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Home-based educational interventions for children with asthma (Review)

Welsh EJ, Hasan M, Li P

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[Intervention Review]

Home-based educational interventions for children with asthma

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ABSTRACT

Background

While guidelines recommend that children with asthma should receive asthma education, it is not known if education delivered in the home is superior to usual care or the same education delivered elsewhere. The home setting allows educators to reach populations (such as the economically disadvantaged) that may experience barriers to care (such as lack of transportation) within a familiar environment.

Objectives

To perform a systematic review on educational interventions for asthma delivered in the home to children, caregivers or both, and to determine the effects of such interventions on asthma-related health outcomes. We also planned to make the education interventions accessible to readers by summarising the content and components.

Search methods

We searched the Cochrane Airways Group Specialised Register of trials, which includes the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, AMED and PsycINFO, and handsearched respiratory journals and meeting abstracts. We also searched the Education Resources Information Center database (ERIC), reference lists of trials and review articles (last search January 2011).

Selection criteria

We included randomised controlled trials of asthma education delivered in the home to children, their caregivers or both. In the first comparison, eligible control groups were provided usual care or the same education delivered outside of the home. For the second comparison, control groups received a less intensive educational intervention delivered in the home.

Data collection and analysis

Two authors independently selected the trials, assessed trial quality and extracted the data. We contacted study authors for additional information. We pooled dichotomous data with fixed-effect odds ratio and continuous data with mean difference (MD) using a fixed-effect where possible.

Main results

A total of 12 studies involving 2342 children were included. Eleven out of 12 trials were conducted in North America, within urban or suburban settings involving vulnerable populations. The studies were overall of good methodological quality. They differed markedly in terms of age, severity of asthma, context and content of the educational intervention leading to substantial clinical heterogeneity. Due to this clinical heterogeneity, we did not pool results for our primary outcome, the number of patients with exacerbations requiring emergency department (ED) visit. The mean number of exacerbations requiring ED visits per person at six months was not significantly

different between the home-based intervention and control groups (N = 2 studies; MD 0.04; 95% confidence interval (CI) -0.20 to 0.27). Only one trial contributed to our other primary outcome, exacerbations requiring a course of oral corticosteroids. Hospital admissions also demonstrated wide variation between trials with significant changes in some trials in both directions. Quality of life improved in both education and control groups over time.

A table summarising some of the key components of the education programmes is included in the review.

Authors' conclusions

We found inconsistent evidence for home-based asthma educational interventions compared to standard care, education delivered outside of the home or a less intensive educational intervention delivered at home. Although education remains a key component of managing asthma in children, advocated in numerous guidelines, this review does not contribute further information on the fundamental content and optimum setting for such educational interventions.

PLAIN LANGUAGE SUMMARY

Home-based educational interventions for families of children with asthma

Asthma is a common childhood illness causing wheezing, coughing and difficulty in breathing. Guidelines on the care of children with asthma recommend that children and families should receive education on how to manage their condition. The current review looked at 12 studies with a total of 2342 children comparing asthma education received at home with either usual care or a less intensive home-based education programme. Eleven out of 12 trials were conducted in North America, within urban or suburban settings involving socioeconomically disadvantaged families. A table summarising some of the key components of the education programmes is presented in the review.

The included studies varied in the characteristics of children (e.g. age, severity of asthma), the education delivered and the way each outcome was reported. This made it difficult to compare the results and provide overall conclusions and we did not pool results for most of the outcomes. There was also diversity in the findings of the individual trials. We were able to combine the results of two studies reporting the average number of emergency department visits per child, which was not different at six months between the home education group and the group receiving the usual care. Only one trial contributed to our other primary outcome, exacerbations (flare-ups) requiring a course of oral corticosteroids. Hospital admissions also demonstrated wide variation between trials with significant changes in some trials in both directions. Quality of life improved in both education and control groups over time.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Education versus control for children with asthma

Education versus control for children with asthma

Patient or population: children with asthma
Settings:
Intervention: education versus control

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Education versus control				
Exacerbations leading to emergency department visits	See comment	See comment	Not estimable	985 (8 studies)	⊕⊖⊖⊖ **very low** [1,2,3,4]	There was too much clinical heterogeneity to pool this outcome
Mean exacerbations requiring a course of oral corticosteroids	See comment	See comment	Not estimable	500 (2 studies)	⊕⊖⊖⊖ **very low** [1,2,3,4]	There was too much clinical heterogeneity to pool this outcome

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (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

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Downgraded two because there was so much heterogeneity in the study populations; we decided not to pool this outcome
[2] Downgraded one due to limitation in populations which were predominantly North American socioeconomically disadvantaged children
[3] We did not downgrade for indirectness because we felt that there were several reasonably sized RCTS for this outcome. That we did not pool is reflected in downgrading for inconsistency.
[4] We did not downgrade for publication bias as most of the trials reported minimal difference in the outcomes of children in the intervention/control groups and therefore we do not think that trials showing no evidence of treatment effect are less likely to be published than others.

Summary of findings 2. Education versus other home-based education for children with asthma

Education versus other home-based education for children with asthma

Patient or population: patients with children with asthma
Settings:
Intervention: education versus other home-based education

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Education versus other home-based education				
Exacerbations leading to ED visits	See comment	See comment	Not estimable	181 (1 study)	⊕⊖⊖⊖ **very low** [1,2,3]	There was only one trial contributing to this outcome so we were unable to pool
Mean exacerbations requiring a course of oral corticosteroids	See comment	See comment	Not estimable	193 (1 study)	⊕⊖⊖⊖ **very low** [1,2,3]	There was only one trial contributing to this outcome so we were unable to pool

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (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; **OR:** Odds ratio; **ED:** Emergency Department

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Downgraded one due to limitation in populations which were predominantly North American socioeconomically disadvantaged children.
[2]We did not downgrade for publication bias as most of the trials reported minimal difference in the outcomes of children in the intervention/control groups and therefore we do not think that trials showing no evidence of treatment effect are less likely to be published than others.
[3] We downgraded one for imprecision as only one trial contributed to this outcome.

BACKGROUND

Description of the condition

Asthma is a chronic condition affecting the airways causing wheezing, coughing and difficulty in breathing. It is the most common chronic condition affecting children and is estimated to affect over 300 million people worldwide (GINA 2008). Although a cure does not currently exist, symptoms can be controlled.

Asthma impacts on sufferers' quality and enjoyment of life. They may be less able to undertake strenuous activities and often display increased levels of depression and anxiety (Clayton 2005). Asthma places a financial burden on both the patient and the state from direct medical costs and reduced productivity resulting from days lost at work or school (Wu 2007).

People across the international spectrum of economic development are affected (de Oliveira 1999). Low socioeconomic groups experience higher levels of asthma morbidity (British Guideline on the Management of Asthma; de Oliveira 1999). In addition, people from minority groups have poorer asthma outcomes and typically make more asthma-related visits to emergency departments (Bailey 2009).

Description of the intervention

Asthma education extends beyond simply providing information. It aims to integrate knowledge, improve self management and produce behaviour change. Education is recommended as an integral part of asthma management (NAEPP 2007; British Guideline on the Management of Asthma; GINA 2008). Education can be delivered to individuals or groups in a number of ways, such as personalised action plans, computer/video games, internet-enabled packages, role play, problem-solving, lectures, workshops and booklets. Education may be delivered by a variety of instructors including clinicians, nurses, other allied health professionals and community health workers.

How the intervention might work

Specific components of education interventions may affect behaviour change by:

- reinforcing basic information about asthma to embed understanding;
- emphasising adherence to prescribed long-term controller medication;
- emphasising the importance of avoiding environmental triggers;
- providing self monitoring techniques to help patients identify and respond appropriately to worsening asthma;
- providing written action plans to help patients respond correctly to exacerbations; and
- improving communication between patients and clinicians.

There are existing reviews showing benefits of education. Wolf 2002 conducted a large systematic review showing that asthma education aimed at two to 18 year olds gave modest improvements in airflow and self efficacy and modest reductions in days off school and emergency department visits. Bhogal 2006 showed that symptom-based written action plans are better than peak flow-based ones for preventing acute care visits in children. Gibson 2002 showed that peak flow or symptom-based self monitoring, coupled with regular medical review and a written action plan led to improved health outcomes in adults. Boyd 2009 showed that asthma education aimed at children and their carers who have attended the emergency department for acute exacerbations resulted in fewer subsequent visits to the emergency department and hospital admissions.

Why it is important to do this review

Education programmes delivered outside of the home may be poorly attended due to a lack of transportation or childcare for siblings. Children with asthma from low-income families may be more likely to experience such barriers to care. These children also tend to have more severe disease and morbidity at baseline and may derive additional benefit from educational interventions (Brown 2002). Some education programmes attempt to capture a wider audience by employing school-based delivery, but this does not address obstacles to attendance by caregivers and preschool children. Home-based education offers an alternative solution to improving access to education.

Asthma education delivered in the home is distinct from that delivered in clinics or schools in factors relating to the educator, the family members receiving it and the environment. Community health workers may provide the education. Although their expertise in asthma management may not be as extensive as that of health professionals, the families may be more responsive to these workers who often share the same socioeconomic status, language and/or culture. Interventions at home could be delivered to additional family members. They may feel more relaxed at home and therefore be more receptive to ideas (Shelledy 2009). Additionally, it provides an opportunity for educators to offer case-specific guidance on improvements to the living environment (Bryant-Stephens 2008).

Wolf 2002 recommended that self management education should be routinely used as part of standard asthma therapy in children. This review included a heterogeneous group of education programmes provided in multiple settings. The current review will focus on trials involving asthma education delivered at home to children and/or their caregivers. It will also provide an updated review of home-based education, which was recommended for young children in the most recent asthma guidelines from the United States (NAEPP 2007) but with a limited quality of evidence (level C).

OBJECTIVES

1. To assess the effects of educational interventions for asthma, delivered in the home to children, their parents or both, on asthma-related outcomes.
2. To make the education interventions accessible to readers by summarising the content and components.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled clinical trials (RCTs). We planned to include quasi-randomised trials (e.g. participants allocated by day of week or hospital number).

Types of participants

We included children and adolescents between two and 18 years of age with an existing diagnosis of asthma. We also included trials with children aged one to two years old if the majority of the children were older than two. We accepted both doctor-diagnosed asthma or asthma identified against objective criteria for asthma symptoms.

Types of interventions

Inclusion criteria

We included any type of self management education programme delivered in the home of the child or adolescent. We included self management programmes delivered to children, their parents or both. We only included interventions aimed at changing behaviour including one or more of the following methods: providing information about asthma symptoms, medication and inhaler technique; symptom or lung function monitoring; provision or development of personalised action plan; development of coping strategies; improving communication between clinician and patient.

We included control groups that received either usual care, waiting list or a less intensive education programme than the intervention arm, such as information only. We analysed data from usual care control groups separately from those who received a less intensive home-based educational intervention.

Exclusion criteria

We excluded education that provided only information with no face-to-face education programmes, e.g. just giving the child or parent a booklet, smoking cessation programmes for parents and education interventions delivered to physicians, nurses or other healthcare providers rather than the child or carer. We excluded programmes primarily aimed at, and providing, environmental modification (i.e. provision of vacuum cleaners with high-efficiency particulate air (HEPA) filters, HEPA air purifiers, ventilation fans, remediation of mould-contaminated carpet or wallboard, professional pest control, roach or rodent traps, anti-allergy mattress or pillow covers) to reduce exposure to indoor allergens. Although this kind of environmental remediation may have a positive effect on asthma outcomes, these studies tend to focus on remediation with education as a secondary measure and may be better addressed as a separate review rather than as a subgroup of this review. We did not exclude trials based on language.

Types of outcome measures

Outcome measures were not a criterion for exclusion in the review.

Primary outcomes

1. Exacerbations leading to emergency department visits.
2. Exacerbations requiring a course of oral corticosteroids.

Secondary outcomes

1. Functional health status (quality of life, days of restricted activity, nights of disturbed sleep, day symptoms).
2. Days off school or caregiver days off work.
3. Exacerbations leading to hospitalisations.
4. Lung function (FEV1 (forced expiratory volume in one second) and PEF (peak expiratory flow)).
5. Withdrawals from intervention or usual care.

Search methods for identification of studies

Electronic searches

We identified trials using the Cochrane Airways Group Specialised Register of trials, which is derived from systematic searches of bibliographic databases including the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, AMED and PsycINFO, and handsearched respiratory journals and meeting abstracts (please see the Airways Group search methods for further details). We searched all records in the Specialised Register coded as 'AST' using the following terms:

educat* or train* or instruct* or teach* or taught or coach* or learn* or behav* or self-monitor* or "self monitor*" or self-manag* or "self manag*" or self-car* or "self car*" or patient-cent* or "patient cent*" or patient-focus* or "patient focus*" or "management plan*" or "management program*"

In addition, we searched the Education Resources Information Center database (ERIC) using the terms home* AND asthma*, reference lists of trials and review articles. The latest search was January 2011.

We searched both databases from the date of their inception and there was no restriction on the basis of language.

Searching other resources

We reviewed reference lists of all primary studies and review articles for references to additional studies. We contacted authors of identified trials where possible and asked them to identify other published and unpublished studies.

Data collection and analysis

Selection of studies

One review author (EJW) went through the search to remove references clearly unrelated to the scope of the review based on title alone. Two review authors (EJW and PL for Airways Register search; EJW and MH for ERIC search) independently examined the titles and abstracts of the remaining reports. We retrieved the full text of the potentially relevant references and assigned each reference to a study identifier. Two of authors (EJW, PL) independently compared each study against inclusion criteria and we resolved discrepancies by consensus.

Data extraction and management

We extracted information from each study for the following characteristics.

1. Design (design, total duration study, number of study centres and location, withdrawals, date of study).
2. Participants (N, mean age, age range, gender, asthma severity, diagnostic criteria, baseline lung function, sociodemographics, caregivers' education, ethnicity, inclusion criteria, exclusion criteria).
3. Interventions (total number of intervention and control groups. For each intervention or control group: treatment,

programme topics, setting, session type, number of sessions, session length, educator, time span of intervention, self management strategy, educational strategy, instructional methods/tools, additional information and net treatment, incentives, cost).

4. Outcomes (outcomes specified and collected, time points reported).
5. Aims.
6. Risk of bias.

Two authors (EJW, MH or PL) extracted data from the studies and resolved any discrepancies by discussion and consensus, or by consulting a third party where necessary. For each trial, one author (EJW or PL) transferred data from data collection forms into Review Manager 5.1 and this was checked by the other.

Assessment of risk of bias in included studies

We assessed risk of bias in included studies as high, low or unclear using the Cochrane Collaboration's 'Risk of bias' tool and the following headings: 1) sequence generation; 2) allocation concealment; 3) blinding; 4) incomplete outcome data; 5) selective outcome reporting; 6) other bias.

Unit of analysis issues

Studies that compare two types of education intervention with a control may yield important comparison results between two education types (Wolf 2002). We therefore entered both intervention arms separately in the meta-analyses and split the control group in half (to avoid double-counting) rather than combining the two arms (Higgins 2008).

Dealing with missing data

We requested additional data including missing numerical data and information required for the risk of bias assessment from trialists.

Analyses based on change scores were preferred, but we used final values where change scores were not available.

Assessment of heterogeneity

We reported heterogeneity using the I^2 statistic and descriptively by examining the clinical characteristics of the population and interventions.

Assessment of reporting biases

We reported the proportion of participants contributing to each outcome in comparison to the total number randomised. We intended to examine funnel plots but there were insufficient trials.

Data synthesis

We planned to combine dichotomous data using the Mantel-Haenszel fixed-effect odds ratio using 95% confidence intervals. We planned to combine continuous data with either mean difference (MD) or standardised mean difference (SMD) using a fixed-effect model and 95% confidence intervals.

We presented absolute differences in a 'Summary of findings' table for the primary outcomes which we produced using GRADE methodology.

Subgroup analysis and investigation of heterogeneity

We planned to investigate heterogeneity based on the following predefined subgroups.

1. Children (2 to 12) versus adolescents (12 to 18).
2. Mild/moderate versus severe asthma.
3. Short time frame trials < 6 months versus long time frame > 6 months.
4. Physician or nurse versus community health worker.

We planned to apply a test for interaction between subgroup estimates (Altman 2003).

Sensitivity analysis

We planned to assess the sensitivity of our primary outcomes to the degree of risk of bias. We planned to compare the results of fixed and random-effects models. If combining change scores and final value scores we planned to look at baseline imbalance.

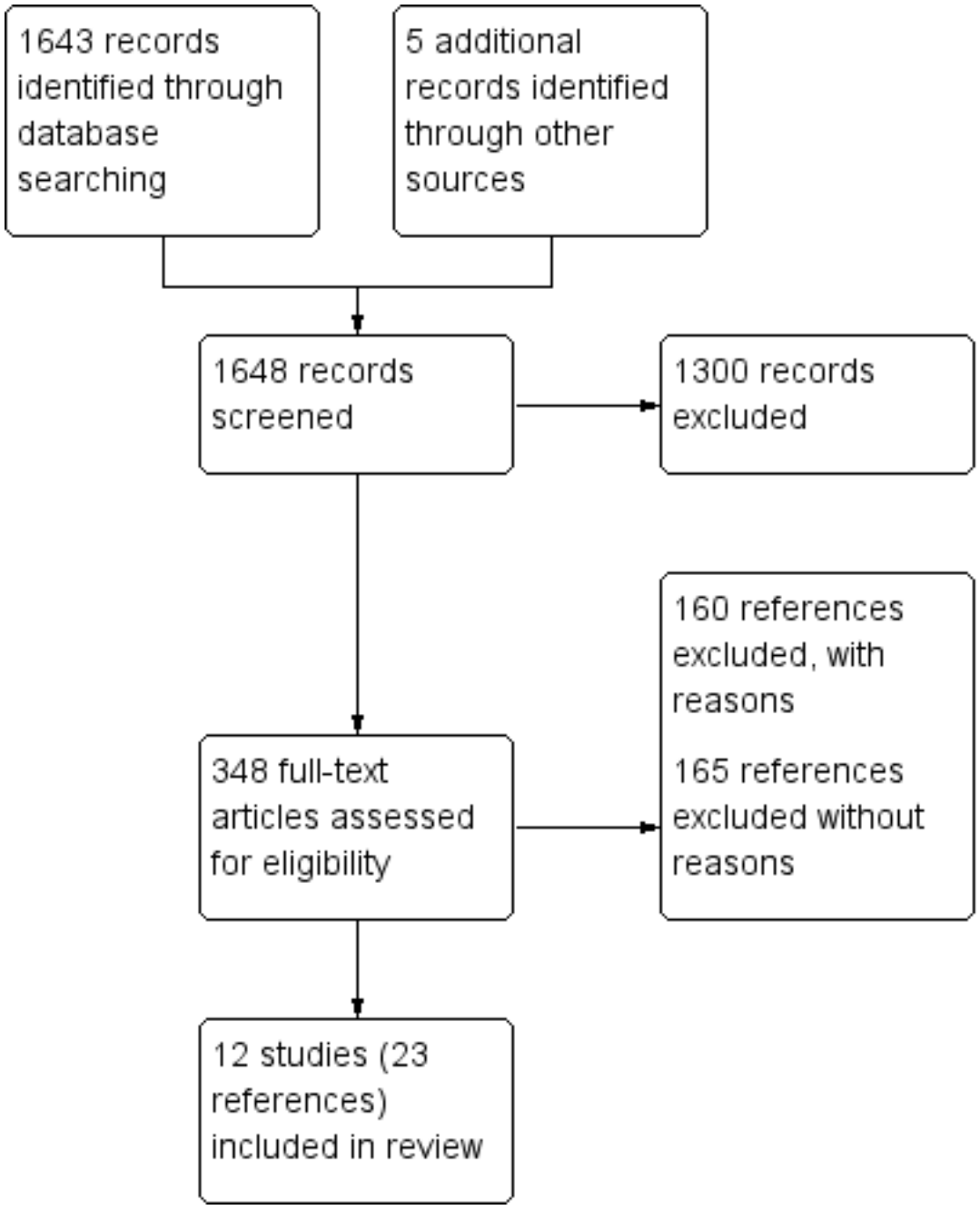
RESULTS

Description of studies

Results of the search

The search of the Airways Register returned 1584 references. We discarded 487 references that were clearly not relevant to the review question on the basis of title alone. We examined the remaining 1097 references. There were 130 initial disagreements which were resolved through discussion. We retrieved 235 full-text documents in total identified from the search. We identified five references from contacting authors and reference lists of included studies. We contacted the author of an abstract who identified the full text which was in press (Seid 2010). We contacted the author of a www.clincaltrial.gov entry who informed us that the trial had been published in full (Galbreath 2008) and one study that had previously been excluded on the basis of title and abstract was identified from a previous review (Gorelick 2006). We imported these 348 references into Review Manager 5.1, grouped the references into studies and discarded duplicate references, although these groupings evolved during the process of data extraction. Ultimately we identified 12 unique studies for inclusion. A PRISMA diagram can be found in Figure 1.

Figure 1. Study flow diagram.



The search in the ERIC database returned 59 references. Six studies were identified as potentially eligible. Three of these had been returned by the Airways Register search, whilst the other three were ultimately excluded.

Included studies

There were 12 included randomised controlled trials reporting data on children who had received education delivered in the home. There were a total of 2342 participants. Full details can be found in Characteristics of included studies. Key characteristics of the participants and education programme content are summarised in Table 1.

Setting and populations

Ten studies took place in the USA (Brown 2002; Butz 2006; Gorelick 2006; Brown 2006; Galbreath 2008; Kamps 2008; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010), one in Canada (Dolinar 2000) and one in New Zealand (Mitchell 1986). The latter study divided the population into two ethnic groups; Polynesian and European children (Mitchell 1986). Patients were recruited mostly from the Emergency Department (ED) in four studies (Brown 2006; Gorelick 2006; Otsuki 2009; Butz 2010), mostly outpatient clinics in five studies (Dolinar 2000; Brown 2002; Butz 2006; Kamps 2008; Seid 2010) and following a hospital admission in two studies (Mitchell 1986; Fisher 2009). One study recruited patients by various methods

including referrals, reviewing patient lists and the media (Galbreath 2008). Eleven of the studies were conducted between 2000 to 2010, while one was much older (Mitchell 1986). The studies varied in size from 15 to 316 participants.

Seven studies reported participants with a range of asthma severity from mild to severe, with the latter group varying from 4% to 37% (Brown 2002; Butz 2006; Brown 2006; Gorelick 2006; Galbreath 2008; Butz 2010; Seid 2010). Kamps 2008 enrolled participants with moderate to severe asthma, while Dolinar 2000 described the participants as having stable asthma. The Mitchell 1986 cohort had frequent asthma attacks and Otsuki 2009 enrolled patients prescribed an asthma controller medication. All studies included patients who had a health care utilisation visit in the past year (either ED or hospitalisation), except Dolinar 2000 who excluded patients with an exacerbation requiring a visit to the ED in the previous year. A table of control group rates for ED visits and hospitalisations provides an indicator of severity and can be found in Table 2.

The trials enrolled participants with a range of age groups. Three trials included infants less than two years which was outside of the inclusion criteria for this review. However, we included them as the majority of participants would have been over two years (Dolinar 2000; Brown 2002; Brown 2006). The majority of participants were children (up to 12 years old) rather than teenagers (12 to 18 years old).

The studies were predominantly conducted in urban or suburban settings involving vulnerable populations. The exceptions were Dolinar 2000 where the majority of families were above the low-income level in Canada and Mitchell 1986 who recruited and analysed data for European and Polynesian children separately, since the Polynesian children were previously reported to have lower socioeconomic status and differences in asthma management and outcomes (Mitchell 1981; Mitchell 1984). Eight studies reported high levels of participants on Medicaid or public insurance (Brown 2002; Butz 2006; Gorelick 2006; Galbreath 2008; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010) or attending subsidised community clinics (Seid 2010). Eight studies included greater than 50% participants from ethnic minorities (Brown 2002; Butz 2006; Gorelick 2006; Galbreath 2008; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010), one study was conducted in a predominantly white population (Brown 2006) while the remaining three trials did not report the ethnic groups of participants.

Interventions

A summary of the educational interventions for each study is displayed in Table 1. Eight studies included four to six-weekly to monthly home visits that generally lasted 30 to 60 minutes each (Mitchell 1986; Butz 2006; Gorelick 2006; Galbreath 2008; Kamps 2008; Otsuki 2009; Butz 2010; Seid 2010), one study delivered eight home visits lasting 90 minutes (Brown 2002), while another three studies only had one or two home visits (Dolinar 2000; Brown 2006; Fisher 2009). Three studies (Gorelick 2006; Galbreath 2008; Fisher 2009) included additional telephone sessions. The educator who provided the home sessions assisted in one or more primary care clinic visits in two studies (Brown 2006; Butz 2010).

The shortest follow-up was three months (Dolinar 2000) followed by two trials with six months follow-up (Brown 2006; Gorelick 2006), while the remaining nine studies collected follow-up data for nine to 24 months from initial enrolment.

Five studies employed nurses to deliver asthma education (Mitchell 1986; Dolinar 2000; Brown 2002; Brown 2006; Butz 2006) and four studies involved either nurses, social workers or health educators (Gorelick 2006; Fisher 2009; Otsuki 2009; Butz 2010). Galbreath 2008 used nurses for the telephonic intervention and employed pulmonary therapists for the home visits, while Kamps 2008 employed licensed psychologists or master's level psychology students. Seid 2010 provided in-home asthma education through bachelor's level, bilingual, bicultural home visitors, and the problem-skills training intervention component was delivered by bilingual and bicultural bachelor's or master's level health educators.

All programmes provided basic education on the concepts of asthma, such as pulmonary anatomy and physiology as well as the disease process. Six of the studies provided printed materials (such as booklets) and/or homework to complete after the educational sessions (Dolinar 2000; Brown 2002; Gorelick 2006; Kamps 2008; Otsuki 2009; Seid 2010). All programmes reviewed asthma medications along with inhaler technique and reviewed strategies for self management of the disease. One study used electronic devices to provide objective feedback to inform patients and families on medication adherence (adherence monitoring arm of Otsuki 2009), while another study kept track of nebuliser use electronically to measure study outcomes (Butz 2006). Galbreath 2008 provided active disease monitoring and management via scheduled telephone calls and access to a 24-hour hotline. Written action plans were reviewed and/or provided in 10 out of 12 studies (Dolinar 2000; Brown 2002; Butz 2006; Brown 2006; Gorelick 2006; Galbreath 2008; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010). All but one study (Otsuki 2009) specifically mentioned educational interventions that reviewed asthma triggers, measures to reduce environmental allergens or both.

Most interventions were based on already-existing asthma educational programmes, some founded on theories of learning. Brown 2002 used the Wee Wheezers programme (Wilson 1996b), developed using principles of social learning theory by a team of paediatricians, pulmonologists, psychologists, public health educators and educational video specialists. Brown 2002 modified the scripts and handouts to make them culturally appropriate and target low-literacy level parents. Butz 2006 also made use of Wee Wheezers as well as the A+ Asthma Club Programme (Schneider 1997), the latter of which uses the PRECEDE (Predisposing, Reinforcing, Enabling Constructs in Educational Diagnosis and Evaluation) planning model. Additional programmes included the Air Force Asthma Program developed by the Ontario Lung Association (Dolinar 2000), the National Jewish Asthma Disease Management Program and Pulmonary Therapies LLC programme (Galbreath 2008), the Fight Asthma Milwaukee Allies (Gorelick 2006), and the Air Wise Program and The Clubhouse Kids Learn Asthma interactive computer program (Kamps 2008). Butz 2010 designed an asthma communication education programme based on the chronic care model (Wagner 2001; Bodenheimer 2002) and other studies examining clinician-parent-child communication (Halterman 2001; Tates 2001). The community health workers in Fisher 2009 used the Transtheoretical Model to assess participants' readiness for change and adopted asthma management behaviours accordingly. They also used a

"nondirective supportive style" in their interactions. Kamps 2008 used behaviour management techniques to promote adherence, specifically the Exchange Program for Improving Medication Adherence (Rapoff 1999). Similarly, Seid 2010 employed problem-solving skill training based on a concept by D'Zurilla (D'Zurilla 1971; D'Zurilla 1986) and a protocol previously tested on mothers of children with cancer (Varni 1999). Seid 2010 based the care co-ordination component of their intervention on the Robert Wood Johnson Foundation's Allies Against Asthma community health worker model (Friedman 2006). The NHLBI guidelines were explicitly stated as the basis of asthma management in five trials (Brown 2002; Brown 2006; Galbreath 2008; Fisher 2009; Seid 2010), while the Air Wise Program used in Kamps 2008 was affiliated with the NHLBI.

Three studies involved two intervention and one control group (Gorelick 2006; Otsuki 2009; Seid 2010). All intervention groups were included in this review except the intensive primary care linkage arm of the Gorelick 2006 trial, since there was no home education component.

Control groups

Control groups received routine care in nine trials, which may have involved asthma education but not provided in the home setting (Mitchell 1986; Dolinar 2000; Brown 2002; Brown 2006; Gorelick 2006; Galbreath 2008; Fisher 2009; Otsuki 2009; Seid 2010) and form the basis of the first comparison in this review. The remaining three studies provided controls with home-based general asthma education, while providing additional education for specific therapies or skills in the intervention group (nebuliser therapy education, asthma communication education and strategies to improve adherence to inhaled corticosteroids for Butz 2006, Butz 2010 and Kamps 2008, respectively). These three studies form the basis of our second comparison of education versus a less intensive educational intervention.

Compliance

The full intervention was delivered to over 70% of participants in all trials except Brown 2006 in which 39% of adults and children completed the programme.

Outcomes

The primary outcomes of the trials varied. For Brown 2006, it was time to first relapse for asthma (ED or unscheduled visit for asthma). Butz 2010 defined caregiver reported symptom days and nights over the past 30 days as the primary outcome; Butz 2006 looked at asthma severity, number of ED visits and medication usage (*email communication with author*); Dolinar 2000 used parental coping, caregiver perception of change and quality of life; Fisher 2009 reported hospitalisations at 12 months; Galbreath 2008 chose time to first asthma-related events, quality of life and rates of healthcare utilisation; Gorelick 2006 used proportion of patients experiencing an ED visit over six months; Kamps 2008 reported adherence to inhaled corticosteroids using an electronic monitor (MDILog); Otsuki 2009 chose ED visits; and Seid 2010 measured health-related quality of life. Two studies did not define primary outcomes (Mitchell 1986; Brown 2002).

For full details of outcomes reported in each study, see Characteristics of included studies.

We obtained additional data from three trialists (Butz 2006; Gorelick 2006; Butz 2010).

Aims

The overall aims of the studies varied (Table 3), testing different interventions to improve various outcomes (listed in the section above).

Excluded studies

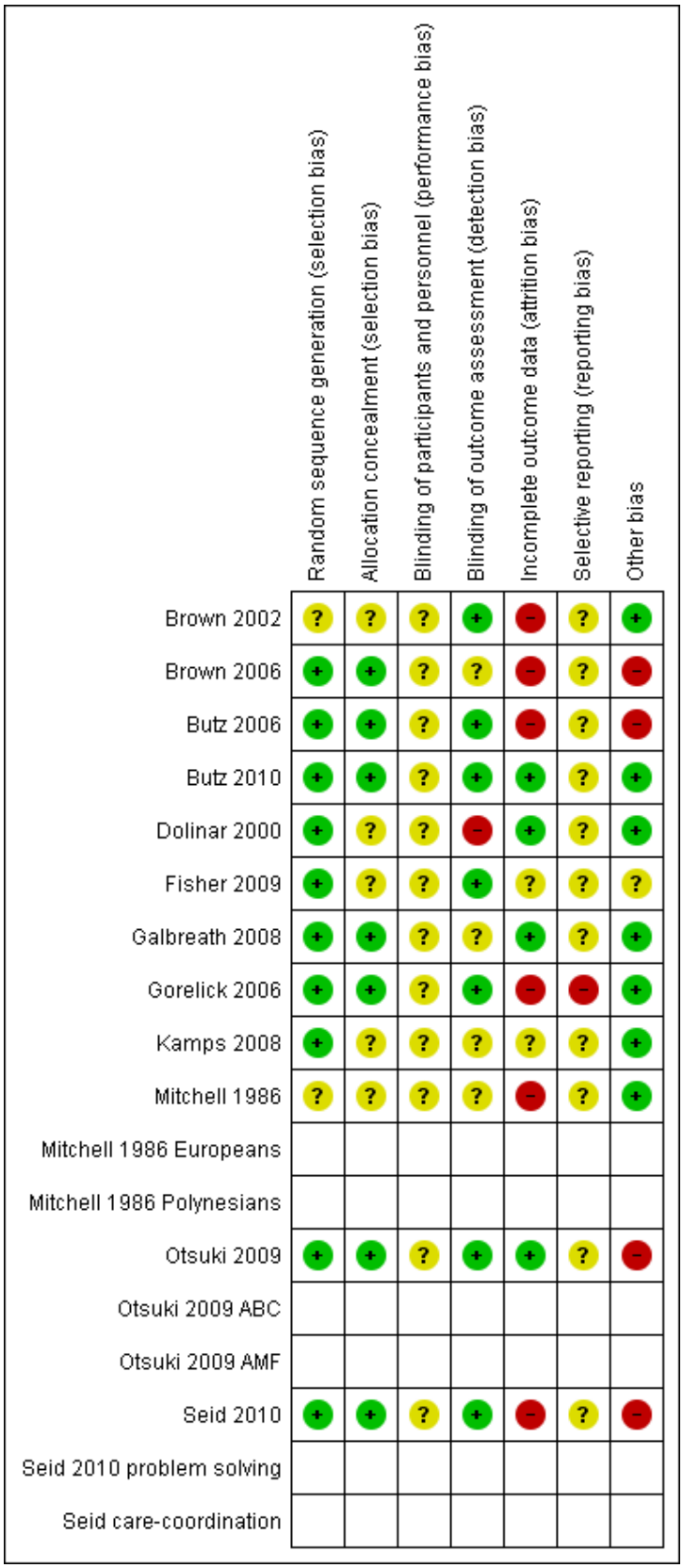
We recorded the reasons for exclusion of 160 studies after retrieving the full-text documents (see Characteristics of excluded studies). We excluded 26 studies aimed primarily at environmental remediation or which supplied participants with allergen-reducing materials (such as mattress encasings and HEPA (high-efficiency particulate air) filters); 25 studies conducted on adults; 66 studies delivering the education outside the home; 12 studies providing education primarily via multimedia but without face-to-face; in-person education delivered in the home; three studies delivering an exercise-based intervention; three studies providing a low-intensity information-only intervention; one study using a self help kit; one study involving a decision-making programme aimed at reducing substance misuse; three studies aimed at education physicians or nurses; and one study for multiple reasons (randomisation not described, location of education delivered not specified, no extractable data and unable to contact the study author). Nineteen studies were not randomised controlled trials.

There was one potentially eligible trial identified that is still ongoing (Rand 2006)

Risk of bias in included studies

Full details of risk of bias judgements can be found in Characteristics of included studies. Graphical representations of our judgements of the risk of bias can be found in Figure 2.

Figure 2. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study.



Allocation

Ten studies reported full details of adequate sequence generation and we judged them to be of low risk of bias (Dolinar 2000; Butz 2006; Brown 2006; Gorelick 2006; Galbreath 2008; Kamps 2008; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010). Two studies were reported as randomised, but gave no description of the methods used and we therefore judged them to be at unclear risk of bias (Mitchell 1986; Brown 2002).

Seven studies were low risk of bias with full details of allocation sequence concealment reported (Brown 2006; Butz 2006; Gorelick 2006; Galbreath 2008; Otsuki 2009; Butz 2010; Seid 2010). The author confirmed allocation concealment in one study (Butz 2006). There were insufficient details for the remaining five studies for us to reach a firm conclusion so we judged them to be at unclear risk of bias (Mitchell 1986; Dolinar 2000; Brown 2002; Kamps 2008; Fisher 2009).

Blinding

The nature of the intervention precludes the possibility of blinding patients or the educator and therefore all the studies were judged to be at unclear risk of performancebias. However, it is possible to blind the people who collected or analysed the data. We judged seven studies to be at low risk of bias with respect to blinding of data collectors (Brown 2002; Butz 2006; Gorelick 2006; Fisher 2009; Otsuki 2009; Butz 2010; Seid 2010). Three studies did not describe blinding, so we judged them to be at unclear risk of bias (Mitchell 1986; Brown 2006; Kamps 2008). Dolinar 2000 was high risk of bias as it was described as non-blinded. The lack of blinding would likely have a greater impact on the more subjective outcomes (e.g. quality of life) than more objective measures (e.g. ED visits).

Incomplete outcome data

We judged four studies to be at low risk of bias due to incomplete outcome data as indicated by withdrawals/losses to follow-up in Table 4 (Dolinar 2000; Galbreath 2008; Otsuki 2009; Butz 2010). Butz 2010 and Dolinar 2000 had similar losses to follow-up in both education and control groups, Galbreath 2008 obtained comprehensive health care utilisation data for 99% of participants and Otsuki 2009 had consistent losses to follow-up across treatment arms which averaged around 10%. We judged six studies to be at high risk of bias with respect to incomplete outcome data (Mitchell 1986; Brown 2002; Brown 2006; Butz 2006; Gorelick 2006; Seid 2010). Brown 2002 had a high number of withdrawals from the treatment arm (n = 6) compared to none on the control arm, Butz 2006 had unbalanced losses of pharmacy records, Brown 2006 had 21% lost to follow-up in the intervention group at six months compared to six percent in the control group, Gorelick 2006 reported the baseline characteristics of those lost to follow-up or with incomplete data (22%) but there were more lost in the treatment versus the control group, while Seid 2010 had high and unbalanced losses to follow-up and refusal to comply, which we assume was related to the nature of the interventions. Mitchell 1986 did not mention how many people contributed data, so we judged this to be at a high risk of bias. The remaining two studies were at unclear risk of bias (Kamps 2008; Fisher 2009). Fisher 2009 unbalanced follow-up survey data but reviewed hospital records for all patients. The risk of bias was unclear because records were only available from one hospital in the city, albeit the latter was where the majority of admissions likely occurred. Kamps 2008 was a small pilot study with poor follow-up, so although the losses were balanced between arms, the reported data were on limited participants.

For consideration of the number of patients withdrawing and those lost to follow-up, please see Effects of interventions and Characteristics of included studies.

Selective reporting

We judged 11 studies to be at unclear risk of bias for selective outcome reporting since there was no published protocol (Mitchell 1986; Dolinar 2000; Brown 2002; Butz 2006; Brown 2006; Galbreath 2008; Kamps 2008; Otsuki 2009; Fisher 2009; Seid 2010; Butz 2010). Five trials (Butz 2006; Galbreath 2008; Otsuki 2009; Butz 2010; Seid 2010) were registered in clinicaltrials.gov but all had one or more secondary outcomes in the protocols that were not reported in the final publications, and were therefore deemed unclear risk of bias. The final study (Gorelick 2006) measured hospital admissions but did not report this in the results and the trialists were unable to provide these data through correspondence. We therefore judged Gorelick 2006 at high risk of selective reporting bias.

Other potential sources of bias

The main additional source of bias identified in these studies was recall bias for outcomes where the patient or parent had to report the number of events experienced over time. We judged seven studies to be at low risk of recall bias (Mitchell 1986; Dolinar 2000; Brown 2002; Gorelick 2006; Galbreath 2008; Kamps 2008; Butz 2010). Dolinar 2000 and Kamps 2008 only reported outcomes that by their nature have to be measured by self report and we therefore judged them to be at low risk of bias. Four studies reviewed medical records for healthcare utilisation (Mitchell 1986; Brown 2002; Galbreath 2008; Butz 2010) while Gorelick 2006 collected both self reported ED visits as well as those in their computerised tracking system. We judged Fisher 2009 to be an unclear risk, once again due to the retrieval of hospitalisations from one hospital only. We judged four studies to be at high risk of bias for outcomes that were self reported, but could have been verified (e.g. ED visits, hospitalisations; Butz 2006; Brown 2006; Otsuki 2009; Seid 2010). Otsuki 2009 compared self reported adherence to pharmacy records for inhaled corticosteroid usage and showed that the self reports overestimated adherence compared to pharmacy records, which highlights the potential for recall bias in these situations and the need for collecting accurate data where possible.

Effects of interventions

See: **Summary of findings for the main comparison** Education versus control for children with asthma; **Summary of findings 2** Education versus other home-based education for children with asthma

Home-based education versus usual care or a less intensive, non-home-based education

Primary outcome: Exacerbations leading to Emergency Department (ED) visits

Six studies involving 985 patients reported the number of patients with one or more asthma exacerbations resulting in ED visit(s) (Mitchell 1986; Dolinar 2000; Brown 2006; Gorelick 2006; Fisher 2009; Seid 2010). The studies were not pooled due to heterogeneity in the study populations, outcome definitions, follow-up time and differences in the control group event rate (Table 2). Brown 2006

reported unscheduled urgent visits to a physician office and ED visits for asthma as a single outcome and Fisher 2009 reported the subset of ED visits that did not result in hospitalisations. Three studies measured outcomes at six months (Mitchell 1986; Brown 2006; Gorelick 2006), one reported data at three months (Dolinar 2000) and one at 24 months (Fisher 2009). Only one study (Mitchell 1986) showed a significant effect favouring controls over the intervention for the European children subgroup (Analysis 1.1). Seid 2010 reported the number of patients experiencing asthma exacerbations at three months and nine months from baseline. Seid 2010 also reported odds ratios for patients with ED visits adjusted for the baseline level of the outcome and covariates (including age, race/ethnicity, Spanish language and mother's education), which were not significant for either of the intervention groups compared to controls.

Three studies involving 525 patients reported the mean number of acute visits for asthma (Brown 2002; Gorelick 2006; Otsuki 2009). The pooled data for two studies on 430 people at six months was not statistically significant (mean difference (MD) 0.04; 95% confidence interval (CI) -0.20 to 0.27; Analysis 1.2). Brown 2002 reported only means without standard deviations and incorporated ED and clinic visits for acute asthma as a single outcome, so we could not pool these data. Although there was a significant decrease over time in the mean number of acute asthma visits at 12 months in both groups, there was no significant net treatment effect. Otsuki 2009 reported mean ED visits in the previous six months at six-month intervals from 0 to 18 months of follow-up. At 18 months, the results (for the previous six months) revealed no significant difference between either intervention groups (basic asthma education or intervention with additional adherence monitoring with feedback) and the control group. However, the authors analysed the decrease in ED visits over the entire 18-month period, and showed that the rate of decrease in ED visits over time was faster in both the combined treatment groups and the adherence feedback group alone than the control group (Otsuki 2009).

Galbreath 2008 reported an adjusted annual asthma exacerbation rate per patient leading to ED visits showing no significant difference between groups.

Primary outcome: Exacerbations requiring oral corticosteroids (OCS)

One study involving 250 patients reported the mean number of exacerbations requiring a course of oral corticosteroids every six months from baseline to 18 months (Otsuki 2009). At six and 18 months, the pooled results for the two intervention arms (basic education and adherence monitoring) were not statistically significant (MD -0.18; 95% CI -0.63 to 0.26 and MD -0.72; 95% CI -1.51 to 0.07 respectively; Analysis 1.3). However, the authors once again demonstrated that the rates of decrease in mean courses of OCS over 18 months follow-up were faster for either intervention groups compared to usual care (Otsuki 2009). Galbreath 2008 reported no statistically significant difference in the number of oral corticosteroid bursts, but the numbers were not provided to allow pooling of results.

Secondary outcome: Quality of life

Five studies on 727 participants measured quality of life (Dolinar 2000; Brown 2002; Gorelick 2006; Galbreath 2008; Seid 2010). Given the difference in instrument scores and missing data in some trials, we present a narrative synthesis below.

Three studies involving 331 patients used the Paediatric Asthma Caregiver's Quality of Life Questionnaire (PACQLQ) to assess quality of life (Dolinar 2000; Brown 2002; Galbreath 2008). Juniper et al developed both the PACQLQ (Juniper 1996a) and Paediatric Quality of Life Questionnaire (PAQLQ; Juniper 1996b), which were validated as evaluative and discriminative instruments for children seven to 17 years old. The PAQLQ contains 23 items in the domains of activity limitation, symptoms and emotional function, administered to the child (Juniper 1996b) while the PACQLQ contains 13 items concerning activity limitations and emotional function administered to the caregiver (Juniper 1996a). Brown 2002 reported improvement in scores among the caregivers of both intervention and control arms. However an intervention effect was only noted in the younger patient subgroup (one to three years old). The remaining two studies failed to show a significant effect of the intervention as measured by the PACQLQ (Dolinar 2000; Galbreath 2008) although in Galbreath 2008 the quality of life improved over time in all groups.

Galbreath 2008 also administered the PAQLQ to children. Galbreath 2008 reported no statistically significant group differences in the quality of life scores at follow-up (adjusted for baseline differences in demographics; P = 0.40), although quality of life improved from baseline in both groups. Seid 2010 reported overall health-related quality of life in 165 children using the PedsQL Total (23 items on physical and psychosocial health) administered to the parent and, if applicable, the child. Seid 2010 also reported quality of life using the PedsQL Asthma (28 items on asthma symptoms, treatment problems, worry and communication) administered to the parent and, if applicable, the child. There was no statistically significant difference in the primary outcome PedsQL Total for parent-reported symptom scores for control versus either intervention groups at three months. At nine months, there was no statistically significant difference between control versus the care co-ordination intervention, but there was a statistically significant difference in control versus care co-ordination with additional problem-solving skills training in the PedsQL Total administered to parents (adjusted MD 4.05; 95% CI 0.63 to 7.4).

Gorelick 2006 had parents/caregivers complete the Integrated Therapeutics Group Child Asthma Short Form (ITG-CASF), containing 10 items specific to asthma, at baseline and six months. This tool was previously validated for use in the ED (Gorelick 2004). The mean change in scores from baseline improved in both intervention and control groups but the difference between groups was not statistically significant.

Secondary outcome: Symptoms

Four studies involving 711 participants reported information relating to asthma symptoms, but we were unable to pool data for this outcome due to missing data, the heterogeneity of tools used to measure symptoms and underlying differences in the control group exacerbation rate (Table 2) (Brown 2002; Galbreath 2008; Otsuki 2009; Seid 2010). Brown 2002 reported the mean for asthma symptom score (using a sub-scale of the PAQLQ) and the mean symptom-free days. Although follow-up analyses were able to show that there was a benefit for symptoms and symptom-free days in the younger children (one to three years old) and not in the older children, overall there was no treatment effect on either outcome.

Galbreath 2008 measured symptom scores using the Lara Asthma Symptom Scale (LASS) and stated that symptom scores decreased over time in all groups, but did not show a significant treatment effect. Otsuki 2009 measured caregiver reports of symptoms every six months (baseline, 6, 12 and 18 months), calculating the mean asthma symptoms in the previous 30 days. None of the mean values for symptom scores were different at each time point between either intervention groups versus controls, but Otsuki 2009 reported differences in the rate of improvement in symptoms over time for the asthma basic care versus control group - the intervention improving faster than the control group over the first 12 months. Using ordinal scales, Seid 2010 reported the percentage of children experiencing daytime symptoms (< twice a week, three to six times a week and every day) and night-time symptoms (< once/week, > once/week) at baseline, three months and nine months after baseline. The odds ratios adjusted for baseline levels and covariates showed no significant different between either intervention groups compared with controls for daytime symptoms, but statistically improved night-time symptoms at three months but not nine months for the care co-ordination/problem-solving skills group compared to controls (odds ratio (OR) 0.33; 95% CI 0.13 to 0.82; Seid 2010).

Secondary outcome: Night-time awakening

No study reported night-time awakening.

Secondary outcome: Days missed from school

One study with 259 participants reported no statistically significant difference between groups in the number of school days missed (Mitchell 1986; Analysis 1.4). One study combining 239 adults and children reported on days missed from school or work, also showing no group difference (Brown 2006).

Secondary outcome: Hospitalisations

Five studies on 1012 participants reported the number of patients experiencing one or more hospitalisations (Mitchell 1986; Dolinar 2000; Fisher 2009; Otsuki 2009; Seid 2010). However, the data were not combined due to clinical heterogeneity and follow-up periods (Analysis 1.5). Fisher 2009 demonstrated reduced hospitalisations at 24 months in the intervention group in (OR 0.4; 95% CI 0.22 to 0.71) and the Europeans in Mitchell 1986 had increased admissions between six and 18 months (OR 2.45; 95% CI 1.25 to 4.83). All the other studies reported no group difference. None of the patients in Dolinar 2000 had a hospital admission.

Two studies on 569 participants reported the mean hospitalisations, although we did not pool due to heterogeneity (Mitchell 1986; Galbreath 2008). Mitchell 1986 had heterogeneity between study populations so we did not to pool this outcome (Analysis 1.6). Mitchell 1986 reported mean hospital admissions at both six months and between six and 18 months. Only the European children showed a significant effect favouring controls in the latter time period. Galbreath 2008 reported no significant treatment effect for the adjusted rates of hospital admissions per patient per year.

Secondary outcome: Lung function

No studies reported this outcome.

Education versus another type of home-based education

Three studies reported on a home-based education intervention compared to another, less intensive type of home-based education as a control group (Butz 2006; Kamps 2008; Butz 2010).

Primary outcome: Exacerbations leading to ED visits

Butz 2006 showed fewer patients in the nebuliser-targeted education group (27/95) reporting at least one ED visit at six months compared to the less intensive education group (40/86), which was a statistically significant (OR 0.46; 95% CI 0.25 to 0.84; Analysis 2.1). Butz 2010 reported no statistically significant difference between groups for the decrease in mean number of ED visits at 12 months.

Primary outcome: Exacerbations requiring oral corticosteroids (OCS)

Butz 2006 reported no statistical differences between intervention and control groups for the mean number of oral corticosteroid prescriptions at 12 months. Butz 2010 reported no significant differences for the mean number of oral corticosteroids filled at 12 months (Analysis 2.2).

Secondary outcome: Quality of life

Kamps 2008 measured physical function and psychosocial health with the generic PedsQL and asthma-related quality of life with the PedsQL Asthma Module (with sections on asthma symptoms, treatment problems, worry, and communication) administered to both child and caregiver. No significant treatment effects were observed using repeated measures analyses of covariance and pooled time series analysis using data from baseline (n = 15), two (n = 10), six (n = 6) and 12 months (n = 5) (Kamps 2008).

Secondary outcome: Symptoms

Kamps 2008 measured caregiver-reported and child-reported asthma symptoms using PedsQL Asthma Module and found no significant difference in treatment effect at baseline and two, six and 12 months. Repeated-measures ANCOVAS did not yield significant interactions or main effects for symptom scores. Butz 2010 reported no statistically significant differences between groups for the decrease in mean number of symptoms during both the day and at night measured with a Likert-type scale at 12 months. We did not pool the data due to differences in measurement tools.

Secondary outcome: Night-time awakening

No study reported this outcome.

Secondary outcome: Days missed from school

No study reported this outcome.

Secondary outcome: Hospitalisations

A single study on 181 participants reported the number of patients experiencing at least one hospitalisation for the previous six months at 12 months follow-up (Butz 2006).There were fewer hospitalisations in the group receiving the additional nebuliser use training compared to the less intensive education, which was a statistically significant difference (OR 0.30; 95% CI 0.09 to 0.98; Analysis 2.3). Butz 2010 reported no difference in the mean number of hospitalisations at 12 months (Analysis 2.4).

Secondary outcome: Lung function

Kamps 2008 did not report any significant differences in lung function (FEF (forced expiratory flow) 25% to 75%) using repeated measures analyses of covariance and pooled time series analysis at two months (n = 10), six months (n = 6) and 12 months (n = 6).

Cost

Galbreath 2008 reported the cost of the four home visits to be USD 206 and USD 531 for the telephonic intervention, totaling USD 737 per participant.

Withdrawals

We decided not to pool these data due to heterogeneity in the trial design (such as the number of education sessions) and reporting of the number of withdrawals. Instead we created Table 4 to reflect the number of patients who completed all or some of the education, patients lost to follow-up and those who withdrew. This table should be viewed and interpreted with caution. Each study had its own definition of completing the programme and in some case people may have missed some sessions yet still be registered as completing the programme. The programmes also varied in number of sessions.

Subgroup analysis

We were unable to perform any of the prespecified subgroup analyses due to the lack of studies. Even if we had more included studies, performing subgroup analysis would be unwise due to the heterogeneity in the studies. We could not subgroup by age as most studies were on two to 12 year olds, except for three studies which included a range of ages spanning childhood and adolescence (Brown 2006; Gorelick 2006; Galbreath 2008). None of the studies could be divided into mild/moderate versus severe as all included children had a range of asthma severities. Fisher 2009 was the only intervention running for longer than six months. We had planned to subgroup by physician or nurse versus community health worker. However, all studies employed nurses combined with either a social worker, a trained health educator or a pulmonary therapist, except Fisher 2009 who employed a community health worker, Kamps 2008 who used a psychologist or a psychology graduate student, Otsuki 2009 an asthma educator, and Seid 2010 who employed bilingual, bicultural graduate asthma visitors.

DISCUSSION

Summary of main results

We included 2342 patients from 12 trials in this review. Of these, eleven trials were conducted in North America. Ten studies were in urban or suburban settings involving vulnerable populations. We summarised the components of the home-based educational interventions in Table 1. We were unable to pool many of the outcomes due to clinical heterogeneity of the populations, interventions and timing of outcome assessment. The control event rates for Emergency Department (ED) visits and hospitalisations were quite different between trials. It is possible that trials with a higher control group event rate (poorly controlled asthma) would more likely achieve a decrease in admissions/ED visits, leading to difficulties in pooling (see Table 2 and further discussion below). Overall the effect of home-based education is heavily dependent on the context of the trial (including but not limited to; aims of study, focus of the education, characteristics of the population) so deriving and interpreting average outcomes across these studies is not meaningful.

Overall completeness and applicability of evidence

Implementation, feasibility and applicability of home-based educational interventions

Many of the included studies tested commercially-available asthma educational interventions covering similar programme topics, although these were delivered differently and with different emphasis on components of education. These studies showed that while home-based interventions are feasible, additional resources and trained personnel are required, which may not be easily applied in real-world settings, especially without adequate financial support. None of the studies analysed cost-effectiveness. Economic data may strengthen the case for such interventions to be included in policy and healthcare budgets, concurrent with more evidence supporting clinical effectiveness. Administrators and policy-makers may want to consider whether children with asthma and their caregivers are able to attend asthma clinics to receive education or whether some families can only be reached by visiting their home.

Our review also draws attention to another issue pertaining to the feasibility of interventions: the ability to retain participants. Although the participants who provided follow-up data generally completed most of the education sessions, there appeared to be a higher attrition rate in the education group compared to the control groups in almost half of the trials. While high and unbalanced withdrawal rates are common in trials with high demands on participants' time, unbalanced withdrawal rates may also provide a biased indication of the effectiveness of home-based education, depending on whether the intervention retained children who were more or less likely to benefit than those who dropped out.

Although most of our included trials employed health professionals (specifically, nurses), it may be possible to improve feasibility and reduce costs of interventions by employing lay workers from the community to deliver the education sessions. Fisher 2009 demonstrated that a programme delivered by community health workers was not only feasible, but also reduced hospitalisations. Community health workers have successfully delivered education in other trials, albeit in programmes primarily aimed at reducing environmental allergens thus beyond the scope of our review (Hovell 2002; Krieger 2002; Krieger 2005). A study by Flores 2009, excluded from this review, employed lay asthma educators in the form of parent mentors and suggested that this was an inexpensive and effective intervention for reducing asthma exacerbations and ED visits over 12 months, leading to overall cost savings.

Two studies in our review require careful interpretation with regards to the applicability of the interventions and results (Mitchell 1986; Butz 2006). Butz 2006 was focused on a population of children using nebulisers to deliver medications at home, which is not currently standard practice for most children with asthma and is not usually recommended in current guidelines (NAEPP 2007; British Guideline on the Management of Asthma; GINA 2008). Butz 2006 was the only trial among three with a home-based control education group that showed a significant treatment effect for reducing ED visits and hospital admissions. This may relate to more severe asthma in children enrolled who were using nebulisers, and hence the greater likelihood of needing ED visits or hospital

admissions for acute asthma (nearly half of the control group had ED visits in this study). Mitchell 1986 was conducted more than two decades ago, when asthma management was different and guidelines were less widely recognised and disseminated (Brouwer 2008).

Quality of the evidence

A criticism of existing research on education for childhood asthma is that no randomised controlled trials (RCTs) have evaluated what are the specific components of the programmes that are effective. Rather, most studies have tested educational interventions featuring a comprehensive strategy (Brouwer 2008; Boyd 2009). Our review has highlighted the clinical heterogeneity present in randomised trials of home-based educational interventions.

Heterogeneity in educational programmes

The diversity in educational programmes (e.g. focus, intensity and duration of education), as well as the variation in the control education and in the assessment of outcomes, led to substantial clinical heterogeneity. Because of this, we did not pool many of the data and were unable to draw definite conclusions from the narrative syntheses. Several sources of heterogeneity are highlighted below.

The aims of the studies varied from reducing ED visits and readmission rates to improving adherence or quality of life. Some studies appeared to focus on one aspect of education (e.g. adherence to steroids or improving nebuliser use) or more specifically on improving an outcome (e.g. reducing readmissions or increasing primary care follow-up). We attempted to summarise the aims of the trials in Table 3 although these were not always explicit in the trial. It is impossible to untangle what impact the differences in the stated aims have on the education delivered and outcomes.

Most trials reported programmes covering comparable education topics (e.g. written action plans, self monitoring) and we tried to capture any differences in Table 1. We were unable to tease out the individual components of the interventions that made a difference to the outcomes measured.

The trials in our review provided a similar intensity of sessions, with a few exceptions. Three studies delivered only a single education session (Dolinar 2000; Brown 2006; Gorelick 2006) while the most intense intervention provided visits every three months for two years (Fisher 2009). Although the latter, more intense trial demonstrated significantly reduced hospital admissions, there are many other possible explanations for this (e.g. this trial also had the highest control group event rate) (Fisher 2009). Therefore we cannot draw definitive conclusions on the effect of programme intensity.

Control group event rates and population differences

Heterogeneity was present in the control groups, as each trial and institution likely had different standards of usual care, and the severity of asthma and trial duration was heterogeneous. Although not an outcome in our review, there were three deaths in the trial by Butz 2006, two in Otsuki 2009 and two adults died in Galbreath 2008, which may be an indication of asthma severity or a higher-risk population. In the case of the three trials with a home-based education control group (Butz 2006; Kamps 2008; Butz 2010), there may have been a decreased ability to detect a difference between groups due to the controls receiving less intense education in the home setting.

Children with asthma are likely to have different levels of access to care, which may affect outcomes. For example, a child may benefit from education if the caregiver learns when to seek medical attention before an exacerbation becomes too severe, but if a primary care provider is not accessible they may end up having to make a non-urgent ED visit. The end result is an educational intervention that has outcomes that become difficult to interpret. To investigate this further we looked at the event rates for ED visits and hospitalisations in the control groups (Table 2). From the trials reporting ED visits as an outcome, four had relatively high control group ED visit rates (38% to 54%; Butz 2006; Brown 2006; Gorelick 2006; Fisher 2009) and these trials may be more likely to show a decrease in ED visits than the three reporting lower rates of ED visits (5% to 15%; Mitchell 1986; Dolinar 2000; Seid 2010). However, most of the individual trial results were not statistically significant for ED visits (except Butz 2006 and Mitchell 1986, with their unique populations and limited applicability of results, as previously described) and we were unable to draw conclusions. The statistically significant difference in hospitalisations observed in Fisher 2009 may be explained by the high hospitalisation control group event rate (59%) compared to the lower event rates for the other studies (8% to 33%; Table 2).

Some outcome measures improved over time in both intervention and control groups

In many of the included studies, outcomes such as quality of life scores improved in both groups over the trial period (Brown 2002; Gorelick 2006; Galbreath 2008; Seid 2010). This may be due to recruitment factors (patients are enrolled after an ED visit or hospital admission, when they are potentially at their sickest and the majority will get better) or the natural evolution of the disease (younger children getting better with age). This highlights the importance of observing data over extended periods of time to assess whether change is truly due to the intervention and whether the effects are long-lasting after the trial period.

Potential biases in the review process

Although we attempted to apply a systematic process for including and excluding studies in this review and followed the criteria prespecified in our protocol, the final decisions are open to interpretation or criticism. In order to reduce clinical heterogeneity, we excluded some trials that had mixed interventions, such as those with more education delivered outside of the home (e.g. Flores 2009) or more focus on environmental allergen reduction (e.g. Jones 2001; see Characteristics of excluded studies for more information).

Agreements and disagreements with other studies or reviews

The current review brings together new trials that were not included in previous systematic reviews (Coffman 2008; Boyd 2009; Wolf 2002). Some of these RCTs were also missing from the last update of the National Asthma Education and Prevention Program (NAEPP) guidelines in 2007 (NAEPP 2007), which revealed the need for more research at the time and recommended home-based education for young children based on evidence from two RCTs (Jones 2001; Brown 2002) only one of which was

included in this current review. Previous reviews have supported asthma self management education in children to improve outcomes such as reduced asthma-related morbidity and acute health care utilisation. Wolf 2002 included 32 trials examining asthma self management educational interventions in children and adolescents that took place in various settings (including home, clinic and school). Only one study from our review was included in Wolf's review (Mitchell 1986). Wolf 2002 noted that the majority of the trials were poorly reported and lacked sufficient data for meta-analyses. Likewise, Coffman 2008 meta-analysed 37 trials conducted solely in the United States in the clinical setting on education to decrease acute care services use and Boyd 2009 included 38 trials on education for children who had attended the ED. Altogether, the pooled trials in these reviews demonstrated statistically significant decreased ED use in terms of the risk of subsequent ED visits (risk ratio (RR) 0.73; 95% confidence interval (CI) 0.65 to 0.81; Boyd 2009) as well as the mean number of ED visits (standardised mean difference (SMD) -0.21; 95% CI -0.33 to -0.09; Wolf 2002 and SMD -0.17; 95% CI -0.31 to -0.03; Coffman 2008). In Coffman 2008, the reduced odds of ED visits was just outside of statistical significance (odds ratio (OR) 0.78; 95% CI 0.61 to 1.01). The other primary outcome in the current review (exacerbations requiring a course of oral corticosteroids) was not previously reported, but hospital admissions were shown to decrease in two reviews (Boyd 2009 and Coffman 2008), quality of life scores improved in one review (mean difference (MD) 0.13, 95% 0.73 to 0.99; Boyd 2009) and days of restricted activity decreased in another (SMD -0.29; 95% CI -0.49 to -0.08; Wolf 2002). To reiterate an earlier point, these reviews included a heterogenous group of educational interventions. It is unclear which components of the programmes contributed to the significant benefits observed.

These previous reviews also examined interventions conducted within a wide range of settings. Coffman 2008 observed favourable results in trials where comprehensive education occurred in the clinical setting. They hypothesised that this may have permitted access to medical charts and information, allowing for a more individualised intervention. There may also be more support for school-based asthma education and a future Cochrane Review will address this question.

AUTHORS' CONCLUSIONS

Implications for practice

We included 2342 patients from 12 trials in this review, most of which involved a vulnerable urban population of North American children with asthma hypothesised to benefit from home-based asthma educational interventions. We were unable to pool many of the outcomes due to clinical heterogeneity. Overall the effect of home-based education is heavily dependent on the context (aims, control group event rate, type and intensity of education etc.) of that education so trying to derive an average outcome across the studies is not meaningful. We found inconsistent evidence for home-based asthma educational interventions compared to standard care, education delivered outside of the home or a less intensive educational intervention delivered at home. Although education remains a key component of managing asthma in children, advocated in numerous guidelines, our review does not contribute further information on the fundamental content and optimum setting for such educational interventions. We cannot rule out the possibility that home-based education may be beneficial under some circumstances, where resources and funding permit.

Implications for research

Asthma self management education is recommended in guidelines and we did not find evidence to either support or reject the notion that home-based education may be beneficial. There are still important questions that could benefit from well-designed trials to address the following issues:

1. Defining the exact components of education that are linked with improved asthma knowledge and outcomes. This will involve addressing the heterogeneity of trials and may involve:
   a. comparing similar programmes or programmes with slight variations (for example, with differences in duration, number of visits, types of educators, length of follow-up);
   b. designing trials with multiple intervention arms to tease out which components of education are effective;
   c. standardising reporting of outcomes - for example, reporting a minimum set of outcomes (such as those specified in this review) and using the same validated quality of life questionnaire(s).
2. Cost-effectiveness: while cost data were not well-reported in the included trials, further work is needed to establish whether the extra costs of delivering education in homes ties in with a reduction in costly outcomes such as acute health care visits. Demonstration of cost-effectiveness, along with clinical effectiveness, would support the widespread adoption of such programmes by health systems financing them.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

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

Brown 2002

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: clinics associated with a University School of Medicine or a children's hospital in Atlanta, Georgia, USA Study duration and start date: 12 months, September 1997 to June 1999
Participants	N (completed) = 101 (98) Mean age (range): 4.2 (1.1 to 7.0) Gender (% male): 63% Asthma severity: mild intermittent (19%), mild persistent (56%), moderate persistent (21%), severe persistent (4%) Diagnostic criteria: NAEPP Concurrent treatment: 85% had been previously prescribed one of more daily anti-inflammatories (cromolyn (43%), ICS (78%), antileukotriene modifier (6%), LABA (6%). In addition, some children had been prescribed theophylline (8%) and/or a brief course of OCS (26%) and all but one of the children had been prescribed SABA (98%, 16% were using SABA only) Socioeconomic indicators: parents received no high school (28%), high school qualification (50%), some college (22%) Ethnicity: 90% African American Eligibility criteria: children between 1 and 6.99 years of age at study entry and had made a healthcare visit for asthma in the preceding year and who were prescribed daily asthma medication. The primary care giver had to speak English and have no know involvement with illegal drugs. Those who refused or could not be contacted were excluded.

Brown 2002 *(Continued)*

Interventions	Educator: registered nurses trained in the Wee Wheezers at Home programme. Nurses attended supervisory sessions twice a month and focused on their cases and received ongoing training. The same nurse conducted all 8 sessions with a family. Audience: families (86% mothers) and their children. Others present in the household were also invited to participate Where delivered: home-based INTERVENTION GROUP N (completed): 55 (49) N, duration and frequency of education sessions: 8 weekly sessions of 90 minutes Educational/self management strategy: Based on Wee Wheezers at Home programme. The teaching script of which was adapted for low-literacy levels (5th grade) and adapting for child audience and ensuring cultural appropriateness of materials. The material was delivered over 8 sessions rather than 4. Each 90-minute session consisted of the caregiver and nurse jointly completing a checklist of the child's symptoms for the previous week (5 minutes), a discussion of the previous weeks homework (5 minutes), the session topics (60 minutes), a review of concepts learned during that session (5 minutes) and assigning homework (5 minutes). Example of caregiver/child activities include tracing the airflow on a picture of a child with the lungs drawn, identifying and colouring asthma cues and environmental triggers in a colouring book, practising belly breathing, keeping an asthma diary, watching videos about asthma management and practicing the use of a peak flow meter. Educational materials used/provided: printed materials, homework and occasional videotapes Programme topics: session 1) basic concepts of asthma; 2) developmentally appropriate involvement of child in asthma self management plan and asthma cues; 3) asthma medication and non-medication techniques for managing asthma symptoms as part of action plan and working together with child to administer medicines; 4) symptoms of asthma attacks, review of asthma action plan, children with chronic health problems; 5) symptom prevention including trigger identification, environmental control measures and use of preventative medication; 6) communication about asthma to teachers, physicians and family members; 7) review of asthma concepts; 8) review of communication about asthma. Incentives: at the baseline visit, parents gave consent and received USD 25 and were given USD 25 for each of 2 further data collection visits Compliance: 20% of the 49 families who completed the education received some or no lessons CONTROL GROUP: received no education but did receive the data collection visits. Families of control group were offered one educational home visit after completion of data collection. N (completed): 46 (46) Net treatment: complete education programme
Outcomes	Outcomes measured: asthma morbidity: a rating of how much patents were bothered by symptoms, the number of symptom-free days since most recent asthma visit, the number of acute visits for asthma exacerbations. Caregivers quality of life: measured by questionnaire on how much caregiver was bothered or worried by their child's symptoms. Caregivers' rating of the level of child's participation in administering asthma medication and symptoms prevention and treatment. Outcomes reported: as stated Time points: baseline, 3 (actually about 19 weeks) and 12 months. The number of acute asthma visits were collected fore the previous year at baseline and 12 months.
Notes	Funding: National Institute of Nursing Research grant R01NR04431
Risk of bias	

Brown 2002 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomised". Groups balanced by medical site and season of enrolment. Comment: not described
Allocation concealment (selection bias)	Unclear risk	"Families were informed of their group assignment via a letter" Comment: unclear who assigned participants to their groups
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	It was not possible to blind participants or personnel
Blinding of outcome assessment (detection bias) All outcomes	Low risk	A graduate student blind to group assignment abstracted asthma-related information from the child's medical records. Project social worker collected data from families was blinded, although may have become aware of group assignment in certain instances.
Incomplete outcome data (attrition bias) All outcomes	High risk	One control group family and 3 intervention families could not be contacted at 3 months and two control families could not be contacted at 12 months. Six families withdrew on assignment to treatment group and this can be assumed to be related to the treatment. Comment: only have outcome data for the 49/55 families who completed the intervention. Complete data for all the control patients.
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	Low risk	Observational used over self reports where possible

Brown 2006

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: community hospital Grand Rapids, USA Study duration and start date: 2004
Participants	N (completed) = 248 (239) adults and children; 137 (129) children Mean age (range): adults and children, but data were presented separately for those under 18 years Gender (% male): 46% Asthma severity: mild intermittent (23%), mild persistent (21%), moderate persistent (19), severe persistent (37%) Diagnostic criteria: NHLIB Expert Panel 2 Guidelines or had visited the ED at least once in the last year (71%) Concurrent treatment: 80% on inhaled corticosteroids Socioeconomic indicators: no high school diploma ˜18%, high school qualification ˜ 32%, some college ˜50% Ethnicity: 30% African American, 59% white, 11% other

Brown 2006 *(Continued)*

	Eligibility criteria: moderate to severe persistent asthma or had visited the ED at least once in the last year. Although moderate to severe asthma was an eligibility criteria, patients with mild intermittent of mild persistent were also included.
Interventions	Educator: trained asthma nurse educator Audience: parent and child Where delivered: primary care clinic/home INTERVENTION GROUP N (completed): 120 (117, 66 children) N, duration and frequency of education sessions: 1 session in primary care clinic within 3 weeks of initial ED visit, 1 session at home 6 weeks after first session. Educational/self management strategy: 1) optimising medical therapy based on NHLBI guidelines; 2) optimising understanding of asthma management and control by stressing self evaluation and monitoring; 3) developing or refining individually tailored AMP; 4) conducting follow-up home visit to identify potential asthma triggers and reinforce recent changes in treatment and management Programme topics: before ED discharge patients received age-appropriate instruction from respiratory therapist on the use of inhaler/spacer/PEF meter from the asthma nurse educator who called to arrange a follow-up appointment with the primary care physician within 5 days. At the clinic appointment, patient, parent and asthma nurse educator worked with the primary care physician to review current treatment, develop written action plan and provide education about appropriate response to further asthma exacerbations. The home visit included review of current medication and inhaler, spacer and PEF meter techniques, asthma management plan and encouraged distribution of the plan to school, day-care etc. Basic education relating to triggers, early warning signs and prevention was also given, along with an in-home environmental evaluation. Incentives: 2 USD 10 grocery vouchers Compliance: 39% of the intervention group did not comply with any of the post ED activities CONTROL GROUP: standard management consistent with NHLBI 2 guidelines. Received instruction by respiratory therapist on proper use of inhaler and spacer, and if age appropriate, peak expiratory flow meter. Written discharge instructions including recommendation to contact PCP within 3 to 5 days to schedule follow-up appointment. If no regular PCP, referral made using hospital-affiliated paediatric clinic for children. ED physician dictation faxed to PCP. N (completed): 128 (122, 63 children) Net treatment: appointment with primary care provider facilitated by the nurse educator and home visit
Outcomes	Outcomes measured: primary outcome was time to first asthma relapse (asthma-related visit to ED or unscheduled urgent visit to physician office during 6-month follow-up period); secondary outcomes were total number of ED visits and hospitalisations during 6 months, self reported compliance with spacer and PEF, use of asthma management plan, self reported actions taken to reduce exposure to asthma triggers, missed work or school days Outcomes reported: as above Time points: follow-up data collected by telephone call at 2 and 6 months after enrolment
Notes	Funding: grant from the Centers for disease control and the Butterworth Foundation

Risk of bias

Bias	Authors' judgement	Support for judgement

Brown 2006 *(Continued)*

Random sequence generation (selection bias)	Low risk	Patients were stratified by age and "randomised using computer-generated random numbers..." Patients were enrolled consecutively from selected ED shifts representing a broad range of time of day and day of week
Allocation concealment (selection bias)	Low risk	"... followed by the use of sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	Loss to follow-up was 21% in group and 6% in the control arm. Comment: the loss to follow-up was high and unbalanced, and there were more losses in the intervention arm which is related to the treatment and people's willingness to comply
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	High risk	ED visits and hospitalisations were self reported

Butz 2006

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: pediatric primary care (30%), pulmonary/allergy clinics (50%) and ED practices (20%) associated with the University of Maryland medical System and the Johns Hopkins Hospital, Baltimore, USA Study duration and start date: October 2001 to December 2003 (recruitment)
Participants	N (completed) = 221 (181) Mean age (range): 4.6 (2 to 9) Gender (% male): 65% Asthma severity: mild intermittent (5%), mild persistent (61%), moderate persistent (21%), severe persistent (14%) Diagnostic criteria: national guidelines Concurrent treatment: number of SABA prescriptions in the past 6 months from baseline from pharmacy data mean (SD) 1.8 (1.9), Number of OCS prescriptions in the past 6 months from baseline from pharmacy data mean (SD) 0.6 (0.9), number of ICS prescriptions in the past 6 months from baseline from pharmacy data mean (SD) 0.9 (1.4) Baseline lung function:

Butz 2006 *(Continued)*

	Socioeconomic indicators: no high school diploma (24%), high school qualification (39%), some college or trade school or college graduate (38%). Annual household income less than USD 20,000 48%, more than or equal to USD 20,000 40% (sic). Medicaid health insurance 80%. Ethnicity: African American 89%, other 11% Eligibility criteria: children resident in Baltimore aged 2 to 9 years with a previous medical diagnosis of asthma. Children should have experienced daytime asthma symptom at least 2 or more times a week within the past 30 days, night-time asthma symptom at least 2 or more times a week within the past 30 days, use of a nebuliser to administer asthma medication within the past 30 days, 1 or more ED visits for asthma within the past 12 months or hospitalisation for asthma in the past 12 months. Exclusion criteria were low or no nebuliser use in the prior 30 days and children newly diagnosed as having asthma.
Interventions	Educator: 3 community health nurses with paediatric asthma training. Supervised monthly by a paediatric nurse asthma specialist. Audience: parents and child Where delivered: home NEBULISER INTERVENTION GROUP N (completed): 110 (95) N, duration and frequency of education sessions: 6 x 1-hour sessions over 6 months Educational/self management strategy: The parent component of the educational intervention included teaching comparison of a child's normal breathing to breathing patterns noted during an acute asthma episode. Parents taught to recognise each asthma symptoms (cough, wheeze, inability to talk and signs including intercostal retractions and use of a PFM in children over 5 years of age, so that they could make accurate treatment decisions. Specific nebuliser-use education targeted accurate medication dispensing including measuring accurate amount of medication, pouring medication in nebuliser cup, the frequency of changing nebuliser mask and tubing, and the cleaning and maintenance of the nebuliser device. The programme was based on the Wee Wheezers Program and the A+ Asthma Club Program and teaching paediatric symptom identification in children with asthma, and recommendations for nebuliser therapy Educational materials used/provided: home visit checklist used by nurse (available in the public health nursing paper) Compliance: number of sessions attended mean (SD): 5.6 (1.2) STANDARD ASTHMA EDUCATION CONTROL GROUP: a less intensive intervention group. Received basic asthma education, comparable to education received during non-urgent care visits. Facilitating access to acute asthma care, encouraging parents to obtain WAP from healthcare provider, addressed dose and frequency of current medication, teaching the use of a PFM to children over 5 years old. No symptom identification or nebuliser use was taught. 3 asthma education visits Mean (SD) of completed home visits: 2.9 (0.5) N (completed): 111 (86) Net treatment: specific quick relief and controller medication use, symptom identification and nebuliser use technique
Outcomes	Outcomes measured: symptom frequency, appropriate nebulizer and asthma medication use, ED visits and hospitalisations (reported as events in the past 6 months) Outcomes reported: as above

Butz 2006 *(Continued)*

	Time points: baseline, 12 months
Notes	Funding: grant NR05060 from the National Institute for Nursing Research Further information on education available from study authors: yes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised "based on even or odd digits from a random digit list"
Allocation concealment (selection bias)	Low risk	Project co-ordinator and principal investigator did not order of allocation (*email communication with author*)
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Project co-ordinator and co-investigators all blinded (*email communication with author*)
Incomplete outcome data (attrition bias) All outcomes	High risk	Nebuliser intervention: 14% excluded from follow-up (10% no pharmacy data, 2% died, 3% lost). SAE 23% excluded (18% no pharmacy data, 1% died, 4% lost.
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	High risk	Self reports were verified except for hospitalisations

Butz 2010

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: paediatric ED (72%), paediatric community practices (28%), Johns Hopkins Hospital, Baltimore, USA Study duration and start date: December 2004 to December 2006 (recruitment)
Participants	N (completed) = 231(193) Mean age (range): 8.02 (6 to 12) Gender (% male): 60.6% Asthma severity: mild intermittent (22.6%), mild persistent (48.3%), moderate persistent (16.1%), severe persistent (13.0%) Diagnostic criteria: NHLBI Concurrent treatment: controller medication use (68%), SABA canister equivalents in past 12 months (mean 2.61; SD 2.8), Oral corticosteroid fills past 12 months (mean 1.17; SD 1.5), inhaled corticosteroid canisters past 12 months (mean 1.82; SD 2.6), LABA past 12 months (mean 0.44; SD 1.5), ratio controller to total asthma medications fills for 12 months (mean 0.41; SD 0.3)

Butz 2010 *(Continued)*

	Baseline lung function: Socioeconomic indicators: income < USD 20,000 (57.1%); income >= USD 20,000 (42.9%); caregiver education < high school graduate (32.0%); high school graduate or more education (68.0%) Ethnicity: African American (92.6%), white (3.5%), other/missing (3.9%) Eligibility criteria: children 6 to 12 years old with physician-diagnosed asthma, currently used controller and/or SABA medication, with one or more asthma ED visits or hospitalisation in preceding year and no specialty care within past year.
Interventions	Educator: trained nurse/health educator Audience: parents and child Where delivered: home ASTHMA COMMUNICATION INTERVENTION N (completed): 121 (100). Mean 3.29 (SD 1.2) out of 4 visits. N, duration and frequency of education sessions: 4 home visits x 30 to 45 minutes each, over 8 weeks Educational/self management strategy: communication skills education (role play, cue cards for enhanced communication with clinician), assistance in arranging clinician appointments, reinforcement of medication device technique. Also received control group education intervention (see below) Educational materials used/provided: written asthma educational materials (same as control) as well as one-page cue card to enhance caregiver to clinician communication Compliance: mean 3.29 (SD 1.2) out of 4 home visits; 60% had 1 clinic visit, 27% had 2 clinic visits STANDARD ASTHMA EDUCATION CONTROL GROUP: 3 asthma education visits, each 30 minutes over 8 weeks. Teaching topics: asthma triggers, medications, standard device training for peak-flow meter and inhaler/spacer technique, reducing barriers to regular follow-up asthma care. Families received written educational materials. No home environment assessment performed. N (completed): 110 (93). Mean 2.27 (SD 1.1) out of 3 visits. Net treatment: asthma communication education (communication skills education, assistance in arranging clinician appointments, reinforcement of medication device technique with child)
Outcomes	Outcomes measured: morbidity measures (caregiver reported symptom days and nights over past 30 days, asthma severity using symptoms and rescue medication frequency algorithm from NHLBI, activity limitation from asthma, number of ED and clinician visits, number of hospitalisations), pharmacy-based medication use (appropriate controller and SABA medications based on pharmacy records over 12 months, oral corticosteroid prescription fills, appropriate controller med use (ratio of controller:total asthma medications)), caregiver rating of communication with PCP (4-item, 5-point Likert-type scale), and characteristics of home and clinician visits (checklists for completed home visits and psychosocial issues; for intervention group, checklists used to examine content of communication between clinician and caregiver) Outcomes reported: as above Time points: baseline, 12 months
Notes	Funding: grant NR008544 from the National Institute for Nursing Research

Risk of bias

Bias	Authors' judgement	Support for judgement

Butz 2010 *(Continued)*

Random sequence generation (selection bias)	Low risk	Random digits generated by STATA (*email communication with Dr. Butz*)
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Research staff remained blinded for all follow-up surveys
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat analysis; -intervention 83% lost to follow-up and control 86% lost to follow-up
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	Low risk	Although most health care utilisation outcome self reported, ED and clinician visits verified by child's clinician

Dolinar 2000

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: paediatric outpatient office in Sudbury, Ontario, Canada Study duration and start date:
Participants	N (completed) = 40 families with 56 children. Intervention delivered to parents. Mean age (range): 5 years (1 to 10) Gender (% male): 43% Asthma severity: collected, but not reported Socioeconomic indicators: well-supported financially and most families had 2 parents. 67% earned over CAD 40,000 Ethnicity: Eligibility criteria: Parents with at least 1 child, 10 years old or younger with a diagnosis of asthma for greater than 6 months. Parents must have responsibility for the management of the child's asthma, no previous participation in asthma health education programme, avoid any other education programme, and be able to read, write and communicate in English
Interventions	Educator: principal investigator of the project Audience: parents Where delivered: home-based INTERVENTION GROUP

Dolinar 2000 *(Continued)*

	N (completed): 20 (18) families N, duration and frequency of education sessions: a single, 2-hour session Educational/self management strategy: education session based on the Air Force Asthma Program Educational materials used/provided: childhood asthma education booklet representing conventional care Programme topics: provides information on asthma and decreases concerns related to the care of a child with asthma. Reinforcement of rational for therapy, compliance and follow-up. Assist the parent in the day-to-day management of their child's asthma and smoking cessation and alternative coping strategies to enhance respiratory health. CONTROL GROUP: received childhood asthma education booklet representing conventional care. The content of the education was the same for both groups, but the mode of delivery varied. N (completed): 20 (17) families Net treatment:
Outcomes	Outcomes measured: parental coping measured by Hymovich's Parent Perception Inventory (PPI), quality of life measured by the Paediatric Asthma Caregiver Quality of Life Questionnaire (PACQLQ) and change in asthma measured by the Caregiver Perception of Change (CPC) survey Outcomes reported: final values not reported apart from for caregiver perception of change Time points: 3-month follow-up
Notes	Cost: no detailed costing done, but asthma educator costs CAD 30 to 34 per hour inclusive of transport costs Funding: Ontario Lung Association awarded a fellowship to fund project

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Families were randomly assigned to one of the treatment arms using the Moses-Oakford method, and were assigned in blocks to assure equal numbers in each group"
Allocation concealment (selection bias)	Unclear risk	"Consecutive asthmatic patients and their families were recruited by the office staff and referred to the researcher, unaware of the allocation schedule." Not described
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not described, but study described as "non-blinded" so assumed not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	5 families lost to follow-up; 2 from experimental, 3 from control

Dolinar 2000 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	Low risk	Only self reports possible

Fisher 2009

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: St Louis Children's hospital (SLCH; hospitalised children), Missouri, USA Study duration and start date: April 1997 to March 2001
Participants	N (completed) = 191 (189); intervention delivered to parents Mean age (range): 4.9 (2 to 8) Gender (% male): 59% Asthma severity: mean hospitalisations in the previous year; treatment 0.47 (0.86) usual care 0.49 (0.79). Mean ED visits in the previous year treatment 1.07 (1.81) usual care 0.94 (1.39). Parents rating of symptoms in the previous week of randomisation (1 = very often to 3 = never) treatment 2.28 (0.52) usual care 2.35 (0.50) Diagnostic criteria: not specified Concurrent treatment: not specified Baseline lung function: not specified Socioeconomic indicators (parents' education): no high school diploma 33%, high school qualification 40%, some college 23%, college graduate 4% Ethnicity: predominantly African American Eligibility criteria: parents of children 2 to 8 years old who had been hospitalised for asthma at SLCH, received Medicaid, diagnosis of asthma made by admitting physician, resident of predominantly African American population defined by zip codes in St Louis City and county, phone number on record. Excluded if the phone was disconnected, 10 phone calls went unanswered or refusal to participate.
Interventions	Educator: 3 trained asthma educators, African American women from the same neighbourhood as the participants who were high school educated and full-time university employees Educators received 3 months initial training in: asthma disease process, asthma action plans, communication techniques, social support, behaviour change strategies (including Transtheoretical Model). Weekly training thereafter with supervision meetings with nurse, psychologist and expert in Transtheoretical Model. Audience: parents of children with asthma Where delivered: in the home or a ‘neutral site, i.e. local fast food restaurant’ INTERVENTION GROUP N (completed): 97 (96) N, duration and frequency of education sessions: 2 home visits and telephone calls biweekly for 3 months, then monthly for duration of 2-year intervention Educational/self management strategy: 1st and 2nd visit was a review of 7 key asthma management behaviours (see below) with parent and assessment of their readiness to adopt them (using Transthe-

Fisher 2009 *(Continued)*

	oretical Model). Subsequent visits consisted of problem-solving and adoption of 7 key behaviours. Emphasis on use of asthma action plan. If child was re-hospitalised during the study, coaches reinitiate bi-weekly contact with parents. Coaches also discussed general stressors such as moving residence, social service resources, housing, illness of parent and new jobs. Coaches categorised parent's readiness to adopt management behaviours using the Transtheoretical Method, according to stage pre-contemplation, contemplation, preparation, action or maintenance. Use of asthma action plan emphasised at all stages. Other 6 behaviours discussed in order of parent's readiness to adopt them and individually tailored. The intervention was "implemented in a flexible manner that followed a nondirective supportive style" tailored to individual. The style was co-operative and accepting of feelings and choices, i.e. coaches said they would call back in a few weeks to "check in with you" not "check up on you". Coaches' approach was reliable and persistent, but non-demanding. Educational materials used/provided: not specified Programme topics: 1) use of an Asthma Action Plan; 2) administration of asthma controller medications; 3) administration of asthma-reliever medications at first symptoms; 4) attendance at asthma monitoring visits with a primary care provider every 3 to 4 months; 5) development of a collaborative partnership with the primary care provider; 6) minimisation of exposure to second-hand tobacco smoke; 7) minimisation of exposure to cockroach allergen Incentives: USD 10 for completing baseline survey, USD 10 for completing evaluations surveys by telephone each at 6, 12 and 18 months. USD 50 given on completion of final survey and home visit at 24 months. Compliance: 4% of patients did not participate in any education or phone calls, 86% had contacts through more than 4 of 8 quarters, and the mean number of contacts was 21 over the 2 years CONTROL GROUP: standard inpatient care pathway including asthma education and discharge planning, asthma action plan and suggested to attend a follow-up appointment with the primary care provider within 1 week of discharge N (completed): 94 (93) Net treatment: education sessions delivered in the home or at a neutral site and telephone calls
Outcomes	Outcomes measured: hospitalisations, coaches records, telephone surveys (details not described) Outcomes reported: as above and ED visits not followed by hospitalisations Time points: hospitalisations were monitored from the hospital admissions register monthly and reported at 24 months. Telephone surveys: 0, 6, 12, 18, 24 months.
Notes	Cost: not specified Funding: NHLBI, NIEHS, peers for progress of the American Physicians Foundation and Eli Lily grants

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"On the basis of random numbers, under supervision by the project statistician" "Those randomized to the asthma coach group were assigned to a coach based on openings in their case load"
Allocation concealment (selection bias)	Unclear risk	Unclear

Fisher 2009 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Those abstracting hospitalization data from charts were blind to condition and to the nature of the comparison between coaching and usual care" "...survey workers who were blinded to condition conducted computer-assisted surveys with parents by telephone." All emergency care and hospitalisations due to asthma were scanned electronically using case numbers, addresses, names of guardians/children and child's date of birth
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Two withdrawals due to transfer of child custody "St Louis has a second paediatric hospital, Cardinal Glennon Children's Hospital but its records were not reviewed" "it is assumed that in the study cohort more than 95% of readmissions would be to SLCH, providing nearly complete ascertainment of all readmissions among study participants" Comment: there might have been hospitalisations in the other hospital that have gone unrecorded. The authors discuss the possibility that the true figure may be lower.
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	Unclear risk	Same rational as above regarding incomplete capture of hospitalisations with SLCH records only

Galbreath 2008

Methods	Study design: parallel, randomised, controlled trial. STAMP trial Recruitment setting: 7 centres in Texas, USA Study duration and start date: August 2003 to May 2006
Participants	N (completed) = 473 (301) Mean age (range): ˜9.5 (5 to 17). Adults and children were enrolled in this study, but data were presented separately Gender (% male): 59% Asthma severity: mild intermittent 6.7%; mild persistent 28.8%; moderate persistent 33.6%; severe persistent 30.9% Diagnostic criteria: NAEPP and GINA 2002 Concurrent treatment: patents on short-acting beta2-agonists (95%); long-acting beta2-agonists (38%); oral corticosteroids (5%); theophylline (< 1%); leukotriene inhibitors (41%); ICS alone (32%) Baseline lung function: FEV1 %predicted control group 97.4 (15.9); AM group 97 (19.5); ADM 100.3 (21.5) Socioeconomic indicators: Medicaid or SCHIP (56%); enrolled in indigent programme (2%); private insurance (36%); uninsured (6%) Ethnicity: black/other 17%; Caucasian 15%; Hispanic 68%

Galbreath 2008 *(Continued)*

	Eligibility criteria: age 5 to 64 years with a physician diagnosis of asthma and access to telephone, access to a primary care provider (those without were provided telephone numbers for suitable clinics) AND one or more of the following: One hospitalisation, emergency department visit with a diagnosis of asthma within the previous 12 months or 4 or more office visits with a diagnosis of asthma within the previous 12 months or 6 or more canisters of inhaled beta2-agonist in the preceding 12 months or physician diagnosis of moderate to severe persistent asthma based on symptoms and/or pulmonary function testing. Exclusion criteria Other lung diseases with a possible reactive component, any disease other than asthma requiring long-term systemic corticosteroids, enrolment in any other asthma disease management programme, plan to move out of local area within the next 18 months.
Interventions	Educator: trained programme nurse Audience: There were 2 intervention groups of different intensity Intervention group: augmented disease management. Telephone disease management plus home visits. N (completed): 157 (94) Where delivered: telephone calls to child's home and home visits N, duration and frequency of education sessions: 6 or 7 telephone calls focusing on disease management and 4 home visits at 1, 2, 3 and 6 months Educational/self management strategy: telephone call 1. Evaluate existing self management strategy, health status and educational needs. Provide individual advice and training and developed written action plan. Subsequent calls reviewed written action plan and provided more advice and training. 24-hour hotline available which patients were encouraged to call if they experienced symptoms. Programme nurses faxed reports/recommendations to primary care provider who ultimately directed care. Patients also received 4 home visits from a pulmonary therapist. A locally developed programme structure around a national guideline based list of education topics. Provided hands-on instruction in use of equipment, reviewed an encouraged individualised asthma action plan and conducted a home environmental evaluation. Educational materials used/provided: an asthma action plan was provided if the child did not already have one Compliance: 70% completed at least 80% of the programme - although these data were for adults and children CONTROL GROUP: routine care. Spacers and peak flow meters were made available to control group on request N (completed): 159 (2)
Outcomes	Outcomes measured: primary outcomes: time to first asthma-related emergency department visit or inpatient hospitalisation, AQLQ/PAQLQ overall score, and rates of asthma-related utilisation (inpatient admissions, ED visits and urgent office visits for asthma), respectively. Secondary outcomes: rate of initiation of controller medications, number of oral corticosteroid bursts prescribed during office visits, asthma symptom scores, and number of school days missed Symptoms measured on the Lara Asthma Symptom Scale and quality of life measure on PAQLQ and PACQLQ Outcomes reported: although "asthma symptom diaries" was in the initial protocol, authors decided not to use these pre-enrolment due to concerns over feasibility, reliability and validity Time points: 6 and 12 months. HCU outcomes collected through medical record review and telephone calls at 2-monthly intervals.

Galbreath 2008 *(Continued)*

Notes	Cost: the telephone-only programme cost USD 531 per patient, and the augmented programme that included home visits cost USD 737 per patient Funding: Grant from US department of health and human services and the CDC There was also an adult arm of the trial where the same education was conducted in patents of 18 to 64 years of age

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Individuals who met inclusion criteria and signed a consent form were randomly assigned to 1 of the 3 study groups, using a sequence of randomly permuted blocks generated with the statistical package Stata."
Allocation concealment (selection bias)	Low risk	"The randomisation sequence was transferred to a series of consecutively numbered, sealed cardboard randomisation boxes that contained a printed sheet in English and Spanish describing the participant's study group assignment as well as a holding chamber (spacer) for those randomly assigned to either of the intervention groups." "Boxes were packaged so that blinded research staff could not identify the group assignment from the sound or weight of the box. Non blinded study coordinators were available to answer participant questions about the study".
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Data collected by trained research staff blinded to intervention group. Medical record abstraction was performed by trained study staff who were blinded to study group
Incomplete outcome data (attrition bias) All outcomes	Low risk	"All participants were telephonically polled regarding healthcare utilization every 2 months throughout the trial. Study staff requested medical records for both inpatient and outpatient encounters from all identified providers and healthcare facilities for the entire duration of a participant's enrolment in the trial." "comprehensive healthcare utilization data were obtained for 99% of participants"
Selective reporting (reporting bias)	Unclear risk	"Our initial protocol used symptom-free days as 1 of the primary outcomes. However, before enrolment of study patients, we made a decision not to use asthma symptom diaries, based on concerns about feasibility, reliability, and validity." Comment: assumed done
Other bias	Low risk	Comprehensive healthcare utilisation data collected through the use of medical record review

Gorelick 2006

Methods	Study design: 3-arm parallel, randomised, controlled trial Recruitment setting: Children's Hospital of Wisconsin ED

Gorelick 2006 *(Continued)*

	Study duration and start date: February 2003 to May 2004
Participants	N (completed) = 234 (180) Mean age (range): 6.8 years (study criteria 2 to 17 years) Gender (male): 66% Asthma severity: mild intermittent 30%; mild persistent 28%; moderate persistent 28%; severe persistent 14% Diagnostic criteria: NAEPP (1997) Concurrent treatment (uses controller medications): 60% Socioeconomic indicators: 60% public insurance Ethnicity: black 69%; white 21%; Latino 8% Eligibility criteria: residents of Wisconsin, aged 2 to 18 years of age, treated at the ED for acute asthma (defined as wheezing or respiratory distress treated with at least 1 inhaled bronchodilator treatment in a patient with physician-diagnosed asthma or history of wheezing treated with beta-agonists). Exclusions: Non-English speaking caregivers and participants with other chronic diseases (e.g. CF, bronchopulmonary dysplasia), tracheostomy, who had previously been enrolled in the study, enrolled in ED Allies tracking system (web-based computer database of ED visits for asthma or wheezing illnesses), or previously received care co-ordination or case management.
Interventions	Educator: case manager (nurse or social worker) Audience: families Where delivered: home (and telephone calls) INTERVENTION GROUP (intensive primary care linkage and care co-ordination/case management - CC/CM) N (completed): 118 (81) N, duration and frequency of education sessions: 6 home sessions (average 4/patient; 1st visit 60 minutes and subsequent 30 minutes), several phone calls (average 2.3 calls/patient) Educational/self management strategy: Patients received standard education and discharge planning in ED same as control group Intensive primary care linkage: copy of ED chart and letter recommending asthma care plan faxed to PCP office. Research co-ordinator called PCP office to notify of ED visit and inquire if follow-up scheduled. Subjects called day after ED visit and asked if follow-up arranged; could get assistance in making appointment (also called on days 3, 5, 7 until appointment reported); day 14 contacted again to see if follow-up visit made; if no PCP, given list or instructed to call insurance carrier for list. CC/CM: patients then enrolled in Flight Asthma Milwaukee (FAM) Allies coalition. This programme helped co-ordinate health and social services across different agencies and clinicians for children with asthma and their families. Patients were assigned to a nurse or social worker case manager (depending on patients' health insurance cover) who then: a) performed standardised asthma needs assessment and environmental and smoking assessments; b) identified and addressed family asthma goals by using a personalised care plan; c) provided asthma education by using the FAM Allies asthma toolkit and additional materials; and d) made referrals to community and other services as appropriate. Educational materials used/provided: FAM Allies asthma toolkit Programme topics: FAM Toolkit covers the following topics: trigger management, medications and delivery devices, self management tools (written action plan and asthma diaries, peak flow meters) Incentives: none Compliance: 72% (85/118) had at least 1 home visit; average of 4 successful visits per patient and 2 missed per patient. 69% (81/118) completed all telephone follow-up at 1, 3 and 6 months CONTROL GROUP: Standard education and discharge planning in ED, including: Mastering Asthma (videotape) shown during ED visit, assessment and teaching of proper use of peak-flow meter and metered-dose inhaler with spacer device, acute asthma medications for current exacerbation, instructions to follow-up with primary caregiver within 7 days, written asthma care plan based on chronic symptoms N (completed): 116 (99) Net treatment: intensive primary care linkage and care co-ordination/case management

Gorelick 2006 *(Continued)*

Outcomes	Outcome measured: ED visits for asthma (self reported and through web-based tracking system), number of hospitalisations for asthma, use of controller medications, Integrated Therapeutics Group Child Asthma Short Form (ITG-CASF) quality of life score, smoking status of family and caregivers Outcome reported: ED visits for asthma (self reported and tracking system), use of controller medications, ITG-CASF quality of life score, smoking status of family and caregivers
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated list
Allocation concealment (selection bias)	Low risk	Sealed, opaque envelope, sequentially numbered study packet
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Single-blind (person collecting data through telephone interviews was blinded)
Incomplete outcome data (attrition bias) All outcomes	High risk	69% completed in CC/CM; 85% completed in control. The 77 patients lost to follow-up or excluded from analysis (including 2nd intervention arm of intensive primary linkage only) were similar to those completing the study with respect to age, chronic asthma severity, ED visits in previous 12 months. However, lost to follow-up were more likely to have public insurance and be non-white. Although the authors attempted to describe the baseline characteristics of all those lost to follow-up or with incomplete data, there was an imbalance in the control group (15%) versus the intervention group (31%).
Selective reporting (reporting bias)	High risk	Hospital admissions in previous 6 months not reported although measured
Other bias	Low risk	Provide self reported ED visits as well as those obtained through web-based tracking system

Kamps 2008

Methods	Study design: parallel, randomised, 3-arm controlled trial Recruitment setting: 1 university asthma allergy clinic in an urban medical centre and 1 private practice asthma allergy clinic in a suburban area in New Orleans, USA Study duration and start date:
Participants	N (completed) = 15 Withdrawals: from 20 eligible randomised children, 2 were run as pilot participants and 3 participants dropped out during treatment, so 5 were excluded from analysis Mean age (range): 9 years (7 to 12)

Kamps 2008 *(Continued)*

	Gender (% male): intervention 57%; control 75% Asthma severity: moderate to severe persistent Diagnostic criteria: National Heart, Lung, and Blood Institute, National Asthma Education and Prevention Program criteria Concurrent treatment: inhaled corticosteroids (beclomethasone or fluticasone) Baseline lung function FEF 25%-75%, mean (± SD): intervention 76.4 (17.8); control 54.2 (37.5) Socioeconomic indicators: intervention: no high school diploma % mother (father) 0 (0)%, high school qualification 0 (14)%, some college 100 (86)%; control: no high school diploma 50 (57)%, high school qualification 25 (14)%, some college 25 (29)%. Household income intervention < USD 30,000 29%, USD 30,000 to 50,000 14%, > USD 50,000 57%; control < USD 30,000 62%, USD 30,000 to 50,000 13%, > USD 50,000 25% Ethnicity: 20% African American, 53% European American, 27% Hispanic American Eligibility criteria: moderate-severe persistent asthma as determined by their physician according to NHLBI guidelines and had been prescribed an inhaled corticosteroid (beclomethasone or fluticasone). Participants should have been less than 70% adherent to medication during run-in. Participants who were adherent to medication regimen by electronic monitoring during 2 weeks run-in period were excluded.
Interventions	Educator: 2 licensed psychologists and 2 masters-level graduate students in psychology. There was a manual for each session and educators completed a checklist of tasks and treatment met regularly to discuss implementation. Adherence data reviewed and discussed with children/parents at each session Audience: children and parents Where delivered: home-based INTERVENTION GROUP N (completed): 7 (7) N, duration and frequency of education sessions: 6 weekly sessions, approximately 60 minutes in length Educational/self management strategy: standard care plus a comprehensive asthma education programme. Targeted adherence improvement strategies such as focused education, monitoring, contingency management and discipline techniques. Aimed at improving adherence to ICS. Adherence to inhaled corticosteroids was measured by MDILog (records date, time of activation of a MDI) Pulmonary function tests taken by spirometer Educational materials used/provided: 'The Clubhouse Kids Learn About Asthma' computer program Programme topics: session 1) taught about treatment through interactive computer program The Clubhouse Kids Learn About Asthma and written material covering normal lung function, physiology of asthma, medications, trigger reduction strategy; session 2) monitoring skills and adherence improvement strategies such as taking medication with regularly scheduled activities; session 3) behavioural management techniques to promote adherence; session 4) barriers to adherence for individual families and written solutions provided; session 5) adherence-related cognitive restructuring component – children's thought related to taking their asthma medication were examined; session 6) review of adherence improvement strategies. Incentives: none Compliance: the majority of families did not attend all follow-up sessions

Kamps 2008 *(Continued)*

	CONTROL GROUP: standard care plus a comprehensive asthma education programme, on topic from Air Wise Program. Six sessions of approximately 60 minutes including lung anatomy, identification of asthma triggers and prevention of asthma attacks, treatment and monitoring of symptoms. Also watched The Clubhouse kids Learn About Asthma. Parents and children learned about the importance of communication with service providers and were taught relaxation techniques and coping strategies for stress/asthma management. No targeted adherence strategies. N (completed): 8 (8) Net treatment: targeted adherence improvement strategies given, such as focused education, monitoring, contingency management and discipline techniques Adherence data reviewed with children and parents
Outcomes	Outcomes measured: adherence, pulmonary lung function Outcomes reported: reported only FEF 25%-75% as it is the most sensitive measure Time points: adherence: measured continually by electronic device at baseline, at each of the 6 visits, 2 weeks after the intervention (called 2 month) and then each month for the following 10 months Pulmonary lung function: each week of baseline and then once a month for 12 months paediatric QoL: once during baseline and the each month for 12 months healthcare cost data collected each month for 12 months
Notes	Cost: expenses related to asthma management incurred by families over the full 12 months; intervention USD 111.63; control USD 214.43, although there was a large standard deviation for the particularly high month in the control group which may reflect a particularly high cost and skew the cost for this treatment Funding: National Institute of Child Health and Human Development Grant number HD34784 Based on the thesis of Jodie L Kamps; we did not look at the thesis in the process of writing this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Stratified by age < 9/6 and > 9.7 year prior to randomisation. "A randomisation table was developed by a statistics consultant prior to participant recruitment to assign children to a group…"
Allocation concealment (selection bias)	Unclear risk	"… and we assigned children to groups based on this table."
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Very small study with poor follow-up. However, the losses to follow-up were balanced between arms.
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported

Kamps 2008 *(Continued)*

Other bias	Low risk	Only self reports possible

Mitchell 1986

Methods	Study design: parallel, randomised, controlled trial Recruitment setting: patients discharged from paediatric medical ward of Auckland Hospital for asthma Study duration and start date: April 1983 to April 1984
Participants	N (completed) = 200 (164), European children and 168 (95) Polynesian children Mean age (range): (2 to 14) Gender (% male): Same age and sex ratio across European and Polynesian children Asthma severity: "In this study the children were having frequent attacks of asthma (an average of 13 each year, lasting on average two days), were missing an average of three and a half weeks of school because of asthma, and by the completion of the study had had an average of 5-3 admissions to hospital for asthma." Concurrent treatment: "European children were taking a larger number of medications for asthma than Polynesians (1-8 (1-2) v 1-4 (1-3), respectively, P<0-001), and were significantly more likely to be taking cromoglycate, inhaled steroids, and sympathomimetics." Baseline lung function: Socioeconomic indicators: European children significantly more advantaged than Polynesian children Ethnicity: either European or Polynesian Eligibility criteria: excluded if child was less than 2 years old, they lived outside of the hospital catchment area, had had a previous life-threatening attack or they were not either Polynesian of European
Interventions	Educator: community child health nurse Audience: children and their families Where delivered: home INTERVENTION GROUP N (completed): European 83; Polynesian 50 N, duration and frequency of education sessions: 6 monthly sessions Educational/self management strategy: basic asthma management with emphasis on reducing environmental triggers and encouraging patient to visit GP rather than ED. No attempt made to influence type of treatment or follow-up that the patient received. Educational materials used/provided: Programme topics: 1) Explanation of anatomy, pulmonary physiology, pathophysiology of lung and factors that can provoke asthma 2) description of drugs used in asthma 3) emphasis of importance of avoiding stimuli that may provoke asthma and controlling patient's environment 4) check on drug compliance and correct use of aerosols 5) encouraged to attend follow-up clinic visit to either paediatrician at outpatient clinic or GP and to consult GP rather than A&E. Incentives:

Mitchell 1986 *(Continued)*

	Compliance: "Of the returns, eight (6%) had no visits as the families could not be located, 35 (26%) had some but not all six of the monthly visits, and 92 (68%) had all six of the monthly visits." CONTROL GROUP: not described, assume no intervention N (completed): European 81; Polynesian 45 Net treatment:
Outcomes	Outcomes measured: self administered postal questionnaire (6 months after discharge from hospital), school absenteeism. Days off school, exacerbations leading to hospitalisation, GP and other treatment outside of the home. Outcomes reported: as above Time points: number of readmissions, duration of readmission at 6 and 18 months
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomised"
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Blinding of those extracting data from hospital charts was not described. Self reported outcomes, except hospitalisations.
Incomplete outcome data (attrition bias) All outcomes	High risk	Not stated
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	Low risk	Used hospital records to confirm readmissions and length of hospital stay

Mitchell 1986 Europeans

Methods	
Participants	
Interventions	
Outcomes	

Mitchell 1986 Europeans *(Continued)*

Notes	

Mitchell 1986 Polynesians

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Otsuki 2009

Methods	Study design: 3-arm, parallel, randomised, controlled trial Recruitment setting: Johns Hopkins Paediatric ED, Baltimore, USA Study duration and start date:
Participants	N (completed) = 250 (204) Mean age (range): 7.0 (2 to 12) Gender (% male): 62% Asthma severity: physician diagnosed asthma, 2 x ED visits or 1 x hospitalisations in the preceding year and on asthma controller medications Diagnostic criteria: physician diagnosed asthma Concurrent treatment: leukotriene modifiers (24%); inhaled corticosteroids 72% Socioeconomic indicators: Medicaid (86%); caregiver completed high school (69%); household income < USD 10,000 per year (38%) Ethnicity: 98% black Eligibility criteria: physician diagnosed asthma, 2 ED visits or one hospitalisation for asthma in the previous year, resident in Baltimore City and prescribed asthma controller medication
Interventions	Educator: trained asthma educators Audience: parent and child Where delivered: home INTERVENTION GROUP: Asthma Basic Care Group (ABC) N (completed): n = 84, 92% completed 6 month and 96% completed 18-month surveys N, duration and frequency of education sessions: 5 x 30 to 45 minutes sessions at weeks 1, 2, 3, 4 and 8 weeks after randomisation Educational/self management strategy: 5 core components 1) review of prescribed asthma regimen and training in medication, spacer and peak flow technique; 2) development of an asthma action plan;

Otsuki 2009 *(Continued)*

	3) identification of barriers to accessing health care and problem-solving to remove them; 4) discussion of beliefs and concerns about asthma and medications; 5) provision of written asthma education materials. Educational materials used/provided: written asthma education materials and asthma action plan. INTERVENTION GROUP: Adherence Monitoring with Feedback Group (AMF) N (completed): n = 83, 87% completed 6-month and 80% completed 18-month surveys N, duration and frequency of education sessions: Educational/self management strategy: received the ABC programme as described above plus the following: 1) objective feedback of medication adherence from an electronic adherence monitor and the asthma educator was trained to provide support in a non-threatening way; 2) families were encouraged to set asthma control goals (e.g. no coughing at night); 3) the importance of positive reinforcement such as verbal praise and low-cost rewards was emphasised. The educator worked with families to identify barriers when goals were not achieved; 4) families were taught strategies to monitor adherence and asthma symptoms by using behavioural charts and symptom diaries, the educator highlighted relationships between improvements in symptoms and adherence where possible. Educational materials used/provided: written asthma education materials and asthma action plan Incentives: none but parents were encouraged to provide low-cost rewards and verbal praise as incentives for adherence CONTROL GROUP: usual care N (completed): n = 83, 92% completed 6-month and 93% completed 18-month surveys Compliance: 67% completed all 5 visits. Completed 4.0 and 3.8 visits on average for the ABC and AMF intervention groups respectively
Outcomes	Outcomes measured: caregiver-reported frequency of asthma symptoms, ED visits, hospitalisation, courses of OCS, adherence to ICS and number of ICS refills Outcomes reported: as above Time points: baseline, 6, 12 and 18 months Patients were encouraged to seek care from their primary care provider
Notes	Funding: NHLBI grant

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"randomised" via blocked randomisation schema
Allocation concealment (selection bias)	Low risk	Assignment place in sealed envelopes which were opened after completion of baseline surveys
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Research staff who conducted telephone surveys were blinded

Otsuki 2009 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	The numbers lost to follow-up at each survey were balanced between treatment arms and consistently around 10% which is to be expected
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	High risk	Although adherence was monitored both by self reports and through pharmacy records, hospitalisations and ED visits were only recorded via self reports

Otsuki 2009 ABC

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Otsuki 2009 AMF

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Seid 2010

Methods	Study design: 3-arm, parallel, randomised, controlled trial Recruitment setting: San Diego, California. Families recruited from Federally Qualified Health Centers, commercial HMO, school/daycare, local asthma initiatives, or self referred Study duration and start date:11 June 2004 to 16 October 2007
Participants	N (completed) = 252 (211 completed at least 1 follow-up) Mean age (range): 7.37 (2 to 14) Gender (% male): 61.1% Asthma severity: mild 27.0%, moderate 40.5%, severe 32.5%

Seid 2010 *(Continued)*

	Diagnostic criteria: persistent asthma (mild, moderate, severe) as per NHLBI criteria using symptoms, activity level, exacerbations Concurrent treatment: Baseline lung function: Socioeconomic indicators: 84% recruited from Federally Qualified Health Centres (subsidised community clinics treating generally un/underinsured on sliding scale fee); most patients low income; mother's education < 6th grade 26%, 7th to 9th grade 23%, 10th to 12th grade 24%, high school graduate 8%, some college 13%, college graduate 5%, graduate/professional degree 0.4%; father's education < 6th grade 28%, 7th to 9th grade 25%, 10th to 12th grade 21%, high school graduate 8%, some college 11%, college graduate 7%, graduation/professional degree 0.5% Ethnicity: Hispanic 83% (Spanish only 56%), non-Hispanic white 4%, non-Hispanic black 8%, other 4% Eligibility criteria: 2 to 14 years with physician-diagnosed persistent asthma, whose parents spoke English or Spanish
Interventions	Educator: CC = 2 bilingual, bicultural bachelor's level asthma home visitors; PST = bilingual, bicultural, master's level health educator Audience: PST = primary caregiver, although children encouraged to participate Where delivered: INTERVENTION GROUP: care co-ordination (CC); care co-ordination + problem-solving skill training (CC + PST) N (completed): CC = 81 (71); PST = 84 (60) N, duration and frequency of education sessions: CC = 5, 45 to 60 minutes sessions, weekly; PST = 6, 45 to 60 minutes sessions, weekly Educational/self management strategy: CC = structured set of educational interventions with written material, based on NHLBI guidelines, Robert Wood Johnson Foundation's Allies Against Asthma community health worker model; PST = based on D'Zurilla's conceptualisation and adapted from comprehensive protocol used in previous trial of PST in mothers and children with cancer Educational materials used/provided: CC = written materials on programme topics (described below); PST = treatment manual, worksheets for each step, cartoon handouts to reinforce main ideas Programme topics: CC = what is asthma, asthma medications and devices, asthma action plan, how to recognise and respond to symptom onset, how to reduce irritants and allergens in home. Referred families when needed to existing health insurance enrolment assistance, smoking cessation, other community support services; provided PCP with summaries of interventions, updates on progress, and noting family difficulties and needs; PST = session 1 rapport building, understanding medical and social situation, presenting overview of PST curriculum, assigning first homework; session 2 review homework, introduced idea of developing alternative solutions, assigned homework (defining and evaluating options); session 3 review homework, developed action plan, assigned homework (implementing action plan); session 4 to 6 depended on outcome of actions, focusing on alternative plans if results of action plan not satisfactory to client or on additional problems if results satisfactory Compliance: treatment fidelity (percent of prescribed intervention behaviours performed) 98.4% CC, 97.5% CC + PST; intervention fidelity (percent of sessions delivered) 91.6% CC, 71.8% CC + PST; in PST group, 23.8% received no PST sessions, 52.4% received all PST sessions CONTROL GROUP: received ongoing asthma care from their place of care; after T3 follow-up, offered CC + PST intervention N (completed): 87 (73) Net treatment: care co-ordination +/- problem-solving skills training

Seid 2010 *(Continued)*

Outcomes	Outcomes measured: parent-reported child generic HRQOL using PedsQL total, asthma symptoms using PedsQL asthma, utilisation (recall of ED, inpatient, urgent doctor's appointments for asthma over past 6 months at T1, 3 months at T2, 6 months at T3) Outcomes reported: PedsQL total parent, child; PedQL asthma parent, child; daytime symptoms, nighttime symptoms, ED visits, visits to hospital, unscheduled office visits Time points: baseline (T1), post-intervention (about 3 months after baseline, T2), 6 month follow-up (about 9 months after baseline, T3)
Notes	Cost: Funding: grant from Maternal and Child Health Bureau of the Health Resource and Services Administration; 2nd author holds copyright and trademark of PedsQL

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Blocked randomisation, stratified by site of care and disease severity; prepared randomisation lists created by statistician
Allocation concealment (selection bias)	Low risk	Randomisation lists concealed until intervention assignment
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not possible to blind patients or educators
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Research staff blinded to intervention group administered surveys
Incomplete outcome data (attrition bias) All outcomes	High risk	CC intervention: 20% lost (7% refused), PST intervention 32% lost (19% refused) These are unbalanced and assumed to be due to the nature of the intervention
Selective reporting (reporting bias)	Unclear risk	No protocol published, but assume all of the measured outcomes reported
Other bias	High risk	Parent-reported healthcare utilisation

Seid 2010 problem solving

Methods
Participants
Interventions
Outcomes
Notes

Seid care-coordination

Methods
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A&E : accident and emergency
ABC : Asthma Basic Care
AM: Asthma management
ADM: Augmented disease management (in Galbreath, DM plus in-home visits by a respiratory therapist),
AMF: Adherence Monitoring with Feedback
AMP: asthma management plan
AQLQ: Asthma Quality of Life Questionnaire
CC: care co-ordination
CDC: Centers for Disease Control and Prevention
CF: cystic fibrosis
CM: case management
ED: emergency department
FEV1: forced expiratory volume in one second
GCSE: General Certificate of Secondary Education, academic qualification, generally taken in a number of subjects by students aged 14 to 16 in secondary education in England, Wales, and Northern Ireland
GINA: Global Initiative for Asthma
GP: general practitioner
HCU: healthcare utilisation
High School Diploma - a diploma awarded for the completion of high school. In the United States a high school is an upper secondary school which educates children from grade nine (14 years old) or 10 (15) through grade 12 (17 or 18)
HRQOL: health-related quality of life
ICS: inhaled corticosteroid
ITT - intention-to-treat analysis
LABA: long-acting ß2 agonist
NAEPP: National Asthma Education and Prevention Program
NHLBI: National Heart, Lung, and Blood Institute guidelines
NIEHS: National Institute of Environmental Health Sciences
NS: not stated
OCS: oral corticosteroids
PACQLQ: Paediatric Asthma Caregiver's Quality of Life Questionnaire
PAQLQ: Paediatric Quality of Life Questionnaire
PCP: primary care provider
PEF: peak expiratory flow
PFM: peak flow meter
PST: problem-solving skill training
QoL: quality of life
SABA: short-acting ß2 agonist
SAE: serious adverse event
SCHIP: State Children's Health Insurance Program administered by the United States Department of Health and Human Services that matches funds to states for health insurance to families with children. Designed to cover uninsured children in families with incomes that are modest but too high to qualify for Medicaid.
SD: standard deviation
STAMP: South Texas Asthma Management Project
WAP: written action plan
Where we report means for baseline characteristics, we took the mean across all arm where necessary

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

Study	Reason for exclusion
Adgate 2008	Focus on removing allergen through cleaning procedures
Agertoft 1998	The education component was provided in the clinic and the training was using the turbuhaler at home
Agrawal 2005	Patients in the intervention group were given an individualised written home-management plan, but the standard education administered to both intervention and control groups was not delivered at home
Akkaya 1997	Education delivered in an outpatient clinic
Aleman Mendez 1992	No data available to extract, unsure of where education was delivered, randomisation not described and could not contact author
Alexander 1972	Education delivered in groups in treatment rooms in care homes
Alexander 1988	Appointments held in the allergy division in a medical centre
Andersen 2007	Published as abstract only. Appears to be education delivered by the internet. Author did not confirm that there was no face to face education delivered in the home.
Arbes 2003	Provided insect bait and professional cleaning
Arbes 2004	Provided insect bait and professional cleaning
Barnes 2008	Provided home-cleaning
Bateman 2000	Education mainly in adults. Full text not published.
Becker 2003	Education delivered to small groups, i.e. outside home
Bender 1997	An observational study looking at the "medical, demographic, and psychologic characteristics of asthmatic children and adults who dropped out of a year-long medication trial" rather than a randomised controlled trial
Bender 2003	Delivered in patient education centres. Study looking at reasons for attrition in CAMP trial
Bonner 2002	Although this intervention included a baseline interview delivered at home and home visits and telephone calls to check compliance, the education component of this study was delivered in group sessions outside of the home
Bonsignore 2008	Delivered exercise training and monitoring in a gym centre
Bramson 1996	Commentary piece, not a randomised controlled trial
Brewin 1995	Education delivered in the hospital
Brosco 2005	This is an ongoing observational study designed to document prevalence of asthma in preschool children, identify barriers to optimal asthma care, assess clinics and improve asthma outcomes
Bryant 2001	Removal of common indoor asthma triggers

Study	Reason for exclusion
Bryant-Stephens 2004	The active group received education plus environmental remediation whereas the control group received observational home visits only
Bryant-Stephens 2008a	The comparison group was the same home-based education plus environmental remediation - i.e. a higher intensity intervention
Burkhart 2001	Education component delivered outside of the home. Weekly telephone calls encourage adherence to peak flow monitoring
Burkhart 2007	Sessions conducted in child-friendly interview rooms at the university
Butz 2005a	Education delivered in workshops
Butz 2007	Not delivered in the home
Bynum 2001	Education delivered by video teleconference calls at local clinics
Callahan 2003	Provided mattress encasings and HEPA filters
Callahan 2004	Not a RCT
CAMP	Describes recruitment into education programme, not a RCT
Catov 2005	Not a randomised controlled trial
Chan 2003	Web-based education
Chan 2007	Clinic and web-based education
Chiang 2004	Group parent education sessions delivered on an outpatient basis
Clark 1986	Education delivered in hospital clinics
Claus 2004	Education delivered to small groups
Cohen 1979	Single asthma discussion group
Colland 2004	Study aimed at encouraging parents and children to recognise prodromal signs and to double the amount of medication at the first prodromal sign. Visits conducted at an outpatient clinic.
Cote 1997	Participants aged over 16
Dahl 1990	Web-based education delivered at school/home
Deaves 1993	Not a randomised controlled trial
Delaronde 2005	Quasi-randomised - some of the patients had a choice about which group they were allocated. Results data included adult data.
Donaghy 1995	Education delivered in the clinic. Also patients in the range 13 to 50 years old.
Eggleston 2004	Provided HEPA filter
Eggleston 2005	Provided cockroach/rodent extermination, mattress/pillow encasings etc.

Study	Reason for exclusion
Evans 1999	Education component delivered to groups
Finkelstein 2000	Adults
Finkelstein 2002	No education component delivered other than environmental awareness
Flores 2009	Group work
Friedman 1999	Assume telecommunication study is excluded. However, we could not find the full-text article to check properly.
Gardida 2002	Education delivered in schools
Greineder 1995	Education delivered outside of the home
Greineder 1999	Education delivered outside of the home
Griffiths 2004	Education delivered outside of the home
Guendelman 2002	Education delivered in the clinic, game played at home
Holzheimer 1998	Education delivered outside of the home. Children were given a book to take home at the end of the intervention.
Homer 2000	Computer game played in the hospital clinic
Homer 2005	Education delivered to multidisciplinary teams from practices (physician, nurse and front office staff person) rather than children or parents of children with asthma
Horner 2004	Education delivered in school
Horner 2006	Education delivered in school
Horner 2008	Education delivered in school
Hovell 1994	Compared groups randomised to receive counselling to reduce a child's exposure to environmental tobacco smoke
Hovell 2002	Both groups received same asthma education, but the more intense group also received counselling of the parent in reducing the child to environmental tobacco smoke. Although one could argue that this is simply a more intense form of education, we felt that the trial was asking a different clinical question than intended by our review.
Hughes 1991	Study aimed at improving the home environment and reducing exposure to tobacco smoke. Also mainly delivered outside of the home.
Huss 2003	Web-based education
Indinnimeo 2009	Not delivered in the home
Jain 1991	Yoga training given during a hospital stay
Jan 2007	Web-based education

Study	Reason for exclusion
Jenkinson 1988	Study old and not aimed at behaviour change, no separate paediatric data or outcomes useful to our review
Jerant 2009	Adults
Jones 2001	Aimed at reduce a child's exposure to environmental tobacco smoke. We felt that this was a sufficiently different clinical question to that being asked by this review
Joseph 2000	Education delivered in a hospital meeting room
Joseph 2005	Education delivered in school
Kamps 2004	A commentary article
Karnick 2007	Delivered at the clinic
Kay Bartholomew 2006	Education delivered in school
Kercsmar 2006	Received environmental remediation including a water filter and mould/damp ventilation
Khan 2004	Single phone call delivered education
Klinnert 2005	Trial is in infants less than 2 years old and main focus was environmental remediation
Kokubu 1999	Adults
Kotses 1996	Adults
Krieger 2009	Provided mattress encasements
Krishna 2003	Education via computer package available in consultation and waiting rooms
Kuijer 2007	Adults
La Roche 2006	Delivered to groups of patients at outpatient clinic
LeBaron 1985	Education delivered in the office
Lecheler 1988	Intervention comparing interval and continuous running training with not educational component
Lee 2010	Adults - via keywords
Letz 2004	Education delivered in the clinic
Lewis 1987	Sessions that started out as individual families and then moved into group sessions, therefore delivered outside of the home
Lewis 1994	Education given in lectures
Li 2006	Patients not allocated randomly
Lieberman 2001	Review of video games for different diseases, some of which were asthma. Not a randomised controlled trial.
Linicome 2001	Part of PAC-PORT II trial delivering education to healthcare providers

Study	Reason for exclusion
Liu 2001	Patients randomised to 3 intervention groups, however the control group was not randomised, but selected from a neighbouring hospital
Liu 2007	Adults
Mandhane	Education delivered in school
Marabini 2002	Adults
McCarthy 2002	Education component delivered in groups
McConnell 2005	Provided mattress encasings and trained families in cleaning
McGhan 2010	Education delivered in school
McNabb 1985	Education delivered in a clinic
McPherson 2006	Game played at home
Mendes 2010	An aerobic exercise intervention
Meszaros 2003	Adults
Mildenhall 1997	Adults
Morgan 2004	Provided environmental remediation including mattress encasings and HEPA filters
Mosnaim 2008	Education/positive messages delivered by MP3 players rather than face-to-face
Moudgil 1998	An observational study
Nishioka 2006	Not a randomised controlled trial
Nokela 2010	Adults
O'Connor 1996	Part of Morgan et al, NEJM, 2004. Excluded because it was an environmental intervention with little or no education.
Page 1999	A RCT is not described in this paper
Parker 2008	Environmental remediation given
Perrin 1992	Delivered in a clinic
Persky 1999	Emphasis on environmental remediation
Petro 2005	Adults
Put 2003	Adults and delivered outside of the home
Rakos 1985	Education was in the form of a self help kit
Rand 2005a	Delivered in school

Study	Reason for exclusion
Rhee 2008	This study aimed to help decision-making and reduce risk by reducing substance misuse among participants
Ronchetti 1997	Delivered in groups in a clinic
Rubin 1986	Computer game used in the clinic
Schatz 2006	Adults
Schmidt 1993	Not randomised
Shames 2004	Video game plus a telephone hotline
Shegog 2001	Education delivered on a university campus
Shields 1990	Telephone calls were reinforcement rather than education - which was delivered in the ED
Shields 2004	Education delivered at school
Slader 2006	Adults
Smith 2004	The telephone call to the parents home did not deliver education (which was administered previously in the emergency department), just encouraged and helped the parents to make a follow-up appointment
Sommaruga 1995	Adults
Steurer-Stey 2010	Adults and delivered in outpatients
Stevens 2002	Education delivered in an outpatient clinic
Sublett 2000	Adults
Sun 2010	Adults
Szczepanski 2010	Delivered in groups
Tagaya 2005	No education delivered in the home. There was a booklet to take home.
Takaro 2004	Emphasis on providing environmental remediation
Takaro 2004a	Provided environmental remediation such as mattress encasements
Talabere 1990	We could not obtain separate data for the children educated at home from this thesis
Thoonen 2002	Adults
Tong 2002	Patients not allocated randomly
Tsoukleris 2007	An observational study
Urek 2005	Adults
Valery 2007	Much of the education was delivered outside of the home

Study	Reason for exclusion
van Es 2001	Education delivered by doctors in group/individual sessions at the clinic and additional education provided by an asthma nurse at the same visit
Vazquez 1993	Delivered in the clinic
Walders 2006	Education delivered in the clinic. Patients in the experimental group were granted access to an hot-line where they could ask an asthma nurse for advice; this was not deemed to be an education intervention.
Warschburger 2003	Education delivered to groups of parents at the clinic
Weiss 2003	Education provided to physician
Wensley 2001	Self management education delivered outside the home, although the participants were randomised to either symptom-based or PFM-based monitoring at home
Willems 2004	Education component was minimal/absent
Williams 2006	Environmental remediation the main focus, supplied mattress casings etc.
Wilson 1996a	Small group sessions therefore not in the child's home
Wise 2007	Internet telehealth care intervention
Yoon 1989	Adults
Zhao 2005	Patients not allocated randomly
Zorc 2005	Emergency department based

CAMP: Childhood Asthma Management Program
ED: Emergency Department
HEPA: high-efficiency particulate air (filter)
NEJM: New England Journal of Medicine
PFM: peak flow meter
RCT: randomised controlled trial

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

Adams 2004

Methods
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Boone 2002

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Cameron 1989

Methods	Booklet explained by a nurse in 4 sessions and the showing of a videotaped dramatisation of the same information
Participants	Intervention group N = 16 parents Control group N = 15 parents
Interventions	
Outcomes	Six-month follow-up
Notes	"Preliminary report shows that the parents of both groups had similar levels of knowledge of asthma at the initial test. On retesting at the six-month follow-up, the parents in both groups did significantly better than on the initial test. However, the experimental group's improvement was statistically better than that of the controls (P = 0.003). More important are the changes in attitude and behaviour implied by the higher rate of casualty visits, and the higher rate of attacks identified in cases as compared with controls. The fall in admissions among cases, while controls had a steady rate of admissions in both the year of the study and in the preceding year, has positive economic implications that are especially exciting in a developing country such as ours (AU)."

Kelly 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Mishra 2005

Methods	
Participants	

Mishra 2005 *(Continued)*

Interventions	
Outcomes	
Notes	

Rand 2004

Methods	This appears to be an intervention about a mobile asthma education unit called a 'breathmobile'
Participants	
Interventions	
Outcomes	
Notes	

Strunk 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Taylor-Fishwick 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Yang 2005

Methods	
Participants	

Yang 2005 *(Continued)*

Interventions
Outcomes
Notes

Yildiz 2002

Methods
Participants
Interventions
Outcomes
Notes

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

Rand 2006

Trial name or title	Increasing Adherence to Asthma Medication in Urban Teens
Methods	Randomised, parallel, open-label trial
Participants	Estimated enrolment 226 10 to 15 years
Interventions	Participants will be randomly assigned to 1) Self management or 2) Motivational interviewing plus self management training. The duration of the intervention condition will be 5 home visits over 2 months. Follow-up measures will be collected from families at 3 and 6 months post-randomisation.
Outcomes	Primary outcome measure: adherence to asthma controller therapy as measured by electronic medication monitoring Secondary outcome measures: number of symptom-free days, emergency department utilisation and hospitalisation, caregiver/adolescent quality of life
Starting date	May 2006. Estimated completion Jan 2012.
Contact information	Cynthia Rand crand@jhmi.edu
Notes	

DATA AND ANALYSES

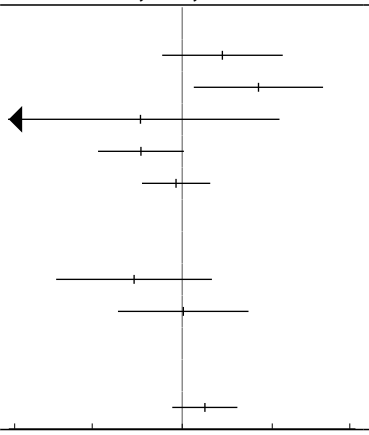
Comparison 1. Education versus control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to emergency department visits	8		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 ED visits between baseline and 6 months	5		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 ED visits between 3 and 9 months from baseline	2		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 ED visits between baseline and 2 years	1		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Mean exacerbations resulting in ED visits	3		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 mean exacerbations between baseline and 6 months	3	430	Mean Difference (IV, Fixed, 95% CI)	0.04 [-0.20, 0.27]
2.2 mean exacerbations between 12 and 18 months from baseline	2	250	Mean Difference (IV, Fixed, 95% CI)	-0.32 [-0.74, 0.10]
3 Mean exacerbations requiring a course of oral corticosteroids	2	500	Mean Difference (IV, Fixed, 95% CI)	-0.31 [-0.70, 0.07]
3.1 Mean exacerbations between baseline and 6 months	2	250	Mean Difference (IV, Fixed, 95% CI)	-0.18 [-0.63, 0.26]
3.2 Mean exacerbations between 12 and 18 months from baseline	2	250	Mean Difference (IV, Fixed, 95% CI)	-0.72 [-1.51, 0.07]
4 Days missed from school or work	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.1 Mean days off school in 6 months	2		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
5 Exacerbations leading to hospitalisation	7		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.1 Admission in 6 months from baseline	4		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5.2 Hospitalisation between 3 and 9 months from baseline	2		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5.3 Admissions between 6 and 18 months from baseline	2		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5.4 Admissions between 12 and 18 months from baseline	2		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5.5 Admissions between baseline and 2 years	1		Odds Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Mean exacerbations leading to hospitalisation	3		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
6.1 Annual exacerbation rate	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
6.2 Mean admissions over 6 months since baseline	2		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
6.3 Mean exacerbations between 6 and 18 months	2		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]

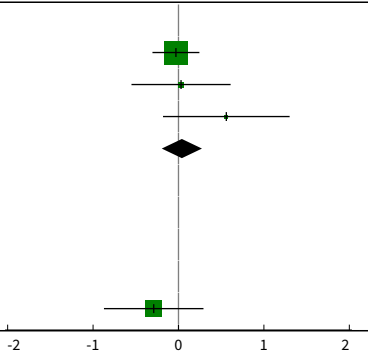
Analysis 1.1. Comparison 1 Education versus control, Outcome 1 Exacerbations leading to emergency department visits.

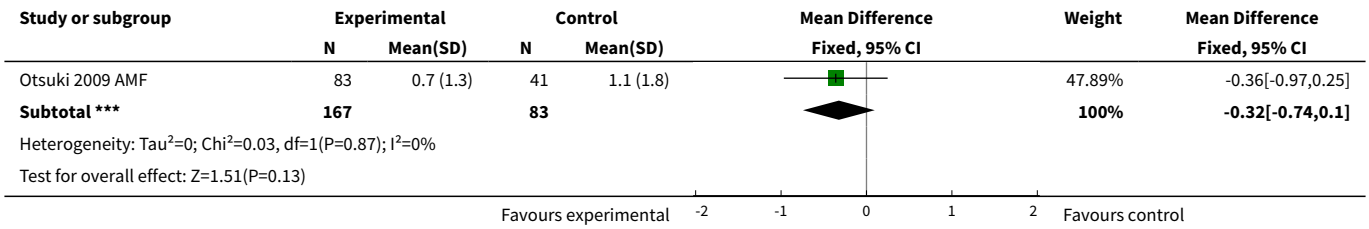
Study or subgroup	Experimental n/N	Control n/N	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
1.1.1 ED visits between baseline and 6 months				
Mitchell 1986 Polynesians	12/50	6/45		2.05[0.7,6.03]
Mitchell 1986 Europeans	14/83	4/81		3.91[1.23,12.43]
Dolinar 2000	1/20	2/20		0.47[0.04,5.69]
Brown 2006	15/66	24/63		0.48[0.22,1.03]
Gorelick 2006	29/81	38/99		0.9[0.49,1.65]
1.1.2 ED visits between 3 and 9 months from baseline				
Seid 2010 problem solving	4/57	5/33		0.42[0.11,1.7]
Seid 2010	10/65	5/33		1.02[0.32,3.27]
1.1.3 ED visits between baseline and 2 years				
Fisher 2009	61/96	50/93		1.5[0.84,2.68]



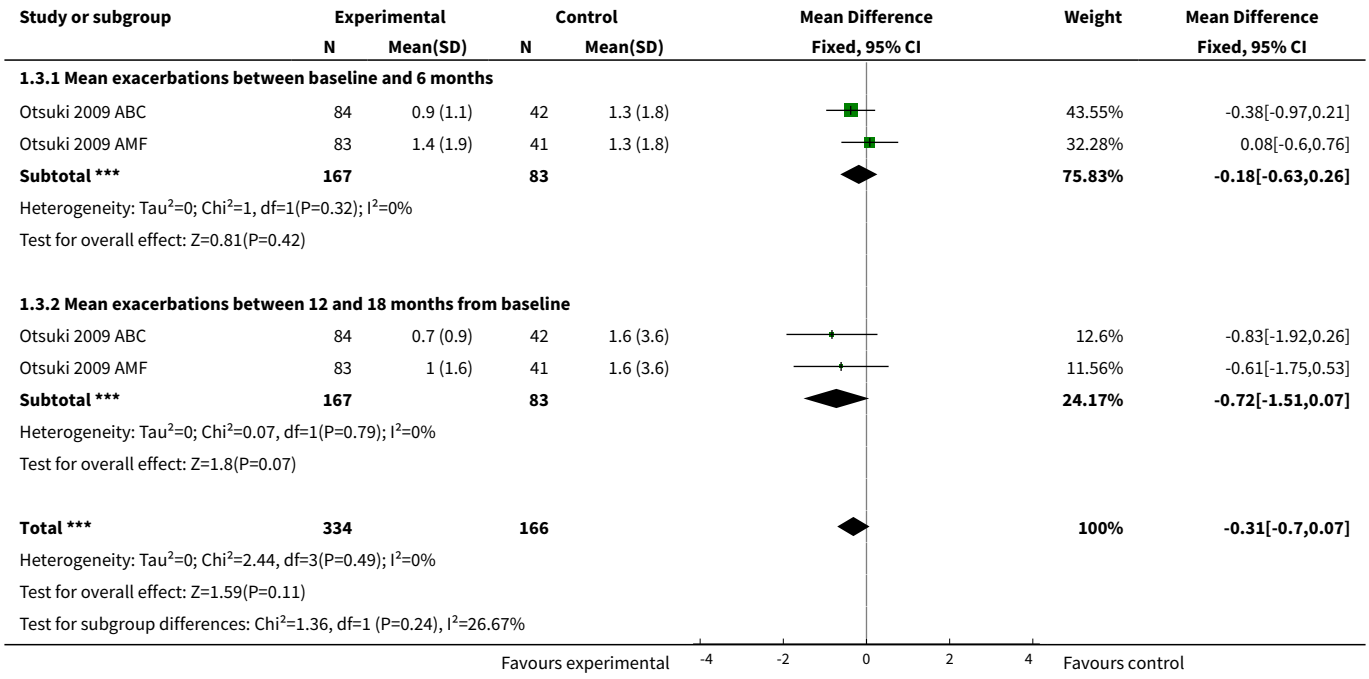
Analysis 1.2. Comparison 1 Education versus control, Outcome 2 Mean exacerbations resulting in ED visits.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
1.2.1 mean exacerbations between baseline and 6 months							
Gorelick 2006	81	0.6 (0.9)	99	0.6 (1)		73.45%	-0.03[-0.3,0.24]
Otsuki 2009 ABC	84	1.2 (1.3)	42	1.2 (1.7)		16.46%	0.03[-0.55,0.61]
Otsuki 2009 AMF	83	1.7 (2.5)	41	1.2 (1.7)		10.09%	0.56[-0.18,1.3]
Subtotal ***	**248**		**182**			**100%**	**0.04[-0.2,0.27]**
Heterogeneity: Tau^2=0; Chi^2=2.14, df=2(P=0.34); I^2=6.64%							
Test for overall effect: Z=0.33(P=0.74)							
1.2.2 mean exacerbations between 12 and 18 months from baseline							
Otsuki 2009 ABC	84	0.8 (1)	42	1.1 (1.8)		52.11%	-0.29[-0.87,0.29]

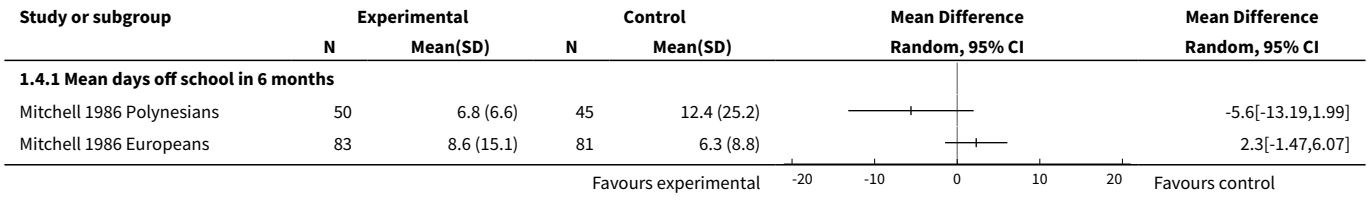




Analysis 1.3. Comparison 1 Education versus control, Outcome 3 Mean exacerbations requiring a course of oral corticosteroids.

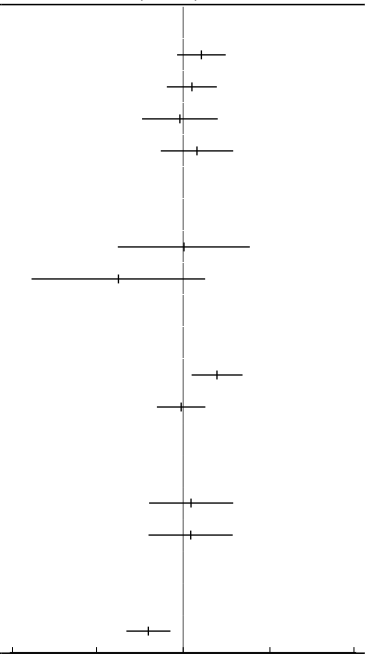


Analysis 1.4. Comparison 1 Education versus control, Outcome 4 Days missed from school or work.



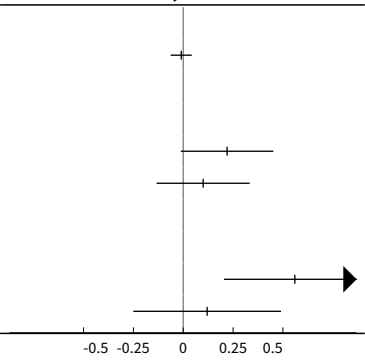
Analysis 1.5. Comparison 1 Education versus control, Outcome 5 Exacerbations leading to hospitalisation.

Study or subgroup	Experimental n/N	Control n/N	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
1.5.1 Admission in 6 months from baseline				
Mitchell 1986 Europeans	28/94	22/106		1.62[0.85,3.09]
Mitchell 1986 Polynesians	27/84	23/84		1.26[0.65,2.44]
Otsuki 2009 ABC	13/84	7/42		0.92[0.34,2.5]
Otsuki 2009 AMF	19/83	7/41		1.44[0.55,3.77]
1.5.2 Hospitalisation between 3 and 9 months from baseline				
Seid 2010	4/65	2/33		1.02[0.18,5.86]
Seid 2010 problem solving	1/57	3/33		0.18[0.02,1.79]
1.5.3 Admissions between 6 and 18 months from baseline				
Mitchell 1986 Europeans	30/94	17/106		2.45[1.25,4.83]
Mitchell 1986 Polynesians	27/84	28/84		0.95[0.5,1.8]
1.5.4 Admissions between 12 and 18 months from baseline				
Otsuki 2009 ABC	12/84	5/42		1.23[0.4,3.77]
Otsuki 2009 AMF	12/83	5/41		1.22[0.4,3.72]
1.5.5 Admissions between baseline and 2 years				
Fisher 2009	35/96	55/93		0.4[0.22,0.71]



Analysis 1.6. Comparison 1 Education versus control, Outcome 6 Mean exacerbations leading to hospitalisation.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
1.6.1 Annual exacerbation rate						
Galbreath 2008	157	0.1 (0.2)	159	0.1 (0.2)		-0.01[-0.06,0.04]
1.6.2 Mean admissions over 6 months since baseline						
Mitchell 1986 Europeans	94	0.5 (1)	106	0.3 (0.7)		0.22[-0.01,0.45]
Mitchell 1986 Polynesians	84	0.5 (0.8)	84	0.4 (0.7)		0.1[-0.13,0.33]
1.6.3 Mean exacerbations between 6 and 18 months						
Mitchell 1986 Europeans	94	0.8 (1.7)	106	0.3 (0.7)		0.56[0.2,0.92]
Mitchell 1986 Polynesians	84	0.7 (1.3)	84	0.6 (1.1)		0.12[-0.25,0.49]



Comparison 2. Education versus other home-based education

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Exacerbations leading to ED visits	1		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Mean exacerbations requiring a course of oral corticosteroids	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3 Exacerbations leading to hospitalisation	1		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Mean hospital admissions	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.1 Admissions between 6 and 12 months follow-up	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 2.1. Comparison 2 Education versus other home-based education, Outcome 1 Exacerbations leading to ED visits.

Study or subgroup	Education n/N	Less intensive education n/N	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
Butz 2006	27/95	40/86		0.46[0.25,0.84]

Favours experimental 0.01 0.1 1 10 100 Favours control

Analysis 2.2. Comparison 2 Education versus other home-based education, Outcome 2 Mean exacerbations requiring a course of oral corticosteroids.

Study or subgroup	Education N	Education Mean(SD)	Less intensive education N	Less intensive education Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
Butz 2010	100	0.7 (1.2)	93	0.6 (1.1)		0.03[-0.29,0.35]

Favours experimental -1 -0.5 0 0.5 1 Favours control

Analysis 2.3. Comparison 2 Education versus other home-based education, Outcome 3 Exacerbations leading to hospitalisation.

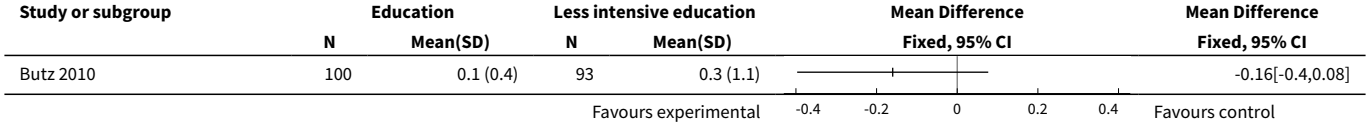
Study or subgroup	Education n/N	Less intensive education n/N	Odds Ratio M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
Butz 2006	4/95	11/86		0.3[0.09,0.98]

Favours experimental 0.01 0.1 1 10 100 Favours control

Analysis 2.4. Comparison 2 Education versus other home-based education, Outcome 4 Mean hospital admissions.

Study or subgroup	Education N	Education Mean(SD)	Less intensive education N	Less intensive education Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
2.4.1 Admissions between 6 and 12 months follow-up						

Favours experimental -0.4 -0.2 0 0.2 0.4 Favours control



ADDITIONAL TABLES

Table 1. Summary of characteristics of included studies

Study	No./ length sessions, where	Educator	Programme length (follow-up time)	% severe (how identified) (inclusion criteria relating to HCU/ meds)	Mean age (range)	Social indicators (education status refers to caregiver)	Basic education[1], printed materials and homework	Medication/ inhaler technique	Self management	Monitoring2 or telecare	Written action plan	Trigger ID/ environmental	Other
Brown 2002 N = 101	8 x 90-minute home weekly, USA	Nurse	< 6 months (12 months)	4 (as per medication regimen) (Healthcare visit for asthma in past year and on daily asthma medication)	4.2 (1 to 7)	Low-income families < high school 28%, high school qualification 50%, > high school 22% 90% African American	√√	√	√		√	√	Wee Wheezers
Brown 2006 N = 137	1 x clinic, 1 x home, USA	Nurse	< 6 months (6 months)	37 (NHLBI) (Moderate to severe asthma or had visited the ED in the past year)	< 18	< high school 18%, high school qualification 32%, > high school 50% 30% African American, 59% White	√	√	√		√	√	Stressed monitoring and self evaluation
Butz 2006 N = 221	6 x 1-hour home, USA	Nurse	6 months (12 months)	14 (NAEPP) (regular nebuliser use and ED visit/hospitalisation in past year)	4.5 (2 to 9)	Low-income families < high school 24%, high school qualification 28%, > high school 38% on MedicAid 80% African American 89%	√	√	√		√	√	* The control group receive a home visit education programme and the additional intervention for the intervention group is a nebulis-

Table 1. Summary of characteristics of included studies *(Continued)*

													er-based intervention. nebuliser group only: Wee Wheezers, A+ Asthma Club Program
Butz 2010	4 x 30 to 45 minutes home, accompanied to primary care clinic visits x 6 months, USA	Nurse/ health educator	8 weeks (12 months)	13 (NHLBI) >= 1 asthma ED visits or hospitalisation in preceding year	8.0 (6 to 12)	Caregiver education < high school graduate 32.0%; high school graduate or more education 68.0% Income < USD 20,000: 57.1%; >= USD 20,000: 42.9%	√√	√	√		√	√	Asthma communication education based on Chronic Care Model and other communication concepts
Dolinar 2000 N = 56	1 x 2-hour home, Canada	Principal investigator (nurse)	< 6 months (3 months)	'Stable asthma' with a diagnosis for over 6 months. Those presenting with an acute exacerbation were excluded.	5 (1 to 10)	High school 38%, college/university 63% Family income < CAD 20,000 (Cdn) 13%	√√	√	√	√		√	Air Force Asthma
Fisher 2009	2 x home, biweekly telephone calls x 3 months, then monthly	3 African American women from same neighbourhoods as	2 years (2 years)	Not specified but recruited after hospitalisation	4.9 (2 to 8)	No high school diploma 33%, high school qualification 40%, some college 23%, college graduate 4%	√	√	√	√	√	√	Transtheoretical Model (behaviour change strategy)

Table 1. Summary of characteristics of included studies *(Continued)*

	USA	partici-pants											
Gal-breath 2008 N = 473	4 x home at 1, 2, 3 and 6 months, 6 to 7 tele-phone sessions, USA	Regis-tered nurses for edu-cation over the phone and 24 hour hotlines. Pul-monary therapist	6 (12 months)	31 (NAEPP) 48 (GINA 2002) (ED visit or hospitalisa-tion or 4 x GP visits or 6+ canisters of beta-ago-nist or diag-nosis of mod-erate-severe asthma in past year)	9.5 (5 to 17)	Medicaid or SCHIP 56%, black/other 18%, white 15%, His-panic 68%	√	√	√	√	√	√	
Gore-lick 2006 N = 352	1 x 60 minutes home then 5 x 30 minutes home, plus sev-eral tele-phone calls over 6 months USA	Case manag-er (nurse or social worker)	6 months (6 months)	14 (NAEPP) (current ED visit for asth-ma, treat-ed with 1 in-haled bron-chodilator, and history of physician di-agnosed asth-ma or wheez-ing treated with beta-ag-onists)	6.8 (2 to 18)	60% public insur-ance black 69%, white 21%, Latino 8%	√√	√	√	√	√	√	Fight Asthma Milwaukee (FAM) Allies Coalition
Kamps 2008 N = 15	6 x 1 hour weekly home, USA	Licensed psychol-ogists or mas-ters-lev-el psy-chology graduate students	< 6 months (12 months)	Moderate to severe persis-tent (NHLBI) (Prescribed ICS)	9 (7-12)	Half of partici-pants recruited from urban and half from subur-ban areas Intervention: high school qualifi-cation mothers 0% fathers 14%,	√√	√	√		√	√	* The control group also re-ceive a stan-dard com-prehensive education programme based on Air Wise pro-gramme and

Table 1. Summary of characteristics of included studies *(Continued)*

						some college mothers100% fathers 86%; control: no high school diploma mothers 50% fathers 57%, high school qualification mothers 25 fathers 14%, some college mothers 25 fathers 29%. 20% African American, 53% European American, 27% Hispanic American						they watched Clubhouse Kids Learn About Asthma. The Clubhouse Kids Learn Asthma More intense group received a behavioural management technique intervention to improve adherence to corticosteroids. Unique barriers to adherence were identified and discussed and written solutions were provided.
Mitchell 1986 N = 368	6 x 1 hour monthly home, New Zealand	Community child health nurse	6 months (18 months)	Children who had been admitted to hospital for asthma (Patients who had been discharged from hospital in the past year)	5.8 (2 to 14)	European children significantly more advantaged than Polynesian children	√	√	√		√	
Otsuki 2009 ABC	5 x 30 to 40 minutes	Trained asthma educators	< 6 months (18 months)	Physician diagnosed asthma, 2 x ED visits or 1 x hos-	7.14 (2 to 12)	Medicaid 89%, caregiver completed high school 69%	√√	√	√ discussed strategies	√		Identification of barriers to health care and discus-

Table 1. Summary of characteristics of included studies *(Continued)*

N = 250 (total)	home, USA			pitalisations in the preceding year and on asthma controller medications		98% African American							sion of beliefs and concerns
Otsuki 2009 AMF	5 x 30 to 40 minutes home, USA	Trained asthma educators	< 6 months (18 months)	"	6.83 (2 to 12)	Medicaid 89%, caregiver completed high school 69% 98% African American	√√	√	√	√ electronic medication/ feedback monitors	√		Identification of barriers to health care and discussion of beliefs and concerns. Goal-setting, reinforcement of adherence goals and importance of rewards
Seid 2010 N = 252 (total)	5 x 45 to 60 minutes, weekly, USA	Bilingual, bicultural bachelors educated asthma home visitors	< 6 months (9 months)	33	7.37 (2 to 14)	85% from subsidised community clinics (most low-income) No diploma 73%, high school graduate 8%, > college19% Hispanic 83%, white 4%, black, 8%	√√	√	√		√	√	
Seid 2010 problem solving	6 x 45 to 60 minutes, weekly, USA	Bilingual, bicultural masters educated asthma home visitors	< 6 months (9 months)	33	7.37 (2 to 14)	"	√√	√	√		√	√	Problem-solving skill training, rapport building

1. Basic education on concepts of asthma

2. Monitoring of asthma management by a health professional or electronic device
ED: Emergency Department; ICS: inhaled corticosteroid; NAEPP: National Asthma Education and Prevention Program; NHLBI: National Heart, Lung, and Blood Institute guidelines; SCHIP: State Children's Health Insurance Program administered by the United States Department of Health and Human Services that matches funds to states for health insurance to families with children. Designed to cover uninsured children in families with incomes that are modest but too high to qualify for Medicaid.

Table 2. Control group event rates

Study	Control group risk EMERGENCY DEPARTMENT VISITS	Control group risk HOSPITALISATIONS (period reported, from baseline)
Brown 2006	38% (0 to 6 months)	-
Butz 2006	47% (0 to 6 months)	13% (0 to 6 months)
Dolinar 2000	10% (0 to 6 months)	-
Fisher 2009	54% (0 to 2 years)	59% (0 to 2 years)
Gorelick 2006	38% (0 to 6 months)	-
Mitchell 1986 Europeans	5% (0 to 6 months)	21% (6 months) 16% (6 to 18 months)
Mitchell 1986 Polynesians	13% (0 to 6 months)	27% (6 months) 33% (6 to 18 months)
Otsuki 2009	-	17% (6 months) 12% (12 to 18 months)
Seid 2010	15% (3 to 9 months)	8% (3 to 9 months)

Table 3. Aims of studies

Study	Aims
Mitchell 1986	In New Zealand readmission rates are higher in Polynesian children than in European children. The study was designed to find out if community child health nurses in the patients home could reduce school absenteeism, encourage visits to the GP and reduce the number of readmissions to hospital and teach parents when and how to seek medical help for an attack not responding to usual treatment.
Dolinar 2000	Does home-based education resource influence parental coping, perception of asthma change and quality of life?
Brown 2002	"A home-based program may be the most developmentally appropriate and ecologically valid methods of delivering asthma education to low income inner city families". Wanted to evaluate efficacy in terms of parental participation and effectiveness in terms of decreasing morbidity and increasing the caregiver's quality of life and asthma management skills.
Butz 2006	"Low-income minority children have disproportionately high morbidity and mortality rates" and "tend to rely on hospital emergency rooms as primary source of asthma care". Therefore aimed to decrease ED visits/hospital admissions by helping parents understand when the child's asthma was worsening and train them specifically in home nebuliser use.
Gorelick 2006	Evaluated the impact of educating children in the emergency department and then following up with home-based education interventions compared to standard care alone.

Table 3. Aims of studies *(Continued)*

Brown 2006	A "structured comprehensive asthma education program delivered by an experienced asthma nurse educator within a local asthma coalition would be an effective method of reducing asthma relapse in patients who had moderate-sever persistent asthma."
Galbreath 2008	A telephonic and home-visiting asthma education delivered by a respiratory therapist designed to decrease healthcare utilisation and generate cost savings.
Kamps 2008	Designed to increase adherence to asthma treatment regimens.
Otsuki 2009	To evaluate a feedback of electronically monitored adherence and education programme in reducing ED visits ad asthma mediation adherence, symptoms, hospitalisations and courses of oral steroids.
Fisher 2009	Hypothesised that "community health workers may help reduce disproportionate asthma health burden among children from low-income families". Used a non-professional asthma coach to try and reduce rehospitalisation.
Seid 2010	Problem-solving may be useful in helping families, especially lower socioeconomic status families improve their asthma management behaviours to improve quality of life.
Butz 2010	Hypothesised that a programme designed to improve clinician-caregiver communication would be associated with reduced symptom days and nights and increased compliance with appropriate controller medication in inner-city children.

ED: Emergency Department

Table 4. Completers/ withdrawals

Study	% completed full education programme	Partial completion	Completed no sessions	Lost to follow-up	Withdrawals
Brown 2002	71%	11%	7%	-	11%
Brown 2006	38%*	9% received only clinic visit* 15% received only home visit*	39%*	Intervention group 21% Control group 6% (reported for children)	Not reported * these data are from both adults and children
Butz 2006	Most completed	-	-	Nebuliser: 14% excluded from follow-up (10% no pharmacy data, 2% died, 3% lost). SAE 23% excluded (18% no pharmacy data, 1% died, 4% lost)	Not reported
Butz 2010	-	More intense group received mean 3.29 out of 4 visits Control received mean 2.27 out of 3 visits	-	More intense group 17% Control group 14%	Not reported
Dolinar 2000	100%	-	-	5%	0

Table 4. Completers/ withdrawals *(Continued)*

Fisher 2009	-	-	4% (no substantive contact)	Hospitalisations available for all participants. 83% completed surveys	Not reported
Galbreath 2008	70% completed at least 80% of the intervention - although this was for adults and children	-	-	35%	2
Gorelick 2006	Average of 4 (out of 6) home visits per patient (average of 2 missed visits per patient); average 2.3 calls per patient	72% had at least 1 home visit	-	22%	
Kamps 2008	100%	-	-	2 months 33% 6 months 60% 12 months 67%	3
Mitchell 1986	68%	26%	6%	Not reported	Not reported
Otsuki 2009	ABC 71%; AMF 63%	-	-	˜10%	1 person deceased in each group
Seid 2010	67% completed all 5 visits	Completed 4.0 (CC) and 3.8 (CC + PST) visits on average	-	CC intervention: 20% lost (7% refused), PST intervention 32% lost (19% refused)	PST 19% and CC 6% "refused"

ABC: Asthma Basic Care
AMF: Adherence Monitoring with Feedback
SAE: serious adverse event
PST: problem-solving skill training

APPENDICES

Appendix 1. Calculation of number of ED visits for Mitchell 1986

Intervention group

Europeans: 83 (total) x 48% (asthma attack not responding to Tx at home) x 34% Tx @ hospital = 14
Polynesians: 50 (total) x 49% (asthma attack not responding to Tx at home) x 47% Tx @ hospital = 12

Control group

Europeans: 81 (total) x 46% (asthma attack not responding to Tx at home) x 11% Tx @ hospital = 4
Polynesians: 45 (total) x 44% (asthma attack not responding to Tx at home) x 30% Tx @ hospital = 6

WHAT'S NEW

Date	Event	Description
5 September 2014	Amended	PLS title amended. Reference to withdrawn protocol removed

HISTORY

Protocol first published: Issue 4, 2010
Review first published: Issue 10, 2011

Date	Event	Description
11 April 2013	Amended	NIHR acknowledgement added

CONTRIBUTIONS OF AUTHORS

EJW: Screening search results, co-ordinating review team, data extraction, data entry and drafting review.

MH: Screening ERIC search results, data extraction, commenting on draft.

PL: Screening search results, data extraction, data entry, drafting review, providing clinical input.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

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External sources

- NIHR, UK.

  Programme grant

INDEX TERMS

Medical Subject Headings (MeSH)

*House Calls; Asthma [*therapy]; Caregivers [*education]; Emergency Service, Hospital [statistics & numerical data]; Patient Education as Topic [*methods]; Quality of Life; Vulnerable Populations

MeSH check words

Child; Humans