmonised effect sizes	5	1596	Odds Ratio (Random, 95% CI)	0.74 [0.60, 0.90]
27 Withdrawal from the study	13	3442	Odds Ratio (Random, 95% CI)	1.14 [0.92, 1.43]

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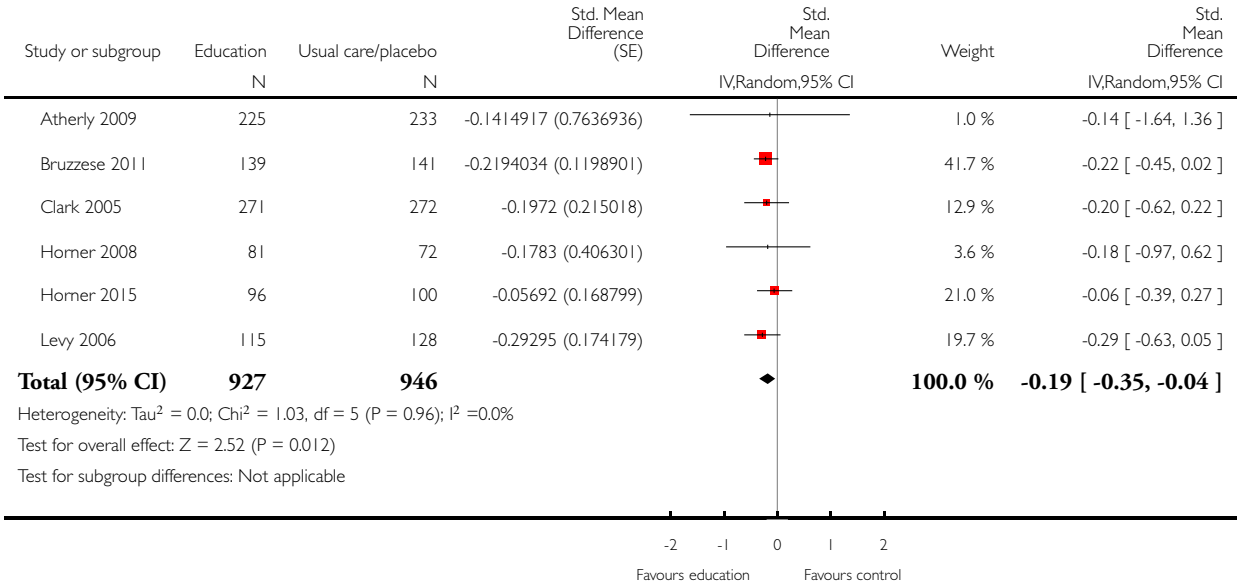
Analysis 1.1. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 1 Exacerbations leading to hospitalisation.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 1 Exacerbations leading to hospitalisation



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Analysis 1.2. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 2 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 2 Exacerbations leading to emergency department (ED) visits

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Atherly 2009	225	233	0.036203 (0.91615)		2.2 %	1.04 [0.17, 6.25]
Bruzzese 2011	139	141	-0.52479 (0.217943)		18.2 %	0.59 [0.39, 0.91]
Cicutto 2005	132	124	-0.36088 (0.407044)		8.6 %	0.70 [0.31, 1.55]
Cicutto 2013	625	691	-1.14502 (0.317415)		12.1 %	0.32 [0.17, 0.59]
Clark 2005	272	271	-0.004 (0.3286)		11.6 %	1.00 [0.52, 1.90]
Horner 2008	81	72	-0.15415 (0.447288)		7.5 %	0.86 [0.36, 2.06]
Horner 2015	96	100	0 (0.306104)		12.7 %	1.00 [0.55, 1.82]
Howell 2005	12	5	-0.59982 (1.048624)		1.7 %	0.55 [0.07, 4.29]
Levy 2006	115	128	-0.51962 (0.315807)		12.2 %	0.59 [0.32, 1.10]
McGhan 2003	65	71	0.249363 (0.632744)		4.2 %	1.28 [0.37, 4.43]
McGhan 2010	71	126	0.97338 (0.67978)		3.7 %	2.65 [0.70, 10.03]
Persaud 1996	18	18	-1.25276 (0.737327)		3.2 %	0.29 [0.07, 1.21]
Velsor-Friedrich 2005	28	24	-0.45676 (0.933208)		2.1 %	0.63 [0.10, 3.94]
Total (95% CI)	**1879**	**2004**			**100.0 %**	**0.70 [0.53, 0.92]**

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 16.16$, df = 12 (P = 0.18); $I^2 = 26\%$

Test for overall effect: Z = 2.54 (P = 0.011)

Test for subgroup differences: Not applicable

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Analysis 1.3. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 3 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 3 Absence from school

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.38207 (0.120627)		12.6 %	-0.38 [-0.62, -0.15]
Cicutto 2005	132	124	-0.25559 (0.150825)		10.6 %	-0.26 [-0.55, 0.04]
Cicutto 2013	625	691	-0.22931 (0.071145)		15.9 %	-0.23 [-0.37, -0.09]
Gerald 2006	305	269	0.198715 (0.08385)		15.0 %	0.20 [0.03, 0.36]
Gerald 2009	125	115	0.084988 (0.200481)		8.0 %	0.08 [-0.31, 0.48]
Howell 2005	9	4	0.151706 (0.63494)		1.3 %	0.15 [-1.09, 1.40]
McGhan 2003	65	71	-0.18135 (0.227497)		6.9 %	-0.18 [-0.63, 0.26]
McGhan 2010	71	126	0.24628 (0.18688)		8.7 %	0.25 [-0.12, 0.61]
Persaud 1996	18	18	-0.23645 (0.334639)		4.0 %	-0.24 [-0.89, 0.42]
Splett 2006	916	645	0.019 (0.051402)		17.0 %	0.02 [-0.08, 0.12]
Total (95% CI)	**2405**	**2204**			**100.0 %**	**-0.07 [-0.22, 0.08]**

Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 30.09$, df = 9 (P = 0.00042); $I^2 = 70\%$

Test for overall effect: Z = 0.93 (P = 0.35)

Test for subgroup differences: Not applicable

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Analysis 1.4. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 4 Days of restricted activity.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 4 Days of restricted activity

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.34872 (0.120444)		22.4 %	-0.35 [-0.58, -0.11]
Cicutto 2005	132	124	-0.32152 (0.151164)		14.2 %	-0.32 [-0.62, -0.03]
Cicutto 2013	691	625	-0.27103 (0.071708)		63.3 %	-0.27 [-0.41, -0.13]
Total (95% CI)	**962**	**890**			**100.0 %**	**-0.30 [-0.41, -0.18]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.34$, df = 2 (P = 0.84); $I^2 = 0.0\%$

Test for overall effect: Z = 5.18 (P < 0.00001)

Test for subgroup differences: Not applicable

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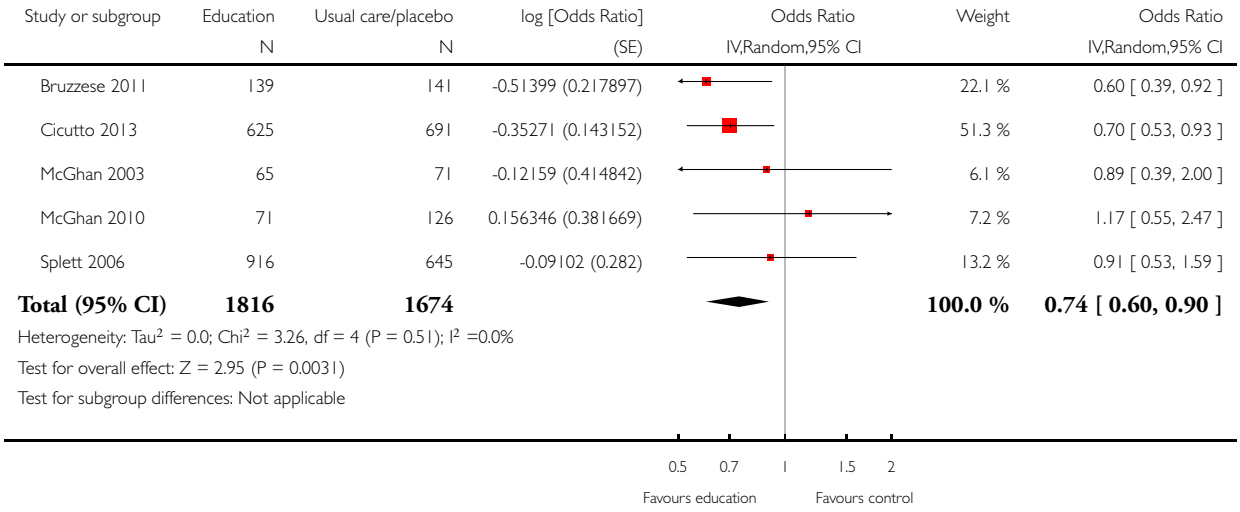
Analysis 1.5. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 5 Unplanned visit to hospital or GP due to asthma symptoms.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 5 Unplanned visit to hospital or GP due to asthma symptoms



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Analysis 1.6. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 6 Experience of daytime and night-time symptoms - daytime symptoms.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

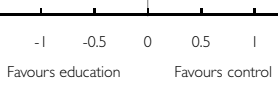
Outcome: 6 Experience of daytime and night-time symptoms - daytime symptoms

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Atherly 2009	225	233	-0.02599 (0.16825)		26.9 %	-0.03 [-0.36, 0.30]
Bruzzese 2008	12	11	-0.15076 (0.418137)		4.4 %	-0.15 [-0.97, 0.67]
Bruzzese 2011	139	142	-0.20991 (0.119859)		53.1 %	-0.21 [-0.44, 0.03]
Shah 2001	113	138	-0.23978 (0.26904)		10.5 %	-0.24 [-0.77, 0.29]
Velsor-Friedrich 2005	28	24	-0.0921 (0.388717)		5.0 %	-0.09 [-0.85, 0.67]
Total (95% CI)	**517**	**548**			**100.0 %**	**-0.15 [-0.33, 0.02]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.92$, df = 4 (P = 0.92); $I^2 = 0.0\%$

Test for overall effect: Z = 1.77 (P = 0.076)

Test for subgroup differences: Not applicable



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Analysis 1.7. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 7 Experience of daytime and night-time symptoms - night-time symptoms.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 7 Experience of daytime and night-time symptoms - night-time symptoms

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2008	12	11	-0.43322 (0.42328)		12.8 %	-0.43 [-1.26, 0.40]
Bruzzese 2011	139	142	-0.38753 (0.120658)		48.3 %	-0.39 [-0.62, -0.15]
Howell 2005	12	7	0.253008 (0.520697)		9.1 %	0.25 [-0.77, 1.27]
McGhan 2003	65	71	0.117308 (0.227133)		29.8 %	0.12 [-0.33, 0.56]
Total (95% CI)	**228**	**231**			**100.0 %**	**-0.18 [-0.52, 0.15]**

Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 5.01$, df = 3 (P = 0.17); $I^2 = 40\%$

Test for overall effect: Z = 1.09 (P = 0.28)

Test for subgroup differences: Not applicable

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Analysis 1.8. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 8 Use of reliever therapies, e.g. beta $_2$ -agonists.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 8 Use of reliever therapies, e.g. beta$_2$ -agonists

Study or subgroup	Education N	Usual care N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Gerald 2009	125	115	-1.43343 (0.659303)		40.7 %	0.24 [0.07, 0.87]
McGhan 2010	71	126	-0.12958 (0.342507)		59.3 %	0.88 [0.45, 1.72]
Total (95% CI)	**196**	**241**			**100.0 %**	**0.52 [0.15, 1.81]**

Heterogeneity: Tau^2 = 0.57; Chi^2 = 3.08, df = 1 (P = 0.08); I^2 =68%

Test for overall effect: Z = 1.03 (P = 0.30)

Test for subgroup differences: Not applicable

Analysis 1.9. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 9 Corticosteroid dosage and/or use of add-on therapies (usage of).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 9 Corticosteroid dosage and/or use of add-on therapies (usage of)

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Bruzzese 2011	139	142	0.372521 (0.240089)		55.9 %	1.45 [0.91, 2.32]
McGhan 2003	65	71	0.106523 (0.407782)		19.4 %	1.11 [0.50, 2.47]
McGhan 2010	71	126	-0.03897 (0.361197)		24.7 %	0.96 [0.47, 1.95]
Total (95% CI)	**275**	**339**			**100.0 %**	**1.25 [0.88, 1.77]**

Heterogeneity: Tau^2 = 0.0; Chi^2 = 1.00, df = 2 (P = 0.61); I^2 =0.0%

Test for overall effect: Z = 1.22 (P = 0.22)

Test for subgroup differences: Not applicable

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Analysis 1.10. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 10 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 10 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of)

Study or subgroup	Education N	Usual care N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Std. Mean Difference IV,Random,95% CI
Horner 2015	96	100	-0.60551 (0.172664)		-0.61 [-0.94, -0.27]
Howell 2005	12	7	0.953191 (0.545906)		0.95 [-0.12, 2.02]

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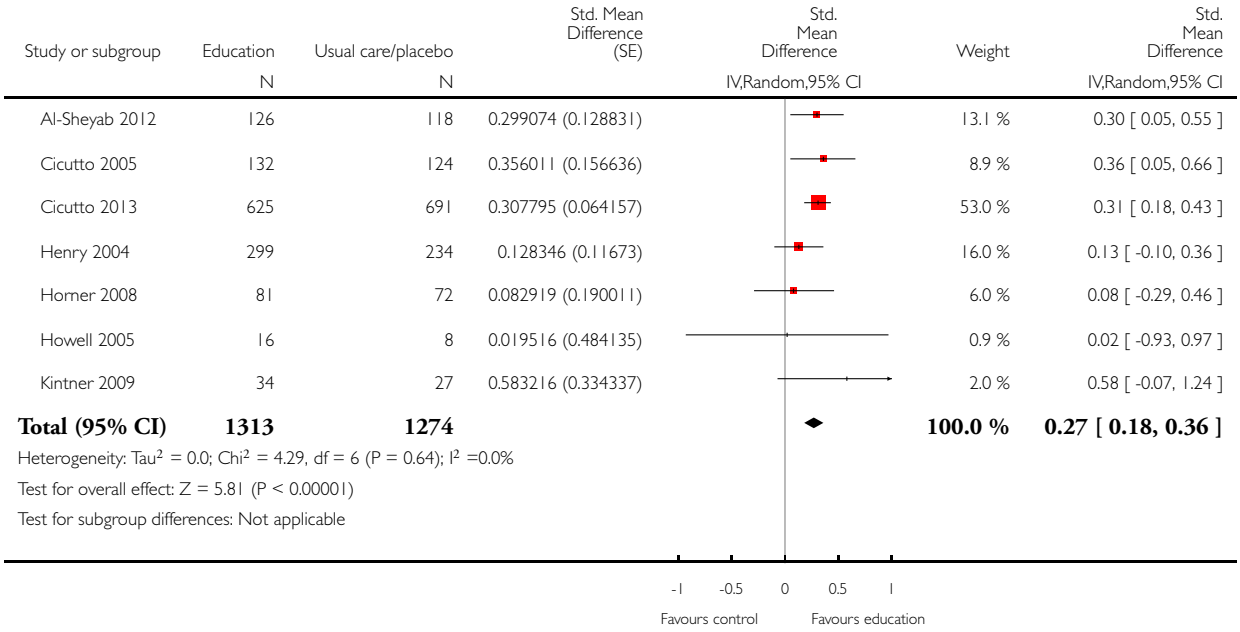
Analysis 1.11. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 11 Health-related quality of life (SMD).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 11 Health-related quality of life (SMD)



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Analysis 1.12. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 12 Health-related quality of life (MD).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

Outcome: 12 Health-related quality of life (MD)

Study or subgroup	Education N	Mean(SD)	Usual care/placebo N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Al-Sheyab 2012	126	5.42 (1.571496)	118	4.07 (1.520789)		13.2 %	1.35 [0.96, 1.74]
Cicutto 2005	132	5.5 (2.0195)	124	5 (2.0195)		11.5 %	0.50 [0.00, 1.00]
Cicutto 2013	625	5.8 (1.602)	691	5.4 (1.869)		16.2 %	0.40 [0.21, 0.59]
Henry 2004	299	5.27 (2.142)	234	5.11 (2.3205)		13.3 %	0.16 [-0.22, 0.54]
Horner 2008	81	1.74 (0.825)	72	1.69 (0.825)		15.2 %	0.05 [-0.21, 0.31]
Howell 2005	16	4.96 (1.6625)	8	4.93 (2.2125)		2.4 %	0.03 [-1.71, 1.77]
Patterson 2005	81	0.3 (1.19)	92	0.23 (0.98)		14.2 %	0.07 [-0.26, 0.40]
Shah 2001	138	0.21 (1.3)	113	0.12 (1.3)		14.2 %	0.09 [-0.23, 0.41]
Total (95% CI)	**1498**		**1452**			**100.0 %**	**0.35 [0.06, 0.64]**

Heterogeneity: $Tau^2 = 0.12$; $Chi^2 = 37.31$, df = 7 ($P<0.00001$); $I^2 = 81\%$

Test for overall effect: Z = 2.40 (P = 0.017)

Test for subgroup differences: Not applicable

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Analysis 1.13. Comparison 1 Effects of school-based asthma interventions vs usual care, Outcome 13 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 1 Effects of school-based asthma interventions vs usual care

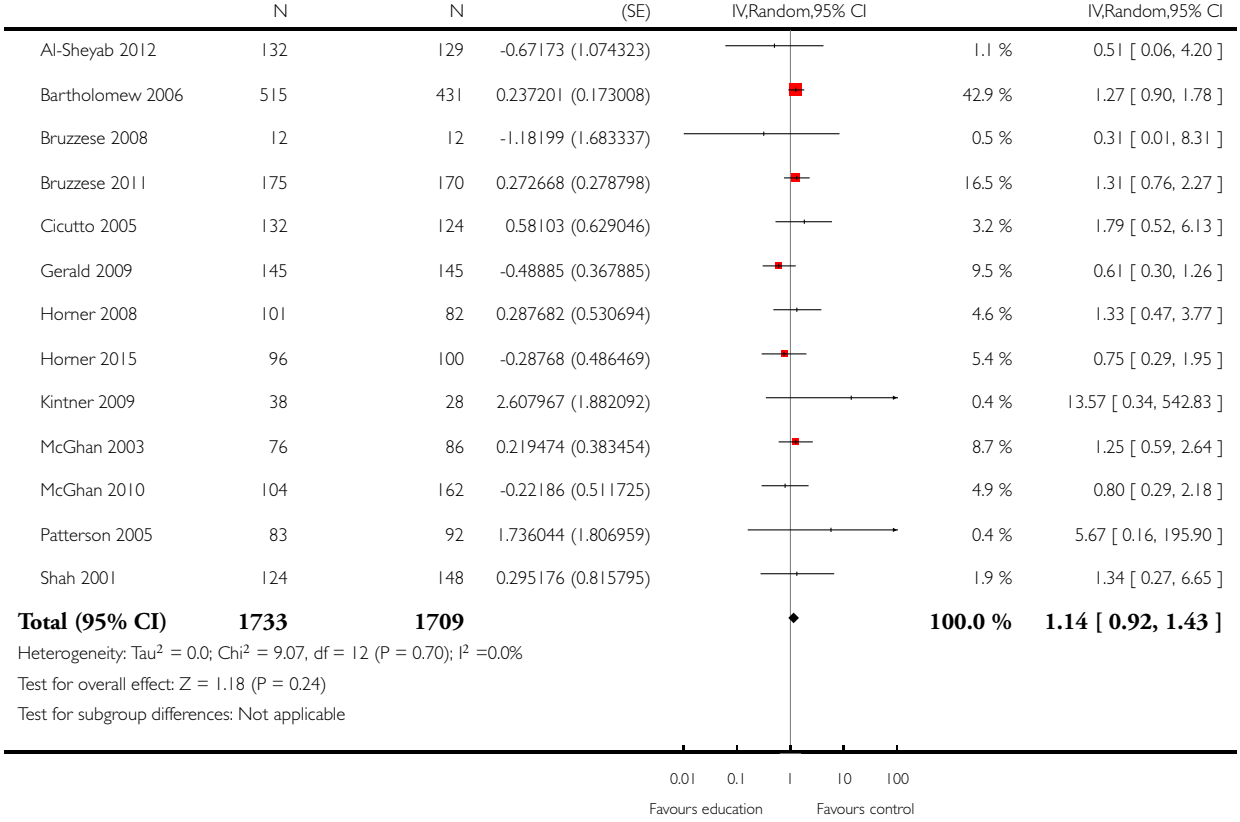
Outcome: 13 Withdrawal from the study

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Al-Sheyab 2012	132	129	-0.67173 (1.074323)		1.1 %	0.51 [0.06, 4.20]
Bartholomew 2006	515	431	0.237201 (0.173008)		42.9 %	1.27 [0.90, 1.78]
Bruzzese 2008	12	12	-1.18199 (1.683337)		0.5 %	0.31 [0.01, 8.31]
Bruzzese 2011	175	170	0.272668 (0.278798)		16.5 %	1.31 [0.76, 2.27]
Cicutto 2005	132	124	0.58103 (0.629046)		3.2 %	1.79 [0.52, 6.13]
Gerald 2009	145	145	-0.48885 (0.367885)		9.5 %	0.61 [0.30, 1.26]
Horner 2008	101	82	0.287682 (0.530694)		4.6 %	1.33 [0.47, 3.77]
Horner 2015	96	100	-0.28768 (0.486469)		5.4 %	0.75 [0.29, 1.95]
Kintner 2009	38	28	2.607967 (1.882092)		0.4 %	13.57 [0.34, 542.83]
McGhan 2003	76	86	0.219474 (0.383454)		8.7 %	1.25 [0.59, 2.64]
McGhan 2010	104	162	-0.22186 (0.511725)		4.9 %	0.80 [0.29, 2.18]
Patterson 2005	83	92	1.736044 (1.806959)		0.4 %	5.67 [0.16, 195.90]
Shah 2001	124	148	0.295176 (0.815795)		1.9 %	1.34 [0.27, 6.65]
Total (95% CI)	**1733**	**1709**			**100.0 %**	**1.14 [0.92, 1.43]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 9.07$, df = 12 (P = 0.70); $I^2 = 0.0\%$

Test for overall effect: Z = 1.18 (P = 0.24)

Test for subgroup differences: Not applicable



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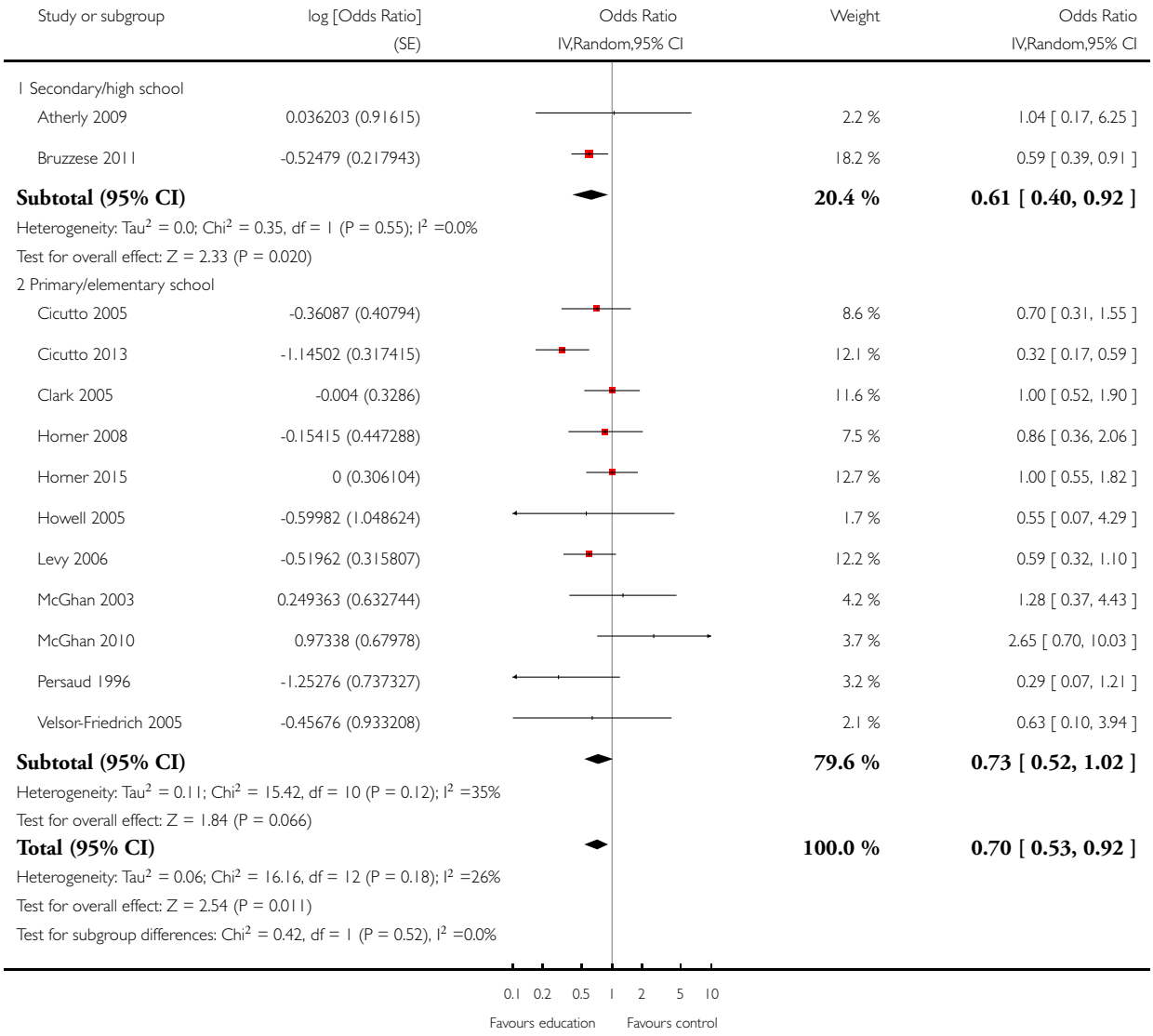
Analysis 2.1. Comparison 2 Effects of school-based asthma interventions vs usual care subgrouped by school type, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 2 Effects of school-based asthma interventions vs usual care subgrouped by school type

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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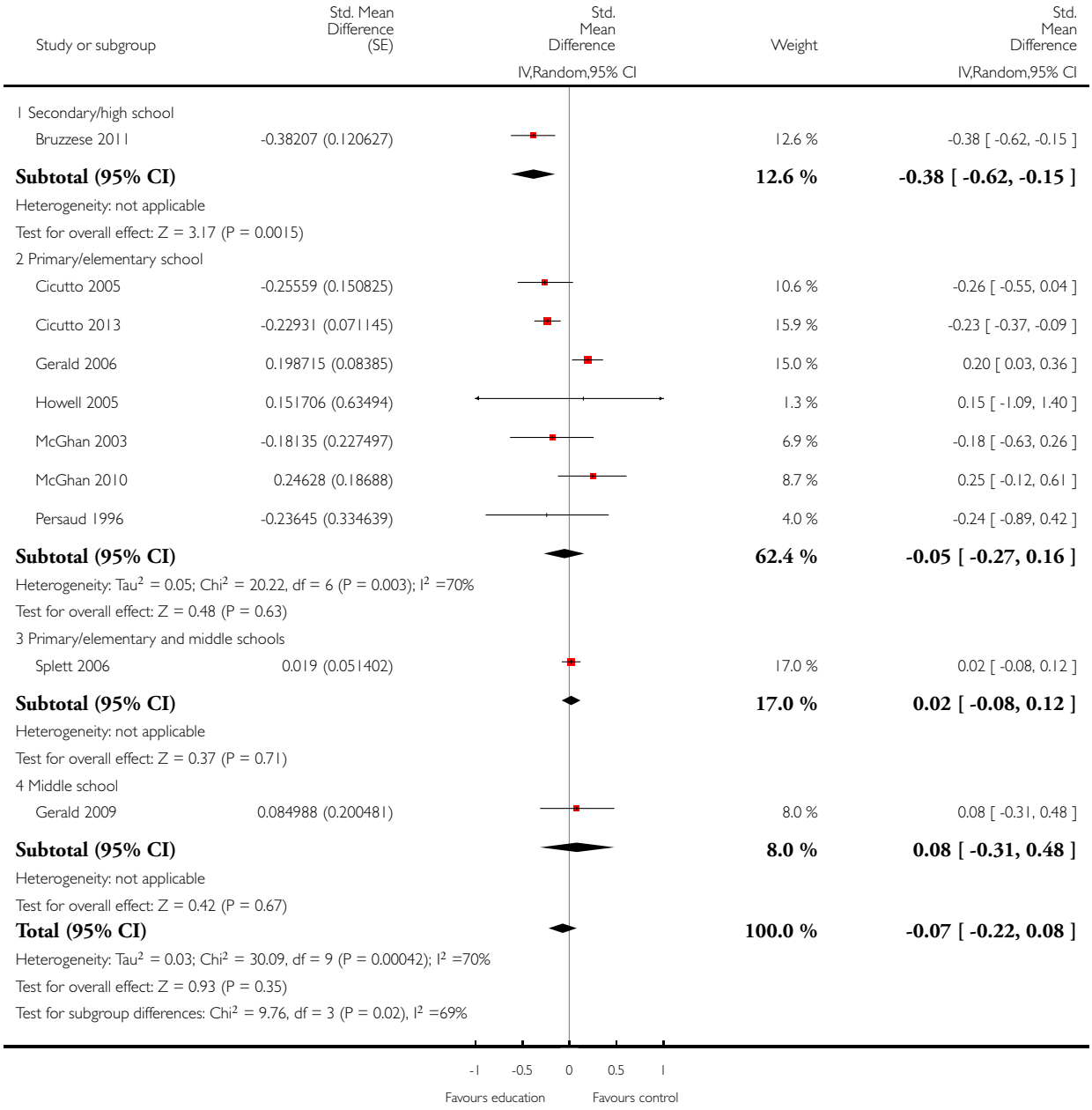
Analysis 2.2. Comparison 2 Effects of school-based asthma interventions vs usual care subgrouped by school type, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 2 Effects of school-based asthma interventions vs usual care subgrouped by school type

Outcome: 2 Absence from school



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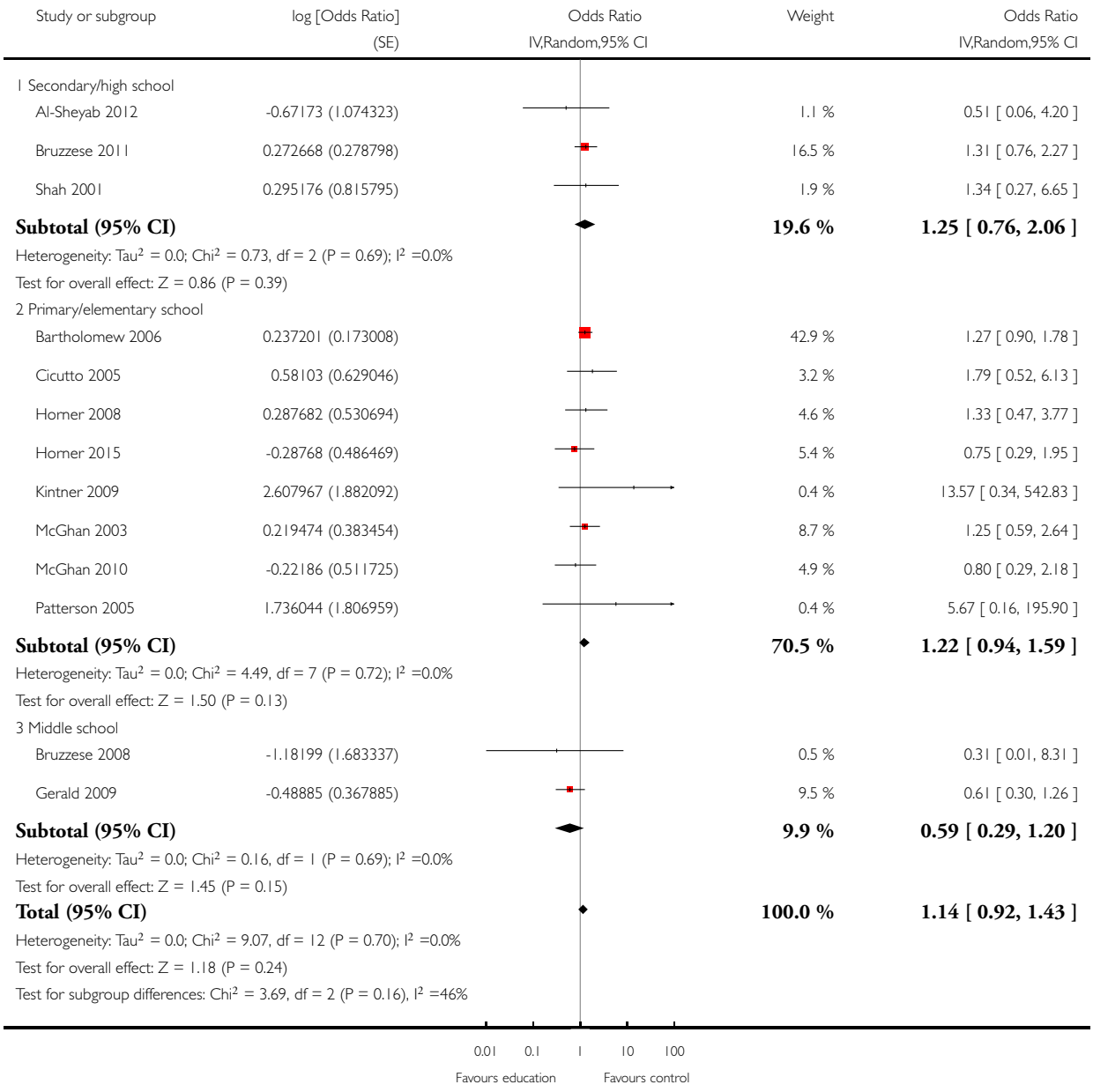
Analysis 2.3. Comparison 2 Effects of school-based asthma interventions vs usual care subgrouped by school type, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 2 Effects of school-based asthma interventions vs usual care subgrouped by school type

Outcome: 3 Withdrawal from the study



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Analysis 3.1. Comparison 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children

Outcome: 1 Exacerbations leading to emergency department (ED) visits

Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
1 Aged 11 to 15, 16 to 18				
Bruzzese 2011	-0.52479 (0.217943)		18.2 %	0.59 [0.39, 0.91]
Subtotal (95% CI)			**18.2 %**	**0.59 [0.39, 0.91]**
Heterogeneity: not applicable				
Test for overall effect: Z = 2.41 (P = 0.016)				
2 Aged 11 to 15				
Atherly 2009	0.036203 (0.91615)		2.2 %	1.04 [0.17, 6.25]
Subtotal (95% CI)			**2.2 %**	**1.04 [0.17, 6.25]**
Heterogeneity: not applicable				
Test for overall effect: Z = 0.04 (P = 0.97)				
3 Aged 5 to 10, 11 to 15				
McGhan 2003	0.249363 (0.632744)		4.2 %	1.28 [0.37, 4.43]
Persaud 1996	-1.25276 (0.737327)		3.2 %	0.29 [0.07, 1.21]
Subtotal (95% CI)			**7.4 %**	**0.64 [0.15, 2.76]**
Heterogeneity: Tau^2 = 0.66; Chi^2 = 2.39, df = 1 (P = 0.12); I^2 =58%				
Test for overall effect: Z = 0.61 (P = 0.54)				
4 Aged 5 to 10				
Cicutto 2005	-0.36087 (0.40794)		8.6 %	0.70 [0.31, 1.55]
Cicutto 2013	-1.14502 (0.317415)		12.1 %	0.32 [0.17, 0.59]
Clark 2005	-0.004 (0.3286)		11.6 %	1.00 [0.52, 1.90]
Horner 2008	-0.15415 (0.447288)		7.5 %	0.86 [0.36, 2.06]
Horner 2015	0 (0.306104)		12.7 %	1.00 [0.55, 1.82]
Howell 2005	-0.59982 (1.048624)		1.7 %	0.55 [0.07, 4.29]
Levy 2006	-0.51962 (0.315807)		12.2 %	0.59 [0.32, 1.10]
McGhan 2010	0.97338 (0.67978)		3.7 %	2.65 [0.70, 10.03]
Velsor-Friedrich 2005	-0.45676 (0.933208)		2.1 %	0.63 [0.10, 3.94]
Subtotal (95% CI)			**72.2 %**	**0.74 [0.51, 1.06]**
Heterogeneity: Tau^2 = 0.11; Chi^2 = 13.02, df = 8 (P = 0.11); I^2 =39%				
Test for overall effect: Z = 1.67 (P = 0.095)				

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Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Total (95% CI)			**100.0 %**	**0.70 [0.53, 0.92]**
Heterogeneity: Tau² = 0.06; Chi² = 16.16, df = 12 (P = 0.18); I² =26%				
Test for overall effect: Z = 2.54 (P = 0.011)				
Test for subgroup differences: Chi² = 0.82, df = 3 (P = 0.85), I² =0.0%				

Analysis 3.2. Comparison 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children

Outcome: 2 Absence from school

Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Aged 11 to 15, 16 to 18				
Bruzzese 2011	-0.38207 (0.120627)		12.5 %	-0.38 [-0.62, -0.15]
Subtotal (95% CI)			**12.5 %**	**-0.38 [-0.62, -0.15]**
Heterogeneity: not applicable				
Test for overall effect: Z = 3.17 (P = 0.0015)				
2 Aged 5 to 10, 11 to 15				
Gerald 2009	0.084988 (0.200481)		8.0 %	0.08 [-0.31, 0.48]
McGhan 2010	0.24628 (0.18688)		8.7 %	0.25 [-0.12, 0.61]
Persaud 1996	-0.23645 (0.334639)		4.0 %	-0.24 [-0.89, 0.42]
Splett 2006	0.019 (0.051402)		17.0 %	0.02 [-0.08, 0.12]
Subtotal (95% CI)			**37.6 %**	**0.03 [-0.06, 0.13]**
Heterogeneity: Tau² = 0.0; Chi² = 2.09, df = 3 (P = 0.55); I² =0.0%				
Test for overall effect: Z = 0.68 (P = 0.50)				
3 Aged 5 to 10				
Cicutto 2005	-0.25559 (0.150825)		10.6 %	-0.26 [-0.55, 0.04]

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Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Cicutto 2013	-0.22931 (0.071145)		15.9 %	-0.23 [-0.37, -0.09]
Gerald 2006	0.198715 (0.08385)		15.0 %	0.20 [0.03, 0.36]
Howell 2005	0.151706 (0.601981)		1.4 %	0.15 [-1.03, 1.33]
McGhan 2003	-0.18135 (0.227497)		6.9 %	-0.18 [-0.63, 0.26]
Subtotal (95% CI)			**49.8 %**	**-0.09 [-0.34, 0.16]**
Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 17.15$, df = 4 (P = 0.002); $I^2 = 77\%$				
Test for overall effect: Z = 0.71 (P = 0.48)				
Total (95% CI)			**100.0 %**	**-0.07 [-0.22, 0.08]**
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 30.11$, df = 9 (P = 0.00042); $I^2 = 70\%$				
Test for overall effect: Z = 0.93 (P = 0.35)				
Test for subgroup differences: $Chi^2 = 10.45$, df = 2 (P = 0.01), $I^2 = 81\%$				

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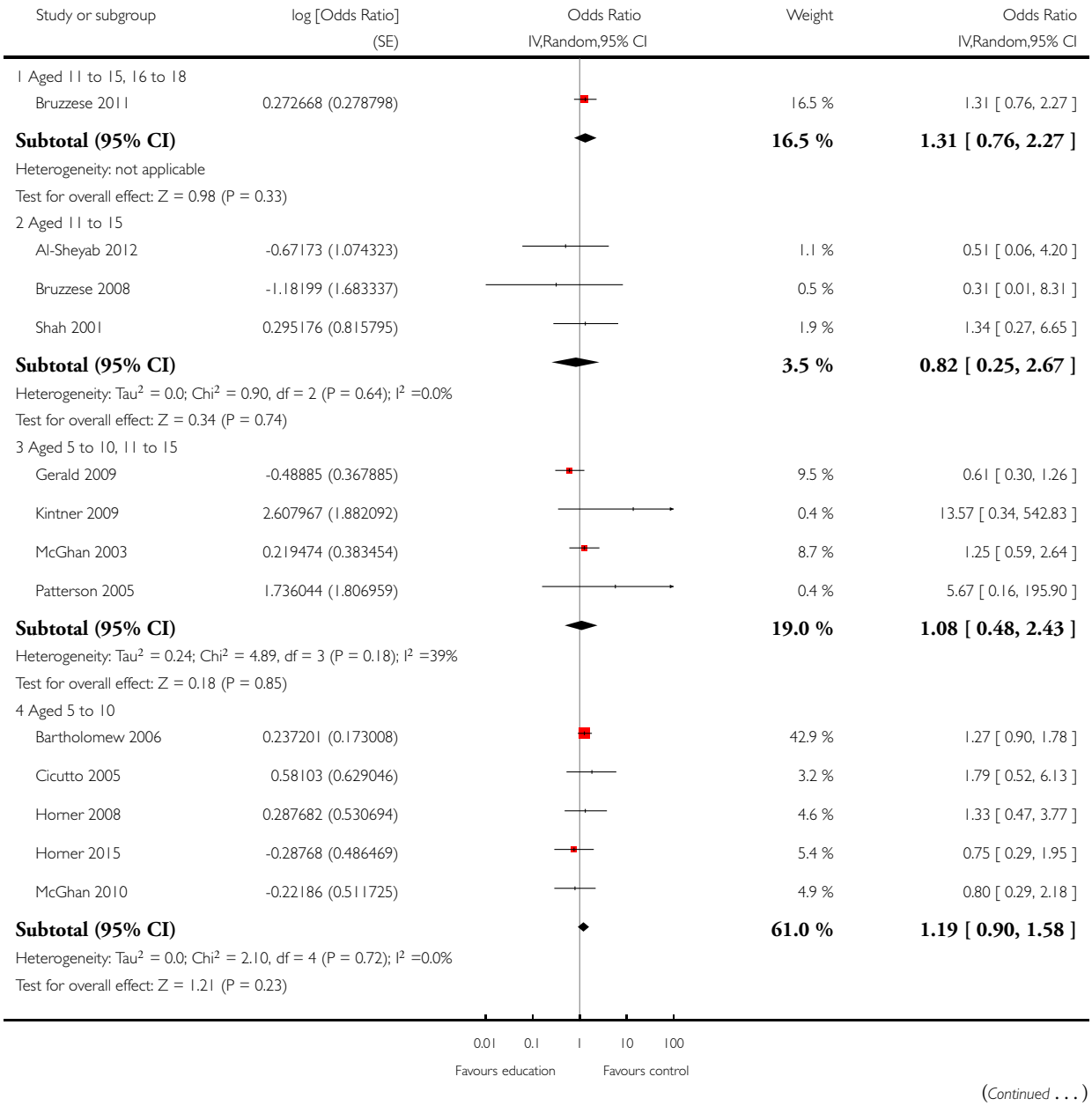
Analysis 3.3. Comparison 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 3 Effects of school-based asthma interventions vs usual care subgrouped by age of children

Outcome: 3 Withdrawal from the study



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Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Total (95% CI)			**100.0 %**	**1.14 [0.92, 1.43]**
Heterogeneity: Tau² = 0.0; Chi² = 9.07, df = 12 (P = 0.70); I² =0.0%				
Test for overall effect: Z = 1.18 (P = 0.24)				
Test for subgroup differences: Chi² = 0.57, df = 3 (P = 0.90), I² =0.0%				

Analysis 4.1. Comparison 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES), Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES)

Outcome: 1 Exacerbations leading to emergency department (ED) visits

Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
1 Low SES over 50%				
Levy 2006	-0.51962 (0.315807)		12.2 %	0.59 [0.32, 1.10]
Persaud 1996	-1.25276 (0.737327)		3.2 %	0.29 [0.07, 1.21]
Subtotal (95% CI)			**15.4 %**	**0.53 [0.30, 0.94]**
Heterogeneity: Tau² = 0.0; Chi² = 0.84, df = 1 (P = 0.36); I² =0.0%				
Test for overall effect: Z = 2.18 (P = 0.029)				
2 Low SES over 25%				
Cicutto 2013	-1.14502 (0.317415)		12.1 %	0.32 [0.17, 0.59]
Horner 2015	0 (0.306104)		12.7 %	1.00 [0.55, 1.82]
McGhan 2003	0.249363 (0.632744)		4.2 %	1.28 [0.37, 4.43]
Subtotal (95% CI)			**29.0 %**	**0.69 [0.28, 1.69]**
Heterogeneity: Tau² = 0.45; Chi² = 8.17, df = 2 (P = 0.02); I² =76%				
Test for overall effect: Z = 0.81 (P = 0.42)				
3 Unclear or not low SES				
Atherly 2009	0.036203 (0.91615)		2.2 %	1.04 [0.17, 6.25]

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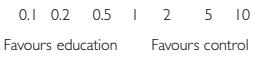
Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Bruzzese 2011	-0.52479 (0.217943)		18.2 %	0.59 [0.39, 0.91]
Cicutto 2005	-0.36087 (0.40794)		8.6 %	0.70 [0.31, 1.55]
Clark 2005	-0.004 (0.3286)		11.6 %	1.00 [0.52, 1.90]
Horner 2008	-0.15415 (0.447288)		7.5 %	0.86 [0.36, 2.06]
Howell 2005	-0.59982 (1.048624)		1.7 %	0.55 [0.07, 4.29]
McGhan 2010	0.97338 (0.67978)		3.7 %	2.65 [0.70, 10.03]
Velsor-Friedrich 2005	-0.45676 (0.933208)		2.1 %	0.63 [0.10, 3.94]
Subtotal (95% CI)			**55.5 %**	**0.76 [0.57, 1.01]**
Heterogeneity: Tau^2 = 0.0; Chi^2 = 5.73, df = 7 (P = 0.57); I^2 =0.0%				
Test for overall effect: Z = 1.89 (P = 0.058)				
Total (95% CI)			**100.0 %**	**0.70 [0.53, 0.92]**
Heterogeneity: Tau^2 = 0.06; Chi^2 = 16.16, df = 12 (P = 0.18); I^2 =26%				
Test for overall effect: Z = 2.54 (P = 0.011)				
Test for subgroup differences: Chi^2 = 1.20, df = 2 (P = 0.55), I^2 =0.0%				



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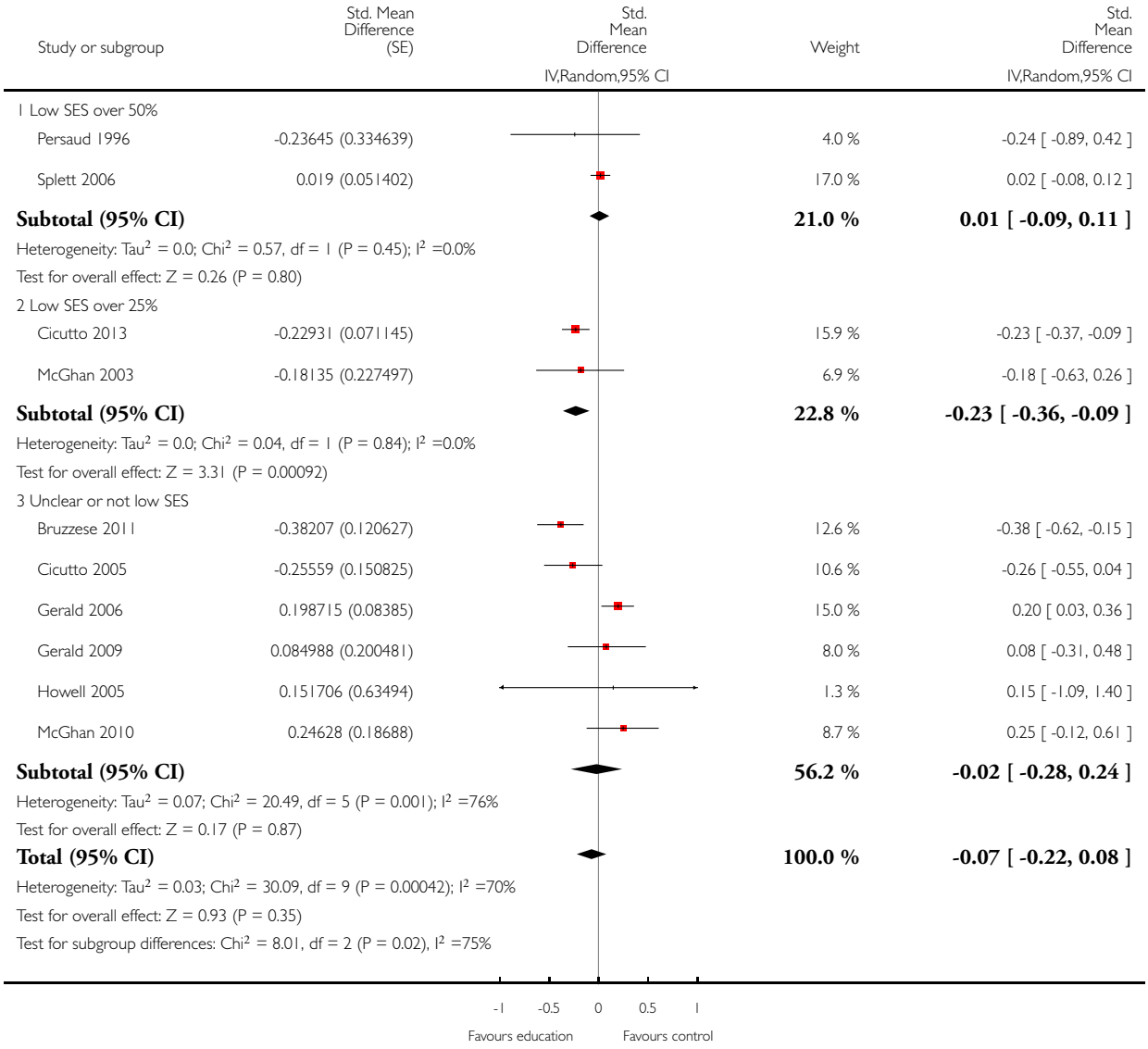
Analysis 4.2. Comparison 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES), Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES)

Outcome: 2 Absence from school



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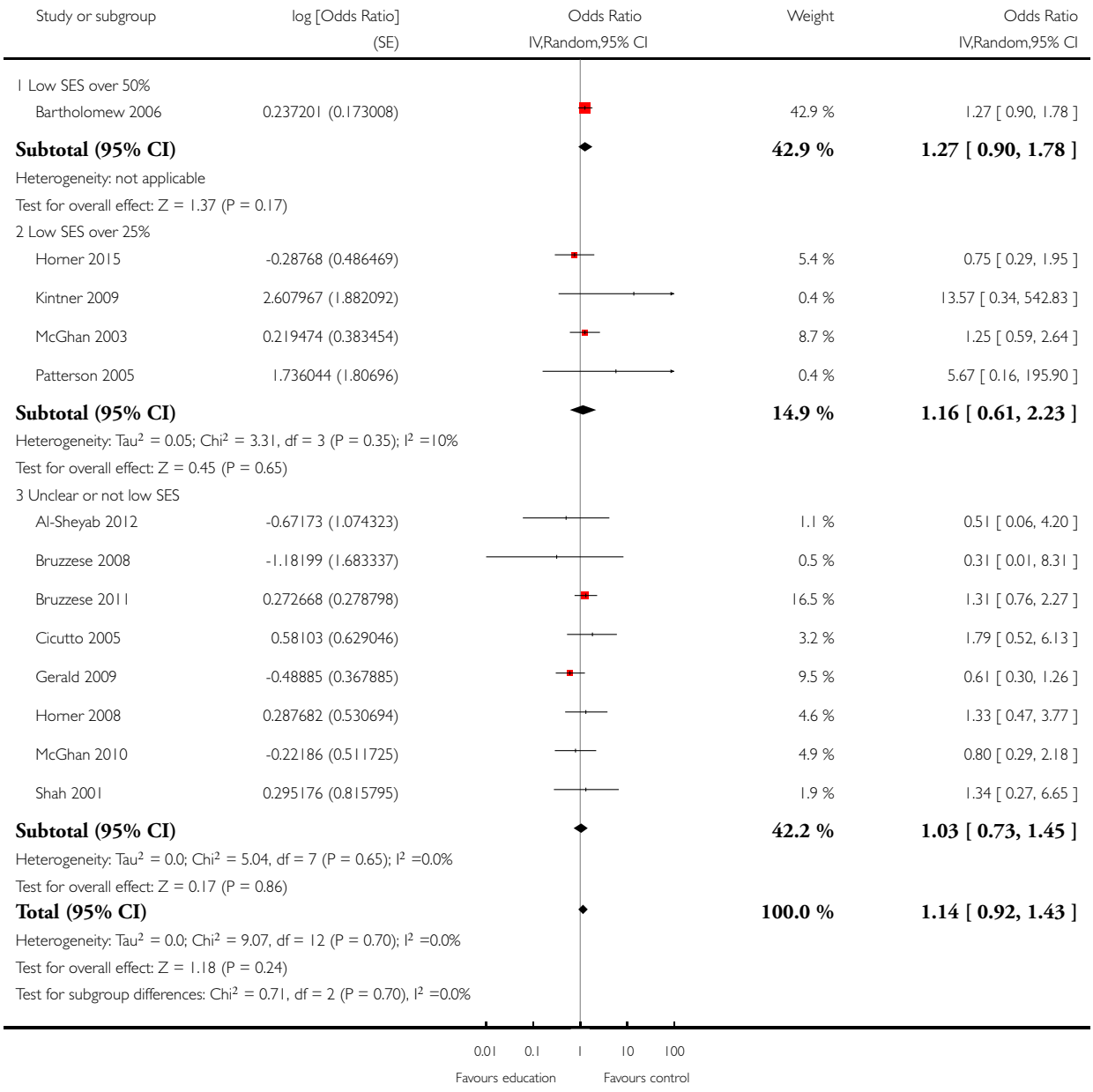
Analysis 4.3. Comparison 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES), Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 4 Effects of school-based asthma interventions vs usual care subgrouped by child socio-economic status (SES)

Outcome: 3 Withdrawal from the study



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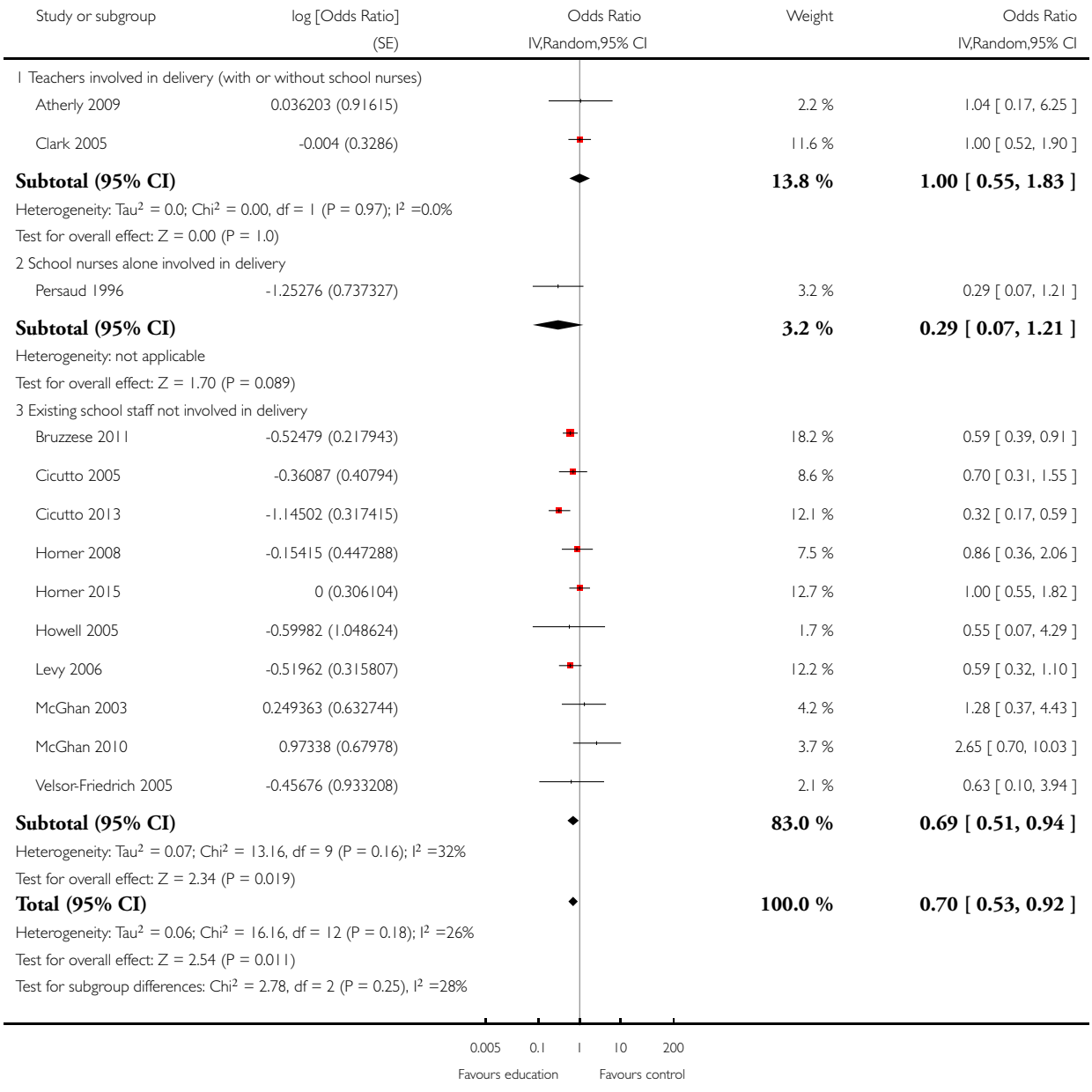
Analysis 5.1. Comparison 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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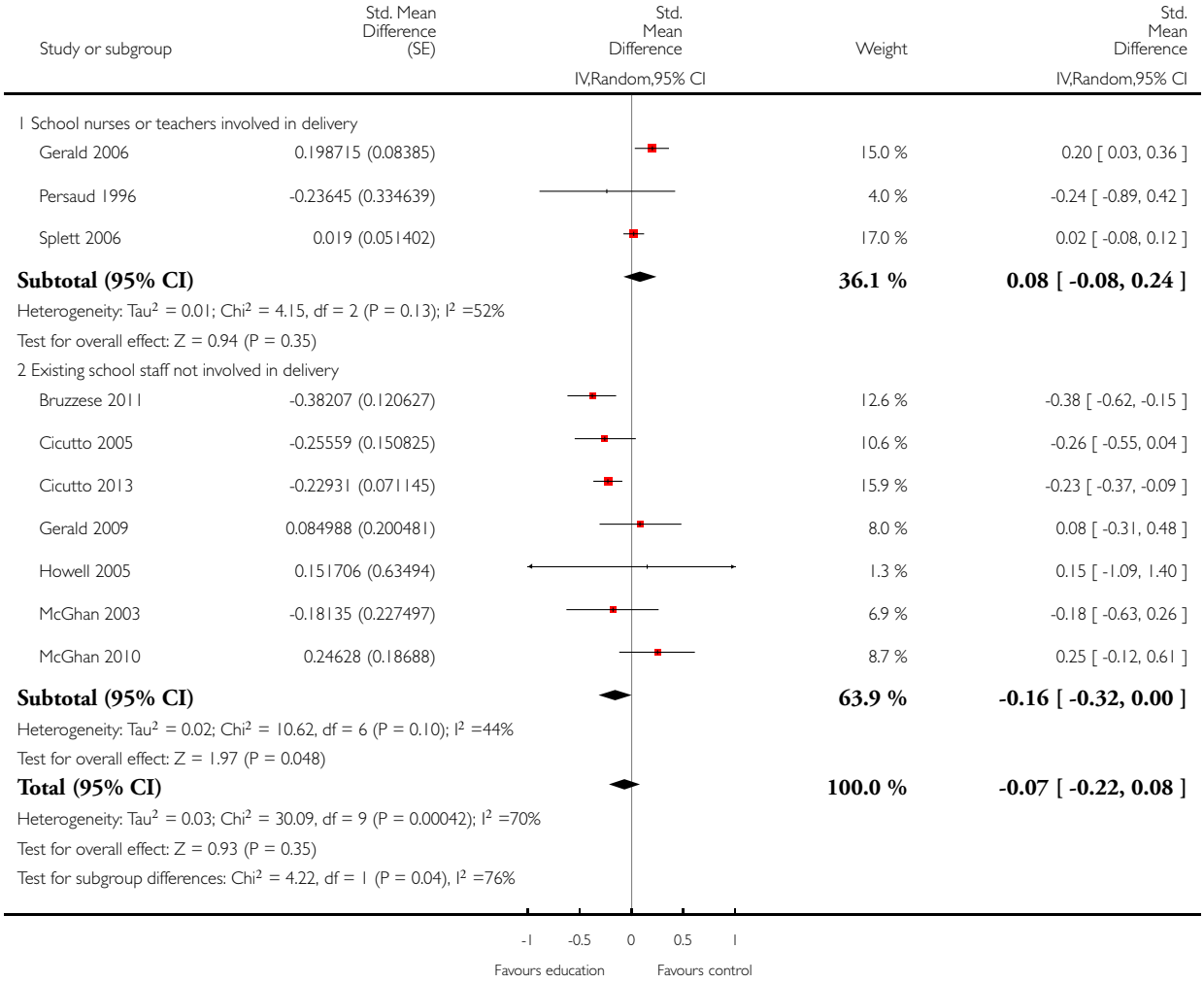
Analysis 5.2. Comparison 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children

Outcome: 2 Absence from school



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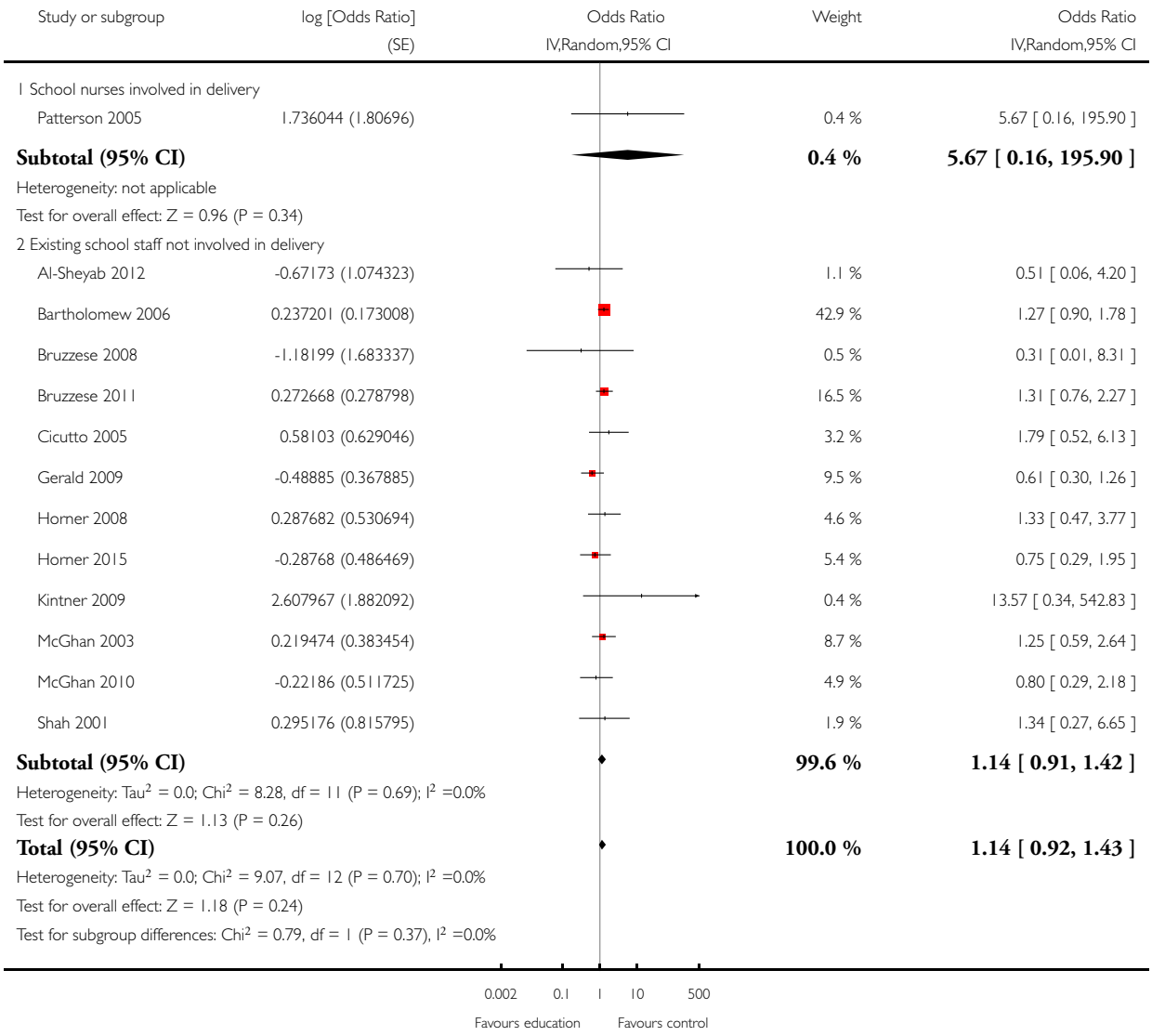
Analysis 5.3. Comparison 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 5 Effects of school-based asthma interventions vs usual care subgrouped by involvement of school staff in direct delivery of self-management skills to children

Outcome: 3 Withdrawal from the study



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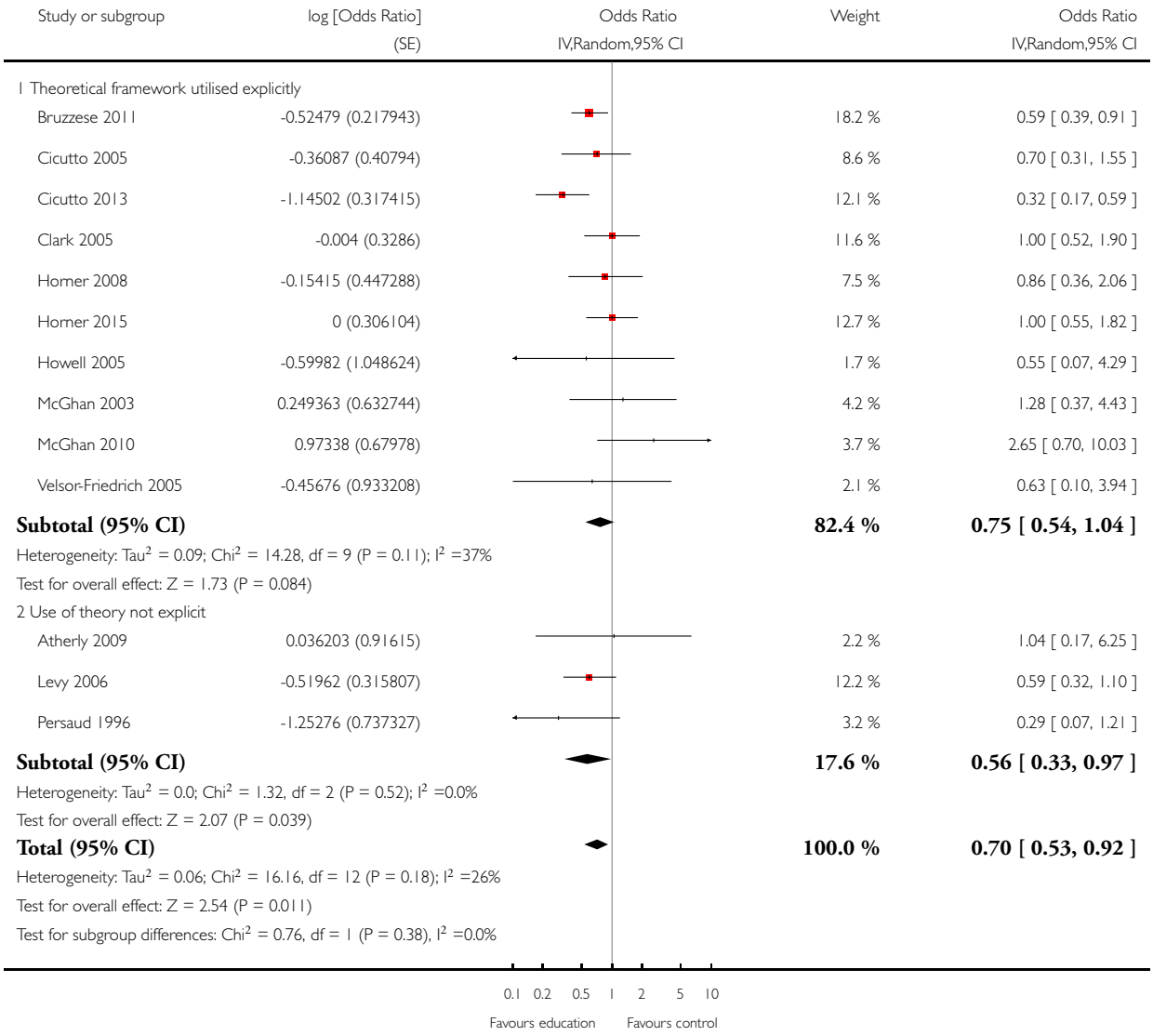
Analysis 6.1. Comparison 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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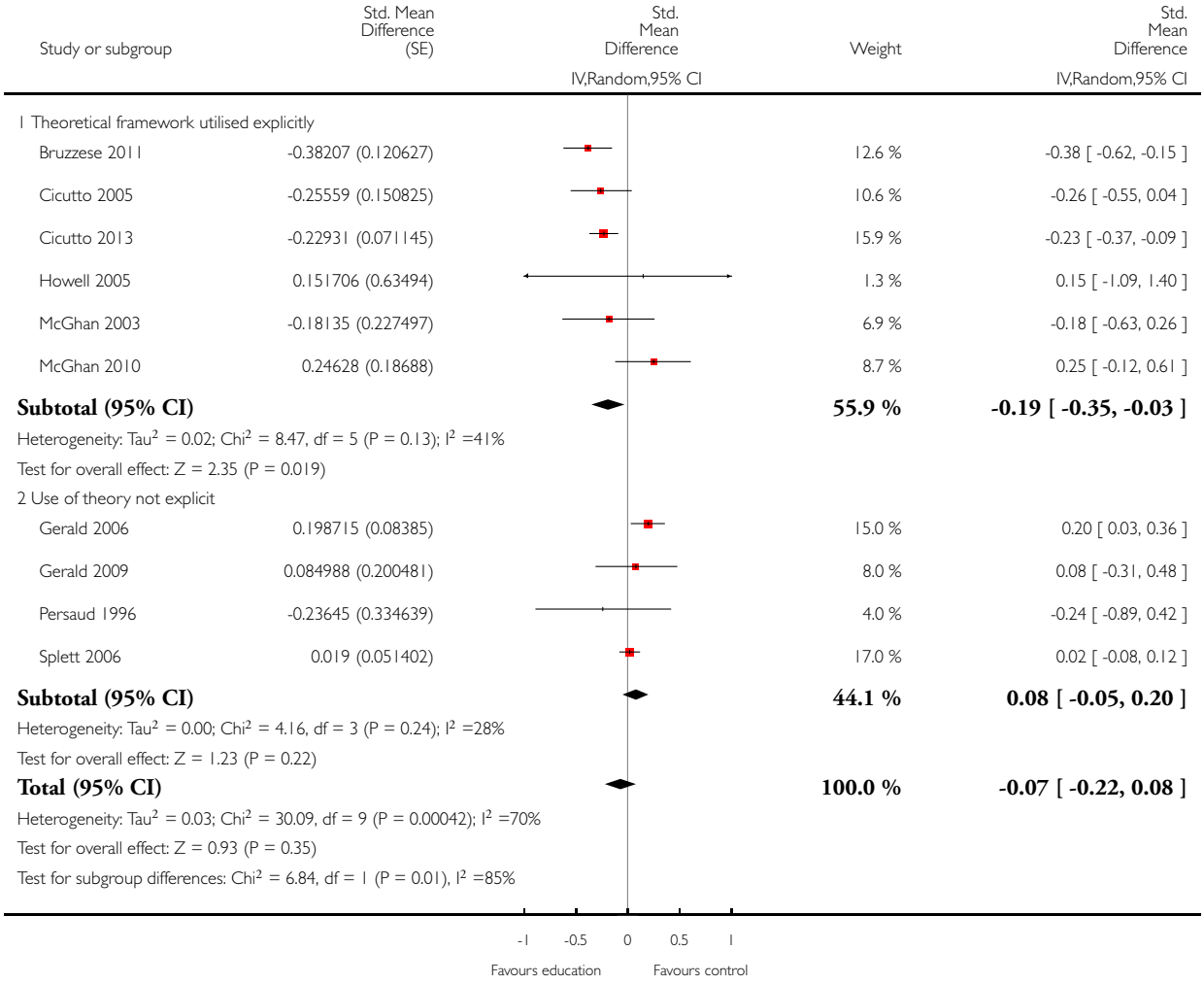
Analysis 6.2. Comparison 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory

Outcome: 2 Absence from school



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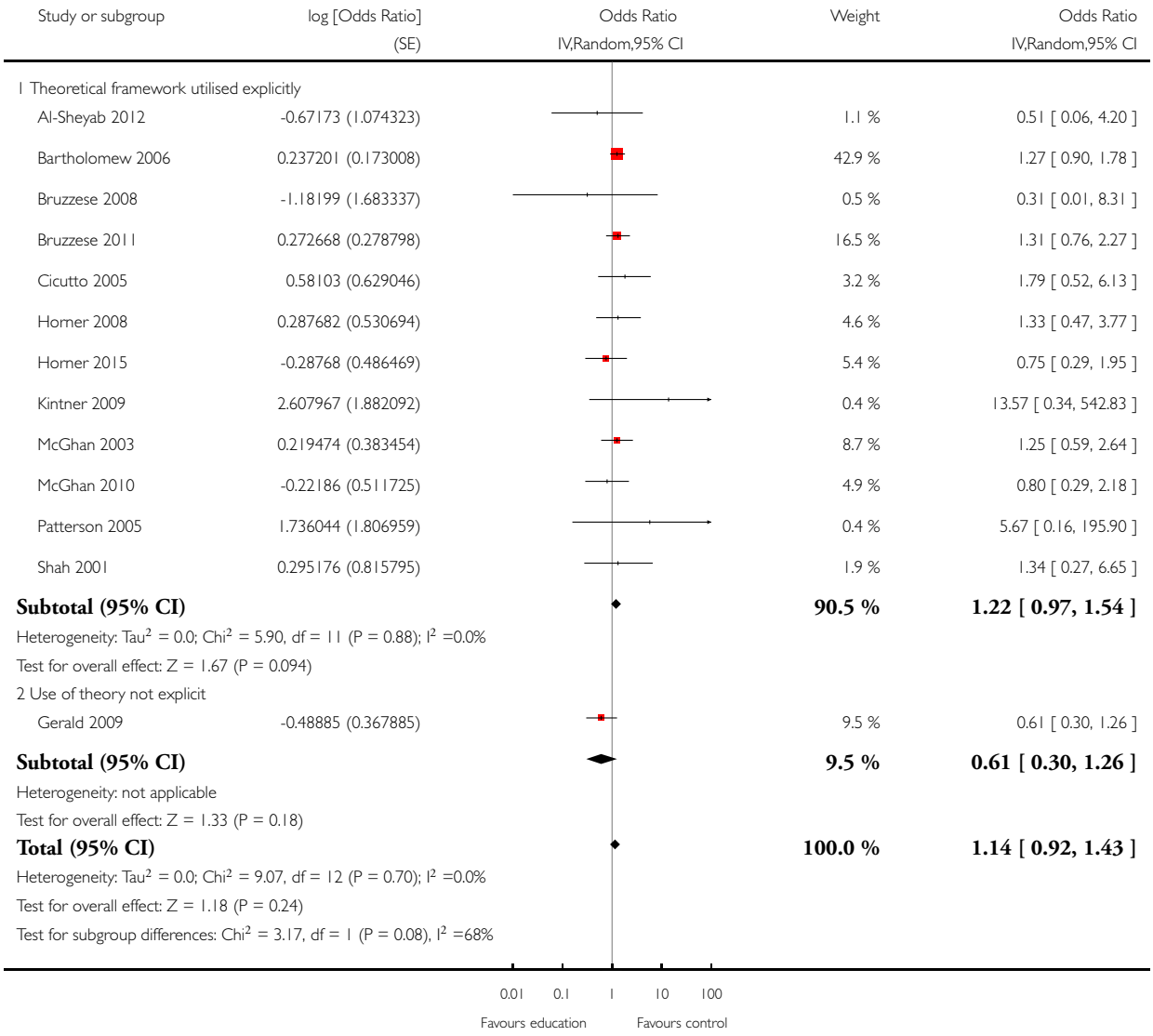
Analysis 6.3. Comparison 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 6 Effects of school-based asthma interventions vs usual care subgrouped by explicit use of theory

Outcome: 3 Withdrawal from the study



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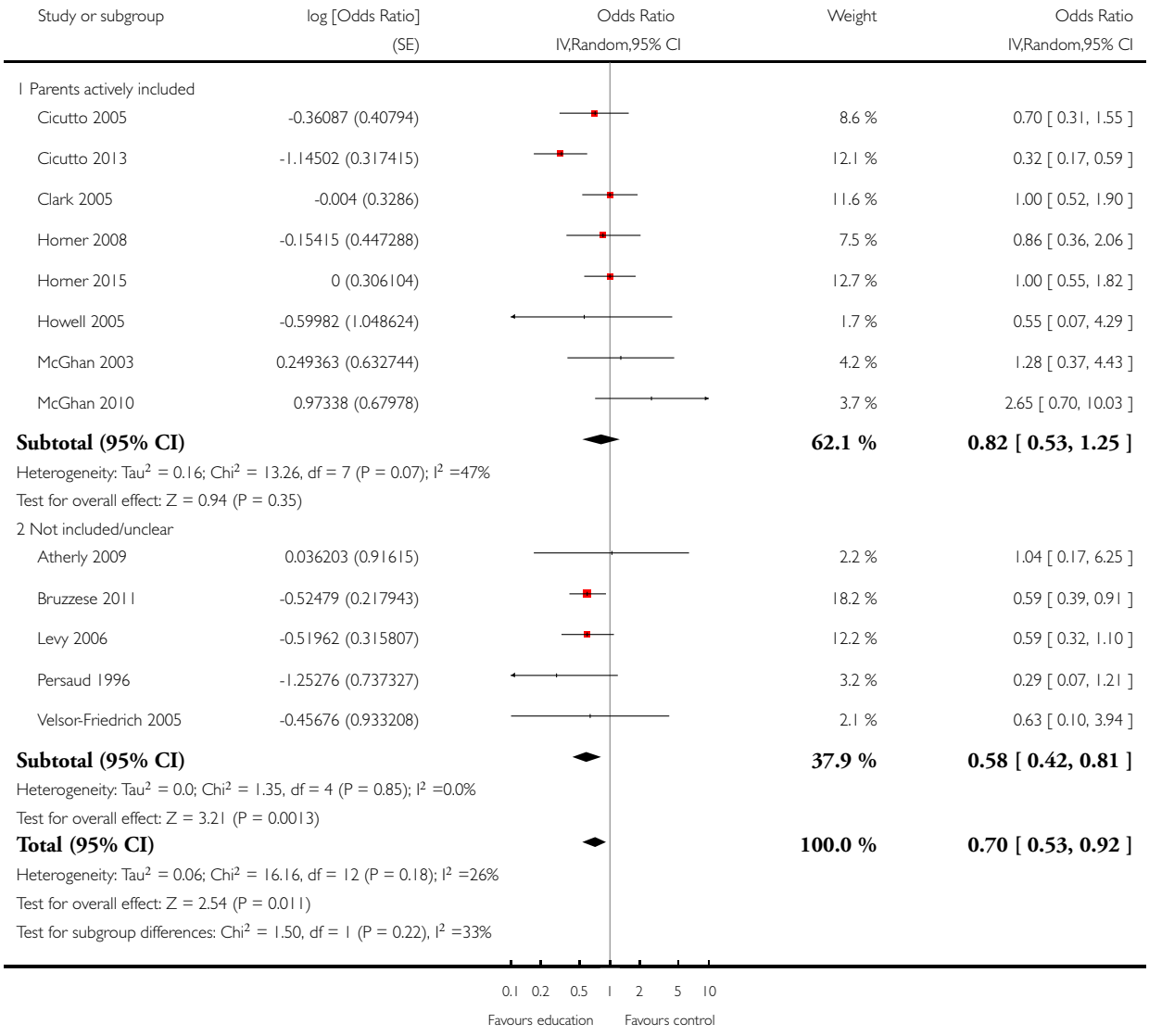
Analysis 7.1. Comparison 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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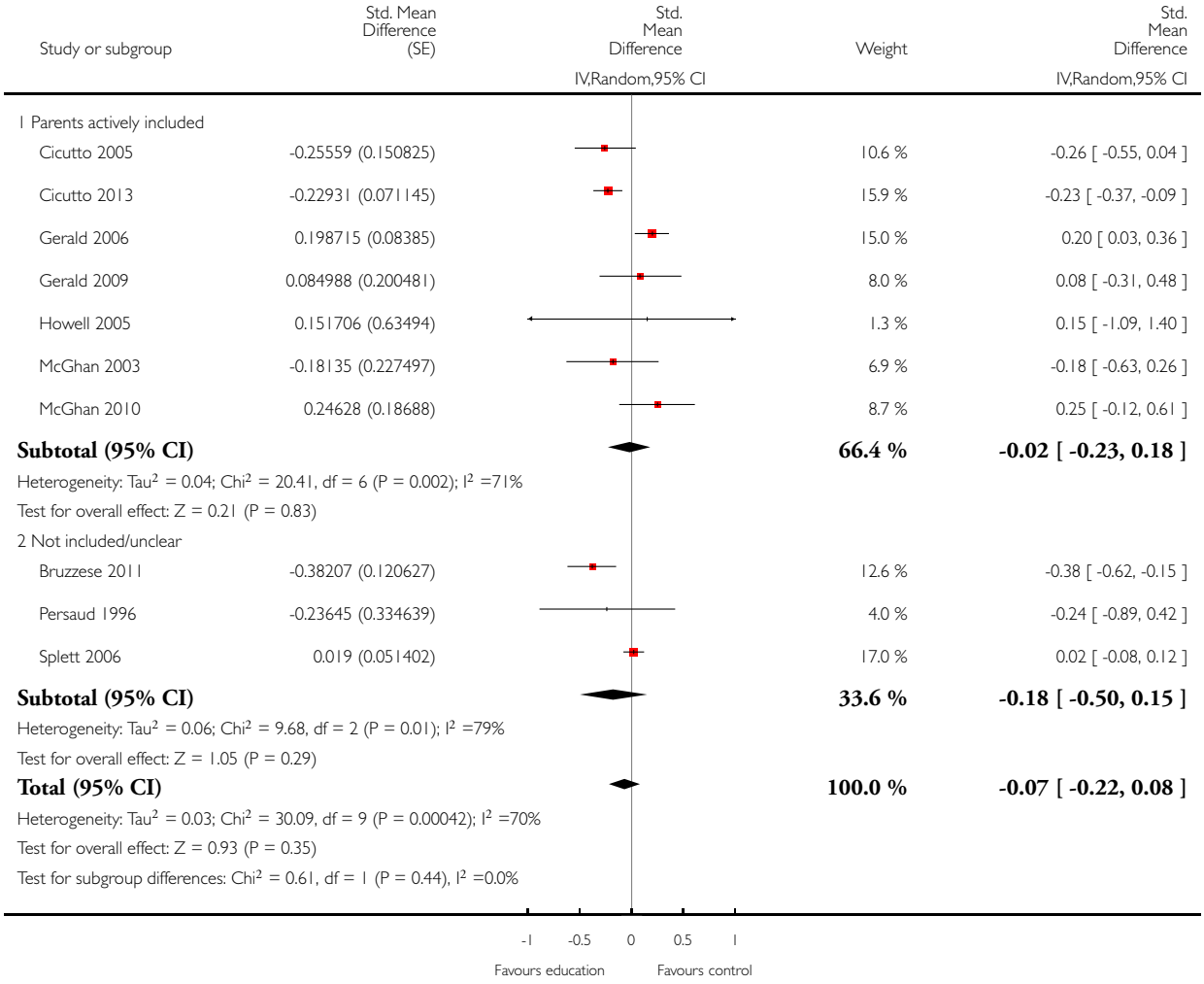
Analysis 7.2. Comparison 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents

Outcome: 2 Absence from school



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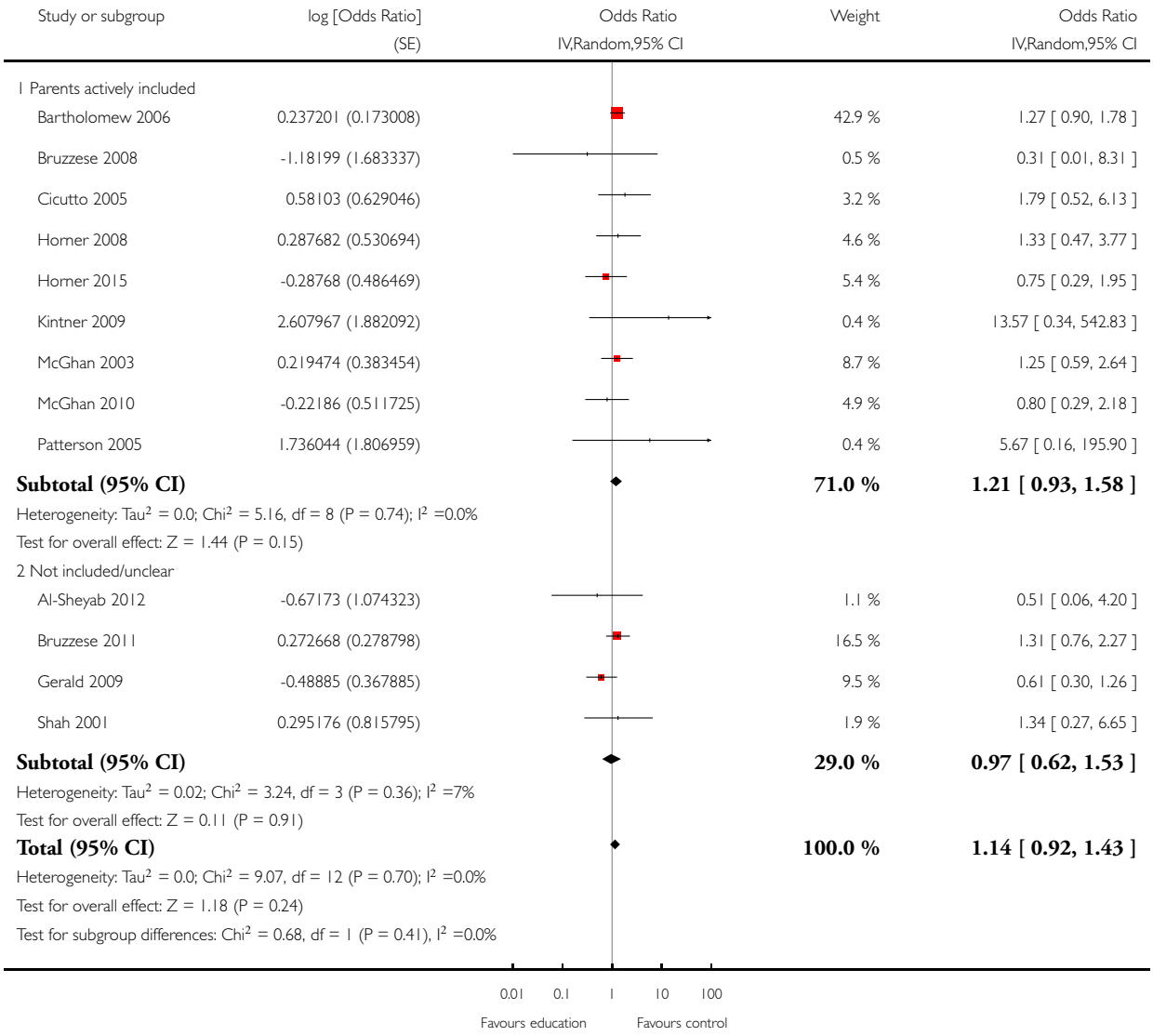
Analysis 7.3. Comparison 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 7 Effects of school-based asthma interventions vs usual care subgrouped by whether design included active inclusion or participation of parents

Outcome: 3 Withdrawal from the study



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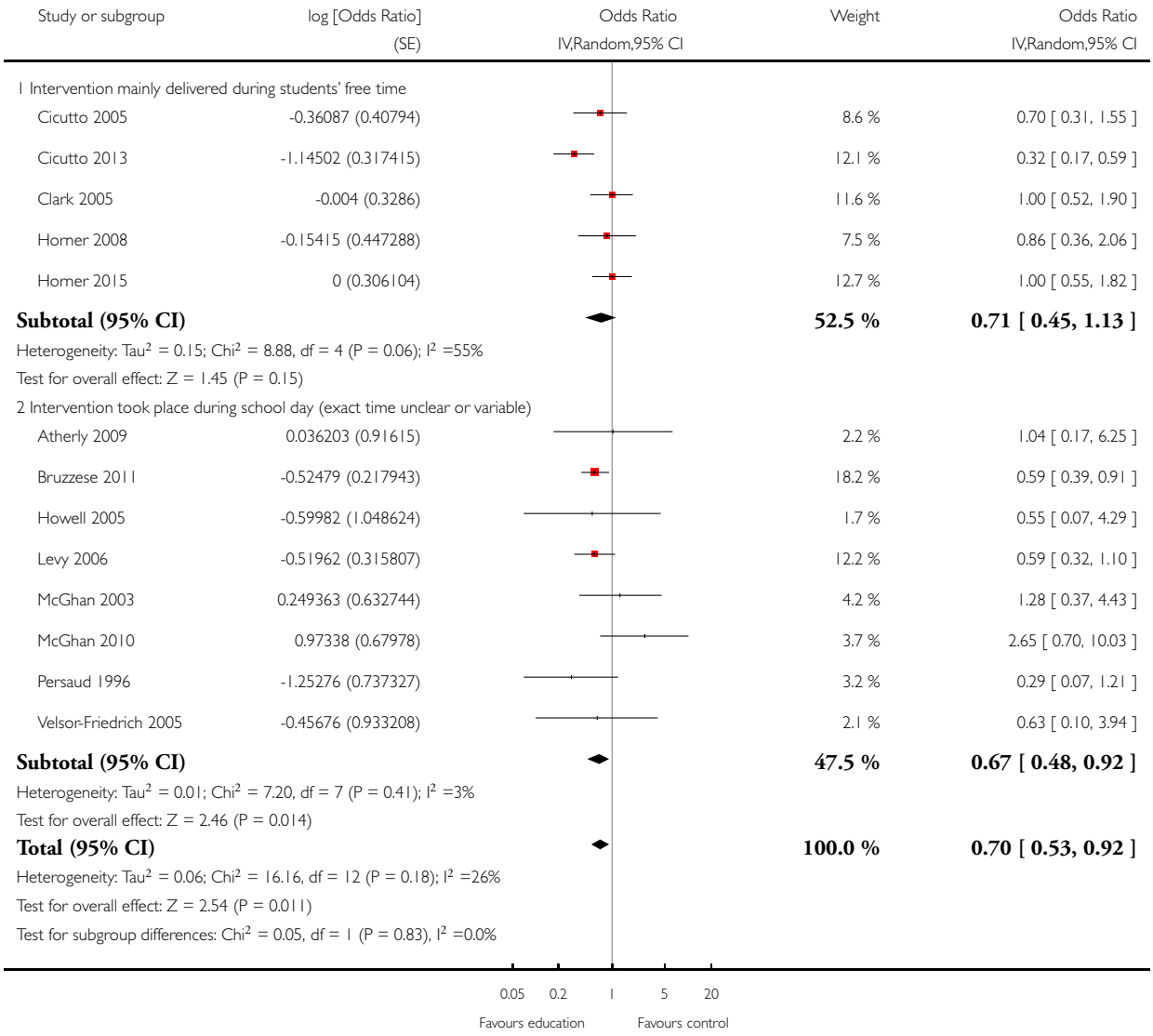
Analysis 8.1. Comparison 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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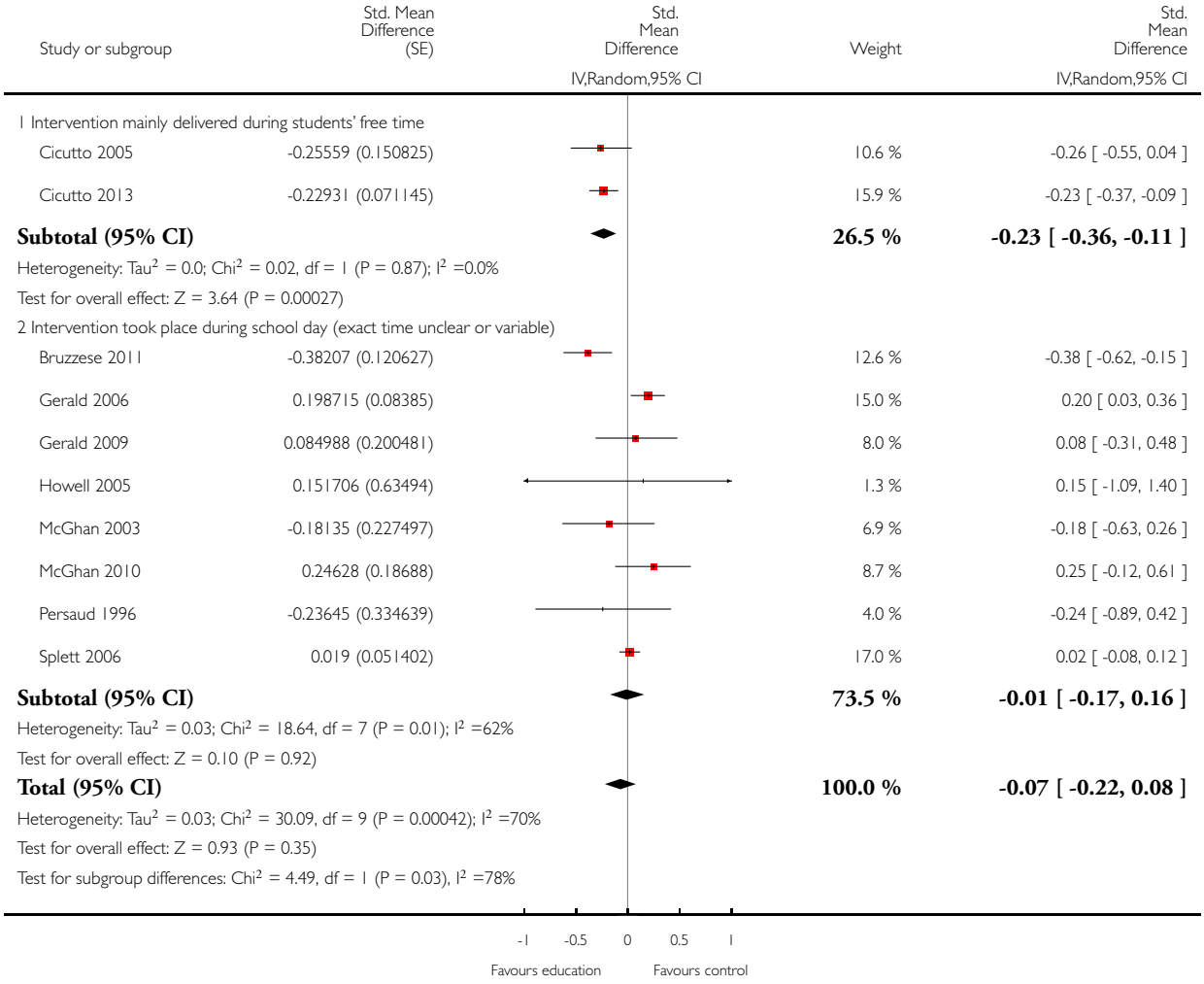
Analysis 8.2. Comparison 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention

Outcome: 2 Absence from school



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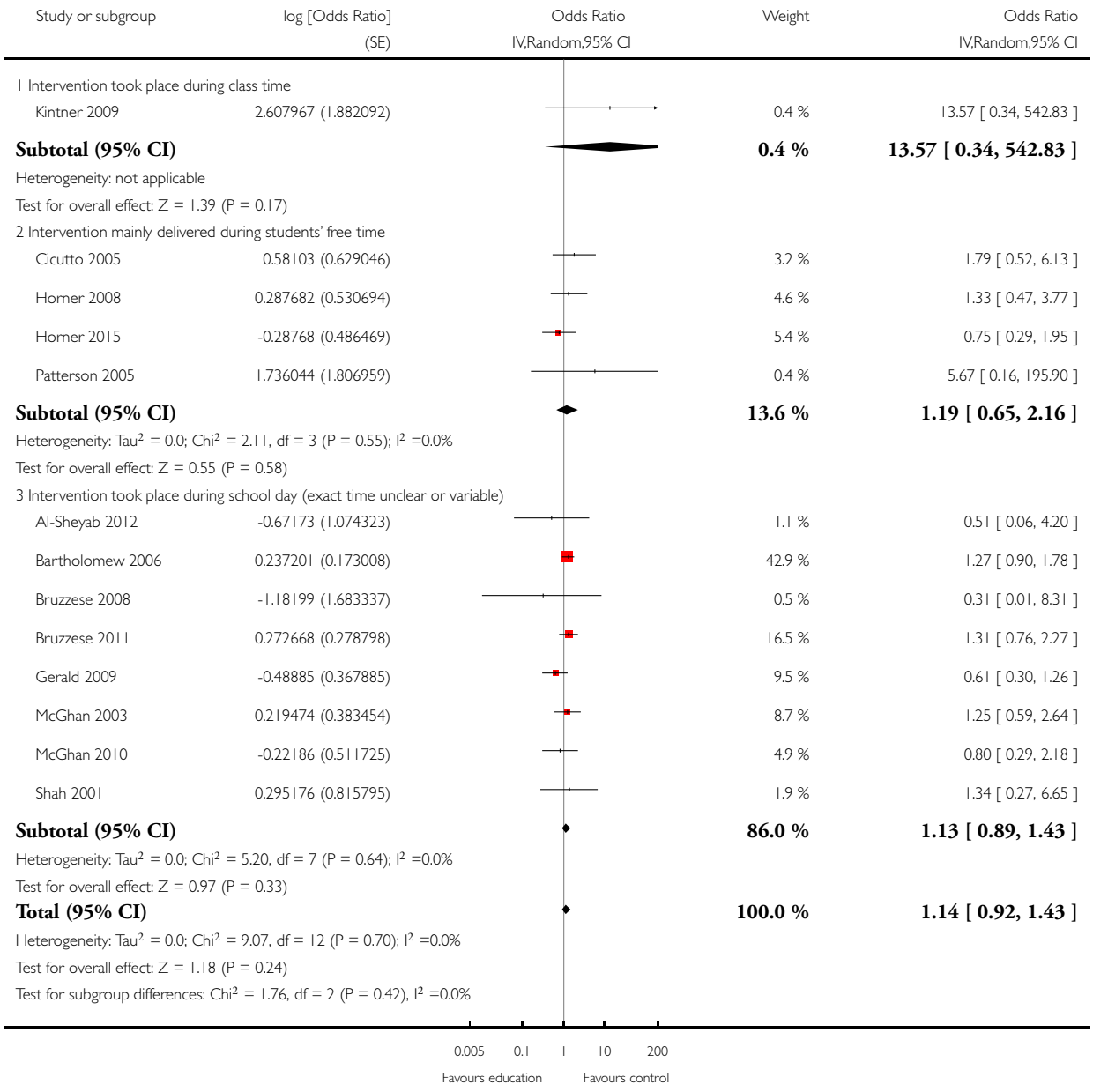
Analysis 8.3. Comparison 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 8 Effects of school-based asthma interventions vs usual care subgrouped by timing of intervention

Outcome: 3 Withdrawal from the study



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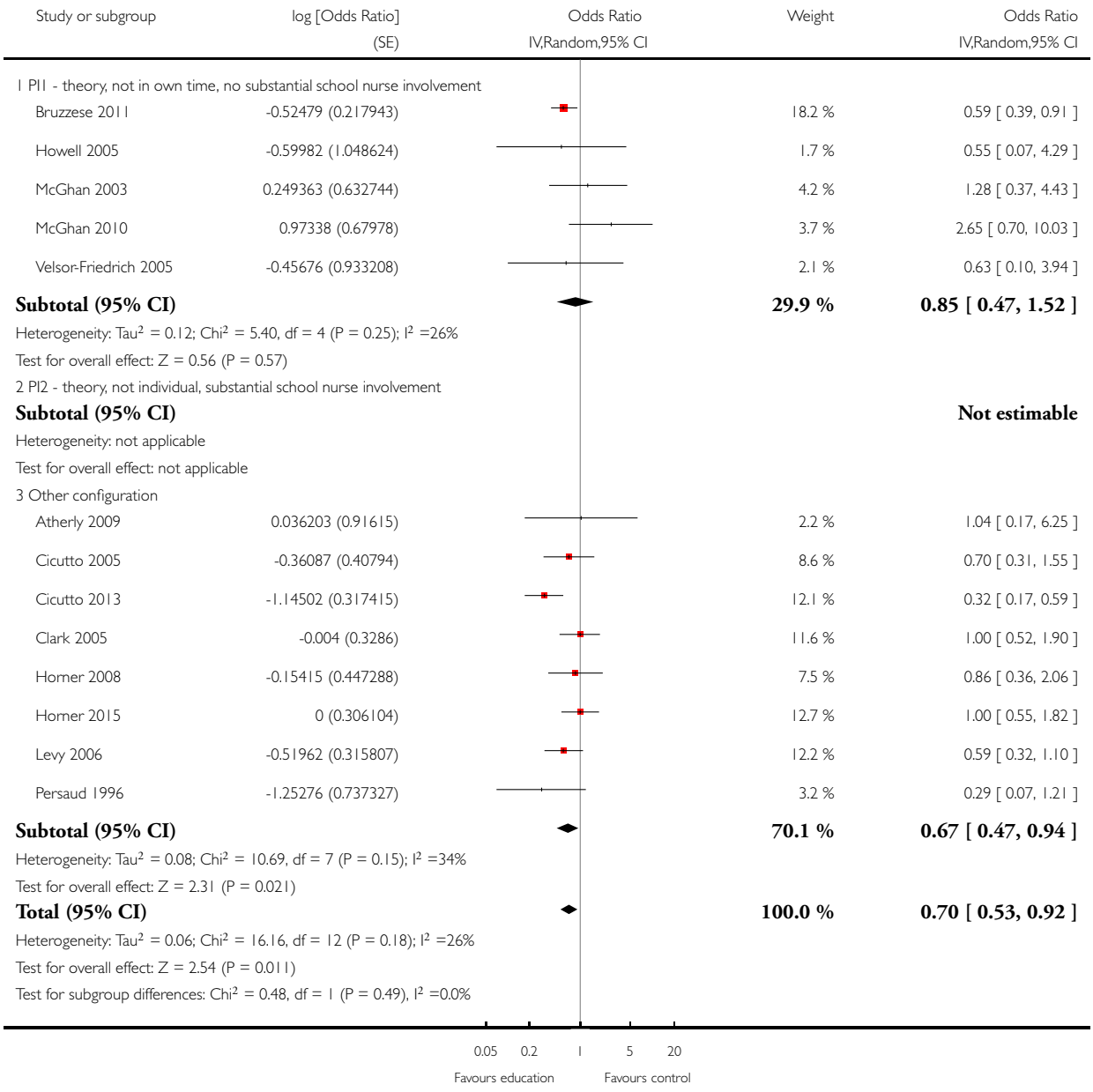
Analysis 9.1. Comparison 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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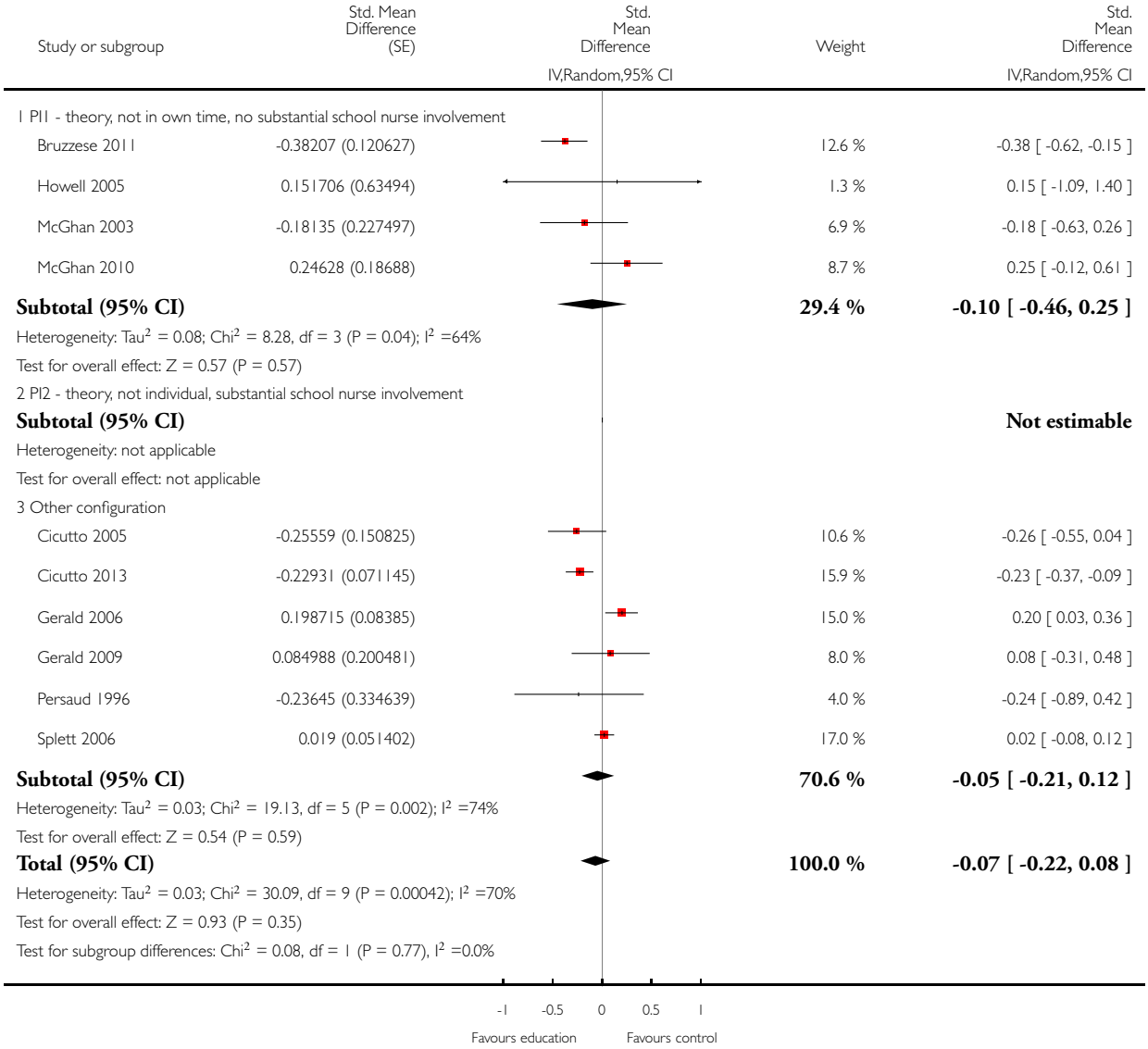
Analysis 9.2. Comparison 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions

Outcome: 2 Absence from school



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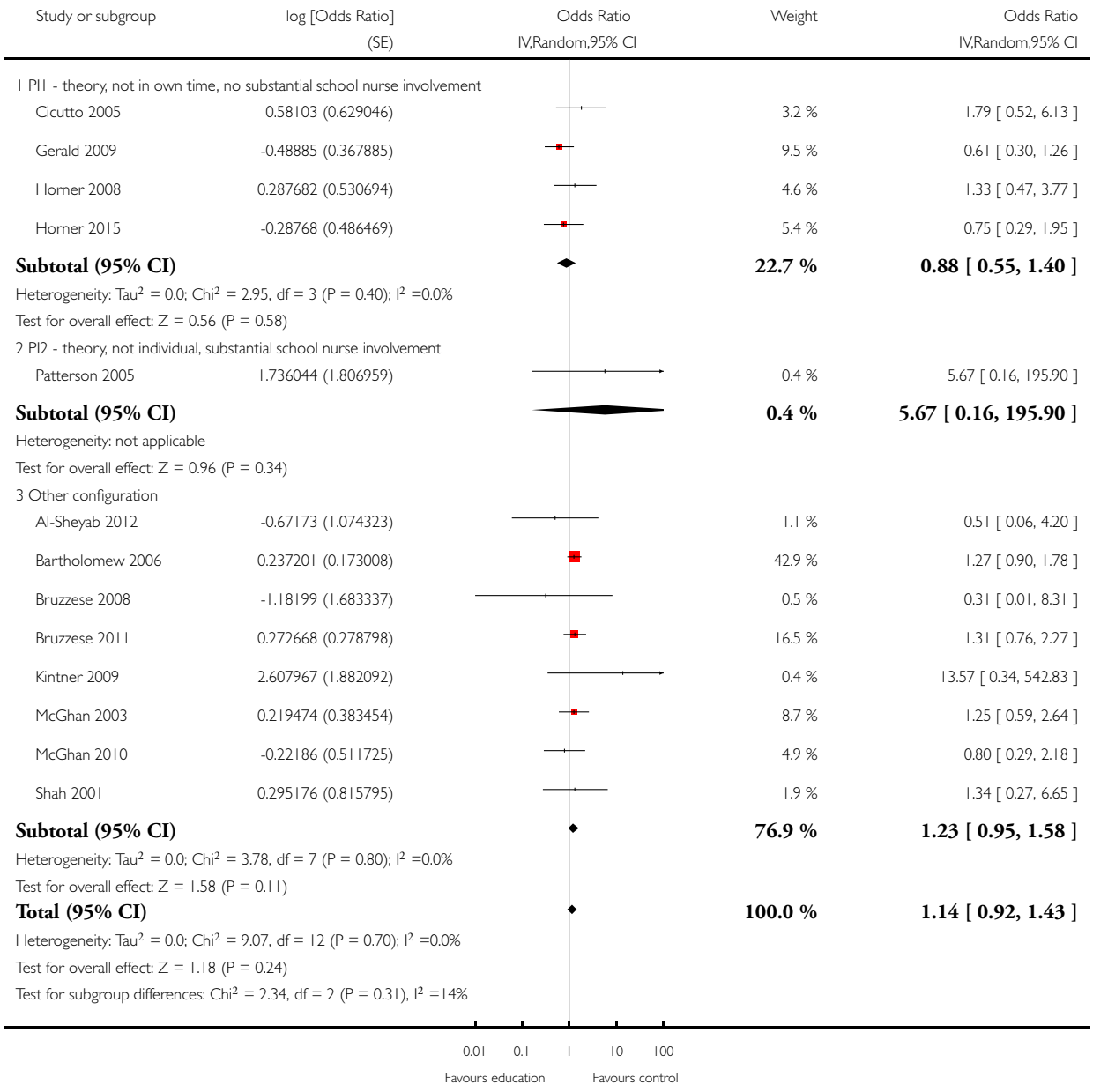
Analysis 9.3. Comparison 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions, Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 9 Effects of school-based asthma interventions vs usual care subgrouped by configuration of conditions

Outcome: 3 Withdrawal from the study



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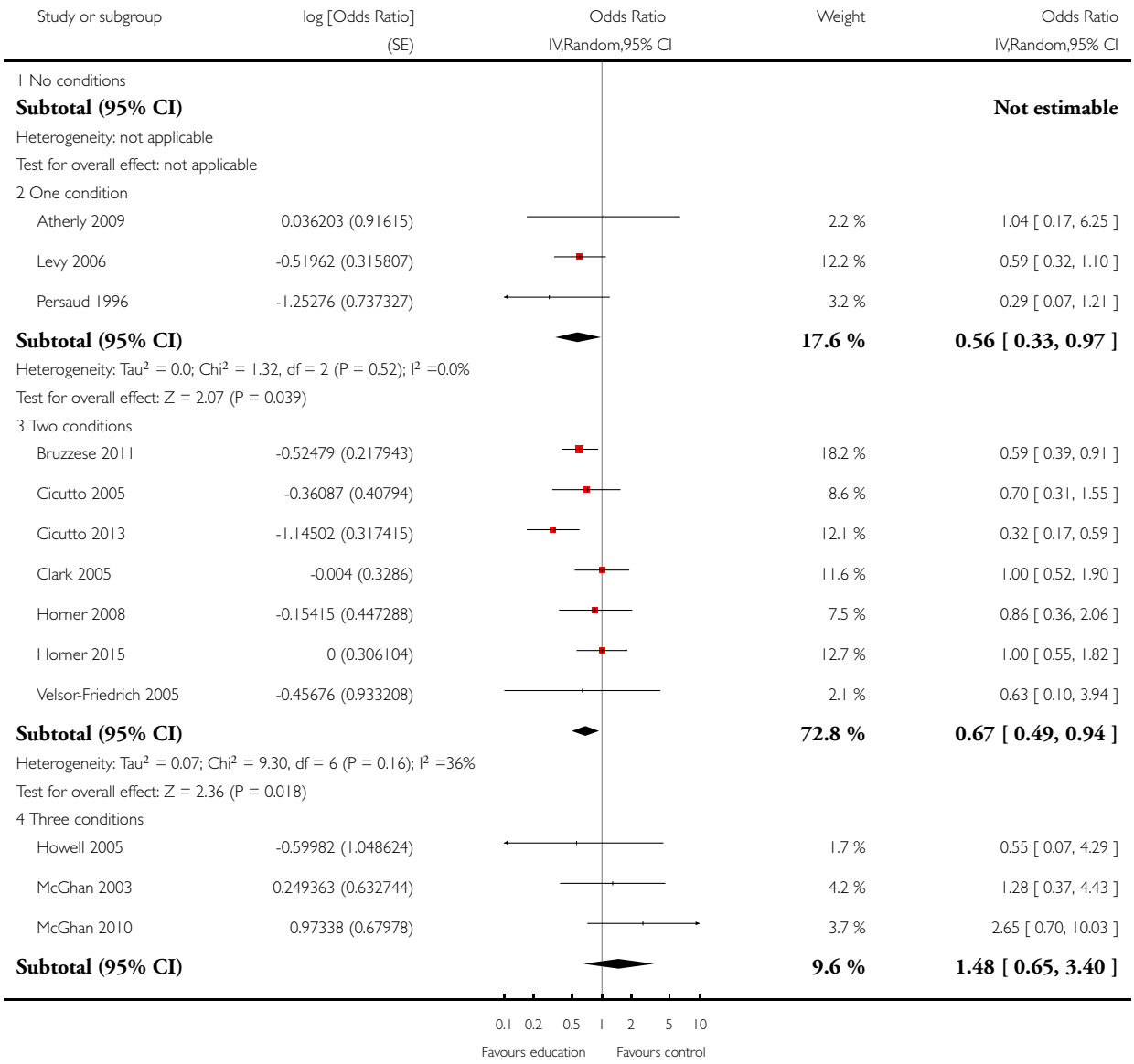
Analysis 10.1. Comparison 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time), Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time)

Outcome: 1 Exacerbations leading to emergency department (ED) visits



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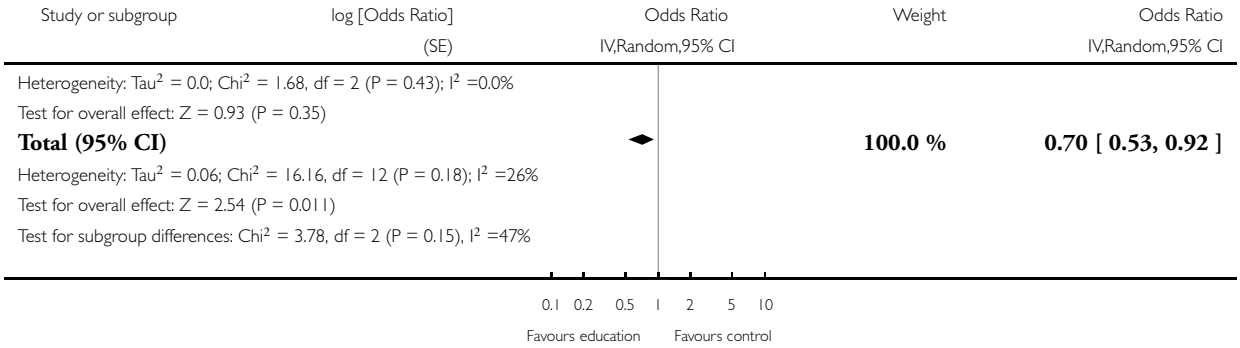
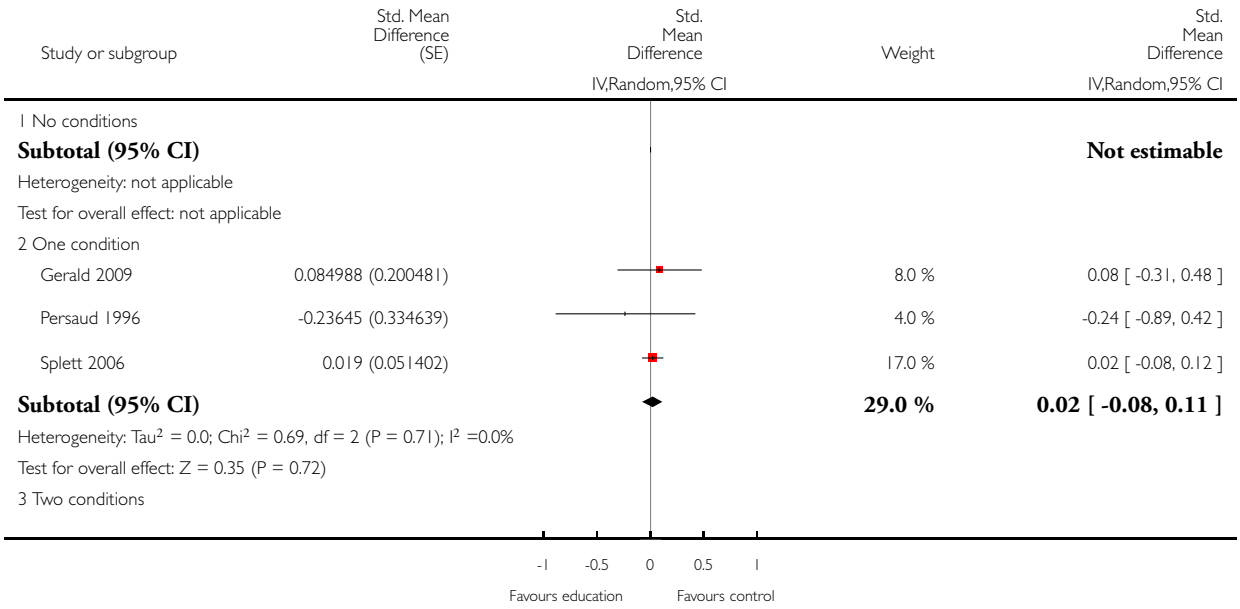


Analysis 10.2. Comparison 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time), Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time)

Outcome: 2 Absence from school



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Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	-0.38207 (0.120627)		12.6 %	-0.38 [-0.62, -0.15]
Cicutto 2005	-0.25559 (0.150825)		10.6 %	-0.26 [-0.55, 0.04]
Cicutto 2013	-0.22931 (0.071145)		15.9 %	-0.23 [-0.37, -0.09]
Gerald 2006	0.198715 (0.08385)		15.0 %	0.20 [0.03, 0.36]
Subtotal (95% CI)			**54.1 %**	**-0.16 [-0.43, 0.11]**
Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 22.34$, df = 3 (P = 0.00006); $I^2 = 87\%$				
Test for overall effect: Z = 1.15 (P = 0.25)				
4 Three conditions				
Howell 2005	0.151706 (0.63494)		1.3 %	0.15 [-1.09, 1.40]
McGhan 2003	-0.18135 (0.227497)		6.9 %	-0.18 [-0.63, 0.26]
McGhan 2010	0.24628 (0.18688)		8.7 %	0.25 [-0.12, 0.61]
Subtotal (95% CI)			**16.9 %**	**0.07 [-0.22, 0.37]**
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.12$, df = 2 (P = 0.35); $I^2 = 6\%$				
Test for overall effect: Z = 0.50 (P = 0.62)				
Total (95% CI)			**100.0 %**	**-0.07 [-0.22, 0.08]**
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 30.09$, df = 9 (P = 0.00042); $I^2 = 70\%$				
Test for overall effect: Z = 0.93 (P = 0.35)				
Test for subgroup differences: $Chi^2 = 1.70$, df = 2 (P = 0.43), $I^2 = 0.0\%$				

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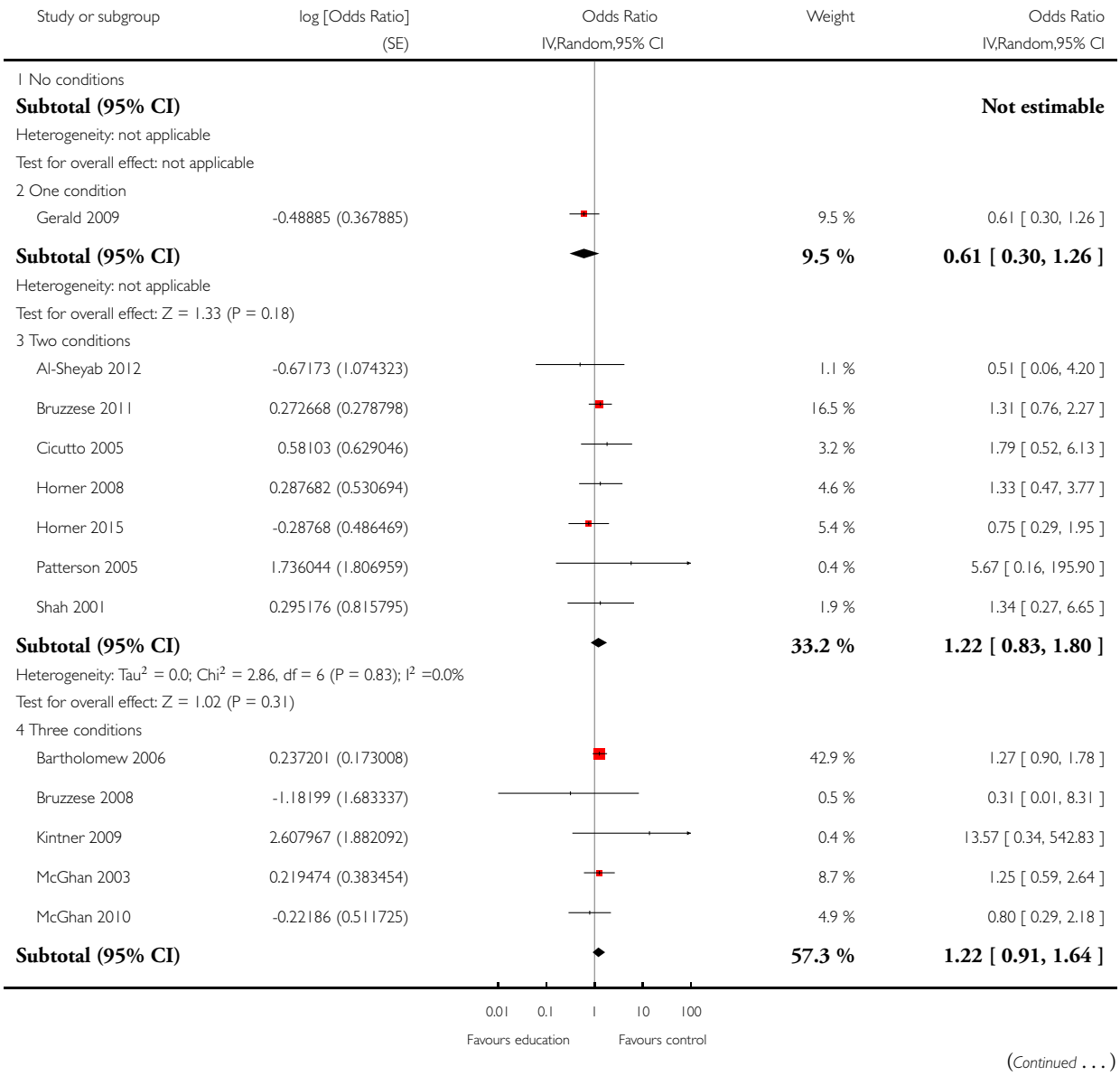
Analysis 10.3. Comparison 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time), Outcome 3 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 10 Effects of school-based asthma interventions vs usual care subgrouped by number of consistent conditions (use of theory, parental involvement, not in own time)

Outcome: 3 Withdrawal from the study



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Study or subgroup	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Heterogeneity: Tau² = 0.0; Chi² = 3.04, df = 4 (P = 0.55); I² =0.0%				
Test for overall effect: Z = 1.33 (P = 0.18)				
Total (95% CI)			**100.0 %**	**1.14 [0.92, 1.43]**
Heterogeneity: Tau² = 0.0; Chi² = 9.07, df = 12 (P = 0.70); I² =0.0%				
Test for overall effect: Z = 1.18 (P = 0.24)				
Test for subgroup differences: Chi² = 3.17, df = 2 (P = 0.21), I² =37%				

Analysis 11.1. Comparison 11 Adjunct analyses - impact of Implementation on selected outcomes, Outcome 1 Exacerbations leading to emergency department (ED) visits.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 11 Adjunct analyses - impact of Implementation on selected outcomes

Outcome: 1 Exacerbations leading to emergency department (ED) visits

Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Successful implementation				
Bruzzese 2011	-0.28933 (0.120159)		18.4 %	-0.29 [-0.52, -0.05]
Cicutto 2013	-0.63128 (0.175)		12.8 %	-0.63 [-0.97, -0.29]
Horner 2015	0 (0.168764)		13.4 %	0.0 [-0.33, 0.33]
Joseph 2010	-0.1533 (0.11309)		19.3 %	-0.15 [-0.37, 0.07]
Subtotal (95% CI)			**63.9 %**	**-0.26 [-0.48, -0.04]**
Heterogeneity: Tau² = 0.03; Chi² = 7.77, df = 3 (P = 0.05); I² =61%				
Test for overall effect: Z = 2.28 (P = 0.023)				
2 Potential issues in adherence, attrition, or dosage				
Howell 2005	-0.33068 (0.57813687)		1.9 %	-0.33 [-1.46, 0.80]
Joseph 2013	0 (0.0971412)		21.3 %	0.0 [-0.19, 0.19]
Levy 2006	-0.28648 (0.174114)		12.9 %	-0.29 [-0.63, 0.05]

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Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Subtotal (95% CI)			**36.1 %**	**-0.09 [-0.28, 0.10]**
Heterogeneity: Tau² = 0.00; Chi² = 2.27, df = 2 (P = 0.32); I² =12%				
Test for overall effect: Z = 0.91 (P = 0.36)				
Total (95% CI)			**100.0 %**	**-0.21 [-0.37, -0.04]**
Heterogeneity: Tau² = 0.02; Chi² = 12.54, df = 6 (P = 0.05); I² =52%				
Test for overall effect: Z = 2.50 (P = 0.012)				
Test for subgroup differences: Chi² = 1.25, df = 1 (P = 0.26), I² =20%				

Analysis 11.2. Comparison 11 Adjunct analyses - impact of Implementation on selected outcomes, Outcome 2 Absence from school.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 11 Adjunct analyses - impact of Implementation on selected outcomes

Outcome: 2 Absence from school

Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Successful implementation				
Bruzzese 2011	-0.38207 (0.120627)		14.2 %	-0.38 [-0.62, -0.15]
Cicutto 2013	-0.22931 (0.071145)		17.8 %	-0.23 [-0.37, -0.09]
Joseph 2010	-0.3254456 (0.113677)		14.7 %	-0.33 [-0.55, -0.10]
Subtotal (95% CI)			**46.7 %**	**-0.28 [-0.39, -0.18]**
Heterogeneity: Tau² = 0.0; Chi² = 1.38, df = 2 (P = 0.50); I² =0.0%				
Test for overall effect: Z = 5.22 (P < 0.00001)				
2 Potential issues in adherence, attrition, or dosage				
Gerald 2006	0.198715 (0.08385)		16.9 %	0.20 [0.03, 0.36]
Howell 2005	0.151706 (0.63494)		1.5 %	0.15 [-1.09, 1.40]
Joseph 2013	-0.10804 (0.0975)		15.9 %	-0.11 [-0.30, 0.08]

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Study or subgroup	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Splett 2006	0.019 (0.051402)		19.0 %	0.02 [-0.08, 0.12]
Subtotal (95% CI)			**53.3 %**	**0.04 [-0.09, 0.18]**
Heterogeneity: Tau² = 0.01; Chi² = 6.09, df = 3 (P = 0.11); I² =51%				
Test for overall effect: Z = 0.60 (P = 0.55)				
Total (95% CI)			**100.0 %**	**-0.12 [-0.28, 0.04]**
Heterogeneity: Tau² = 0.03; Chi² = 30.28, df = 6 (P = 0.00003); I² =80%				
Test for overall effect: Z = 1.47 (P = 0.14)				
Test for subgroup differences: Chi² = 13.53, df = 1 (P = 0.00), I² =93%				

Analysis 12.1. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 1 Exacerbations leading to hospitalisation - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 1 Exacerbations leading to hospitalisation - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.2194034 (0.1198901)		50.6 %	-0.22 [-0.45, 0.02]
Horner 2015	96	100	-0.05692 (0.168799)		25.5 %	-0.06 [-0.39, 0.27]
Levy 2006	115	128	-0.29295 (0.174179)		23.9 %	-0.29 [-0.63, 0.05]
Total (95% CI)	**350**	**369**			**100.0 %**	**-0.20 [-0.36, -0.03]**
Heterogeneity: Tau² = 0.0; Chi² = 1.03, df = 2 (P = 0.60); I² =0.0%						
Test for overall effect: Z = 2.29 (P = 0.022)						
Test for subgroup differences: Not applicable						

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Analysis 12.2. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 2 Exacerbations leading to hospitalisation - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

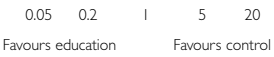
Outcome: 2 Exacerbations leading to hospitalisation - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Atherly 2009	225	233	-0.25664 (1.385187)		5.8 %	0.77 [0.05, 11.68]
Clark 2005	271	272	-0.35767 (0.39)		73.6 %	0.70 [0.33, 1.50]
Horner 2008	81	72	-0.3234 (0.736948)		20.6 %	0.72 [0.17, 3.07]
Total (95% CI)	**577**	**577**			**100.0 %**	**0.71 [0.37, 1.36]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.01$, df = 2 (P = 1.00); $I^2 = 0.0\%$

Test for overall effect: Z = 1.03 (P = 0.30)

Test for subgroup differences: Not applicable



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Analysis 12.3. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 3 Exacerbations leading to hospitalisation - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 3 Exacerbations leading to hospitalisation - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Atherly 2009	225	233	-0.1414917 (0.7636936)		1.0 %	-0.14 [-1.64, 1.36]
Bruzzese 2011	139	141	-0.2194034 (0.1198901)		41.7 %	-0.22 [-0.45, 0.02]
Clark 2005	271	272	-0.1972 (0.215018)		12.9 %	-0.20 [-0.62, 0.22]
Horner 2008	81	72	-0.1783 (0.406301)		3.6 %	-0.18 [-0.97, 0.62]
Horner 2015	96	100	-0.05692 (0.168799)		21.0 %	-0.06 [-0.39, 0.27]
Levy 2006	115	128	-0.29295 (0.174179)		19.7 %	-0.29 [-0.63, 0.05]
Total (95% CI)	**927**	**946**			**100.0 %**	**-0.19 [-0.35, -0.04]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.03$, df = 5 (P = 0.96); $I^2 = 0.0\%$

Test for overall effect: Z = 2.52 (P = 0.012)

Test for subgroup differences: Not applicable

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Analysis 12.4. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 4 Exacerbations leading to emergency department (ED) visits - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 4 Exacerbations leading to emergency department (ED) visits - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.28933 (0.120159)		49.3 %	-0.29 [-0.52, -0.05]
Horner 2015	96	100	0 (0.168764)		25.0 %	0.0 [-0.33, 0.33]
Howell 2005	12	5	-0.3307 (0.578137)		2.1 %	-0.33 [-1.46, 0.80]
Levy 2006	115	128	-0.28648 (0.174114)		23.5 %	-0.29 [-0.63, 0.05]
Total (95% CI)	**362**	**374**			**100.0 %**	**-0.22 [-0.38, -0.05]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 2.21$, df = 3 (P = 0.53); $I^2 = 0.0\%$

Test for overall effect: Z = 2.57 (P = 0.010)

Test for subgroup differences: Not applicable

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Analysis 12.5. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 5 Exacerbations leading to emergency department (ED) visits - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

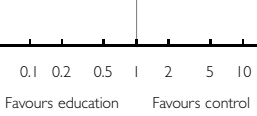
Outcome: 5 Exacerbations leading to emergency department (ED) visits - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Atherly 2009	225	233	0.036203 (0.91615)		5.2 %	1.04 [0.17, 6.25]
Cicutto 2005	132	124	-0.36087 (0.40794)		15.1 %	0.70 [0.31, 1.55]
Cicutto 2013	625	691	-1.14502 (0.317415)		18.5 %	0.32 [0.17, 0.59]
Clark 2005	272	271	-0.004 (0.3286)		18.1 %	1.00 [0.52, 1.90]
Horner 2008	81	72	-0.15415 (0.447288)		13.7 %	0.86 [0.36, 2.06]
McGhan 2003	65	71	0.249363 (0.632744)		9.0 %	1.28 [0.37, 4.43]
McGhan 2010	71	126	0.97338 (0.67978)		8.2 %	2.65 [0.70, 10.03]
Persaud 1996	18	18	-1.25276 (0.737327)		7.2 %	0.29 [0.07, 1.21]
Velsor-Friedrich 2005	28	24	-0.45676 (0.933208)		5.0 %	0.63 [0.10, 3.94]
Total (95% CI)	**1517**	**1630**			**100.0 %**	**0.74 [0.47, 1.16]**

Heterogeneity: $Tau^2 = 0.18$; $Chi^2 = 13.94$, df = 8 (P = 0.08); $I^2 = 43\%$

Test for overall effect: Z = 1.30 (P = 0.19)

Test for subgroup differences: Not applicable



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Analysis 12.6. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 6 Exacerbations leading to emergency department (ED) visits - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

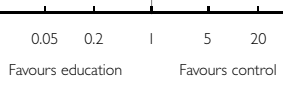
Outcome: 6 Exacerbations leading to emergency department (ED) visits - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Atherly 2009	225	233	0.036203 (0.91615)		2.2 %	1.04 [0.17, 6.25]
Bruzzese 2011	139	141	-0.52479 (0.217943)		18.2 %	0.59 [0.39, 0.91]
Cicutto 2005	132	124	-0.36087 (0.40794)		8.6 %	0.70 [0.31, 1.55]
Cicutto 2013	625	691	-1.14502 (0.317415)		12.1 %	0.32 [0.17, 0.59]
Clark 2005	272	271	-0.004 (0.3286)		11.6 %	1.00 [0.52, 1.90]
Horner 2008	81	72	-0.15415 (0.447288)		7.5 %	0.86 [0.36, 2.06]
Horner 2015	96	100	0 (0.306104)		12.7 %	1.00 [0.55, 1.82]
Howell 2005	12	5	-0.59982 (1.048624)		1.7 %	0.55 [0.07, 4.29]
Levy 2006	115	128	-0.51962 (0.315807)		12.2 %	0.59 [0.32, 1.10]
McGhan 2003	65	71	0.249363 (0.632744)		4.2 %	1.28 [0.37, 4.43]
McGhan 2010	71	126	0.97338 (0.67978)		3.7 %	2.65 [0.70, 10.03]
Persaud 1996	18	18	-1.25276 (0.737327)		3.2 %	0.29 [0.07, 1.21]
Velsor-Friedrich 2005	28	24	-0.45676 (0.933208)		2.1 %	0.63 [0.10, 3.94]
Total (95% CI)	**1879**	**2004**			**100.0 %**	**0.70 [0.53, 0.92]**

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 16.16$, df = 12 (P = 0.18); $I^2 = 26\%$

Test for overall effect: Z = 2.54 (P = 0.011)

Test for subgroup differences: Not applicable



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Analysis 12.7. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 7 Absence from school - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 7 Absence from school - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.38207 (0.120627)		20.8 %	-0.38 [-0.62, -0.15]
Cicutto 2005	132	124	-0.25559 (0.150824)		17.9 %	-0.26 [-0.55, 0.04]
Gerald 2006	305	269	0.198715 (0.08385)		24.5 %	0.20 [0.03, 0.36]
Howell 2005	9	4	0.151706 (0.63494)		2.4 %	0.15 [-1.09, 1.40]
Persaud 1996	18	18	-0.23645 (0.334639)		7.1 %	-0.24 [-0.89, 0.42]
Splett 2006	916	645	-0.01902 (0.051402)		27.3 %	-0.02 [-0.12, 0.08]
Total (95% CI)	**1519**	**1201**			**100.0 %**	**-0.10 [-0.30, 0.11]**

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 18.70$, df = 5 (P = 0.002); $I^2 = 73\%$

Test for overall effect: Z = 0.93 (P = 0.35)

Test for subgroup differences: Not applicable

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Analysis 12.8. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 8 Absence from school - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 8 Absence from school - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Cicutto 2013	625	691	-0.41592 (0.129043)		39.0 %	0.66 [0.51, 0.85]
Gerald 2009	125	115	0.154151 (0.363632)		20.6 %	1.17 [0.57, 2.38]
McGhan 2003	65	71	-0.32893 (0.402185)		18.3 %	0.72 [0.33, 1.58]
McGhan 2010	71	126	0.446708 (0.338962)		22.1 %	1.56 [0.80, 3.04]
Total (95% CI)	**886**	**1003**			**100.0 %**	**0.91 [0.59, 1.42]**

Heterogeneity: $Tau^2 = 0.11$; $Chi^2 = 7.13$, df = 3 (P = 0.07); $I^2 = 58\%$

Test for overall effect: Z = 0.41 (P = 0.68)

Test for subgroup differences: Not applicable

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Analysis 12.9. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 9 Absence from school - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 9 Absence from school - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.38207 (0.120627)		12.5 %	-0.38 [-0.62, -0.15]
Cicutto 2005	132	124	-0.25559 (0.150825)		10.5 %	-0.26 [-0.55, 0.04]
Cicutto 2013	625	691	-0.22931 (0.071145)		16.1 %	-0.23 [-0.37, -0.09]
Gerald 2006	305	269	0.198715 (0.08385)		15.2 %	0.20 [0.03, 0.36]
Gerald 2009	125	115	0.084988 (0.200481)		7.8 %	0.08 [-0.31, 0.48]
Howell 2005	9	4	0.151706 (0.63494)		1.2 %	0.15 [-1.09, 1.40]
McGhan 2003	65	71	-0.18135 (0.221736)		6.9 %	-0.18 [-0.62, 0.25]
McGhan 2010	71	126	0.246283 (0.18688)		8.5 %	0.25 [-0.12, 0.61]
Persaud 1996	18	18	-0.23645 (0.334639)		3.8 %	-0.24 [-0.89, 0.42]
Splett 2006	916	645	-0.01902 (0.051402)		17.3 %	-0.02 [-0.12, 0.08]
Total (95% CI)	**2405**	**2204**			**100.0 %**	**-0.08 [-0.22, 0.07]**

Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 28.52$, df = 9 (P = 0.00078); $I^2 = 68\%$

Test for overall effect: Z = 1.05 (P = 0.29)

Test for subgroup differences: Not applicable

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Analysis 12.10. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 10 Days of restricted activity - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 10 Days of restricted activity - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.34872 (0.120444)		61.2 %	-0.35 [-0.58, -0.11]
Cicutto 2005	132	124	-0.32152 (0.151164)		38.8 %	-0.32 [-0.62, -0.03]
Total (95% CI)	**271**	**265**			**100.0 %**	**-0.34 [-0.52, -0.15]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.02$, df = 1 (P = 0.89); $I^2 = 0.0\%$

Test for overall effect: Z = 3.59 (P = 0.00033)

Test for subgroup differences: Not applicable

Analysis 12.11. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 11 Days of restricted activity - odds ratio.

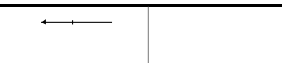
Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 11 Days of restricted activity - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Cicutto 2013	691	625	-0.4916 (0.13006)			0.61 [0.47, 0.79]

Test for subgroup differences: Not applicable



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Analysis 12.12. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 12 Days of restricted activity - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 12 Days of restricted activity - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.34872 (0.120444)		22.4 %	-0.35 [-0.58, -0.11]
Cicutto 2005	132	124	-0.32152 (0.151164)		14.2 %	-0.32 [-0.62, -0.03]
Cicutto 2013	691	625	-0.27103 (0.071708)		63.3 %	-0.27 [-0.41, -0.13]
Total (95% CI)	**962**	**890**			**100.0 %**	**-0.30 [-0.41, -0.18]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.34$, df = 2 (P = 0.84); $I^2 = 0.0\%$

Test for overall effect: Z = 5.18 (P < 0.00001)

Test for subgroup differences: Not applicable

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Analysis 12.13. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 13 Experience of daytime and night-time symptoms - daytime symptoms - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 13 Experience of daytime and night-time symptoms - daytime symptoms - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Atherly 2009	225	233	-0.02599 (0.16825)		31.9 %	-0.03 [-0.36, 0.30]
Bruzzese 2008	12	11	-0.150759 (0.418137)		5.2 %	-0.15 [-0.97, 0.67]
Bruzzese 2011	139	142	-0.20991 (0.119859)		62.9 %	-0.21 [-0.44, 0.03]
Total (95% CI)	**376**	**386**			**100.0 %**	**-0.15 [-0.33, 0.04]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.79$, df = 2 (P = 0.67); $I^2 = 0.0\%$

Test for overall effect: Z = 1.56 (P = 0.12)

Test for subgroup differences: Not applicable

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Analysis 12.14. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 14 Experience of daytime and night-time symptoms - daytime symptoms - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 14 Experience of daytime and night-time symptoms - daytime symptoms - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Shah 2001	113	138	-0.43491 (0.487985)		67.6 %	0.65 [0.25, 1.68]
Velsor-Friedrich 2005	28	24	-0.16705 (0.705055)		32.4 %	0.85 [0.21, 3.37]
Total (95% CI)	**141**	**162**			**100.0 %**	**0.71 [0.32, 1.55]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.10$, df = 1 (P = 0.75); $I^2 = 0.0\%$

Test for overall effect: Z = 0.87 (P = 0.39)

Test for subgroup differences: Not applicable

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Analysis 12.15. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 15 Experience of daytime and night-time symptoms - daytime symptoms - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 15 Experience of daytime and night-time symptoms - daytime symptoms - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Atherly 2009	225	233	-0.02599 (0.16825)		27.1 %	-0.03 [-0.36, 0.30]
Bruzzese 2008	12	11	-0.150759 (0.418137)		4.4 %	-0.15 [-0.97, 0.67]
Bruzzese 2011	139	142	-0.20991 (0.119859)		53.4 %	-0.21 [-0.44, 0.03]
Shah 2001	113	138	-0.23978 (0.26904)		10.6 %	-0.24 [-0.77, 0.29]
Velsor-Friedrich 2005	28	24	-0.02981 (0.413309)		4.5 %	-0.03 [-0.84, 0.78]
Total (95% CI)	**517**	**548**			**100.0 %**	**-0.15 [-0.32, 0.02]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.99$, df = 4 (P = 0.91); $I^2 = 0.0\%$

Test for overall effect: Z = 1.74 (P = 0.082)

Test for subgroup differences: Not applicable

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Analysis 12.16. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 16 Experience of daytime and night-time symptoms - night-time symptoms - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

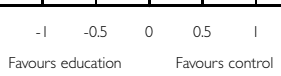
Outcome: 16 Experience of daytime and night-time symptoms - night-time symptoms - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2008	12	11	-0.43322 (0.42328)		7.2 %	-0.43 [-1.26, 0.40]
Bruzzese 2011	139	142	-0.38753 (0.120658)		88.1 %	-0.39 [-0.62, -0.15]
Howell 2005	12	7	0.253008 (0.520697)		4.7 %	0.25 [-0.77, 1.27]
Total (95% CI)	**163**	**160**			**100.0 %**	**-0.36 [-0.58, -0.14]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.47$, df = 2 (P = 0.48); $I^2 = 0.0\%$

Test for overall effect: Z = 3.18 (P = 0.0015)

Test for subgroup differences: Not applicable



Analysis 12.17. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 17 Experience of daytime and night-time symptoms - night-time symptoms - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

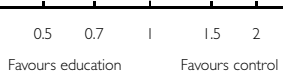
Outcome: 17 Experience of daytime and night-time symptoms - night-time symptoms - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
McGhan 2003	65	71	0.212773 (0.401543)		100.0 %	1.24 [0.56, 2.72]
Total (95% CI)	**65**	**71**			**100.0 %**	**1.24 [0.56, 2.72]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.53 (P = 0.60)

Test for subgroup differences: Not applicable



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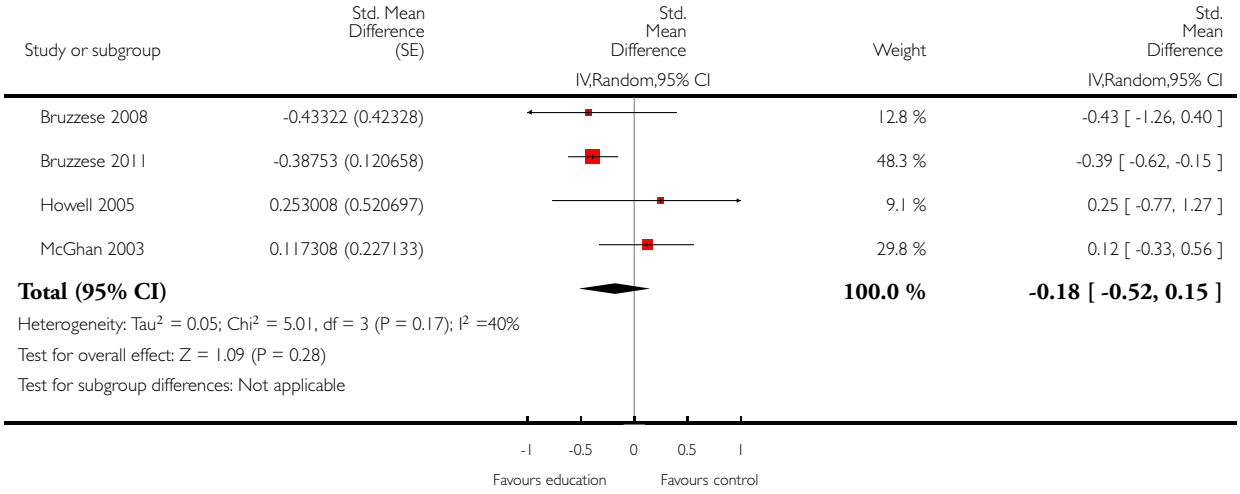
Analysis 12.18. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 18 Experience of daytime and night-time symptoms - night-time symptoms - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 18 Experience of daytime and night-time symptoms - night-time symptoms - harmonised effect sizes



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Analysis 12.19. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 19 Use of reliever therapies, e.g. beta ₂ -agonists - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 19 Use of reliever therapies, e.g. beta₂ -agonists - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Gerald 2009	125	115	-1.43343 (0.659303)		40.7 %	0.24 [0.07, 0.87]
McGhan 2010	71	126	-0.12958 (0.342507)		59.3 %	0.88 [0.45, 1.72]
Total (95% CI)	**196**	**241**			**100.0 %**	**0.52 [0.15, 1.81]**

Heterogeneity: $Tau^2 = 0.57$; $Chi^2 = 3.08$, df = 1 (P = 0.08); $I^2 = 68\%$

Test for overall effect: Z = 1.03 (P = 0.30)

Test for subgroup differences: Not applicable

Analysis 12.20. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 20 Corticosteroid dosage and/or use of add-on therapies (usage of).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 20 Corticosteroid dosage and/or use of add-on therapies (usage of)

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Bruzzese 2011	139	142	0.372521 (0.240089)		57.6 %	1.45 [0.91, 2.32]
McGhan 2003	65	71	0.106523 (0.41837521)		19.0 %	1.11 [0.49, 2.53]
McGhan 2010	71	126	-0.03897 (0.375945)		23.5 %	0.96 [0.46, 2.01]
Total (95% CI)	**275**	**339**			**100.0 %**	**1.25 [0.88, 1.79]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.95$, df = 2 (P = 0.62); $I^2 = 0.0\%$

Test for overall effect: Z = 1.24 (P = 0.22)

Test for subgroup differences: Not applicable

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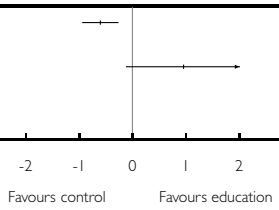
Analysis 12.21. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 21 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 21 Corticosteroid dosage and/or use of add-on therapies (appropriate usage of)

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Std. Mean Difference IV,Random,95% CI
Horner 2015	96	100	-0.60551 (0.172664)		-0.61 [-0.94, -0.27]
Howell 2005	12	7	0.953191 (0.545906)		0.95 [-0.12, 2.02]



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Analysis 12.22. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 22 Health-related quality of life - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 22 Health-related quality of life - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Al-Sheyab 2012	126	118	0.299 (0.128827)		13.1 %	0.30 [0.05, 0.55]
Cicutto 2005	132	124	0.356088 (0.156636)		8.9 %	0.36 [0.05, 0.66]
Cicutto 2013	691	625	0.307795 (0.064158)		53.0 %	0.31 [0.18, 0.43]
Henry 2004	299	234	0.128346 (0.1167)		16.0 %	0.13 [-0.10, 0.36]
Horner 2008	81	72	0.082919 (0.19001164)		6.0 %	0.08 [-0.29, 0.46]
Howell 2005	0	0	0.019516 (0.484135)		0.9 %	0.02 [-0.93, 0.97]
Kintner 2009	0	0	0.583216 (0.334337)		2.0 %	0.58 [-0.07, 1.24]
Total (95% CI)	**1329**	**1173**			**100.0 %**	**0.27 [0.18, 0.36]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 4.29$, df = 6 (P = 0.64); $I^2 = 0.0\%$

Test for overall effect: Z = 5.81 (P < 0.00001)

Test for subgroup differences: Not applicable

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Analysis 12.23. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 23 Health-related quality of life (MD).

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 23 Health-related quality of life (MD)

Study or subgroup	Education N	Mean(SD)	Usual care/placebo N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Al-Sheyab 2012	126	5.42 (1.571496)	118	4.07 (1.520789)		13.2 %	1.35 [0.96, 1.74]
Cicutto 2005	132	5.5 (2.0195)	124	5 (2.0195)		11.5 %	0.50 [0.00, 1.00]
Cicutto 2013	625	5.8 (1.602)	691	5.4 (1.869)		16.2 %	0.40 [0.21, 0.59]
Henry 2004	299	5.27 (2.142)	234	5.11 (2.3205)		13.3 %	0.16 [-0.22, 0.54]
Horner 2008	81	1.74 (0.825)	72	1.69 (0.825)		15.2 %	0.05 [-0.21, 0.31]
Howell 2005	16	4.96 (1.6625)	8	4.93 (2.2125)		2.4 %	0.03 [-1.71, 1.77]
Patterson 2005	81	0.3 (1.19)	92	0.23 (0.98)		14.2 %	0.07 [-0.26, 0.40]
Shah 2001	138	0.21 (1.3)	113	0.12 (1.3)		14.2 %	0.09 [-0.23, 0.41]
Total (95% CI)	**1498**		**1452**			**100.0 %**	**0.35 [0.06, 0.64]**

Heterogeneity: $Tau^2 = 0.12$; $Chi^2 = 37.31$, df = 7 ($P<0.00001$); $I^2 = 81\%$

Test for overall effect: Z = 2.40 (P = 0.017)

Test for subgroup differences: Not applicable

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Analysis 12.24. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 24 Unplanned visit to hospital or GP due to asthma symptoms - standardised mean difference.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 24 Unplanned visit to hospital or GP due to asthma symptoms - standardised mean difference

Study or subgroup	Education N	Usual care/placebo N	Std. Mean Difference (SE)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Bruzzese 2011	139	141	-0.28338 (0.120133)		100.0 %	-0.28 [-0.52, -0.05]
Total (95% CI)	**139**	**141**			**100.0 %**	**-0.28 [-0.52, -0.05]**
Heterogeneity: not applicable						
Test for overall effect: Z = 2.36 (P = 0.018)						
Test for subgroup differences: Not applicable						

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Analysis 12.25. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 25 Unplanned visit to hospital or GP due to asthma symptoms - odds ratio.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

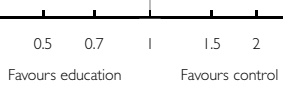
Outcome: 25 Unplanned visit to hospital or GP due to asthma symptoms - odds ratio

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Cicutto 2013	691	625	-0.35271 (0.143152)		65.9 %	0.70 [0.53, 0.93]
McGhan 2003	0	0	-0.12159 (0.414842)		7.8 %	0.89 [0.39, 2.00]
McGhan 2010	0	0	0.156346 (0.381669)		9.3 %	1.17 [0.55, 2.47]
Splett 2006	0	0	-0.09102 (0.282)		17.0 %	0.91 [0.53, 1.59]
Total (95% CI)	**691**	**625**			**100.0 %**	**0.78 [0.62, 0.98]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 2.06$, df = 3 (P = 0.56); $I^2 = 0.0\%$

Test for overall effect: Z = 2.09 (P = 0.037)

Test for subgroup differences: Not applicable



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Analysis 12.26. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 26 Unplanned visit to hospital or GP due to asthma symptoms - harmonised effect sizes.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 26 Unplanned visit to hospital or GP due to asthma symptoms - harmonised effect sizes

Study or subgroup	Education N	Usual care/placebo N	log [Odds Ratio] (SE)	Odds Ratio IV,Random,95% CI	Weight	Odds Ratio IV,Random,95% CI
Bruzzese 2011	139	141	-0.51399 (0.217897)		22.1 %	0.60 [0.39, 0.92]
Cicutto 2013	691	625	-0.35271 (0.143152)		51.3 %	0.70 [0.53, 0.93]
McGhan 2003	0	0	-0.12159 (0.414842)		6.1 %	0.89 [0.39, 2.00]
McGhan 2010	0	0	0.156346 (0.381669)		7.2 %	1.17 [0.55, 2.47]
Splett 2006	0	0	-0.09102 (0.282)		13.2 %	0.91 [0.53, 1.59]
Total (95% CI)	**830**	**766**			**100.0 %**	**0.74 [0.60, 0.90]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 3.26$, df = 4 (P = 0.51); $I^2 = 0.0\%$

Test for overall effect: Z = 2.95 (P = 0.0031)

Test for subgroup differences: Not applicable

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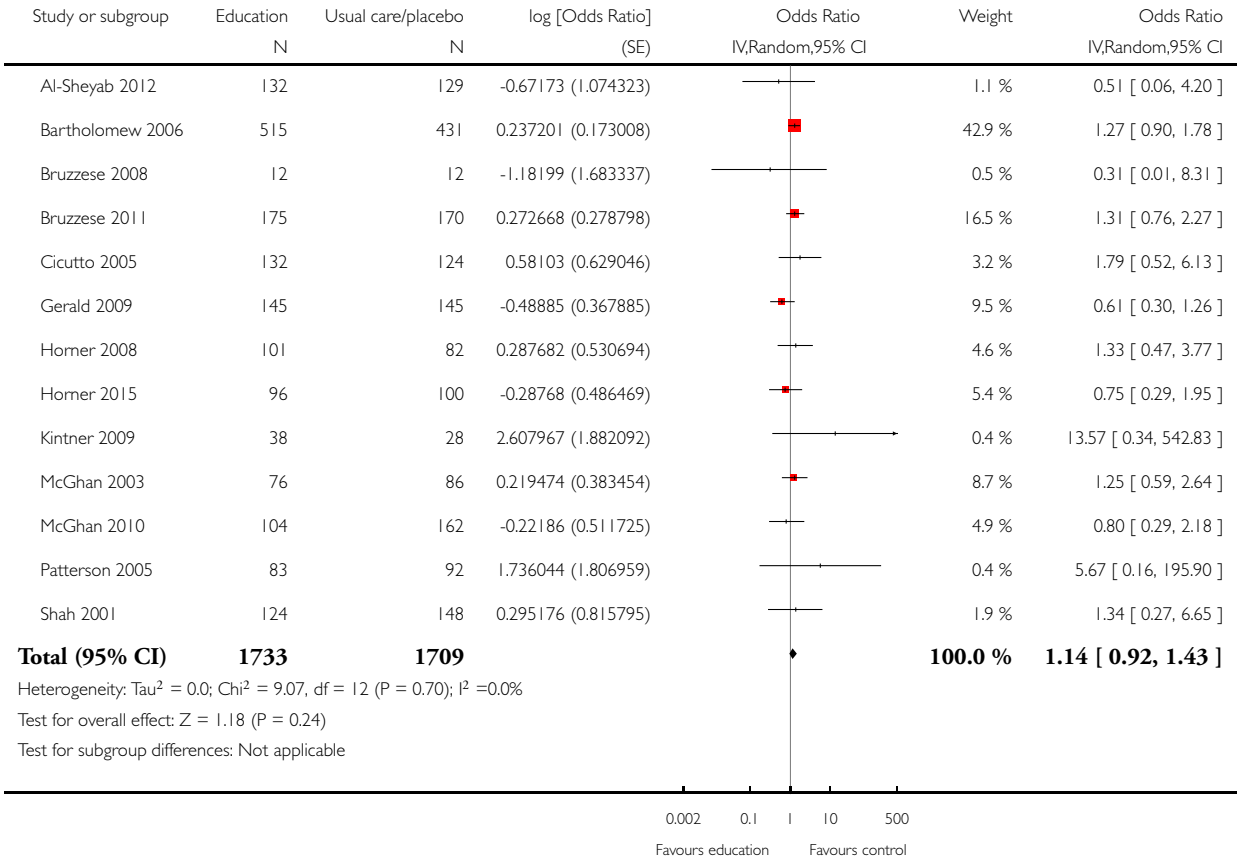
Analysis 12.27. Comparison 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes, Outcome 27 Withdrawal from the study.

Review: School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review

Comparison: 12 Effects of school-based asthma interventions vs usual care, including disaggregated effect sizes

Outcome: 27 Withdrawal from the study



ADDITIONAL TABLES

Table 1. Detailed coding framework for conditions and outcomes

	Field	Instructions for extractors	Coding values and method
	Setting and participants		

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

1	**Number of children**	Recorded total number of children involved in intervention	Transformational assignment implemented to condition, reflecting whether it was a 'large intervention'. Interventions with 15 or fewer children = 0; interventions with 90 children = 0.5; interventions with 300 or more children = 1. Other values fell between 0 and 1
2	**Multiple settings**	Evidence if delivered at more than 1 school	Direct assignment: yes (mentioned) = 1; no evidence = 0
3	**Single sex school**	Evidence if delivered at a single sex school	Direct assignment: yes (mentioned) = 1; no evidence = 0
4	**Type of school**	High school; primary/elementary; junior/middle; other Variable transformed to reflect whether the intervention took place at a high school	Direct assignment: high school = 1; middle/junior = 0.66; elementary/primary = 0.33; missing = 0.5; mixture of high schools and middle schools = 0.75
5	Ethnicity of children	Whether minority ethnic children were targeted/represented. Actual proportions recorded where possible	Transformational assignment Interventions with 25% or fewer children from ethnic minority = 0; interventions with 33.3% of children from ethnic minority = 0.5; interventions with 50% or more children from ethnic minority = 1 When value is missing (and no qualitative statement supports assumption of targeting), assume that this is 'probably not' - i.e. probably not targeted - input value of 0.25
6	Socio-economic status of children	Whether children from lower socio-economic groups were targeted/represented Actual proportions recorded where possible Indicators included parents with low levels of education; low household income; receipt of free school meals	Transformational assignment Interventions with 25% or fewer children from low socio-economic groups = 0; interventions with 33.3% of children from low socio-economic groups = 0.5; interventions with 50% or more children from low socio-economic groups = 1 Where value is missing (and no qualitative statement supports assumption of targeting), assume that this is 'probably not' - i.e. probably not targeted - input value of 0.25
7	Child age	Age groups/classes targeted: ages 5 to 10	Direct assignment: yes (mentioned) = 1; no evidence = 0

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

8		Age groups/classes targeted: ages 11 to 14	Direct assignment: yes (mentioned) = 1; no evidence = 0
9		Age groups/classes targeted: ages 15 to 18	Direct assignment: yes (mentioned) = 1; no evidence = 0
10	Direct recipients	Children directed recipients	Direct assignment: yes (mentioned) = 1; no evidence = 0
11		Teachers directed recipients	Direct assignment: yes (mentioned) = 1; no evidence = 0
12		Parents directed recipients	Direct assignment: yes (mentioned) = 1; no evidence = 0
13		School nurses directed recipients	Direct assignment: yes (mentioned) = 1; no evidence = 0
	Programme design		
14	Theory driven	Did the study name a theoretical framework that underpins the intervention design or delivery style?	Direct assignment: yes (mentioned) = 1; no evidence = 0
15	Intensity of the programme	Coded initially as follows: high intensity = 6+ sessions (group and individual) ; medium intensity = 3 to 5 sessions; low intensity/no evidence of med/high = 1 to 2 sessions; unclear. Variable transformed to reflect whether the intervention was of high intensity	Direct assignment: high intensity = 1, medium intensity = 0.66; low intensity = 0.33. When no evidence on intensity of intervention was included (1 study = (Richmond 2011)), this was coded as 0. 33 (no evidence of high intensity) - interpreted as no evidence of high intensity; for Splett (Splett 2006), such is the degree of personalisation/tailoring that 0.5 was selected as the intensity - each individual session was personalised and lengthy
16	Personalisation/tailoring	Did the programme include individual sessions or use personalisation in any way to alter curriculum to individual students' needs?	Direct assignment: yes, all sessions implemented were personalised/tailored = 1; some sessions were personalised/tailored = 0.66; personalisation/tailored sessions account for only a minor component = 0.5; no evidence, only generic group sessions implemented = 0 Note that this was personalised by or individual sessions were held with an instructor (included guided online sessions) ; self-study components including homework were not included here

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

17	Timing of the intervention	Did the intervention interfere with the child's own time (during lunch or after school)?	Direct assignment: yes, all sessions did = 1; yes, but not all sessions = 0.75; missing data = 0.5; described as not interfering with child's own time = 0
18		Did the intervention interfere with the child's lessons/other education?	Direct assignment: yes, all sessions did = 1; yes, but not all sessions = 0.75; missing data = 0.5; described as not interfering with child's lessons/other education = 0
19	Information about control condition	Described whether trialists were also providing a control for the main intervention (intended to capture complexity of running an intervention and a control)	Direct assignment: yes, an equivalent control = 1; yes, but not an equivalent = 0.66; no control described = 0
20	Instructor or facilitator	Teacher	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
21		Peer	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
22		School nurse	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
23		Self-directed/child-directed	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
24		Parent	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
25		Other	Direct assignment: yes, main instructor = 1; secondary instructor or facilitator = 0.66; not mentioned as an instructor/facilitator = 0
	Programme content		
26	Curriculum	Lung physiology/asthma biology	Direct assignment: yes (mentioned) = 1; no evidence = 0

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

27		Asthma acceptance/asthma into identity	Direct assignment: yes (mentioned) = 1; no evidence = 0
28		Symptom monitoring and correct medication use	Direct assignment: yes (mentioned) = 1; no evidence = 0
30		Avoiding triggers	Direct assignment: yes (mentioned) = 1; no evidence = 0
31		General health including exercise	Direct assignment: yes (mentioned) = 1; no evidence = 0
32		Strengthening alliances including asthma action plans with primary care providers	Direct assignment: yes (mentioned) = 1; no evidence = 0
33		Specific focus on smoking	Direct assignment: yes (mentioned) = 1; no evidence = 0
34		Personalised/tailored (individualised)	Direct assignment: yes (mentioned) = 1; no evidence = 0
35		School performance	Direct assignment: yes (mentioned) = 1; no evidence = 0
36		Emergencies	Direct assignment: yes (mentioned) = 1; no evidence = 0
37		Unknown	Direct assignment: yes (mentioned) = 1; no evidence = 0
38		Specific focus on breathing/relaxation techniques	Direct assignment: yes (mentioned) = 1; no evidence = 0
39	Learning styles	Problem-solving component	Direct assignment: yes (mentioned) = 1; no evidence = 0
40		Self-directed (including homework) component	Direct assignment: yes (mentioned) = 1; no evidence = 0
41		Peer delivery component	Direct assignment: yes (mentioned) = 1; no evidence = 0
42		Interactive (non-didactic) components	Direct assignment: yes (mentioned) = 1; no evidence = 0
43		Didactic components	Direct assignment: yes (mentioned) = 1; no evidence = 0
44		Other style/unclear	Direct assignment: yes (mentioned) = 1; no evidence = 0

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

45	Programme ethos/aims	Emphasis on social benefit	Direct assignment: yes (mentioned) = 1; no evidence = 0
46		Emphasis on improving well-being	Direct assignment: yes (mentioned) = 1; no evidence = 0
47		Emphasis on having fun	Direct assignment: yes (mentioned) = 1; no evidence = 0
48		Emphasis on fostering independence/ personal responsibility	Direct assignment: yes (mentioned) = 1; no evidence = 0
49		Emphasis on developing children's knowledge	Direct assignment: yes (mentioned) = 1; no evidence = 0
50		Emphasis on collaboration	Direct assignment: yes (mentioned) = 1; no evidence = 0
51		Emphasis on tailoring for specific group needs	Direct assignment: yes (mentioned) = 1; no evidence = 0
52		Emphasis on breathing technique	Direct assignment: yes (mentioned) = 1; no evidence = 0
53		Unclear	Direct assignment: yes (mentioned) = 1; no evidence = 0
54	Additional components - school asthma policy	Additional support provided for developing school policy	Direct assignment: yes (mentioned) = 1; no evidence = 0
55		School asthma policy developed organically	Direct assignment: yes (mentioned) = 1; no evidence = 0
	Additional processes undertaken - planned and unplanned		
56	Recruitment methods - school	Ad hoc/convenience sample of schools	Direct assignment: yes (mentioned) = 1; no evidence = 0
57		Census of school district (all schools invited and potentially eligible)	Direct assignment: yes (mentioned) = 1; no evidence = 0
58		Unspecified methods of school recruitment	Direct assignment: yes (mentioned) = 1; no evidence = 0
59	Additional processes to improve/attenuate attrition/enrolment	Marketing materials sent to parents	Direct assignment: yes (mentioned) = 1; no evidence = 0

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

60		Low motivation of students acknowledged and addressed	Direct assignment: yes (mentioned) = 1; no evidence = 0 Note that 1 study received a value of 0.75, as low motivation was acknowledged but was not explicitly described as being addressed (Magzamen 2008)
61		Incentives used (child or parent)	Direct assignment: yes (mentioned) = 1; no evidence = 0 Incentives for teachers and no evidence for children/teachers coded as 0.5
62		Make-up/catch-up sessions provided	Direct assignment: yes (mentioned) = 1; no evidence = 0
63		Reminders sent to parents/children	Direct assignment: yes (mentioned) = 1; no evidence = 0
64	Relationships/engagement	Did teachers engage or participate in the way they were expected to?	Direct assignment: yes, good reported throughout = 1; yes, some weaker evidence of good relationships or evidence that relationships improved during the course of the intervention = 0.75; missing, not applicable, or undetermined = 0.5; no, some weaker evidence of poorer relationships or evidence that relationships deteriorated during the course of the intervention = 0.25; evidence of poor relationships throughout = 0
65		Did parents engage or participate in the way they were expected to?	Direct assignment: yes, good reported throughout = 1; yes, some weaker evidence of good relationships or evidence that relationships improved during the course of the intervention = 0.75; missing, not applicable, or undetermined = 0.5; no, some weaker evidence of poorer relationships or evidence that relationships deteriorated during the course of the intervention = 0.25; evidence of poor relationships throughout = 0 One study described good levels of engagement, but review authors assigned value of 0.25 as a third of parents did not engage as expected (Kintner 2012); similar rationale for Mujuru 2011

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

66		Did school nurses engage or participate in the way they were expected to?	Direct assignment: yes, good reported throughout = 1; yes, some weaker evidence of good relationships or evidence that relationships improved during the course of the intervention = 0.75; missing, not applicable, or undetermined = 0.5; no, some weaker evidence of poorer relationships or evidence that relationships deteriorated during the course of the intervention = 0.25; evidence of poor relationships throughout = 0
67		Did other relevant stakeholders engage or participate in the way they were expected to?	Direct assignment: yes, good reported throughout = 1; yes, some weaker evidence of good relationships or evidence that relationships improved during the course of the intervention = 0.75; missing, not applicable, or undetermined = 0.5; no, some weaker evidence of poorer relationships or evidence that relationships deteriorated during the course of the intervention = 0.25; evidence of poor relationships throughout = 0
	Process outcomes		
68	Child satisfaction	Put in level of satisfaction (%) or record qualitative statement on child satisfaction with the intervention experience. Indicators of satisfaction include children reporting that they enjoyed the intervention; whether the children would recommend the intervention to others; whether children found the intervention helpful. Knowledge development should not be included here	Elements of direct and transformational assignment included here [First] Direct assignment: where there is a qualitative statement indicating positive agreement, assign value of 0.66; where a qualitative statement indicating negative agreement, assign value of 0.33; where no child satisfaction data were collected or data were missing, assign value of 0.5 [Second; including of direct above] Transformational assignment implemented to condition reflecting whether children were satisfied. Interventions with 25% or fewer children satisfied = 0; interventions with 50% of children satisfied = 0.5; missing data coded as 0.5; interventions with 75% or more children satisfied See text for further justification on use of the 75% threshold

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

69	Child attrition (overall level)	Put in level of completion (%) or record qualitative statement on child completion rate	Elements of direct and transformational assignment here. Note thresholds were higher than for satisfaction, as fewer data were missing [First] Direct assignment: where there is a qualitative statement indicating high level of completion, assign value of 0.83; where a qualitative statement indicating problematic completion, assign value of 0.66. Where data are missing, assign value of 0.75 [Second; including of direct above] Transformational assignment implemented to condition reflecting level of completion. Interventions with 66% or fewer children completing the intervention = 0; interventions with 75% of children completing the intervention = 0.5; interventions with 83% or more children completing the intervention = 1. Missing data coded as 0.5 See text for further justification on the use of thresholds
70	Child dosage level	Did the children receive the intended dosage of the intervention? Put in level of dosage (%) or record qualitative statement on child dosage	Elements of direct and transformational assignment here. Note thresholds are higher than for satisfaction, as fewer data are missing [First] Direct assignment: where there is a qualitative statement indicating high level of dosage, assign value of 0.83; where a qualitative statement indicating problematic dosage, assign value of 0.66. Where data are missing, assign value of 0.75 [Second; including of direct above] Transformational assignment implemented to condition reflecting level of dosage. Interventions with 66% or fewer children receiving the full dosage = 0; interventions with 75% of children receiving the full dosage = 0.5; interventions with 83% or more of children receiving the full dosage = 1. Missing data coded as 0.5 See text for further justification on the use of thresholds

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Table 1. Detailed coding framework for conditions and outcomes (*Continued*)

71	Child adherence	Did the children adhere to the intervention instructions, e.g. students being compliant with paperwork; completing homework; going to visit PCPs as instructed, etc. Put in level of adherence (%) or record qualitative statement on child dosage	Elements of direct and transformational assignment here. Note thresholds are higher than for satisfaction as fewer data are missing [First] Direct assignment: where there is a qualitative statement indicating high level of adherence, assign value of 0.83; where a qualitative statement indicating problematic adherence, assign value of 0.66. Where data are missing, assign value of 0.75 [Second; including of direct above] Transformational assignment implemented to condition reflecting level of adherence. Interventions with 66% or fewer children adherent = 0; interventions with 75% of children adherent = 0.5; interventions with 83% or more children adherent = 1. Missing data coded as 0.5 See text for further justification on the use of thresholds
72	Consolidated process variable	Summation of attrition, adherence, and dosage scores as a marker of implementation success	Transformational assignment Score of 0 = 0 implementation not successful; score of 1.5 = mid point between successful and unsuccessful implementation; score of 3 = full implementation success

Table 2. Original and reduced conditions for curriculum content, delivery style, and programme emphasis

Curriculum - original conditions	**Curriculum - reduced conditions**[a]
I. Lung physiology ii. Asthma acceptance iii. Symptom monitoring and treatment iv. Trigger avoidance v. General health vi. Forming alliances vii. Smoking viii. Tailored/personalised ix. School performance x. Emergencies xi. Unknown content	I. Symptom monitoring and alliances ii. Lung physiology and general health iii. Symptom monitoring and trigger avoidance iv. Other various foci v. Unknown
Pedagogical delivery style - original conditions	**Pedagogical delivery style - reduced conditions**[b]

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Table 2. Original and reduced conditions for curriculum content, delivery style, and programme emphasis (*Continued*)

I. Problem-solving ii. Self-direct iii. Peer delivery iv. Interactive v. Didactic vi. No information/other focus	I. Interactive focused style ii. Diverse style iii. Unknown style
Intervention emphasis - original conditions	**Intervention emphasis - reduced conditions**[c]
I. Emphasis on social benefit ii. Emphasis on well-being iii. Emphasis on having fun iv. Emphasis on personal responsibility v. Emphasis on children's knowledge vi. Emphasis on collaboration vii. Emphasis on tailoring/personalisation viii. Emphasis unclear	I. Emphasis on tailoring/personalisation ii. Emphasis on personal responsibility iii. Diffuse emphasis/other

[a] Pseudo-F index = 5.66.
[b] Pseudo-F index = 8.36.
[c] Pseudo-F index = 6.50.

Table 3. Data table for QCA model 1 - setting and participants

	Successful intervention	School-based health centre	High school	Parents directly involved	Teachers received training	School nurses or other stakeholders received training
Joseph 2010	0.52	0.55	1	0	0	0
Kouba 2012	0.33	0.33	1	1	0	0
Dore-Stites 2007	0.67	0.66	0	1	0	0
Joseph 2013	1.00	0.55	1	0	0	0
Mujuru 2011	0.67	0.66	0	0	1	0
Henry 2004	0.83	0.33	1	0	1	0
Pike 2011	0.67	0.33	0	0	1	0
Spencer 2000	0.33	0.66	0	1	0	0
Engelke 2013	0.50	0.66	0.5	1	1	1

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Table 3. Data table for QCA model 1 - setting and participants (*Continued*)

Splett 2006	0.50	1.00	0.5	0	1	1
Kintner 2012	0.83	0.66	1	1	0	1
Berg 2004	0.83	0.66	1	0	0	0
Howell 2005	0.33	0.75	0	1	0	0
Gerald 2006	0.33	0.55	0	0	0	0
Langenfeld 2010	0.33	0.66	0	0	1	0
Al-Sheyab 2012	0.83	0.33	1	0	0	0
Levy 2006	0.52	0.33	0	0	1	0
Terpstra 2012	1.00	0.66	0.66	1	0	0
Horner 2015	0.67	0.66	0	0	0	0
Bruzzese 2008	0.94	0.66	0.66	1	0	0
Lee 2011	0.50	0.66	0	0	0	0
Bruzzese 2004	0.33	0.55	1	0	0	1
Cicutto 2013	0.67	0.33	0	0	0	1
Brasler 2006	0.00	0.66	0.66	1	0	0
Crane 2014	0.50	0.33	0	0	0	0
Bruzzese 2011	0.88	0.55	1	0	0	1
Magzamen 2008	0.19	0.55	0.75	0	1	0

QCA: qualitative comparative analysis.

Table 4. Data table for QCA model 2 - recruitment and retention processes

	Successful intervention	Provision of additional marketing materials	Provision of incentives	Make-up sessions provided	Reminders provided for attendance at activity
Joseph 2010	0.52	1	1	0	0
Kouba 2012	0.33	1	0	1	0

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Table 4. Data table for QCA model 2 - recruitment and retention processes (*Continued*)

Dore-Stites 2007	0.67	1	1	0	0
Joseph 2013	1.00	1	1	0	0
Mujuru 2011	0.67	0	0	0	1
Henry 2004	0.83	0	0	0	0
Pike 2011	0.67	0	0.5	0	0
Spencer 2000	0.33	1	0	0	0
Engelke 2013	0.50	0	0	0	0
Splett 2006	0.50	0	0	0	0
Kintner 2012	0.83	1	1	1	0
Berg 2004	0.83	0	1	0	0
Howell 2005	0.33	0	1	1	1
Gerald 2006	0.33	0	0	0	0
Langenfeld 2010	0.33	0	1	0	0
Al-Sheyab 2012	0.83	0	0	0	0
Levy 2006	0.52	0	0	0	0
Terpstra 2012	1.00	1	1	1	1
Horner 2015	0.67	0	0	0	0
Bruzzese 2008	0.94	0	0	1	0
Lee 2011	0.50	0	0.75	0	0
Bruzzese 2004	0.33	0	1	0	1
Cicutto 2013	0.67	0	0	1	0
Brasler 2006	0.00	1	1	1	1
Crane 2014	0.50	0	0	0	0
Bruzzese 2011	0.88	0	0	1	0

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Table 4. Data table for QCA model 2 - recruitment and retention processes (*Continued*)

Magzamen 2008	0.19	1	1	0	1

QCA: qualitative comparative analysis.

Table 5. Data table for QCA model 4 - modifiable design features

	Successful intervention	Theory driven	Personalised or individual sessions	Intervention takes place during lesson time	Intervention takes place during students' own free time	School nurse involved in delivery of the intervention
Joseph 2010	0.52	1	1	1	0.33	0
Kouba 2012	0.33	1	1	0	1	0
Dore-Stites 2007	0.67	1	0	0.33	0.33	0.66
Joseph 2013	1.00	1	1	0.75	0.75	0
Mujuru 2011	0.67	0	0	1	0	0
Henry 2004	0.83	0	0	1	0	0
Pike 2011	0.67	0	0	1	0	0
Spencer 2000	0.33	0	1	0.33	0.33	0.66
Engelke 2013	0.50	0	0.66	0.33	0.33	1
Splett 2006	0.50	0	1	0.33	0.33	1
Kintner 2012	0.83	1	0	1	1	0.66
Berg 2004	0.83	1	0.66	0.33	0.33	0.66
Howell 2005	0.33	1	1	0.33	0.33	0.66
Gerald 2006	0.33	0	0	1	0.33	0
Langenfeld 2010	0.33	0	1	0.33	0.33	1
Al-Sheyab 2012	0.83	1	0	0.33	0.33	0
Levy 2006	0.52	0	0.66	0.33	0.33	1

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Table 5. Data table for QCA model 4 - modifiable design features (*Continued*)

Terpstra 2012	1.00	1	0	0	1	0.66
Horner 2015	0.67	1	0	0	1	0
Bruzzese 2008	0.94	1	0	0.33	0.33	0.66
Lee 2011	0.50	1	0	1	0	0.66
Bruzzese 2004	0.33	1	1	0.75	0.75	0
Cicutto 2013	0.67	1	0	0	1	0
Brasler 2006	0.00	0	0	0.75	0.75	0.66
Crane 2014	0.50	1	0	0	1	0.66
Bruzzese 2011	0.88	1	1	0.33	0.33	0
Magzamen 2008	0.19	0	0	0	1	1

QCA: qualitative comparative analysis.

Table 6. Data table for QCA model 5 - stakeholder involvement and engagement

	Successful intervention	School asthma policy	Good relationships/engagement with parents	Good relationships/engagement with school nurses	Child Satisfaction	School asthma policy
Joseph 2010	0.52	0	0	0	0	0
Kouba 2012	0.33	0	0	0	0	0
Dore-Stites 2007	0.67	0	0.75	1	1	0
Joseph 2013	1.00	0	1	0	0	0
Mujuru 2011	0.67	0	0.25	0	0	0
Henry 2004	0.83	1	0	0	0	1
Pike 2011	0.67	0	0	0	0	0
Spencer 2000	0.33	0	1	1	0	0
Engelke 2013	0.50	1	1	0	0	1

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Table 6. Data table for QCA model 5 - stakeholder involvement and engagement (*Continued*)

Splett 2006	0.50	1	0	1	0	1
Kintner 2012	0.83	0	0.25	0	1	0
Berg 2004	0.83	0	0	0	1	0
Howell 2005	0.33	0	0.75	0.75	0.633333	0
Gerald 2006	0.33	0	0	0	0	0
Langenfeld 2010	0.33	1	0	1	0	1
Al-Sheyab 2012	0.83	0	0	0	0.633333	0
Levy 2006	0.52	1	0	0	0	1
Terpstra 2012	1.00	0	0.25	0	0	0
Horner 2015	0.67	0	0	0	0	0
Bruzzese 2008	0.94	0	1	0	1	0
Lee 2011	0.50	0	0	0	0	0
Bruzzese 2004	0.33	0	0	0	0.633333	0
Cicutto 2013	0.67	1	0	0	0	1
Brasler 2006	0.00	1	0	1	0.633333	1
Crane 2014	0.50	0	0	1	0	0
Bruzzese 2011	0.88	0	0	0	0	0
Magzamen 2008	0.19	0	0	0	0	0

QCA: qualitative comparative analysis.

Table 7. Included process evaluation studies: methodological characteristics and processes described

Study	Type of study	Approach	Process evaluation elements
Al-Sheyab 2012a	Feasibility study	Qualitative	Thematic analyses of student perceptions
Berg 2004	Outcome and process evaluation	Qualitative and quantitative	Thematic analyses of student perceptions

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Table 7. Included process evaluation studies: methodological characteristics and processes described (*Continued*)

Bignall 2015	Feasibility study	Qualitative and quantitative	Thematic analyses of student perceptions
Brasler 2006	Feasibility/case study of implementation	Quantitative data and trialist reports	Implementation challenges and facilitators identified
Bruzzese 2004	Feasibility study	Qualitative and quantitative	Section evaluating intervention reach, dosage, and student satisfaction
Bruzzese 2011	Outcome evaluation with section on process evaluation	Quantitative	Section evaluating intervention reach (dosage)
Bruzzese 2008	Feasibility study	Qualitative and quantitative	Stand-alone section on process evaluation results assessing implementation and student perceptions
Carpenter 2016	Outcome and process evaluation	Qualitative and quantitative	Thematic analyses of student perceptions
Cicutto 2013	Outcome and process evaluation	(Mainly) Quantitative	In addition to information on other processes of interest, provided a description of wider school support through policy changes (process of interest included in the logic model)
Crane 2014	Feasibility study	Quantitative	Study was included as it represented an implementation study (through focus on the impact of changing dosage schedule)
Dore-Stites 2007	Feasibility study	Quantitative	In addition to information on other processes of interest, provided information on student satisfaction
Engelke 2013	Feasibility study	Quantitative	Detailed process/implementation information was provided
Gerald 2006	Outcome and process evaluation	(Mainly) Quantitative	In addition to information on other processes of interest, provided a description of implementation challenges
Henry 2004	Outcome and process evaluation	(Mainly) Quantitative	In addition to information on other processes of interest, provided a description of wider school support through policy changes (process of interest in the logic model) and as-

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Table 7. Included process evaluation studies: methodological characteristics and processes described (*Continued*)

			sessment of sustainability
Horner 2015	Outcome evaluation with process evaluation information	Quantitative	Included detailed information on attrition and cost-effectiveness
Howell 2005	Outcome and process evaluation	Quantitative	In addition to information on other processes of interest, provided information on student satisfaction
Jackson 2006	Outcome evaluation with process evaluation information	Quantitative	In addition to information on other processes of interest, provided information on student satisfaction
Joseph 2010	Outcome and process evaluation	Quantitative	In addition to information on other processes of interest, provided detailed information on non-adherence
Joseph 2013	Outcome and process evaluation	Quantitative	Included detailed studies of non-adherence and relationship with student characteristics
Kintner 2012	Feasibility study	Quantitative	In addition to information on other processes of interest, provided information on student satisfaction
Kouba 2012	Outcome evaluation with process evaluation information	Quantitative	In addition to information on other processes of interest, provided detailed information on dosage (and dose-response)
Langenfeld 2010	Implementation study	Quantitative	In addition to information on other processes of interest, provided detailed information on dosage (and dose-response)
Lee 2011	Implementation study	Qualitative	In addition to information on other processes of interest, provided detailed information on instructor experiences
Levy 2006	Outcome evaluation with process evaluation information	Quantitative	In addition to information on other processes of interest, provided information on parental adherence to intervention protocol
Magzamen 2008	Outcome evaluation with process evaluation information	Quantitative	In addition to information on other processes of interest, provided information on attrition

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Table 7. Included process evaluation studies: methodological characteristics and processes described (*Continued*)

McCann 2006	Outcome evaluation with process evaluation information	Quantitative	In addition to information on other processes of interest, provided information on teacher adherence/school level commitment
Mickel 2016	Outcome and process evaluation	Qualitative and quantitative	Thematic analyses of student perceptions
Mujuru 2011	Outcome and process evaluation	(Mainly) Quantitative	In addition to information on other processes of interest, provided a description of parental satisfaction
Pike 2011	Outcome and process evaluation	(Mainly) Quantitative	In addition to information on other processes of interest, provided information on teacher adherence/school level commitment
Richmond 2011	Outcome and process evaluation	(Mainly) Quantitative	Included detailed information on adherence and awareness
Spencer 2000	Outcome and process evaluation	Quantitative	In addition to information on other processes of interest, provided information on instructor satisfaction and school level commitment
Splett 2006	Outcome and process evaluation	Quantitative	In addition to information on other processes of interest, provided information on adherence and school level commitment
Terpstra 2012	Outcome and process evaluation	Quantitative	In addition to information on other processes of interest, represented an implementation study by including a focus on the impact of parental involvement/increasing parental awareness

Table 8. Process evaluation studies - summary of intervention characteristics

	Named theoretical framework	Aim	Intervention type	Control	Intensity	Included in QCA
Al-Sheyab 2012a	Developmental stages (not named)	To assess feasibility in the Jordanian context of a peer-led, school-based asthma education	Triple A. Children received education through interactive teaching and learning	N/A	14 hours over 6 days	Setting and participants; further modifiable design features; stakeholder

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

		programme	activities			involvement and engagement
Berg 2004	Social learning theory	To evaluate effects of the Power Breathing programme and individual coaching sessions on asthma knowledge and functional health status	Power Breathing. Children received education in a group session on asthma management	N/A	2 weeks	Stakeholder involvement and engagement
Bignall 2015	None	To test the feasibility and preliminary efficacy of a school-based RCT on breathing retraining for asthma outcomes and anxiety symptoms	Single workshop for children. Children received information on relaxation/breathing techniques	30 minutes of standard asthma education	2 face-to-face visits 1 month apart	None
Brasler 2006	None	To provide adolescents with knowledge and skills to take control of their asthma; to enhance knowledge and skills of school staff, health professionals, and parents	Power Breathing. Children received basic asthma education and addressed social/lifestyle concerns	N/A	3× 90-minute or 6× 45-minute sessions	None
Bruzzese 2004	Self-regulation theory	To help students weave asthma and management strategies into their self-identity	ASMA. Students were taught how to manage their asthma to prevent symptoms and reduced quality of life. Continued medical education was also offered to medical providers	Usual care	3 workshops 2 or 3 weeks apart for 8 weeks	Stakeholder involvement and engagement

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

Bruzzese 2011	Social cognitive theory	To test the efficacy of ASMA	ASMA; academic detailing. Students attended workshops to empower them to manage their asthma. Parents received training on how to support their child's need to manage his or her asthma	Usual care	8-week programme/3× 45-minute sessions and individual coaching sessions once a week for 5 weeks	Further modifiable design features
Bruzzese 2008	Social cognitive theory; cognitive-behavioural therapy	To test the feasibility and short-term outcomes of asthma: it's a family affair!	OAS and ASMA; caregiver education. Intervention students received education about asthma, based on existing materials, from coping with asthma at home and at school; OAS and ASMA	Usual care	6× 75-minute group sessions once a week for 6 weeks; caregiver 5× 90-minute sessions once a week	Setting and participants; further modifiable design features; stakeholder involvement and engagement
Carpenter 2016	None	To test whether a tailored inhaler technique video intervention could be feasibly implemented by school nurses; to improve the inhaler technique of children with asthma	Multiple sessions for children. Children watched a tailored video and demonstrated their inhaler technique before and after	N/A	6 weeks or less	None
Cicutto 2013	Social cognitive theory	To prepare and support children with asthma to be successful managers of their asthma, thereby reducing school absenteeism, in-	Roaring Adventures of Puff. Workshops included goal-setting and self-monitoring, trigger identification, control and avoidance, ba-	Usual care	Unclear	Setting and participants

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

		terrupted activity, and health service use	sic pathophysiology, medication use, symptom recognition, and the asthma action plan, using interactive techniques			
Crane 2014	Educational theory of Jean Piaget	To pilot a shorter, condensed OAS education programme as an alternative, yet still effective, delivery approach compared to the lengthier original programme	OAS. Children received education from OAS	Non-equivalent intervention	10 weeks	Setting and participants; further modifiable design features
Dore-Stites 2007	None	Unclear	OAS; Quest for the Code. Children received a computer game, home activities, and caregiver information	N/A	20 minutes a week for 8 to 9 weeks	Further modifiable design features
Engelke 2013	Case management theory	To identify the process of case management used by school nurses, and when they provide case management to students with asthma. The second aim was to identify the impact of case management on parent perception of how well the child manages illness; parent perception of how well the child keeps	Case management; nurse meetings; multiple sessions for children; multiple sessions for staff. Children received education and counselling, and parent/family education was delivered, as well as education and healthcare co-ordination for teachers/staff	N/A	Unclear	None

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

		up with school work; quality of life and academic achievement of children				
Gerald 2006	None	To evaluate a comprehensive school-based asthma management programme in an inner city, largely African American school system	OAS. The intervention included 3 educational programmes and medical management for children, as well as education for school staff	Usual care	Unclear	None
Henry 2004	Unclear	To determine whether an asthma education programme in schools would have a direct impact on student knowledge and attitudes toward asthma and quality of life of students with asthma; an indirect impact on teacher knowledge and attitudes on asthma and on school policies about asthma; and a sustainable programme after resources were withdrawn	Asthma education. A package about asthma was taught within the PD/H/PE (Personal Development, Health and Physical Education) strand of the school curriculum	Usual care	Unclear	Setting and participants
Horner 2015	Bruhn's theoretical model of asthma self-management	To test effects of 2 modes of delivering an asthma educational intervention on health outcomes and asthma management	7-topic curriculum. The intervention was designed for children in rural areas and included asthma information	In-school asthma classes	16× 15-minute sessions for 5 weeks	None

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

Howell 2005	Learning theory and behaviour modification	To examine whether it was feasible to implement an interactive computer game at school health centres. Second, to examine whether exposure to the game was effective in increasing asthma knowledge, reducing asthma symptoms, and reducing unnecessary healthcare use compared with no exposure to the game	Quest for the Code. Computer game	Usual care	4× 30-minute sessions	None
Jackson 2006	None	To evaluate knowledge and attitude outcomes of an educational asthma programme for third grade children with and without asthma	Single sessions for children. Children completed an educational programme. Teachers were also encouraged to attend	N/A	3 classes per session for 11 sessions	None
Joseph 2010	None	To develop and evaluate a multi-media, web-based asthma management programme	Puff City. A web-based programme was delivered to children to focus on adherence, inhaler availability, and smoking cessation/reduction	Generic asthma websites	Unclear	Further modifiable design features; stakeholder involvement and engagement
Joseph 2013	Behavioural theory	To evaluate a school-based RCT to evaluate Puff City	Adapted version of the Puff City computer programme	Generic asthma education	4× 15-minute sessions	None

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

Kintner 2012	Lifespan development perspective	To evaluate the feasibility of the SHARP programme for students, their family, school personnel, and community partners	SHARP; Community Coalition component	N/A	Once a week for 10 weeks plus a 3-hour community component	Setting and participants; further modifiable design features; stakeholder involvement and engagement
Kouba 2012	Orem's self-care deficit theory	To determine the effectiveness of the ICAN programme for nutrition knowledge and dietary behaviours	Single workshop for staff; multiple sessions for children; Quest for the Code; Fight Asthma Now; additional nurse meetings; combined education	N/A	8 weeks	None
Langenfeld 2010	None	Unclear	OAS; case management; standalone respiratory therapy. Children received the OAS curriculum and case management asthma strategies developed with teachers	N/A	6× 40-minute sessions for 1 school year	None
Lee 2011	The functional context approach	To evaluate the effectiveness and feasibility of using undergraduate nursing students as facilitators to deliver an asthma management programme	OAS. Children received the OAS curriculum	N/A	Unclear	Further modifiable design features
Levy 2006	None	To evaluate the effectiveness of a school-based nurse case management approach to asthma	OAS; monitoring of students; health status. Students received OAS education	Usual care	1 school term	None

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

		in students with poor control	and weekly monitoring of their health status			
Magzamen 2008	None	To evaluate the implementation of Kickin' Asthma	Multiple sessions for children; Kickin' Asthma. Educational sessions, similar to the OAS curriculum. Customised letters were also sent home to describe health needs and goals for each child	N/A	3 months	None
McCann 2006	None	To assess whether a school-based intervention would produce clinical and psychological benefits for children with asthma	Education; role-play. The intervention focused on describing the respiratory condition through a role-play	Respiratory education	45-minute session	None
Mickel 2016	None	To provide Iggy education to more than 75% of children with asthma; To increase asthma knowledge; increase families' awareness of asthma; and cultivate collaboration between school nurses and asthma providers	Iggy and the Inhalers intervention. Children received an asthma education video, poster, comic book, sticker, and trading card programme	N/A	Unclear	None
Mujuru 2011	None	To demonstrate the feasibility of a school-based asthma education programme	OAS. Children received the OAS curriculum	N/A	40-minute session once a week for 2 months	None

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

		for students and to evaluate parents' perspectives on the intervention				
Pike 2011	None	To assess student asthma knowledge gain, teacher acceptance, and grade appropriateness after an intervention	Multiple sessions for children; integrated into the curriculum. Teachers taught lessons with information about asthma	Usual care	7 lesson plans	Setting and participants
Richmond 2011	None	To increase the number of current provider-written asthma action plans submitted to the school nurse at the beginning of the school year	Breathe Your Best. Students were encouraged to receive an asthma action plan from their doctor and to collect their prescriptions	N/A	Unclear	None
Spencer 2000	None	To evaluate the OAS programme for children	OAS. Children received the OAS curriculum	N/A	6× 40-minute sessions	None
Splett 2006	None	To evaluate the effectiveness and sustainability of the Healthy Learners Asthma Initiative	Children received training on asthma self-management. Licensed nurses and healthcare assistants received coaching and reinforcement from asthma resource nurses	Usual care	Varied according to asthma severity and need	None
Terpstra 2012	Social cognitive theory	To test a version of an intervention with a caregiver newsletter vs no newsletter	Multiple sessions for children; materials for parents. Children received skills training on how to use a peak	Intervention or intervention with a newsletter	6-week training	Setting and participants; further modifiable design features

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Table 8. Process evaluation studies - summary of intervention characteristics (*Continued*)

			flow meter. Parents received a newsletter about an important theme from the research			

ASMA: Asthma Self-Management for Adolescents.
ICAN: I Can Control Asthma and Nutrition Now.
N/A: not applicable.
OAS: Open Airways for Schools.
RCT: randomised controlled trial.
SHARP: Staying Healthy-Asthma Responsible & Prepared.
Triple A: Adolescent Asthma Action.

Table 9. Process evaluation studies - summary of study design, setting, and population

	Study design	Number of children	Country	Type of School	Recipients	Age of children (years)	Representation of children from BME backgrounds	Representation of children from low SES backgrounds
Al-Sheyab 2012a	Case study	31	Jordan	High	Children	11 to 18	Unclear	Unclear
Berg 2004	Quasi-experimental	13	USA	High	Children	15 to 18	46.2% African American	Unclear
Bignall 2015	Parallel-group RCT	33	USA	High	Children	11 to 18	100% Black or African American	Unclear
Brasler 2006	Case study	342	USA	Junior/middle	Children; teachers; parents	11 to 14	Unclear	Unclear
Bruzzese 2004	Parallel-group RCT	45	USA	High	Children	11 to 18	Unclear	Unclear
Bruzzese 2011	Parallel-group RCT	345	USA	High	Children	11 to 18	45.5% Hispanic; 37.7% African American; 11.6% mixed; 5.2%	75% free school meals

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Table 9. Process evaluation studies - summary of study design, setting, and population (*Continued*)

							other	
Bruzzese 2008	Parallel-group RCT	24	USA	Junior/ middle	Children; parents	11 to 14	41% Hispanic; 17% White; 8% African American; 34% other	8% unemployed; 21% part-time employment; 71% full-time employment
Carpenter 2016	Quasi-experimental	25	USA	All school types	Children; nurses	Unclear	72% White; 12% Hispanic; 8% African American; 8% Black	Unclear
Cicutto 2013	Cluster RCT	1316	Canada	Primary/ elementary	Children; school board; head teacher; teachers; peers	5 to 10	Unclear	25% to 50% deprived
Crane 2014	Quasi-experimental	45	USA	Primary/ elementary	Children	5 to 10	Unclear	Unclear
Dore-Stites 2007	Quasi-experimental	32	USA	Primary/ elementary	Children; parents	5 to 10	39% African American; 28.6% Caucasian; 14.3% Hispanic; 18% biracial	34.6% < $20,000; 53.8% $21,000 to $40,000
Engelke 2013	Quasi-experimental	143	USA	All school types	Children; teachers; parents; nurses	Unclear	40.6% Caucasian; 37.8% African American; 7% Latino; 14% other	63.6% on Medicaid
Gerald 2006	Cluster RCT	736	USA	Primary/ elementary	Children; teachers	5 to 10	97% African American	Unclear
Henry 2004	Cluster RCT	4161	Australia	High	Children; teachers	11 to 14	Predominantly Caucasian	Unclear

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Table 9. Process evaluation studies - summary of study design, setting, and population (*Continued*)

Horner 2015	Cluster RCT	292	USA	Primary/ elementary	Children	5 to 10	21. 2% African American; 25% Spanish speaking	30.7% low SES
Howell 2005	Cluster RCT	24	USA	Primary/ elementary	Children; parents	5 to 10	75% African American	Unclear
Jackson 2006	Quasi-experimental	943	USA	Primary/ elementary	Children	5 to 10	Unclear	Unclear
Joseph 2010	Parallel-group RCT	314	USA	High	Children	11 to 18	Unclear	52% eligible for free school meals
Joseph 2013	Parallel-group RCT	422	USA	High	Children	11 to 18	98% African American	73% on Medicaid
Kintner 2012	Quasi-experimental	28	USA	High	Children; peers; families; teachers	11 to 14	53. 6% African American; 32.1% White; 3.6% American; 10.7% biracial	35.7% low SES; 42. 9% low middle SES; 17. 8% upper middle SES; 3. 6% high SES
Kouba 2012	Quasi-experimental	25	USA	High	Children	11 to 18	92% African American; 4% Hispanic; 4% mixed	25% to 50% deprived
Langenfeld 2010	Quasi-experimental	286	USA	Primary/ elementary	Children; teachers	5 to 10	63% African American; 23.9% Hispanic; 6. 4% White; 2. 6% Asian	High percentage on free school meals
Lee 2011	Quasi-experimental	827	USA	Primary/ elementary	Children	5 to 10	Unclear	Unclear
Levy 2006	Cluster RCT	243	USA	Primary/ elementary	Children; teachers	5 to 10	97% African American	80% on Medicaid

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Table 9. Process evaluation studies - summary of study design, setting, and population (*Continued*)

Magzamen 2008	Quasi-experimental	845	USA	High; junior/middle	Children	11 to 18	Unclear	Unclear
McCann 2006	Parallel-group RCT	219	UK	Primary/ elementary	Children; teachers	5 to 10	Unclear	< 25% deprived
Mickel 2016	Quasi-experimental	173	USA	Primary/ elementary	Children	5 to 10	63.6% African American; 13.3% Hispanic; 20.2% White	> 50% deprived
Mujuru 2011	Quasi-experimental	18	USA	Primary/ elementary	Children; parents	5 to 10	Unclear	39% Medicaid
Pike 2011	Quasi-experimental	236	USA	Primary/ elementary	Children; teachers	5 to 10	75% African American (approx.)	80% free school meals (approx.)
Richmond 2011	Narrative	Unclear	USA	Primary/ elementary	Children	5 to 10	100% African American	80% free school meals
Spencer 2000	Quasi-experimental	369	USA	Primary/ elementary	Children; parents	5 to 14	Unclear	34% free school meals
Splett 2006	Cluster RCT	1561	USA	All school types	Children; school staff	Unclear	66% African American; 6% Hispanic; 5% American Indian; 3% Asian; 20% White	73% free school meals
Terpstra 2012	Quasi-experimental	58	USA	Junior/ middle	Children; parents	11 to 14	> 50% BME	> 50% deprived

BME: black and minority ethnicity.
RCT: randomised controlled trial.

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Table 10. Outcome evaluation studies not included in the analyses

Study included as outcome	Reason data not included in quantitative analysis
Bruzzese 2004	Feasibility study uses randomised controlled trial (RCT) design with no quantitative data presented
Bruzzese 2010	Abstract only located and outcomes were not presented in an extractable format
Clark 2004	Published effect sizes that were extractable but of a different effect size from other studies
Clark 2010	No outcome measured in the study matched the review protocol
McCann 2006	Outcomes were not presented in an extractable format (disaggregated data for asthmatic children unavailable)
Monforte 2012	Abstract only located and outcomes were not presented in an extractable format
Mosnaim 2011	No outcome measured in the study matched the review protocol
Praena-Crespo 2010	Abstract only located and outcomes were not presented in an extractable format
Pulcini 2007	No outcome measured in the study matched the review protocol
Srof 2012	Outcomes were not presented in an extractable format (data on overall quality of life were not presented in full; only subdomains of quality of life are available)

Table 11. Outcome evaluation studies - summary of study design, setting, and population

	Study design	Number of children	Country	Type of school	Recipients	Age of children (years)	Representation of children from BME backgrounds	Representation of children from low SES backgrounds
Al-Sheyab 2012	Clustered parallel RCT	261	Jordan	4 public high schools	Children	11 to 15	Unclear	Unclear
Atherly 2009	Clustered parallel RCT	524	USA	Junior and high schools	Children	11 to 15	Unclear	Unclear
Bartholomew 2006	Clustered parallel RCT	948	USA	Elementary schools	Children; care providers; parents/ carers	5 to 10	45% African American; 51% Hispanic; 3% Caucasian	Deprived individuals > 50%

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Table 11. Outcome evaluation studies - summary of study design, setting, and population (*Continued*)

Bruzzese 2004	RCT	45	USA	2 public high schools	Children	Unclear	Unclear	Unclear
Bruzzese 2008	Clustered parallel RCT	24	USA	1 middle school	Children; caregivers	11 to 15	41% Hispanic; 17% African American	71% parents full-time employment
Bruzzese 2010	Clustered parallel RCT	Unclear	USA	25 public schools	Children; caregivers	Mean age, 12.8	Unclear	Unclear
Bruzzese 2011	Clustered parallel RCT	340	USA	5 high schools	Children	Mean age, 15	> 80% BME	Unclear
Cicutto 2005	Clustered parallel RCT	256	Canada	26 elementary schools	Children	5 to 10	Unclear	Average household income $53,000
Cicutto 2013	Clustered RCT	1316	Canada	170 primary/ elementary schools	Children; families	5 to 10	Unclear	Deprived individuals 25% to 50%
Clark 2004	Clustered parallel RCT	835	USA	14 public high schools	Children; parents/ carers; classmates; school personnel	5 to 10	98% African American	45% annual income < $15,000
Clark 2005	Clustered parallel RCT	639	China	21 elementary schools	Children	7 to 11	Unclear	Unclear
Clark 2010	Clustered parallel RCT	1292	USA	19 middle schools	Children	Mean age, 11.6	93% African American	48% annual income < $15,000
Gerald 2006	Parallel-group RCT	736	USA	54 elementary schools	Children	Mean age, 11	97% Black	Unclear
Gerald 2009	Parallel-group RCT	290	USA	Unclear	Children	5 to 10	91% Black	Unclear
Henry 2004	Clustered parallel RCT	Unclear	Australia	Secondary schools	Children	11 to 15	< 50% BME	Unclear

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Table 11. Outcome evaluation studies - summary of study design, setting, and population (*Continued*)

Horner 2008	Clustered parallel RCT	183	USA	18 elementary schools	Children	5 to 10	47% Hispanic; 30% White; 22% African American	Unclear
Horner 2015	Clustered parallel RCT	196	USA	3 elementary schools	Children	5 to 10	> 50% BME	Deprived individuals 25% to 50%
Howell 2005	Clustered parallel RCT	25	USA	4 elementary schools	Children; families	5 to 10	75% African American	Unclear
Kintner 2009	Clustered parallel RCT	59	USA	5 schools	Children	9 to 12	30% Black; 36% White; 18% biracial	Deprived individuals 25% to 50%
Levy 2006	Clustered parallel RCT	243	USA	14 elementary schools	Children	5 to 10	98% African American	85% TennCare
McCann 2006	Clustered parallel RCT	229	England	24 primary/junior schools	Children; parents	5 to 10	Unclear	Deprived individuals < 25%
McGhan 2003	Clustered parallel RCT	162	Canada	18 elementary schools	Children	5 to 10	< 50% BME	Deprived individuals 25% to 50%
McGhan 2010	Clustered parallel RCT	206	Canada	Elementary schools	Children; parents/carers; teachers	Mean age, 8.6	Unclear	Unclear
Monforte 2012	Clustered parallel RCT	Unclear	USA	8 elementary schools	Children	5 to 10	Unclear	Unclear
Mosnaim 2011	Clustered parallel RCT	344 youth; 192 teens	USA	Elementary schools	Children	Median age 10	> 50% BME	Deprived individuals > 50%
Patterson 2005	Clustered parallel RCT	175	Ireland	Primary schools	Children	7 to 11	Unclear	Deprived individuals 25% to 50%
Persaud 1996	Parallel-group RCT	36	USA	10 schools	Children	Mean age, 10.2	69% African American	69% received Medicaid

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Table 11. Outcome evaluation studies - summary of study design, setting, and population (*Continued*)

Praena-Crespo 2010	Clustered parallel RCT	279	Spain	16 high schools	Children	11 to 15	Unclear	Unclear
Pulcini 2007	Clustered parallel RCT	40	USA	Middle schools	Children	11 to 15	Unclear	Unclear
Shah 2001	Clustered parallel RCT	272	Australia	High schools	Children	11 to 15	Unclear	Unclear
Splett 2006	Clustered parallel RCT	1561	USA	K-8 schools	Children	5 to 15	66% African American	73% free school meals
Srof 2012	Parallel group RCT	39	USA	High schools	Children	14 to 18	Unclear	Unclear
Velsor-Friedrich 2005	Clustered parallel RCT	52	USA	4 elementary schools	Children	Mean age, 10.1	100% African American	Unclear

BME: black and minority ethnicity.
RCT: randomised controlled trial.

Table 12. Outcome evaluation studies - summary of intervention characteristics

	Named theoretical framework	Aim	Intervention type	Control	Intensity	Outcomes Included in meta-analysis
Al-Sheyab 2012	Self-efficacy	To test the impact of the Triple A programme on health-related outcomes in high school students	Triple A. Bilingual health workers trained peer leaders from year 11 to deliver 3 Triple A lessons	Unclear	3× lessons	HRQoL
Atherly 2009	None	To describe an analysis and results of the cost-effectiveness of the Power Breathing programme	Power Breathing. This intervention focussed on education about asthma, asthma control strategies,	Unclear	3× 90-minute lessons	Hospitalisations; ED visits; Experience of daytime and nighttime symptoms

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

			and psychosocial concerns			
Bartholomew 2006	Social cognitive theory	To describe the evaluation of a school-based intervention to improve asthma self-management, medical care, the school environment, symptoms, and the functional status of children	Multi-component intervention involving direct delivery to children, care providers, and parents/guardians. Children received education through the Watch, Discover, Think and Act interactive computer programme	Unclear	Unclear	Withdrawal
Bruzzese 2004	None	Unclear	ASMA. Continued medical education was also offered to medical providers	Usual care	3× lessons	None
Bruzzese 2008	Social cognitive theory; cognitive-behavioural theory	To describe asthma: it's a family affair; to present feasibility and preliminary outcome data from a pilot RCT	Elements of OAS and ASMA were provided to students; caregivers also received education	Usual care	6× lessons	Experience of daytime and nighttime symptoms; Withdrawal
Bruzzese 2010	None	To test the efficacy of an RCT: it's a family affair, a school-based, family-focussed intervention to improve asthma outcomes in preadolescents	ASMA and academic detailing. Students received workshops to empower them to manage their asthma. Parents received training to support their child's need to manage their asthma	Unclear	Children: 6× lessons; caregivers: 5× lessons	Withdrawal

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

Bruzzese 2011	Social cognitive theory	Unclear	ASMA. Students received group sessions and individual tailored coaching sessions, delivered by trained health educators	Wait-list control	3× group sessions; individual coaching sessions	Hospitalisations; ED visits; School absence; Restricted activity days; Unplanned GP or hospital visits; Experience of daytime and nighttime symptoms; Use of corticosteroids; Withdrawal
Cicutto 2005	Social cognitive theory; self-regulation theory	To evaluate an asthma education programme for children with asthma	Roaring Adventures of Puff. Children received group sessions on asthma and goal-setting	Usual care	6× lessons	Hospitalisations; ED visits; School absence; Restricted activity days
Cicutto 2013	Social cognitive theory	To implement an elementary school-based asthma self-management education programme for children with asthma; to work with schools to create an asthma-friendly supportive school environment; to evaluate the programme	Roaring Adventures of Puff. Children received group sessions on asthma and goal-setting	Usual care	6× lessons	ED visits; School absence; Restricted activity days; Unplanned GP or hospital visit; HRQoL; Withdrawal
Clark 2004	None	To assess the impact of a comprehensive school-based asthma programme	OAS; control strategies for schools	Wait-list control	6× lessons and 2× classroom sessions	School absence
Clark 2005	Social cognitive theory	To assess effectiveness in children in China of	OAS; intervention directed at children only	Unclear	5× lessons	Hospitalisations; ED visits

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

		an asthma education programme adapted from a model developed in the USA				
Clark 2010	None	To assess self-management and self-management plus peer involvement	OAS; peer component. In the first treatment arm, an adapted form of OAS was delivered to children. In the second treatment arm, a peer education component was added	Usual care	6× lessons	Experience of daytime and nighttime symptoms
Gerald 2006	None	Unclear	OAS. The intervention included educational programmes and medical management for children, as well as education for school staff	Usual care	6× lessons	Hospitalisations; ED visits; School absence
Gerald 2009	None	To determine the effectiveness of school-based supervised asthma therapy in improving asthma control	Children received asthma education, including a discussion of trigger avoidance (not manualised)	Usual care	1× lesson; multiple supervisions	School absence; Lung function; Use of reliever therapies; Withdrawal
Henry 2004	None	To determine whether an asthma education programme in schools would have a direct impact on student knowledge and attitudes on asthma and an indirect im-	Asthma education. A package about asthma was taught within the PD/H/PE strand of the school curriculum	Usual care	3× lessons	HRQoL

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

		pact on teacher knowledge and attitudes				
Horner 2008	Asthma health education model	To examine changes in rural children's asthma self-management after they received classes, but before they received the family education session	Asthma self-management. The curriculum included a 7-step asthma self-management plan	Health promotion education	16× lessons	Hospitalisations; Withdrawal
Horner 2015	Bruhn's theoretical model of asthma self-management	To test effects of 2 modes of delivering an asthma educational intervention on health outcomes and asthma self-management in school-aged children living in rural areas	7-topic curriculum. The intervention was designed for children in rural areas and included asthma information	Health promotion education	16× lessons	Hospitalisations; ED visits; Withdrawal
Howell 2005	Social learning theory	To examine the feasibility of an interactive computer game in school-based health centres; to test whether exposure to the game was effective in improving knowledge and reducing symptoms and healthcare use	Quest for the Code computer game. The caregiver also participated in medication interviews and received a home visit	Usual care	30-minute session	ED visits; Experience of daytime and nighttime symptoms; HRQoL; School absence; Corticosteroid dosage
Kintner 2009	Lifespan development perspective	To evaluate the preliminary efficacy of SHARP	SHARP. Students worked through the SHARP curriculum. Caregivers also received a 3-hour informa-	Usual care	10× lessons	HRQoL; Withdrawal

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

			tion sharing programme			
Levy 2006	None	To evaluate the effectiveness of a school-based nurse case management approach to asthma in students with poor control	OAS; monitoring of students; health status. Students received OAS education and weekly monitoring of their health status	Usual care	Weekly group sessions and weekly individual sessions	Hospitalisations; ED visits; Withdrawal
McCann 2006	None	To assess whether schools are an appropriate context for an intervention designed to produce clinical and psychological benefits for children with asthma	Education; role-play. The intervention focussed on describing the respiratory condition through a role-play	Education about the respiratory system	1× workshop	None
McGhan 2003	Social cognitive theory	To determine whether an interactive childhood asthma education programme improved asthma management behaviours, health status, and quality of life in elementary school children	Roaring Adventures of Puff. Children received education on asthma in a group setting. Parents and teachers were invited to participate in a school-based asthma awareness event	Usual care	6× lessons	ED visits; School absence; Unplanned GP or hospital visit; Experience of daytime and nighttime symptoms; Withdrawal
McGhan 2010	Social cognitive theory; self-regulation theory	To assess the feasibility and impact of the Roaring Adventures of Puff programme	Roaring Adventures of Puff delivered to children. Parents and teachers participated in an asthma awareness event	Usual care	6× lessons	ED visits; School absence; Unplanned GP or hospital visit; Experience of daytime and nighttime symptoms; Withdrawal

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

Monforte 2012	None	To evaluate the implementation of OAS	OAS. No further information was given	Unclear	Unclear	HRQoL
Mosnaim 2011	None	To assess the impact of the Fight Asthma Now educational programme among 2 populations of predominantly low-income minority students	One-to-one training on spacer technique, peak flow meter use, and use of an asthma action plan. Teens also received education on tobacco avoidance and peer pressure	Usual care	4× sessions	None
Patterson 2005	PRECEDE model	To evaluate the effectiveness of a programme of asthma clubs in improving quality of life for primary school children with asthma	SCAMP. Children used a workbook during sessions to learn about asthma	Wait-list control	8× sessions	Restricted activity days; Lung function; HRQoL; Withdrawal
Persaud 1996	None	To assess the effectiveness of an intervention on knowledge, locus of control, attitudes towards asthma, functional status, school attendance, and ED visits	Individualised education sessions. Children had a personal peak flow meter in the school health office. The school nurse also reviewed the student asthma diary and discussed this with them	Usual care	3× lessons and weekly education sessions	ED visits; School absence
Praena-Crespo 2010	None	To verify whether an asthma education program in schools would have direct benefit for student knowledge and	Asthma programme. No further information was given (abstract only)	Unclear	3× lessons	None

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

		attitudes towards asthma and quality of life for students with asthma				
Pulcini 2007	None	To determine the effectiveness of an intervention to increase the number of AAPs in schools	Peak flow education. Children were given a peak flow meter and were educated on the correct technique to measure lung function	Unclear	Daily for 2 weeks	None
Shah 2001	None	To determine the effects of a peer-led programme for asthma education on quality of life and related morbidity in adolescents with asthma	Triple-A: asthma education and empowerment. Students learnt how to educate their peers about asthma. Peers also led 3 health lessons for classes in school	Wait-list control	3× sessions	Experience of daytime and nighttime symptoms; Lung function; HRQoL; Withdrawal
Splett 2006	None	To improve asthma management among school children and reduce asthma-related school absences, hospitalisations, and ED visits	Children received training on managing their asthma. Licensed nurses and healthcare assistants received coaching and reinforcement from asthma resource nurses	Usual care	Unclear	School absence; Unplanned GP or hospital visit
Srof 2012	Health promotion model	To determine effects of coping skills on asthma self-efficacy, social support, quality of life, and peak flow among adolescents	Asthma diary; 5× coping skills sessions. Students received coping skills training and completed diary entries	Usual care	Sessions over 5 weeks	None

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Table 12. Outcome evaluation studies - summary of intervention characteristics (*Continued*)

Velsor-Friedrich 2005	Self-care deficit theory	To test a 2-part intervention on selected psychosocial and health outcomes for children with asthma	OAS; nurse practitioner visits. Children received the OAS education curriculum and nurse practitioner visits to assess asthma health and further education	Usual care	6× group sessions; individual nurse sessions	ED visits; Experience of daytime and nighttime symptoms; Lung function

AAP: XXX.
ASMA: Asthma Self-Management for Adolescents.
ED: emergency department.
GP: general practitioner.
HRQoL: health-related quality of life.
ICAN: I Can Control Asthma and Nutrition Now.
OAS: Open Airways for Schools.
PD/H/PE: personal development/health/physical education.
PRECEDE: Predisposing, Reinforcing, and Enabling Causes in Educational Diagnosis and Evaluation.
RCT: randomised controlled trial.
SCAMP: School Care and Asthma Management Project.
SHARP: Staying Healthy-Asthma Responsible & Prepared.
Triple A: Adolescent Asthma Action.

Table 13. Details of data transformations and adjustments made for meta-analyses

Study	Indicator	Collection/ reporting point	Mean cluster size (if applicable)	Intra-cluster correlation coefficient applied (if applicable)	Data transformation	Original effect size and standard error (with adjustment for clustering if applicable)	Final or transformed effect size and standard error (with adjustment for clustering if applicable)
Hospitalisations							
Atherly 2009	Instances of hospitalisation in previous 4 weeks	Post intervention (3-month follow-up)	45.8	0.05	Yes - transformed from odds ratio to SMD	OR (0.7736); SE (lnOR) (1.385)	SMD (-0.141) ; SE (0.764)
Bruzzese 2011	Hospitalisations in the past 2 months	Post intervention (12-	N/A	N/A	No	N/A	SMD (-0.219) ; SE (0.120)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

		month follow-up)					
Clark 2005	Hospitalisations	Post intervention (12-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	Yes - transformed from odds ratio to SMD	OR (1.43); SE (estimated from P value (lnOR)) 0.39	SMD (-0.197); SE (0.215)
Gerald 2006	Median hospitalisations (not combined)	N/A	N/A	N/A	N/A	N/A	N/A
Horner 2008	Any hospital stays in the past 12 months (based on parents reporting any stay)	Post intervention (7-month follow-up)	10.1 (reported by study authors)	0.05	Yes - transformed from odds ratio to SMD	OR (0.882); SE (lnOR) (0.791)	SMD (-0.069); SE (0.436)
Horner 2015	Mean number of hospitalisations since the previous data collection (at 8 months)	Post intervention (12-month follow-up)	8.9 (approx.)	0.05	No	N/A	SMD (-0.057); SE (0.169)
Levy 2006	Mean hospital days	Post test (at intervention end)	17.36	0.05	No	N/A	SMD (-0.293); SE (0.174)
Emergency department visits							
Atherly 2009	Instances of ED visits in previous 4 weeks	Post intervention (3-month follow-up)	45.8	0.05	No	N/A	OR (1.036); SE (lnOR) (0.916)
Bruzzese 2011	Mean ED visits in the past 2 months	Post intervention (12-month follow-up)	N/A	N/A	Yes - transformed from SMD to OR	SMD (-0.289); SE (0.120)	OR (0.592); SE (lnOR) (0.218)
Cicutto 2005	ED visits in the past year	Post intervention (12-month follow-up)	9.85	0.05	No	N/A	OR (0.697); SE (lnOR) (0.407)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Cicutto 2013	ED visits in the past year (reports of)	Post intervention (12-month follow-up)	7.7	0.05	No	N/A	OR (0.318); SE (lnOR) (0.317)
Clark 2005	ED visits	Post intervention (12-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No, but see notes	N/A	OR (1.002)*; SE (estimated from P value (lnOR)) 0.072 *Note that the OR was reported as 1.00 in the paper with a P value of 0.98. So information could be used and an SE extracted, a small correction to an OR of 1.002 was applied
Gerald 2006	Median ED visits (not combined)	N/A	N/A	N/A	N/A	N/A	N/A
Horner 2008	Any ED visits in the past 12 months (based on parents reporting any stay)	Post intervention (7-month follow-up)	10.1 (reported by study authors)	0.05	No	N/A	OR (0.857); SE (lnOR) (0.461)
Horner 2015	Mean number of ED visits since the previous data collection (8 months)	Post intervention (12-month follow-up)	8.9 (approx.)	0.05	Yes - transformed from SMD to OR	SMD (0); SE (0.169)	OR (1.00); SE (0.306)
Howell 2005	Mean number of ED visits in the past 6 weeks	Post intervention (3-month follow-up)	4.25	0.05	Yes - transformed from SMD to OR	SMD (-0.331); SE (0.578)	OR (0.549); SE (1.049)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Levy 2006	Mean urgent care or emergency visits	Post test (at intervention end)	17.36	0.05	Yes - transformed from SMD to OR	SMD (-0.286) ; SE (0.174)	OR (0.595); SE (0.318)
McGhan 2003	ED visits in the past year (any)	Post intervention (9-month follow-up)	9	0.05	No	N/A	OR (1.283); SE (lnOR) (0.649)
McGhan 2010	ED visits in the past year (any)	Post intervention (12-month follow-up)	8.3	0.05	No	N/A	OR (2.64); SE (lnOR) (0.707)
Persaud 1996	Children with ED Visits (20-week period post intervention)	Post intervention (events in 20-week period post intervention)	N/A	N/A	No	N/A	OR (0.286); SE (lnOR) (0.737)
Velsor-Friedrich 2005	Urgent doctor visits (any in the past 12 months)	Post intervention (12-month follow-up)	13	0.05	No	N/A	OR (0.683); SE (lnOR) (0.933)
Absence from school							
Bruzzese 2011	Mean self-reported absence in past 2 weeks (any absence)	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	SMD (-0.382) ; SE (0.121)
Cicutto 2005	Parent-reported absence (any absence) over a year	Post intervention (12-month follow-up)	9.85	0.05	No	N/A	SMD (-0.256) ; SE (0.151)
Cicutto 2013	Parent-reported absence (any absence) over a year	Post intervention (12-month follow-up)	7.7	0.05	Yes - transformed from odds ratio to SMD	OR (0.660); SE (lnOR) (0.129)	SMD (-0.229) ; SE (0.071)
Gerald 2006	Absences recorded on school records	Post test (unclear duration)	Clustering accounted for in analytical strategy	Clustering accounted for in analytical strategy	No	N/A	SMD (-0.199) ; SE (0.084)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Gerald 2009	Absence from school due to respiratory illness/asthma *December measure used	Post intervention (15-month follow-up)	N/A	N/A	Yes - transformed from odds ratio to SMD	OR (1.1667); SE (lnOR) (0.364)	SMD (0.085); SE (0.227)
Howell 2005	School days missed in past 6 weeks	Post intervention (3-month follow-up)	3.25	0.05	No	N/A	SMD (0.152); SE (0.635)
McGhan 2003	Any missed school days	Post intervention (9-month follow-up)	9	0.05	Yes - transformed from odds ratio to SMD	OR (0.720); SE (lnOR) (0.413)	SMD (-0.181) ; SE (0.227)
McGhan 2010	(No) Missed school days (any) over past 12 months	Post intervention (12-month follow-up)	8.3	0.05	Yes - transformed from odds ratio to SMD	OR (0.640); SE (lnOR) (0.353)	SMD (0.246); SE (0.195) (note: inverse taken as the intervention favours control)
Persaud 1996	Mean school days of absence based on school records	Post intervention (immediately afterwards)	N/A	N/A	No	N/A	SMD (-0.236) ; SE (0.335)
Splett 2006	Mean percentage of days attended	Post intervention (12-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	N/A	SMD (0.019); SE (0.051)
Days of restricted activity							
Bruzzese 2011	Mean self-reported days of restricted activity in past 2 weeks	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	SMD (-0.349) ; SE (0.120)
Cicutto 2005	Days of limited activity due to asthma	Post intervention (12-month follow-up)	9.85	0.05	No	N/A	SMD (-0.318) ; SE (0.151)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Cicutto 2013	Percentage of students reporting days of restricted activity	Post intervention (12-month follow-up)	7.7	0.05	Yes - transformed from odds ratio to SMD	OR (0.612); SE (lnOR) (0.130)	SMD (-0.271); SE (0.072)
Unplanned visits to medical providers							
Bruzzese 2011	Mean acute care visits in the past 2 months	Post intervention (12-month follow-up)	N/A	N/A	Yes - transformed from SMD to OR	SMD (-0.283); SE (0.120)	OR (0.598); SE (0.217)
Cicutto 2013	Unscheduled care in the past year (reports of)	Post intervention (12-month follow-up)	7.7	0.05	No	OR (0.703); SE (lnOR) (0.143)	SMD (-0.194); SE (0.079)
McGhan 2003	Any unscheduled doctor visits	Post intervention (9-month follow-up)	9	0.05	No	OR (0.886); SE (lnOR) (0.426)	SMD (-0.067); SE (0.235)
McGhan 2010	Unscheduled GP visits (any) over past 12 months	Post intervention (12-month follow-up)	8.3	0.05	No	OR (1.169); SE (lnOR) (0.397)	SMD (0.086); SE (0.219)
Splett 2006	Episodic asthma visits to school health office (over 6 months following start of intervention)	Over 6 months following start of intervention	97.6	0.05	No	OR (0.913); SE (lnOR) (0.282)	SMD (-0.046); SE (0.156)
Daytime symptoms							
Atherly 2009	Mean number of days with asthma symptoms	Post intervention (3-month follow-up)	45.8	0.05	No	N/A	SMD (-0.026); SE (0.168)
Bruzzese 2008	Mean days last 2 weeks with asthma symptoms	Post intervention (2-month follow-up)	N/A	N/A	No	N/A	SMD (-0.151); SE (0.418)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Bruzzese 2011	Mean days last 2 weeks with asthma symptoms	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	SMD (-0.210) ; SE (0.120)
Shah 2001	Number of students reporting attacks in school at follow-up	Post intervention (6-month follow-up)	41.8	0.05	Yes - transformed from odds ratio to SMD	OR (0.647); SE (lnOR) (0.488)	SMD (-0.240) ; SE (0.269)
Velsor-Friedrich 2005	Symptom days in past 2 weeks	Post intervention (12-month follow-up)	13	0.05	Yes - transformed from odds ratio to SMD	OR (0.846); SE (lnOR) (0.705)	SMD (-0.030) ; SE (0.413)
Night-time symptoms							
Bruzzese 2008	Mean nights woken last 2 weeks with asthma symptoms	Post intervention (2-month follow-up)	N/A	N/A	No	N/A	SMD (-0.433) ; SE (0.423)
Bruzzese 2011	Mean self-reported night-time awakenings in past 2 weeks	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	SMD (-0.388) ; SE (0.121)
Howell 2005	Mean number of night-time awakenings in past 6 weeks	Post intervention (3-month follow-up)	4.25	0.05	No	N/A	SMD (0.253); SE (0.478)
McGhan 2003	Waking up in past 2 weeks twice or more	Post intervention (9-month follow-up)	9	0.05	Yes - transformed from odds ratio to SMD	OR (1.237); SE (lnOR) (0.412)	SMD (0.117); SE (0.227)
Use of reliever therapies							
Gerald 2009	Rescue medication use over twice per week *November measure used	Post intervention (15-month follow-up)	N/A	N/A	N/A	OR (0.228); SE (lnOR) (0.582)	N/A

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

McGhan 2003	Number of students with appropriate use of reliever medication	Post intervention (9-month follow-up)	9	0.05	N/A	OR (3.48); SE (lnOR) (0.565)	N/A
McGhan 2010	Used short-acting bronchodilators in past 2 weeks	Post intervention (12-month follow-up)	8.3	0.05	N/A	OR (0.878); SE (lnOR) (0.356)	N/A
Splett 2006	Students with access to reliever medication visiting health office (over 6 months following start of intervention) *Note low levels of children with reliever medication	Over 6 months following start of intervention	97.6	0.05	N/A	OR (1.28); SE (lnOR) (0.282)	N/A
Use of corticosteroids and/or use of add-on therapies							
Bruzzese 2011	Use of controller medication	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	OR (1.451); SE (lnOR) (0.240)
Horner 2015	Inhaled corticosteroid adherence	Post intervention (5-month follow-up)	8.9	0.05	No	N/A	SMD (-0.605) ; SE (0.173)
Howell 2005	Inhaled corticosteroid adherence as prescribed (during past week)	Post intervention (3-month follow-up)	4.25	0.05	No	N/A	SMD (0.953); SE (0.546)
McGhan 2003	Currently using inhaled steroids	Post intervention (9-month follow-up)	9	0.05	No	N/A	OR (1.112); SE (lnOR) (0.418)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

McGhan 2010	Currently using inhaled steroids	Post intervention (12-month follow-up)	8.3	0.05	No	N/A	OR (0.962); SE (lnOR) (0.376)
Splett 2006	Students with access to controller medication visiting health office (over 6 months following start of intervention) *Note low levels of children with controller medication	Over 6 months following start of intervention	97.6	0.05	N/A	OR (1.703); SE (lnOR) (0.806)	SMD (0.293); SE (0.445)
Lung function							
Gerald 2009	Poor peak flow measures (red/amber readings)	Post-intervention (15-month follow-up)	N/A	N/A	No	OR (0.94); SE (lnOR) (0.334)	
Horner 2015	Airway inflammation (exhaled nitric oxide, collected using the single-use RTube collection device, was the biomarker of airway inflammation)	Post intervention (12-month follow-up)	8.9	0.05	No	N/A	SMD (-0.011) ; SE (0.169)
Shah 2001	Forced expiratory volume in 1 second: forced vital capacity before bronchodilator	Post intervention (3-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	N/A	SMD (0.074); SE (0.127)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Patterson 2005	Forced expiratory volume in 1 second (% predicted change)	Post intervention (2-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	N/A	SMD (-0.05); SE (0.177)
Velsor-Friedrich 2005	Peak flow increases as a percentage of pretest peak flow (change)	Post intervention (12-month follow-up)	13	0.05	No	N/A	SMD (-5.905) ; SE (0.839)
Quality of life						**Mean difference (QoL only)**	**Standardised mean difference (QoL only)**
Al-Sheyab 2012	Arabic version of the Pediatric Asthma Quality of Life Questionnaire (PAQLQ) *because of uncertainty about SD values, derived from t/P value of difference between means	Post intervention (3-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	MD 1.35 (CI 0.96 to 1.74)	SMD (0.299); SE (0.129)
Cicutto 2005	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Post intervention (2-month follow-up)	9.85	0.05	No	MD 0.50 (CI 0.00 to 1.00)	SMD (0.356); SE (0.151)
Cicutto 2013	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Post intervention (12-month follow-up)	7.7	0.05	No	MD 0.40 (CI 0.21 to 0.59)	SMD (0.308); SE (0.064)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Henry 2004	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Post intervention (6-month follow-up)	15.2	0.05	No	MD 0.16 (CI -0.22 to 0.54)	SMD (0.128); SE (0.114)
Horner 2008	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Post intervention (7-month follow-up)	10.2	0.05	No	MD 0.05 (CI -0.21 to 0.31)	SMD (0.083); SE (0.196)
Howell 2005	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Post intervention (3-month follow-up)	6	0.05	No	MD 0.03 (CI -1.71 to 1.77)	SMD (0.020); SE (0.484)
Kintner 2009	Quality of life is defined through the Participation in Life Activities Scale	Immediately post intervention	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	N/A	SMD (0.583); SE (0.263)
Patterson 2005	Change in Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life	Change in quality of life between baseline and 4 months post intervention	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	MD 0.07 (CI -0.26 to 0.40)	N/A
Shah 2001	Juniper Pediatric Asthma Quality of Life Questionnaire overall quality of life; percentage of students with clinically significant improvement	Post intervention (3-month follow-up)	Deemed that analysis methods accounted for clustering	Deemed that analysis methods accounted for clustering	No	MD 0.09 (CI -0.23 to 0.41)	N/A

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Withdrawal							
Al-Sheyab 2012	Withdrew between baseline and outcome collection	Post intervention (3-month follow-up)	65.25	0.05	No	N/A	OR (0.511); SE (lnOR) (1.074)
Bartholomew 2006	Lost to follow-up at post-test measure	Post intervention (duration unclear)	11.2	0.05	No	N/A	OR (0.237); SE (lnOR) (0.145)
Bruzzese 2008	Withdrew between baseline and outcome collection	Immediate post intervention	N/A	N/A	No	N/A	OR (0.307); SE (lnOR) (1.683)
Bruzzese 2011	Withdrew between baseline and outcome collection	Post intervention (12-month follow-up)	N/A	N/A	No	N/A	OR (1.313); SE (lnOR) (0.279)
Cicutto 2005	Withdrew between baseline and outcome collection	Post intervention (6-month follow-up)	9.85	0.05	No	N/A	OR (1.788); SE (lnOR) (0.629)
Gerald 2009	Withdrew between baseline and outcome collection	Post intervention (6-month follow-up)	N/A	N/A	No	N/A	OR (1.788); SE (lnOR) (0.613)
Horner 2008	Withdrew between baseline and outcome collection	Post intervention (7-month follow-up)	10.2	0.05	No	N/A	OR (1.333); SE (lnOR) (0.531)
Horner 2015	Failed to complete final data collection	Post intervention (12-month follow-up)	8.9	0.05	No	N/A	OR (0.75); SE (lnOR) (0.486)
Kintner 2009	Withdrew during intervention and between end of intervention and follow-up	Post intervention (12-month follow-up)	13.2	0.05	No	N/A	OR (30.176); SE (lnOR) (1.860)

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Table 13. Details of data transformations and adjustments made for meta-analyses (*Continued*)

Levy 2006	Failure to complete outcome evaluation	Post intervention (12-month follow-up)	17.36	0.05	No	N/A	OR (0.357); SE (lnOR) (0.3881)
McGhan 2003	Withdrew between baseline and outcome collection	Post intervention (9-month follow-up)	9	0.05	No	N/A	OR (1.147); SE (lnOR) (0.5381)
McGhan 2010	Withdrew between baseline and interim outcome collection	Post intervention (6-month follow-up)	8.3	0.05	No	N/A	OR (1.007); SE (lnOR) (0.387)
Patterson 2005	Withdrew during intervention	Post intervention - immediately following intervention	7.95	0.05	No	N/A	OR (5.675); SE (lnOR) (1.087)
Shah 2001	Withdrew between baseline and outcome collection	Post intervention (3-month follow-up)	45.3	0.05	No	N/A	OR (1.343); SE (lnOR) (0.475)

CI: confidence interval.
ED: emergency department.
lnOR: log odds ratio.
MD: mean difference.
N/A: not applicable.
OR: odds ratio.
PAQLQ: Pediatric Asthma Quality of Life Questionnaire.
QoL: quality of life.
SD: standard deviation.
SE: standard error.
SMD: standardised mean difference.

Table 14. Summary of interventions, conditions entered, and model results

Domain (model)	Conditions entered	Sufficient configurations identified that trigger successful implementation
1. Setting and participant features	School health centre; high school; parents direct intervention recipients; teachers direct intervention recipients; school nurses/others direct intervention recipients	Yes

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Table 14. Summary of interventions, conditions entered, and model results (*Continued*)

2. Recruitment and retention processes	Additional marketing materials; provision of incentives; provision of catch-up sessions; provision of reminders	No
3. Curriculum, pedagogy, and intervention emphasis	Focus on establishing alliances with care providers; focus on asthma symptom recognition and management; tailored content; emphasis on personal responsibility; interactive pedagogical style; diverse pedagogical style	No
4. Modifiable intervention processes	Theory driven; run in class time; run in students' free time; school nurse key role in delivery or teaching; personalised or individual 1-to-1 instruction	Yes
5. Stakeholder engagement	School asthma policy; child satisfaction; teachers engaged/relationships developed; parents engaged/relationships developed; school nurses engaged/relationships developed	Yes
6. Consolidated model	Theory driven; run in students' free time; child satisfaction; parents engaged/relationships developed; high school	Yes

Table 15. Data table for QCA model 6 - consolidated model

	Successful intervention	High school	Child satisfaction	Theory driven	Intervention takes place during students' own free time	Good relationships/ engagement with parents
Joseph 2010	0.52	1	0	1	0.33	0
Kouba 2012	0.33	1	0	1	1	0
Dore-Stites 2007	0.67	0	1	1	0.33	0.75
Joseph 2013	1.00	1	0	1	0.75	1
Mujuru 2011	0.67	0	0	0	0	0.25
Henry 2004	0.83	1	0	0	0	0
Pike 2011	0.67	0	0	0	0	0

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Table 15. Data table for QCA model 6 - consolidated model (*Continued*)

Spencer 2000	0.33	0	0	0	0.33	1
Engelke 2013	0.50	0.5	0	0	0.33	1
Splett 2006	0.50	0.5	0	0	0.33	0
Kintner 2012	0.83	1	1	1	1	0.25
Berg 2004	0.83	1	1	1	0.33	0
Howell 2005	0.33	0	0.633333	1	0.33	0.75
Gerald 2006	0.33	0	0	0	0.33	0
Langenfeld 2010	0.33	0	0	0	0.33	0
Al-Sheyab 2012	0.83	1	0.633333	1	0.33	0
Levy 2006	0.52	0	0	0	0.33	0
Terpstra 2012	1.00	0.66	0	1	1	0.25
Horner 2015	0.67	0	0	1	1	0
Bruzzese 2008	0.94	0.66	1	1	0.33	1
Lee 2011	0.50	0	0	1	0	0
Bruzzese 2004	0.33	1	0.633333	1	0.75	0
Cicutto 2013	0.67	0	0	1	1	0
Brasler 2006	0.00	0.66	0.633333	0	0.75	0
Crane 2014	0.50	0	0	1	1	0
Bruzzese 2011	0.88	1	0	1	0.33	0
Magzamen 2008	0.19	0.75	0	0	1	0

QCA: qualitative comparative analysis.

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Table 16. Truth table for QCA model 6 - consolidated model

High school	Child satisfaction	Theory driven	Intervention takes place during students' own free time	Good relationships/ engagement with parents	Outcome code (based on consistency score)	Number of studies with membership in causal combination > 0.5	Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Cases
1	1	1	0	0	1	2	1	1	Al-Sheyab 2012; Berg 2004
1	0	1	1	1	1	1	1	1	Joseph 2013
1	1	1	0	1	1	1	1	1	Bruzzese 2008
1	0	1	0	0	1	2	0.924	0.841	Bruzzese 2011; Joseph 2010
1	1	1	1	0	1	2	0.853	0.752	Bruzzese 2004; Kintner 2012
0	1	1	0	1	1	2	0.815	0.668	Dore-Stites 2007; Howell 2005
1	0	1	1	0	0	2	0.768	0.595	Kouba 2012; Terpstra 2012
0	0	0	0	1	0	1	0.763	0	Engelke 2013; Spencer 2000
1	0	0	0	0	0	1	0.762	0.615	Henry 2004

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Table 16. Truth table for QCA model 6 - consolidated model (*Continued*)

0	0	1	1	0	0	3	0.675	0.463	Cicutto 2013; Crane 2014; Horner 2015
0	0	0	0	0	0	5	0.67	0.322	Gerald 2006; Langenfeld 2010; Levy 2006; Mujuru 2011; Pike 2011; Splett 2006
0	0	1	0	0	0	1	0.6	0	Lee 2011
1	0	0	1	0	0	1	0.358	0	Magzamen 2008
1	1	0	1	0	0	1	0	0	Brasler 2006

QCA: qualitative comparative analysis.

Table 17. Complex solution for QCA model 6 - consolidated model

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	CHILD-SAT*THEORYDRI	0.846	0.756	0.106	0.106	Bruzzese 2008; Dore-Stites 2007; Howell 2005
2	HIGH-SCHOOL*CHILDS	0.845	0.786	0.162	0.063	Al-Sheyab 2012; Berg 2004; Bruzzese 2004; Kintner 2012
3	HIGH-SCHOOL*THEOR	0.949	0.914	0.177	0.078	Al-Sheyab 2012; Berg 2004; Bruzzese 2011; Joseph 2010

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Table 17. Complex solution for QCA model 6 - consolidated model (*Continued*)

4	HIGH-SCHOOL*childsat*	1	1	0.064	0.064	Joseph 2013
	M1	0.875	0.823	0.41		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSAT = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

Table 18. Intermediate solution for QCA model 6 - consolidated model

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	HIGH-SCHOOL*CHILDS	0.839	0.791	0.21	0.053	Al-Sheyab 2012; Berg 2004; Bruzzese 2004; Bruzzese 2008; Kintner 2012
2	HIGH-SCHOOL*THEOR	1	1	0.138	0.064	Bruzzese 2008; Joseph 2013
3	HIGH-SCHOOL*THEOR	0.961	0.942	0.235	0.078	Al-Sheyab 2012; Berg 2004; Bruzzese 2008; Bruzzese 2011; Joseph 2013
4	CHILD-SAT*THEORYDRI	0.846	0.756	0.106	0.064	Bruzzese 2008; Dore-Stites 2007; Howell 2005
	M1	0.862	0.81	0.432		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSATB = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

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Table 19. Summary of results from consolidated model

Consolidated model	Theory driven	Run in children's free time	Child satisfaction	Parents engaged/relationships developed	High school	Successful intervention
Pathway 1	Present	-	Present	-	Present	Yes
Pathway 2	Present	-	-	Present	Present	Yes
Pathway 3	Present	Absent	-	-	Present	Yes
Pathway 4	Present	Absent	Present	Present	-	Yes

Absent: absence of condition is essential in triggering success.
Present: presence of condition is essential in triggering success.
- (symbol): presence or absence of condition is not essential in triggering success.

Table 20. Summary of QCA results based on intermediate solutions

Model 1. Setting and participant features	School health centre	High school	Parents direct intervention recipients	Teachers direct intervention recipients	School nurses/others direct intervention recipients		Successful intervention
Pathway 1	Present	Present	Present	Absent	-		Yes
Pathway 2	Absent	Present	Absent	-	-		Yes
Pathway 3	Absent	-	Absent	Absent	Absent		Yes
Pathway 4	Present	Present	Present	-	Present		Yes
Model 2. Recruitment and retention processes	**Additional marketing materials**	**Provision of incentives**	**Provision of catch-up sessions**	**Provision of reminders**			**Successful intervention**
	-	-	-	-	-		No solution found
Model 3. Curriculum, pedagogy, and intervention emphasis	**Focus on establishing alliances with care providers**	**Focus on asthma symptom recognition and management**	**Tailored content**	**Emphasis on personal responsibility**	**Interactive pedagogical style**	**Diverse pedagogical style**	**Successful intervention**

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Table 20. Summary of QCA results based on intermediate solutions (*Continued*)

	-	-	-	-	-		No solution found
Model 4. Modifiable intervention processes	**Theory driven**	**Run in class time**	**Run in students' free time**	**School nurse key role in delivery or teaching**	**Personalised or individual 1-to-1 instruction**		**Successful intervention**
Pathway 1	Present	-	Absent	Absent	-		Yes
Pathway 2	Present	-	-	Present	Absent		Yes
Model 5. Stakeholder engagement	**School asthma policy**	**Child satisfaction**	**Teachers engaged/ relationships developed**	**Parents engaged/ relationships developed**	**School nurses engaged/ relationships developed**		**Successful intervention**
Pathway 1	Absent	-	-	Present	Absent		Yes
Pathway 2	-	Present	-	-	Absent		Yes
Model 6. Consolidated model	**Theory driven**	**Run in students' free time**	**Child satisfaction**	**Parents engaged/ relationships developed**	**High school**		**Successful intervention**
Pathway 1	Present	-	Present	-	Present		Yes
Pathway 2	Present	-	-	Present	Present		Yes
Pathway 3	Present	Absent	-	-	Present		Yes
Pathway 4	Present	Absent	Present	Present	-		Yes

Absent: absence of condition is essential in triggering success.
Present: presence of condition is essential in triggering success.
QCA: qualitative comparative analysis.
- (symbol): presence or absence of condition is not essential in triggering success.

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Table 21. Truth table for QCA model 1 - setting and participants

School-based health centre	High school	Parents directly involved	Teachers received training	School nurses or other stakeholders received training	Outcome code (based on consistency score)	Number of studies with membership in causal combination > 0.5	Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Cases
1	1	0	1	0	1	2	1	1	Bruzzese 2008; Terpstra 2012
1	0	1	0	0	1	1	1	1	Henry 2004
1	1	1	1	1	1	1	1	1	Kintner 2012
0	0	1	0	1	1	1	0.995	0.99	Cicutto 2013
0	0	0	0	0	1	2	0.918	0.588	Crane 2014; Pike 2011
1	0	0	0	0	1	1	0.889	0.811	Al-Sheyab 2012
1	1	0	0	1	0	2	0.865	0.662	Bruzzese 2004; Bruzzese 2011
1	1	0	0	0	0	4	0.852	0.761	Berg 2004; Joseph 2010; Joseph 2013; Magzamen 2008
0	1	0	0	0	0	4	0.845	0.543	Horner 2015; Langenfeld 2010; Lee 2011;

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Table 21. Truth table for QCA model 1 - setting and participants (*Continued*)

									Mujuru 2011
0	0	1	0	0	0	1	0.763	0.136	Levy 2006
0	1	1	0	0	0	1	0.754	0	Gerald 2006
1	0	0	1	0	0	1	0.751	0.647	Kouba 2012
0	1	0	1	0	0	3	0.73	0.56	Dore-Stites 2007; Howell 2005; Spencer 2000
1	1	1	1	0	0	1	0	0	Brasler 2006

QCA: qualitative comparative analysis.

Table 22. Complex solution for QCA model 1 - setting and participants

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	HIGH-SCHOOL*schoolba	0.913	0.861	0.176	0.043	Al-Sheyab 2012; Henry 2004
2	schoolbased-health*teacherdirect	0.913	0.769	0.294	0.16	Al-Sheyab 2012; Crane 2014; Pike 2011
3	high-school*schoolbasedh	0.995	0.99	0.042	0.042	Cicutto 2013
4	HIGH-SCHOOL*SCHOC	1	1	0.105	0.105	Bruzzese 2008; Terpstra 2012
5	HIGH-SCHOOL*SCHOC	1	1	0.074	0.074	Kintner 2012
	M1	0.952	0.901	0.558		

QCA: qualitative comparative analysis.

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[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); SCHOOLBASEDHEALTH = School Based Health Centre; TEACHERDIRECT = Teachers received directly received component of intervention; PARENTDIRECT = Parents directly received component of intervention; ANYOTHDIR = School nurses or other stakeholders (apart from children) directly received component of intervention; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

Table 23. Intermediate solution for QCA model 1 - setting and participants

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	HIGH-SCHOOL*schoolba	0.904	0.838	0.226	0.093	Al-Sheyab 2012; Henry 2004
2	HIGH-SCHOOL*SCHOC	1	1	0.105	0.105	Bruzzese 2008; Terpstra 2012
3	schoolbased-health*teacherdirect*	0.913	0.769	0.294	0.16	Crane 2014; Pike 2011
4	high-school*TEACHERD	0.778	0.5	0.074	0.042	Cicutto 2013
5	HIGH-SCHOOL*SCHOC	1	1	0.074	0.042	Kintner 2012
	Solution	0.915	0.831	0.608		

QCA: qualitative comparative analysis.

Overall solution

HIGHSCHOOL*schoolbasedhealth*parentdirect +
schoolbasedhealth*teacherdirect*parentdirect*anyothdir +
HIGHSCHOOL*SCHOOLBASEDHEALTH*teacherdirect*PARENTDIRECT +
(highschool*TEACHERDIRECT*ANYOTHDIR +
HIGHSCHOOL*SCHOOLBASEDHEALTH*PARENTDIRECT*ANYOTHDIR)
=> SUCCESSFULIMPLEMENTATION

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); SCHOOLBASEDHEALTH = School Based Health Centre; TEACHERDIRECT = Teachers received directly received component of intervention; PARENTDIRECT = Parents directly received component of intervention; ANYOTHDIR = School nurses or other stakeholders (apart from children) directly received component of intervention; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

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Table 24. Data table for QCA model 3 - curriculum, pedagogy, and intervention emphasis

	Successful intervention	Curriculum reflected forming alliances and monitoring symptoms	Curriculum reflected learning about asthma triggers and monitoring symptoms	Emphasised the intervention as being tailored or personalised	Emphasised developing personal responsibility as aim of the intervention	Pedagogical style focused on interactive methods	Diverse pedagogical style employed
Joseph 2010	0.52	0	1	1	0	0	0
Kouba 2012	0.33	0	0	0	1	0	0
Dore-Stites 2007	0.67	1	0	0	1	0	0
Joseph 2013	1.00	0	1	1	0	0	1
Mujuru 2011	0.67	0	1	0	0	0	0
Henry 2004	0.83	0	0	0	0	0	0
Pike 2011	0.67	0	1	0	0	0	0
Spencer 2000	0.33	0	0	0	0	1	0
Engelke 2013	0.50	0	0	0	0	0	1
Splett 2006	0.50	0	0	0	0	1	0
Kintner 2012	0.83	0	1	0	0	0	0
Berg 2004	0.83	0	1	1	0	0	0
Howell 2005	0.33	0	1	0	0	0	0
Gerald 2006	0.33	1	0	0	0	0	0
Cheung 2015	0.33	0	0	0	1	0	0
Al-Sheyab 2012	0.83	0	1	0	1	0	1
Levy 2006	0.52	0	0	0	0	0	1
Terpstra 2012	1.00	1	0	0	1	0	0
Horner 2015	0.67	1	0	0	1	0	0

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Table 24. Data table for QCA model 3 - curriculum, pedagogy, and intervention emphasis (*Continued*)

Bruzzese 2008	0.94	0	1	0	1	0	0
Lee 2011	0.50	0	0	0	0	0	1
Bruzzese 2004	0.33	0	0	1	0	0	0
Cicutto 2013	0.67	1	0	0	0	0	0
Brasler 2006	0.00	0	1	0	0	0	0
Crane 2014	0.50	0	0	0	1	0	0
Bruzzese 2011	0.88	0	0	1	0	0	0
Magzamen 2008	0.19	0	1	0	0	0	0

QCA: qualitative comparative analysis.

Table 25. Truth table for QCA model 3 - curriculum, pedagogy, and intervention emphasis

Curriculum reflected forming alliances and monitoring symptoms	Curriculum reflected learning about asthma triggers and monitoring symptoms	Emphasised the intervention as being tailored or personalised	Emphasised developing personal responsibility as aim of the intervention	Pedagogical style focused on interactive methods	Diverse pedagogical style employed	Outcome code (based on consistency score)	Number of studies with membership in causal combination > 0.5	Consistency score with subset relationship (n=27 in each assessment); [proportional reduction in inconsistency]	Cases
0	1	1	0	0	1	1	1	1 [1]	Joseph 2013
0	1	0	1	0	0	1	1	0.938 [0.9333]	Bruzzese 2008
0	0	0	0	0	0	0	1	0.833 [0.8]	Henry 2004
0	1	0	1	0	1	0	1	0.833 [0.8]	Al-Sheyab 2012

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Table 25. Truth table for QCA model 3 - curriculum, pedagogy, and intervention emphasis (*Continued*)

1	0	0	1	0	0	0	3	0.778 [0.714]	Dore-Stites 2007; Horner 2015; Terpstra 2012
0	1	1	0	0	0	0	2	0.677 [0.523]	Berg 2004; Joseph 2010
0	0	1	0	0	0	0	2	0.604 [0.486]	Bruzzese 2004; Bruzzese 2011
0	0	0	0	0	1	0	3	0.507 [0.027]	Engelke 2013; Lee 2011; Levy 2006
1	0	0	0	0	0	0	2	0.5 [0.25]	Cicutto 2013; Gerald 2006
0	1	0	0	0	0	0	6	0.448 [0.287]	Brasler 2006; Howell 2005; Kintner 2012; Magzamen 2008; Mujuru 2011; Pike 2011
0	0	0	0	1	0	0	2	0.417 [0]	Spencer 2000; Splett 2006
0	0	0	1	0	0	0	3	0.389 [0]	Crane 2014; Kouba 2012;

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Table 25. Truth table for QCA model 3 - curriculum, pedagogy, and intervention emphasis (*Continued*)

									Langenfeld 2010

QCA: qualitative comparative analysis.

Table 26. Truth table for QCA model 4 - modifiable design features

Theory driven	Personalised or individual sessions	Intervention takes place during lesson time	Intervention takes place during students' own free time	School nurse involved in delivery of the intervention	Outcome code (based on consistency score)	Number of studies with membership in causal combination > 0.5	Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Cases
1	0	0	0	1	1	2	1	1	Bruzzese 2008; Dore-Stites 2007
1	0	0	0	0	1	1	1	1	Al-Sheyab 2012
1	0	1	1	1	1	1	1	1	Kintner 2012
1	1	0	0	0	1	1	0.996	0.993	Bruzzese 2011
1	0	0	1	1	1	1	0.931	0.816	Joseph 2010
1	1	1	0	0	1	2	0.931	0.872	Crane 2014; Terpstra 2012
1	0	1	0	1	1	1	0.903	0.729	Lee 2011
1	1	1	1	0	0	2	0.852	0.729	Bruzzese 2004; Joseph 2013
1	0	0	1	0	0	2	0.833	0.706	Cicutto 2013;

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Table 26. Truth table for QCA model 4 - modifiable design features (*Continued*)

									Horner 2015
1	1	0	0	1	0	2	0.753	0.602	Berg 2004; Howell 2005
1	1	0	1	0	0	1	0.732	0.481	Kouba 2012
0	0	1	0	0	0	5	0.659	0.035	Engelke 2013; Langenfeld 2010; Levy 2006; Spencer 2000; Splett 2006
0	1	0	0	1	0	0	4	0.638	0.484
0	0	1	1	1	0	0	1	0.5	0
0	0	0	1	1	0	0	1	0.444	0

QCA: qualitative comparative analysis.

Table 27. Complex solution for QCA model 4 - modifiable design features

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	THEORY-DRIVEN*personalo	0.926	0.876	0.253	0.148	Bruzzese 2008; Crane 2014; Dore-Stites 2007; Kintner 2012; Lee 2011; Terpstra 2012
2	THEORY-DRIVEN*PERSON	0.938	0.866	0.151	0.033	Bruzzese 2011; Joseph 2013
3	THEORY-DRIVEN*personalo	0.999	0.998	0.149	0.001	Al-Sheyab 2012a; Bruzzese 2008; Dore-Stites 2007

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Table 27. Complex solution for QCA model 4 - modifiable design features (*Continued*)

	M1	0.933	0.883	0.426		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; SCHOOLNURSEINSTRUCT = Substantial component delivered by schools' nurse; PERSONALORINDIVIDUAL = Substantial components delivered that were individually personalised or delivered to individuals; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); RUNINLESSONS = Substantial component run during lesson time; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

Table 28. Intermediate solution for QCA model 4 - further modifiable intervention design features

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	THEORY-DRIVEN*personalo	0.926	0.876	0.253	0.167	Bruzzese 2008; Crane 2014; Dore-Stites 2007; Kintner 2012; Lee 2011; Terpstra 2012
2	THEORY-DRIVEN*runinstud	0.963	0.92	0.258	0.172	Al-Sheyab 2012; Bruzzese 2011; Joseph 2010
	M1	0.933	0.883	0.425		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; SCHOOLNURSEINSTRUCT = Substantial component delivered by schools' nurse; PERSONALORINDIVIDUAL = Substantial components delivered that were individually personalised or delivered to individuals; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); RUNINLESSONS = Substantial component run during lesson time; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

Overall solution

THEORYDRIVEN*runinstudenttime*schoolnurseinstruct +
THEORYDRIVEN*personalorindividual*SCHOOLNURSEINSTRUCT => PROCOUTSUM

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Table 29. Truth table for QCA model 5 - stakeholder involvement and engagement

	School asthma policy	Good relationships/ engagement with parents	Good relationships/ engagement with school nurses	Child satisfaction	Outcome code (based on consistency score)	Number of studies with membership in causal combination > 0.5	Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Cases
1	0	1	0	0	1	1	1	1	Joseph 2013
2	0	1	0	1	1	1	0.958	0.939	Bruzzese 2008
3	0	0	0	1	1	4	0.857	0.786	Al-Sheyab 2012; Berg 2004; Bruzzese 2004; Kintner 2012
4	0	1	1	1	0	2	0.723	0.465	Dore-Stites 2007; Howell 2005
5	1	0	0	0	0	3	0.674	0.515	Cicutto 2013; Henry 2004; Levy 2006
6	0	0	0	0	0	10	0.615	0.405	Bruzzese 2011; Gerald 2006; Horner 2015; Joseph 2010; Kouba 2012; Lee 2011; Magzamen 2008;

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Table 29. Truth table for QCA model 5 - stakeholder involvement and engagement (*Continued*)

									Mujuru 2011; Pike 2011; Terpstra 2012
7	0	0	1	0	0	1	0.6	0	Crane 2014
8	1	1	0	0	0	1	0.5	0	Engelke 2013
9	0	1	1	0	0	1	0.488	0	Spencer 2000
10	1	0	1	0	0	2	0.352	0	Langenfeld 2010; Splett 2006
11	1	0	1	1	0	1	0	0	Brasler 2006

QCA: qualitative comparative analysis.

Table 30. Complex solution for QCA model 5 - stakeholder involvement and engagement

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	anysch-pol*goodrelnur*CHI	0.846	0.794	0.243	0.152	Al-Sheyab 2012; Berg 2004; Bruzzese 2004; Bruzzese 2008; Kintner 2012
2	anysch-pol*GOODRELPAI	0.979	0.972	0.187	0.095	Bruzzese 2008; Joseph 2013
	M1	0.884	0.849	0.339		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: ANYSCHPOL = School asthma policy; GOODRELNUR = Good level of engagement and/or developing relationships with school nurses; GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSAT = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

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Table 31. Intermediate solution for QCA model 5 - stakeholder involvement and engagement

		Consistency score with subset relationship (n = 27 in each assessment)	Proportional reduction in inconsistency	Raw coverage	Unique coverage	Cases
1	goodrelnur*CHILDSAT	0.846	0.794	0.243	0.152	Al-Sheyab 2012; Berg 2004; Bruzzese 2004; Bruzzese 2008; Kintner 2012
2	anyschpol*GOODRELGP/	0.979	0.972	0.187	0.095	Bruzzese 2008; Joseph 2010
	M1	0.884	0.849	0.339		

QCA: qualitative comparative analysis.

[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: ANYSCHPOL = School asthma policy; GOODRELNUR = Good level of engagement and/or developing relationships with school nurses; GOODRELGPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSAT = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]

APPENDICES

Appendix 1. Sources and search methods for the Cochrane Airways Group Specialised Register (CAGR)

Electronic searches: core databases

Database	Frequency of search
CENTRAL	Monthly
MEDLINE (Ovid)	Weekly
Embase (Ovid)	Weekly
PsycINFO (Ovid)	Monthly
CINAHL (EBSCO)	Monthly

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(*Continued*)

AMED (EBSCO)	Monthly

Handsearches: core respiratory conference abstracts

Conference	Years searched
American Academy of Allergy, Asthma and Immunology (AAAAI)	2001 onwards
American Thoracic Society (ATS)	2001 onwards
Asia Pacific Society of Respirology (APSR)	2004 onwards
British Thoracic Society Winter Meeting (BTS)	2000 onwards
Chest Meeting	2003 onwards
European Respiratory Society (ERS)	1992, 1994, 2000 onwards
International Primary Care Respiratory Group Congress (IPCRG)	2002 onwards
Thoracic Society of Australia and New Zealand (TSANZ)	1999 onwards

MEDLINE search strategy used to identify trials for the CAGR

Asthma search

1. exp Asthma/
2. asthma$.mp.
3. (antiasthma$ or anti-asthma$).mp.
4. Respiratory Sounds/
5. wheez$.mp.
6. Bronchial Spasm/
7. bronchospas$.mp.
8. (bronch$ adj3 spasm$).mp.
9. bronchoconstrict$.mp.
10. exp Bronchoconstriction/
11. (bronch$ adj3 constrict$).mp.
12. Bronchial Hyperreactivity/
13. Respiratory Hypersensitivity/
14. ((bronchial$ or respiratory or airway$ or lung$) adj3 (hypersensitiv$ or hyperreactiv$ or allerg$ or insufficiency)).mp.
15. ((dust or mite$) adj3 (allerg$ or hypersensitiv$)).mp.
16. or/1-15

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Filter to identify RCTs

1. exp "clinical trial [publication type]"/
2. (randomised or randomised).ab,ti.
3. placebo.ab,ti.
4. dt.fs.
5. randomly.ab,ti.
6. trial.ab,ti.
7. groups.ab,ti.
8. or/1-7
9. Animals/
10. Humans/
11. 9 not (9 and 10)
12. 8 not 11

The MEDLINE strategy and RCT filter are adapted to identify trials in other electronic databases.

Appendix 2. Search strategy to identify relevant trials from the CAGR (via the Cochrane Register of Studies - CRS)

#1 AST:MISC1
#2 MeSH DESCRIPTOR Asthma Explode All
#3 asthma*:ti,ab
#4 #1 or #2 or #3
#5 MeSH DESCRIPTOR Schools Explode All
#6 MeSH DESCRIPTOR School Health Services
#7 MeSH DESCRIPTOR School Nursing
#8 school*:ti,ab,kw
#9 academ*:ti,ab,kw
#10 colleg*:ti,ab,kw
#11 lesson*:ti,ab,kw
#12 pupil*:ti,ab,kw
#13 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12
#14 MeSH DESCRIPTOR Self Care Explode All
#15 MeSH DESCRIPTOR Health Education Explode All
#16 MeSH DESCRIPTOR Case Management
#17 MeSH DESCRIPTOR Patient Education as Topic
#18 educat*:ti,ab,kw
#19 manag*:ti,ab,kw
#20 self-car*:ti,ab,kw
#21 self NEXT car*:ti,ab,kw
#22 train*:ti,ab,kw
#23 instruct*:ti,ab,kw
#24 teach*:ti,ab,kw
#25 patient-cent*:ti,ab,kw
#26 patient NEXT cent*:ti,ab,kw
#27 MeSH DESCRIPTOR Patient-Centered Care
#28 patient-focus*:ti,ab,kw
#29 patient NEXT focus*:ti,ab,kw
#30 coach*:ti,ab,kw
#31 skill*:ti,ab,kw
#32 knowledge NEXT develop*:ti,ab,kw
#33 tutor*:ti,ab,kw
#34 #14 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33
#35 #4 AND #13 AND #34

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[Note: in search line #1, MISC1 denotes the field in the record in which the reference has been coded for condition, in this case, asthma]

Appendix 3. CENTRAL search strategy

Ti ab kw combined rather than ti; ab for asthma

#1	MESH DESCRIPTOR asthma EXPLODE ALL TREES
#2	asthma*:TI,AB,KY
#3	#1 OR #2
#4	MESH DESCRIPTOR Schools EXPLODE ALL TREES
#5	MESH DESCRIPTOR School Health Services EXPLODE ALL TREES
#6	MESH DESCRIPTOR School Nursing EXPLODE ALL TREES
#7	school*:TI,AB,KY OR academ*:TI,AB,KY OR colleg*:TI,AB,KY OR lesson*:TI,AB,KY OR pupil*:TI,AB,KY
#8	#4 OR #5 OR #6 OR #7
#9	educat*:TI,AB,KY OR manag*:TI,AB,KY OR self-car*:TI,AB,KY OR self NEXT car*:TI,AB,KY OR train*:TI,AB,KY OR instruct*:TI,AB,KY OR teach*:TI,AB,KY OR patient-cent*:TI,AB,KY OR patient NEXT cent*:TI,AB,KY OR patient-focus*:TI,AB,KY OR patient NEXT focus*:TI,AB,KY OR coach*:TI,AB,KY OR skill*:TI,AB,KY OR knowledge NEXT develop*:TI,AB,KY OR tutor*:TI,AB,KY
#10	MESH DESCRIPTOR Self Care EXPLODE ALL TREES
#11	MESH DESCRIPTOR Health Education EXPLODE ALL TREES
#12	MESH DESCRIPTOR Case Management EXPLODE ALL TREES
#13	MESH DESCRIPTOR Patient Education EXPLODE ALL TREES
#14	MESH DESCRIPTOR Patient-Centred Care EXPLODE ALL TREES
#15	#9 OR #10 OR #11 OR #12 OR #13 OR #14
#16	#3 AND #8 AND #15

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Appendix 4. CT.gov search strategy

#1 AST:MISC1
#2 MeSH DESCRIPTOR Asthma Explode All
#3 asthma*:ti,ab
#4 #1 or #2 or #3
#5 MeSH DESCRIPTOR Schools Explode All
#6 MeSH DESCRIPTOR School Health Services
#7 MeSH DESCRIPTOR School Nursing
#8 school*:ti,ab,kw
#9 academ*:ti,ab,kw
#10 colleg*:ti,ab,kw
#11 lesson*:ti,ab,kw
#12 pupil*:ti,ab,kw
#13 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12
#14 MeSH DESCRIPTOR Self Care Explode All
#15 MeSH DESCRIPTOR Health Education Explode All
#16 MeSH DESCRIPTOR Case Management
#17 MeSH DESCRIPTOR Patient Education as Topic
#18 educat*:ti,ab,kw
#19 manag*:ti,ab,kw
#20 self-car*:ti,ab,kw
#21 self NEXT car*:ti,ab,kw
#22 train*:ti,ab,kw
#23 instruct*:ti,ab,kw
#24 teach*:ti,ab,kw

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(*Continued*)

#25 patient-cent*:ti,ab,kw
#26 patient NEXT cent*:ti,ab,kw
#27 MeSH DESCRIPTOR Patient-Centered Care
#28 patient-focus*:ti,ab,kw
#29 patient NEXT focus*:ti,ab,kw
#30 coach*:ti,ab,kw
#31 skill*:ti,ab,kw
#32 knowledge NEXT develop*:ti,ab,kw
#33 tutor*:ti,ab,kw
#34 #14 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33
#35 #4 AND #13 AND #34

Appendix 5. CINAHL search strategy

#1	asthma*
#2	(MH "Asthma+")
#3	(MH "Schools+") OR (MH "School Health Services+") OR (MH "School Nursing+") OR school* OR academ* OR colleg* OR lesson* OR pupil*
#4	(MH "Self Care+") OR (MH "Health Education+") OR (MH "Case Management+") OR (MH "Patient Education+") OR educat* OR manag* OR self-car* OR self n1 car* OR train* OR instruct* OR teach* OR patient-cent*
#5	patient n1 cent* OR (MH "Patient-Centred Care+") OR patient-focus* OR patient N1 focus* OR coach* OR skill* OR knowledge n1 develop* OR tutor*
#6	S4 OR S5
#7	S1 OR S2
#8	S3 AND S6 AND S7

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Appendix 6. AMED search strategy

#1	exp Asthma/
#2	exp Schools/
#3	asthma*.mp. [mp=title, other title, abstract, heading words]
#4	1 or 3
#5	exp School health services/
#6	exp School nursing/
#7	(school* or academ* or colleg* or lesson* or pupil*).mp. [mp=title, other title, abstract, heading words]
#8	2 or 5 or 6 or 7
#9	(educat* or manag* or self-car* or train* or instruct* or teach* or patient-cent* or coach* or skill* or tutor*).mp. [mp=title, other title, abstract, heading words]
#10	((self adj1 car*) or (patient adj1 cent*) or (patient adj1 focus*) or (knowledge adj1 develop*)).mp. [mp=title, other title, abstract, heading words]
#11	exp Self care/
#12	exp Health education/
#13	exp Case management/
#14	exp Patient education/
#15	exp patient centred care/
#16	9 or 10 or 11 or 12 or 13 or 14 or 15
#17	4 and 8 and 16
#18	from 17 keep 1-100
#19	limit 18 to yr="1995 -Current"

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Appendix 7. Embase search strategy

#1	'Asthma'
#2	'Schools'
#3	'School Health Services'
#4	'School Nursing'
#5	'School'
#6	Academy'
#7	'Academic'
#8	'Academies'
#9	'college'
#10	'Colleges'
#11	'lesson'
#12	'Lessons'
#13	'pupil'
#14	'Pupils'
#15	#2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14
#16	'Self Care'
#17	'Health Education'
#18	'Case Management'
#19	'Patient Education'
#20	'Educate'
#21	'Education'
#22	'Educator'
#23	'Manage'
#24	'Management'

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(*Continued*)

#25	'self-care'
#26	'train'
#27	'Training'
#28	'trainer'
#29	'Instruct'
#30	'instructor'
#31	'Instruction'
#32	'teach'
#33	'Teacher'
#34	'patient-center'
#35	'patient center'
#36	'Patient-Centered Care'
#37	'patient-focus'
#38	'patient focus'
#39	'Coach'
#40	'skill'
#41	'Skills'
#42	'knowledge develop'
#43	'Tutor'
#44	#16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or # 33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43
#45	#1 AND #15 AND #44

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Appendix 8. Additional information on the synthesis of process evaluation data and qualitative comparative analysis

Background and theoretical basis for qualitative comparative analysis (QCA)

The QCA approach was developed in the political sciences during the 1980s by Charles Ragin (Ragin 2008), and in turn was based on mathematical developments in electrical engineering and analytical philosophy (Miech 2015; Thiem 2015). In its application within political sciences, QCA was utilised in comparing the characteristics of nations to enhance understanding of the conditions associated with different forms of governance and rule (Thomas 2014). Since then, its use has broadened, and it has been applied in as fields as diverse as ecology (e.g. Hellström 2001), education (Cooper 2005), and dentistry (Singh 2012). In each case, QCA was employed as a solution to the challenge of analysing data containing a small number of cases, each with an extensive array of conditions that may be necessary to trigger a given outcome. This 'small N-many variables' challenge is similar to that often faced by systematic review authors, and we followed the approach developed by Thomas and colleagues in employing QCA to understand conditions associated with our outcome of interest based on published data within primary studies (Thomas 2014). In this review, however, rather than attempting to understand how different configurations of conditions are associated with differentials in effect size (see further examples in Brunton 2014 and Brunton 2014a), we explored their association with different levels of implementation success.

QCA has its basis in set-theoretic logic, and it can be conceptualised as bridging the qualitative and quantitative divide, not only in terms of the types of data employed to undertake QCA but also in the research process and theoretical standpoints taken during stages of the QCA. Aspects of QCA that are aligned with a qualitative standpoint include the iterative process of case selection, reconceptualisation of conditions (or variables), and reconceptualisation of the outcome of interest that takes place during the model specification (Schneider 2010); in this review, the approach adopted very much mirrors the hypothesis-generating role of qualitative research. In contrast, exploration of patterns in their alignment of conditions with the outcome of interest mirrors the quantitative practice of testing variables simultaneously in a regression framework (Schneider 2010). Unlike most quantitative research, QCA is based on set-theoretic principles, where the focus is on sets of conditions as units, rather than on the individual constituent components. This is aligned closely with the statements that social scientists routinely make about the nature of social phenomena that involve descriptions of groups as subsets of larger groups (Ragin 2008). Furthermore, the nature of these relationships is asymmetrical, unlike the symmetrical principles of statistical correlational research.

QCAs allow us to consider two aspects of set relationships. First, the number of those with an outcome who share a given condition, and second, the number with a given condition who share an outcome. The first aspect allows us to consider the degree to which a condition is a 'necessary' component of triggering the outcome (necessity); the second allows us to consider the extent to which a given condition is a sufficient condition for triggering the outcome (sufficiency), with particular application to exploring combinations of cases (Ragin 2008). It It is this second application that is of greatest interest, as it allows us to consider more complex configurations that may trigger an outcome. QCA allows for quantification of these relationships through exploration of different combinations of conditions that achieve an outcome. QCA was developed first by exploring conditions in binary form, although later extensions have allowed for fuzzy-set QCA that allows for ambiguity in both outcome and condition sets (Ragin 2009).

A set membership score for each case based on its characteristics is calculated from the data table, and these are analysed against outcome membership scores. Subset relationships are identified by observing when the membership scores in one set (i.e. a combination of conditions) are *consistently* less than those in another set (i.e. outcome) (see Ragin 2009). In line with the guidance set out by Ragin (Ragin 2009), and reflective of the size of the data set, we set a frequency threshold of one around the number of cases with a membership score greater than 0.5 in each combination (i.e. configuration of conditions and outcomes). QCA is reliant on Boolean algebra to reduce multiple configurations of conditions that lead to outcomes to their instrumental parts, to form a parsimonious solution. Although QCA is analogous in some ways to data reduction techniques employed in statistical analyses, the conditions tested in QCA analyses are included only on the basis of pre-existing theoretical knowledge of the analyst. In this case, our logic model, presented in Figure 1, helped to guide much of our thinking.

Explanation and example of coding strategy

We developed a strategy involving direct and indirect transformation in assembling our data for the QCA. For example, we developed a single variable to reflect whether an intervention took place within a high school. Those interventions that took place exclusively within high schools were assigned a value of 1 (fully within the set), and those that took place exclusively within elementary/primary schools were assigned a value of 0. Further details of this example are found below in Table 1.

Appendix Table 1. Example coding of direct assignment of values - whether the intervention took place in a high school

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Condition = high school	Directly assigned value
High school(s)	1
High schools and junior/middle schools	0.75
Junior/middle school(s)	0.66
Missing information on age	0.5
Primary/elementary school(s)	0

When values were directly assigned in this way, no further calibration was required. In other cases, the assignment followed a combination of direct and transformational assignment. Direct assignment involves a researcher directly assigning values (usually based on categorical or binary source indicators); transformational assignment involves developing rules for how values that are more continuous in nature (and not necessarily bounded by 0 and 1) are coded between zero and one. Transformational assignment was conducted using R, as was most of the QCA synthesis, and a full explanation of transformational assignment and the underlying theoretical principles is provided in Thiem and Dusa (Thiem 2012). In all cases, transformational assignment was based on positive endpoint values, and involved setting thresholds indicating full exclusion from a set, a cross-over point (maximum ambiguity (0.5); which was also used in the case of missing data), and a threshold for full inclusion. An example is provided in Appendix Table 2 below for identification of whether an intervention could be considered a 'large' intervention based on the total number of students involved.

Appendix Table 2. Example coding of transformational assignment of values - whether the intervention was a large intervention

Condition = large intervention	Threshold values
Large interventions (whole school interventions taking place in large schools)	300
Moderately large interventions (approximately 3 classes in the intervention) (maximum ambiguity)	90
Small interventions (less than a single class)	15

We extracted information supporting several conditions (over 90) for studies. We identified five key domains in which these belonged.

- Outcome: process outcomes.
- Condition group 1: setting and participants.
- Condition group 2: programme design.
- Condition group 3: programme content and style.
- Condition group 4: additional processes undertaken to facilitate implementation (planned and unplanned).

To limit the problem of limited diversity, when a large number of possible logical combinations are not supported by cases, we tested the relationship between each condition group and the outcome separately to identify the individual pathway recipes to successful implementation. We then consolidated the information to understand the instrumental components across all four groups and their membership in the outcome set. This approach is analogous to stepwise entry of antecedent variables into a regression model.

Initial results from QCA modelling: a single domain

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Model 1. Setting and participant characteristics

We initially considered constructing sets based on a number of conditions (size of intervention, presence of existing health facilities in schools, high schools, black and minority ethnic students, low socio-economic status, whether teachers received additional training, whether school nurses or others received additional training, and whether parents received an intervention). However, given that we were working with 27 studies, we were concerned that limited diversity would be an issue and re-examined the theoretical justification for inclusion of each condition. In the case of the condition measuring the size of the intervention, we were concerned that this would reflect only a distinction between whether the intervention was a pilot/feasibility study or a full intervention and would not reflect modifiable 'process' and interaction with context per se. With regards to ethnicity and socio-economic status of children, we were concerned that this would be uninformative with regards to modifiable 'processes' and their interaction with context, and we did not include these conditions in the model. A data table and a truth table were constructed for the five remaining conditions (see Table 3 and Table 21).

The truth table showed six configurations that were indicative of a subset relationship with the outcome set and showed good distribution of configurations associated with the outcome and its negation. Several studies formed sets with high levels of consistency, and five showed proportional reduction in inconsistency (PRI) scores above 0.6. PRI is indicative of how distinct a subset configuration is of the outcome compared to negation of the outcome. No suggestions were provided as to an adequate threshold for PRI scores, although 0.6 falls between high and low values suggested elsewhere (Schwellnus 2013). We then proceeded to explore whether the truth table contained contradictory configurations. As we were conducting fsQCA, identification of contradictory configurations was less straightforward than would be the case for crisp-set QCA, and we explored the stability of rows supported by multiple cases for potential contradictory configurations, primarily by examining the original data in Table 3, although we found no evidence.

A complex solution was generated through Boolean minimisation (Table 22), suggesting five pathways towards generating the outcome of interest. We then incorporated information from logical remainders making explicit hypotheses that the presence of school-based health services (including school nurses), the involvement of parents, and the provision of additional training for teachers and other stakeholders would be beneficial to a successful intervention, but making no specific hypotheses about the impact of the intervention conducted in a high school. The intermediate solution gave four potential minimal sums (Table 23), each of which contained three essential prime implicants (three essential routes to the outcome) and two inessential prime implicants (interchangeable routes to the outcome needed to complete the minimal sum). Selection of the minimal solution was based on the most theoretically plausible; we also confirmed that no contradictory simplifying assumptions were made on the outcome and its negation. We explored whether any of the prime implicants selected were associated with negation of the outcome, finding little evidence based on consistency scores achieved for 'unsuccessful' interventions. The solution is displayed below (where upper case notation represents that the condition is present, and lower case represents that the condition is absent).

Overall solution

HIGHSCHOOL*schoolbasedhealth*parentdirect +
schoolbasedhealth*teacherdirect*parentdirect*anyothdir +
HIGHSCHOOL*SCHOOLBASEDHEALTH*teacherdirect*PARENTDIRECT +
(highschool*TEACHERDIRECT*ANYOTHDIR +
HIGHSCHOOL*SCHOOLBASEDHEALTH*PARENTDIRECT*ANYOTHDIR)
=> SUCCESSFULIMPLEMENTATION

*[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; => leads to; Key: HIGHSCHOOL = High School (lower case not in high school); SCHOOLBASEDHEALTH = School Based Health Centre; TEACHERDIRECT = Teachers received directly received component of intervention; PARENTDIRECT = Parents directly received component of intervention; ANYOTHDIR = School nurses or other stakeholders (apart from children) directly received component of intervention; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]*

Our intermediate model achieved an overall coverage score of 0.61 and a consistency score of 0.951, indicating that the solution accounted for most instances of the outcome and was highly sufficient in triggering the outcome (Table 23). The three essential prime implicants were identified, two of which suggested very different pathways to running a successful intervention in a high school. In the first pathway, supported by two studies (Al-Sheyab 2012a; Henry 2004), successful interventions were observed with no school-based health centre and no direct parental involvement. In contrast, evidence from Bruzzese 2008 and Terpstra 2012 suggested that successful interventions were observed with a school-based health centre and direct parental involvement (but no additional training for teachers). When we explored further contextual characteristics (not included within the model due to issues around limited diversity and difficulties in convergence with inclusion of these conditions), both studies indicating that support from a school-based health facility and direct involvement of parents were not essential for running a successful intervention took place in schools with low numbers

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of children from ethnic minorities or low socio-economic status backgrounds. In contrast, both studies suggesting that school-based health centres and involvement of parents were necessary conditions for a successful intervention took place in locations with large numbers of children from lower socio-economic status backgrounds and large numbers from an ethnic minority background (i.e. not the majority ethnic group in the country). This suggests that interventions taking place among larger numbers of marginalised children with asthma are successful support is received from existing school medical facilities or personnel, or when parents are directly involved; this support is not necessary when interventions take place among children who are not predominantly disadvantaged. This is reconfirmed by inclusion of a further (inessential) pathway suggesting that successful interventions in high schools are accompanied by direct parental involvement, additional training for school nurses and other stakeholders (not teachers), and current school-based health facilities (row 5; Table 23). Here the supporting case, represented by Kintner 2012, also took place within a location with a large number of children from low socio-economic status backgrounds and large numbers of children from ethnic minority backgrounds.

Two further prime implicants were identified. The first (inessential) implicant suggested that when interventions were implemented outside high schools, additional teacher training and training of other stakeholders were conditions that were sufficient to generate a successful outcome. A second (essential) primary implicant suggested that not having school-based health facilities, not having additional training for teachers or other stakeholders, and not having additional parental involvement were sufficient conditions to generate an outcome, regardless of whether the intervention took place in a high school. Both of these prime implicants were supported by studies that took place in primary/elementary schools, although additional systematic differences in context were not identifiable.

Such complexity in causal pathways is perhaps an artefact of the fuzzy QCA implemented here, in which we have focused on the setting and on actors involved in the intervention. Results suggest that even among this limited set of conditions, successful interventions with regards to implementation are triggered through a variety of seemingly contradictory pathways that may also reflect non-modifiable contextual characteristics. The evidence presented here suggests that when interventions take place in high schools (or junior schools) with large numbers of marginalised children with asthma, additional components involving parents or support from school-based health facilities are important conditions for ensuring successful implementation. These additional conditions are not necessary found in high schools with a less marginalised student body and may be detrimental to successful implementation. A similar difference was not immediately apparent for interventions taking place outside high schools.

Model 2. Recruitment and retention processes

We attempted to construct a truth table to explore a number of conditions based on recruitment and retention processes, eventually focusing on the use of incentives, marketing materials, reminders, and provision of make-up sessions. Nevertheless, we were unable to detect configurations that were potential subsets of the outcome based on the truth table output (not shown; see Table 4 for data). No configuration was identified as stable enough to support classification as a subset of a positive outcome value. We also tested these conditions against the negation of the outcome but again detected high levels of inconsistency. As such, we decided that this group of conditions did not form configurations that were subsets of successful interventions, and we did not consider them further in our consolidated model.

Model 3. Curriculum, pedagogy, and intervention emphasis

We constructed a model to explore the impact of conditions reflecting curriculum content, pedagogical style, and authors' descriptions of the emphasis of the intervention (see Table 24 for data). After several iterations, six conditions were entered into a model reflecting (I) whether the curriculum reflected forming alliances and monitoring symptoms, (ii) whether the curriculum reflected learning about asthma triggers and monitoring symptoms, (iii) whether study authors emphasised the intervention as tailored or personalised, (iv) whether study authors emphasised developing personal responsibility as an aim of the intervention, (v) whether the pedagogical style focused on interactive methods, and (vi) whether a diverse pedagogical style was employed. These conditions were selected on the basis of being the most theoretically informative (i.e. not simply a reflection of diffuse styles, e.g. other curriculum foci). A truth table was constructed but showed just two configurations that were sufficient to trigger a successful intervention and were supported by a single study each (Table 25). This low coverage of the outcome precluded further analysis. The same conditions were tested against the negation of the outcome, but no configuration displayed adequate levels of consistency.

Model 4. Further modifiable intervention design features

Conditions included in this model reflected modifiable design features of the intervention that were reported by study authors. The first condition reflected the extent to which study authors reported that their interventions were grounded in a named theoretical framework underpinning the intervention. Although it is likely that all interventions were grounded in theory to some extent, and a vast majority

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of studies presented supporting literature to justify delivery of the intervention, reporting a named theoretical framework in the process evaluation may signal that a theoretical framework continued to shape the study and was used as a reference point throughout the design of all stages of the trial. Two conditions reflected whether students' own time was interrupted (e.g. lunchtime, free periods), or whether their normal educational programme was interrupted by delivery of the intervention. We included a condition reflecting the extent to which the intervention was delivered or facilitated by a school nurse to capture the importance (or not) of having known medical personnel involved in the intervention as a condition for successful implementation. Finally, it was hypothesised that running personalised or individual sessions may impact the ability of trialists to deliver a successful intervention; negatively, this may impact on trialists' ability to balance individualised sessions across a larger cohort of students.

From the raw data (Table 5), configurations were created and were examined for their sufficiency in generating a successful intervention initially through construction of a truth table (Table 26). This initially showed six configurations that were associated with generating a successful intervention, all of which had been theory driven and included as a condition (although just one combination was supported by multiple cases). This table was then minimised, and a complex solution was generated (Table 27). However, a number of logical remainders were omitted from the derivation of this solution (17) and were used in developing a parsimonious solution (not shown) and an intermediate solution (Table 28). In developing the intermediate solutions, we hypothesised that conditions that reflected the presence of personalised and individual sessions, or that suggested that the intervention interrupted students' free time, would be negatively associated with successful implementation, and the presence of other conditions entered would impact positively.

Overall solution

THEORYDRIVEN*runinstudenttime*schoolnurseinstruct +
THEORYDRIVEN*personalorindividual*SCHOOLNURSEINSTRUCT => SUCCESSFULIMPLEMENTATION

*[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; => leads to; Key: THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; SCHOOLNURSEINSTRUCT = Substantial component delivered by schools' nurse; PERSONALORINDIVIDUAL = Substantial components delivered that were individually personalised or delivered to individuals; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); RUNINLESSONS = Substantial component run during lesson time; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]*

The intermediate solution above was checked for the presence of contradictory simplifying assumptions (none were detected), and the sufficiency of the configurations was checked for negation of the outcome (no sufficient configurations were detected). The solution confirms the importance of being theory driven as a sufficient condition in generating the outcome and identifies two configurations that include this condition. Two pathways were identified: the first pathway (row 1) suggests that school nurse involvement is needed if the intervention does not involve personalised or individualised sessions. This suggests that when an intervention provides only group-based or generic content, school nurse input is needed to ensure successful implementation. However, the second pathway suggests that when interventions are not provided during students' free time (and therefore implicitly take place during students' learning time), successful implementation is achieved when involvement of a school nurse is not observed. A factorised (simplified) version of the solution is displayed below:

THEORYDRIVEN*(personalorindividual*SCHOOLNURSEINSTRUCT + runinstudenttime*schoolnurseinstruct) => SUCCESSFULIMPLEMENTATION

The factorised solution emphasised that being theory driven is a common condition for triggering a successful outcome within specific configurations. The presence of a school nurse in facilitating successful implementation is important in group or non-tailored interventions, although absence of the school nurse is important for interventions that may take place within lesson or assembly time. Although the model captures two configurations with high levels of sufficiency (both consistency scores and overall model score are over 0.9), modest coverage scores (0.43 for the model) suggest that there remain several other pathways in which the outcome is triggered that are not identified in this set of conditions (Table 28).

Model 5. Stakeholder involvement and engagement

We explored levels of stakeholder involvement and engagement (I) across the school level (through development of school policies for asthma), (ii) at the child level (by measuring child satisfaction), and (iii) at the level of other stakeholders by exploring teacher, parent, and school nurse engagement. These latter conditions reflected whether study authors reported instances of problematic or enthusiastic engagement. For the latter four conditions, a missing code was initially entered into models to reflect where the condition was irrelevant (the intervention did not include involvement of a given stakeholder) or where the information was not collected. High levels of missing data precluded construction of appropriate configurations of conditions, and missing data were later coded as 'zero', indicating that the condition was absent or unreported (this is reflected in the raw data table (Table 6); this also meant that negative instances of a

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condition were coded in the same way as missing data or 'not applicable', although no instances of negative child satisfaction were identified). We lowered the consistency threshold to 0.8 (which remained relatively high) to reflect the low frequency of occurrence of these conditions.

The initial truth table revealed substantial amounts of limited diversity, and no configurations predicting the outcome were supported by multiple cases (Table 29); therefore we removed teacher engagement due to its infrequent occurrence (low coverage as a condition). We then explored the revised truth table, identifying three configurations sufficient for the outcome and supported by five studies. The truth table also revealed that five configurations remained as logical remainders that were not supported by observations. We then implemented Boolean minimisation to generate a complex solution (Table 30), and we imposed specific directional hypotheses on child satisfaction and development of the school asthma policy (both expected to lead to positive outcomes) to create an intermediate solution (Table 31).

Overall solution

goodrelnur*CHILDSAT +
anyschpol*GOODRELPAR*goodrelnur => SUCCESSFULIMPLEMENTATION

*[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: ANYSCHPOL = School asthma policy; GOODRELNUR = Good level of engagement and/or developing relationships with school nurses; GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSAT = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]*

The intermediate solution indicated two essential prime implicants (pathways) sufficient to generate a positive outcome. One included child satisfaction as a sufficient condition, and one included reporting good levels of engagement with parents. Student satisfaction, although rarely measured, is a sufficient condition for generating a successful intervention. Similarly, parental engagement, even when parents were not necessarily directly involved in the intervention beyond providing consent for student participation, appeared to be a sufficient condition for successful implementation later. Both were sufficient only in the presence (or absence) of other conditions. Each implicant had high levels of consistency and high PRI levels, suggestive of sufficient configurations, although individual implicants exhibited low levels of coverage, and overall the solution had low levels of raw coverage (0.339, lying beneath thresholds suggested elsewhere (e.g. Ho et al., 2016)). This low coverage reflects the low frequency of reporting of included conditions by study authors. Although such low coverage would usually indicate that conditions lacked empirical importance, it is difficult to make this link with these data. What the evidence in model 5 does reinforce is the importance of measuring child satisfaction and parental engagement, as higher levels of both are found to trigger successful implementation. Despite this link, these conditions go unreported by trialists in almost half of studies, even within process evaluations (see data in Table 6).

Model 6. Consolidated model

We developed a consolidated model using evidence from models 1, 4, and 5 to understand some of the most important conditions to consider in designing an intervention. As we wanted to identify conditions that were empirically meaningful as well as sufficient, we selected conditions that were included in configurations with high consistency and coverage scores. To aid interpretability of the solutions, we focused on conditions with a consistent direction in a solution; this also reflected the type of data that we were working with that are dependent on trialists' reports, as opposed to standardised inventories of activities from across interventions.

We selected four conditions from model 4 (modifiable intervention design features) that reflected whether interventions were theory-driven, were delivered as personalised or individual sessions, or took place during students' own free time, and whether a school nurse was involved in delivery of the intervention. In addition, we included whether high levels of child satisfaction were reported (from model 5) and whether the intervention took place in a high school (model 1). The data table for this model is found in Table 15. The initial truth table showed six configurations of conditions spread across 10 studies that were classified as triggering a successful intervention (Table 16). Each of these configurations was theory-driven, and a complex solution was generated based on this initial truth table identifying four essential prime implicants sufficient for triggering successful implementation of an intervention (see Table 17). Logical remainders were an issue, with 18 configurations unsupported by cases, and parsimonious and intermediate solutions were generated using simplifying assumptions from these configurations. The intermediate solution, presented in Table 18, makes directional assumptions on four of the five conditions, with child satisfaction, parental engagement, and interventions being theory driven expected to lead to a positive outcome, while running an intervention during students' own time was expected to lead to a negative outcome.

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Overall solution

HIGHSCHOOL*CHILDSAT*THEORYDRIVEN +
HIGHSCHOOL*THEORYDRIVEN* GOODRELGPAR +
HIGHSCHOOL*THEORYDRIVEN*runinstudenttime +
CHILDSAT*THEORYDRIVEN*runinstudenttime*GOODRELENGPAR => SUCCESSFULIMPLEMENTATION

*[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSAT = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]*

The solution emphasises the importance of being theory-driven across all settings. Three of the essential prime implicants were restricted in coverage to high schools. Here the evidence suggests that in addition to being theory-based, having good levels of engagement with parents, or having high levels of child satisfaction, or running the intervention outside the students' own time leads to a successfully implemented intervention. An essential prime implicant that is not restricted to high schools also reinforces these findings by showing that being theory-based, fostering high levels of student satisfaction, reporting good levels of parental engagement, and running an intervention outside students' own time are sufficient conditions for triggering a positive outcome. As with a large portion of the data included here, this solution has modest levels of coverage, accounting for almost half of the instances of the outcome, and indicating that there remain diverse pathways to running a successful intervention that have not been included within the QCA solution. A factorised representation of the minimal sum, as presented below, helps to simplify the solution.

CHILDSATB*THEORYDRIVEN*runinstudenttime*GOODRELPAR + HIGHSCHOOL*THEORYDRIVEN*(CHILDSAT + runinstudenttime + GOODRELPAR) => SUCCESSFULIMPLEMENTATION

*[Notation: Upper case = condition is present; Lower case = condition is absent; * = logical and; + logical or; Key: HIGHSCHOOL = High School (lower case not in high school); THEORYDRIVEN = Authors explicitly named theory or presented conceptual model for intervention; RUNINSTUDENTTIME = Substantial component run in students' own time (e.g. lunchtime); GOODRELPAR = Good level of reported in engagement and/or developing relationships with parents; CHILDSATB = Children reported as satisfied; SUCCESSFULIMPLEMENTATION = Implementation of intervention successful]*

We checked for the presence of contradictory configurations in developing the solution and examined whether any of the configurations described above also predicted negation of the outcome, but we found no evidence in either case. This confirms that these combinations did consistently lead to successful implementation of school-based asthma interventions, and were not associated with poor levels of implementation, but that they were not necessarily observed with a high degree of frequency.

CONTRIBUTIONS OF AUTHORS

Role	Author
Drafting the protocol	KH, DK, TL, JG, VM, JT
Developing a search strategy	KH, DK, TL, JG, VM, JT
Searching for trials	KH, DK
Obtaining copies of trials	KH, DK
Providing subject expertise	JG
Providing methodological expertise	JT, TL
Selecting which trials to include	KH, DK, JG, JT

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(*Continued*)

Extracting data from trials	KH, DK
Entering data into RevMan	KH, DK
Carrying out the analysis	KH, DK
Interpreting the analysis	KH, DK, TL, JG, JT
Drafting the final review	KH, DK, TL, JG, JT
Updating the review	KH, DK

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Our original protocol specified that we would locate process evaluation studies, although our inclusion criteria were expanded to include studies that evaluated the process of implementing interventions, regardless of whether they were stand-alone process evaluations. Although our original protocol did not specify that we would include only stand-alone process evaluations, this clarification does represent a difference between the language of protocol and the studies included in the review.

We extracted all data on school absences, and they were eligible for analysis, regardless of collection method, including those collected through administrative records. This is a deviation from the published protocol, which specified that parent-reported absences alone would be our outcome of interest.

We intended to conduct a sensitivity analysis of alternative estimated ICCs to studies for which these values are missing; however a suitable alternative ICC apart from the estimate used in analyses was not identified; thus we did not conduct additional sensitivity analyses.

Sensitivity analyses were planned on the basis of country (OECD country vs other), although we did not carry out these analyses due to lack of variation according to this characteristic.

We had originally specified daytime and night-time symptoms as a single outcome, but we split this into two separate outcomes to maintain conceptual coherence. Similarly, we developed two models for corticosteroid usage in an attempt to ensure conceptual coherence.

Our protocol originally specified that thorough investigation of heterogeneity would take place only when heterogeneity as measured as I^2 exceeding 25%. This was the case for ED visits and school absences; no other outcome met this threshold. However, we also conducted subgroup analyses of withdrawals, despite low heterogeneity, because of the conceptual similarity of this outcome and the implementation success that was the focus of the QCA.

Our protocol reported that we would include all outcomes in the 'Summary of findings' table (except withdrawals). In practice, we did not include lung function because of insufficient evidence to develop a meta-analysis. In addition, we did not include evidence of corticosteroid dosage because it is unclear whether the outcome reflected dosage as part of step-up or step-down therapy (see discussion).

Because our QCA involved examining dosage, attrition, and adherence as process outcomes, we deemed that these were not suitable for examining effects among studies of short duration. This meant we excluded six reports of interventions that involved one or two face-to-face sessions (Bignall 2015; Carpenter 2016; Jackson 2006; McCann 2006; Mickel 2016; Richmond 2011), which we did not explicitly describe in the protocol.

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