CICER
Tacaíocht don Treoirlíne Chliniciúil
Clinical Guideline Support

# SYSTEMATIC REVIEWS OF CLINICAL AND COST-EFFECTIVENESS

# Specialist assessment and self-management education after an acute asthma exacerbation

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Health Information and Quality Authority
An tÚdarás Um Fhaisnéis agus Cáilíocht Sláinte

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
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NATIONAL CLINICAL EFFECTIVENESS COMMITTEE

HRB An Bord Taighde Sláinte Health Research Board

# About CICER

In 2016, the Department of Health requested that the Health Research Board (HRB) fund an evidence synthesis service to support the activities of the Ministerially appointed National Clinical Effectiveness Committee (NCEC). Following a competitive process, the Health Information and Quality Authority (HIQA) was awarded research funding spanning the period from 2017 to 2024 to produce the evidence to support the development of National Clinical Guidelines. This funding was renewed through a competitive process to support the work of the Centre in Ireland for Clinical guideline support and Evidence Reviews (CICER) from 2024 to 2028. CICER comprises a dedicated multidisciplinary research team supported by staff from the Health Technology Assessment team in HIQA, the Discipline of Public Health and Primary Care in the School of Medicine in Trinity College Dublin, as well as national and international clinical and methodological experts.

With regard to clinical guidelines, the role of the CICER team is to independently review evidence and provide scientific support for the development, by guideline development groups (GDGs), of National Clinical Guidelines for the NCEC. The CICER team undertakes systematic reviews of the clinical effectiveness and cost effectiveness of interventions included in the guidelines, as well as estimating the budget impact of implementing the guidelines. The CICER team also works closely with the GDGs and provides tailored training sessions; assists in the development of clinical questions and search strategies; performs systematic reviews of international clinical guidelines and supports the assessment of their suitability for adaptation to Ireland; and supports the development of evidence-based recommendations informed within the National Clinical Guidelines.

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# Plain Language Summary

**Title**: For people who have been admitted to hospital for an asthma attack, can self-management education and or assessment by an asthma specialist improve their health?

## Key messages

- Self-management education, with or without specialist assessment, may prevent future serious asthma attacks requiring hospital visits.
- It is uncertain if self-management education, with or without specialist assessment, helps patients to increase their asthma knowledge, follow their treatment plan, or improve their quality of life.
- More well-designed studies are needed: they should use standard ways of measuring important outcomes and look at the value for money.

## Background

Asthma is a long-term health issue that can impact breathing. An asthma attack is when a person's asthma symptoms become temporarily worse. Sometimes people have to go to the emergency department or hospital when they are having an asthma attack, and sometimes asthma attacks can be very serious or even deadly.

After being admitted to hospital for an asthma attack, treatment can include self-management education and assessment by an asthma specialist. Self-management education helps a person living with asthma to better manage their asthma themselves by learning more information and skills. Assessment by an asthma specialist means a detailed examination, testing, and discussion with a healthcare professional who has specialised knowledge or training in asthma.

## What did we want to find out?

We wanted to find out if specialist assessment and or self-management education after an asthma attack works to:

- prevent future severe asthma attacks that need to be treated in hospital
- improve patient satisfaction

- improve patient asthma knowledge
- help with other outcomes, like future asthma attacks, including those that are not serious enough to need treatment in hospital, following a treatment plan, asthma control, and quality of life.

We also wanted to find out if specialist assessment and or self-management education were good value for money.

### What did we do?

We searched for published research studies that looked at specialist assessment and or self-management education after a person was in hospital for an asthma attack. The evidence is up to date to June 2025, meaning any studies published after June 2025 would not have been picked up by our search. We compared and summarised the results of the studies and rated our confidence in them, based on factors such as how well the research study was conducted.

### What did we find?

We found 13 studies that involved adults that were 16 years or older who had been to hospital for treatment of their asthma attack. The studies collected information for between four and 12 months after the hospital visit. Seven of the studies were conducted in the US. The most recent study was published in 2011. Five of the studies were at least partly funded by pharmaceutical companies.

- We found self-management education, with or without specialist assessment, may reduce future serious asthma attacks that require a hospital visit.
- We found that it is uncertain whether self-management education (with or without specialist assessment) improves asthma knowledge or quality of life, or if it helps people follow their treatment plan.
- We did not find any studies that investigated if self-management education and or specialist assessment were good value for money.

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# List of abbreviations that appear in this report

| | |
|---|---|
| **ACQ-7** | Asthma Control Questionnaire 7 |
| **ACT** | Asthma Control Test |
| **AQLQ** | Asthma Quality of Life Questionnaire |
| **BTS/SIGN** | British Thoracic Society and Scottish Intercollegiate Guidelines Network |
| **CICER** | Centre in Ireland for Clinical guideline support and Evidence Reviews |
| **ED** | emergency department |
| **EuroQol** | European Quality of Life |
| **EQ-5D-5L** | EuroQoL 5-Dimension 5-Level |
| **GDG** | guideline development group |
| **GINA** | Global Initiative for Asthma |
| **GRADE** | Grading of Recommendations Assessment, Development and Evaluation |
| **HIQA** | Health Information and Quality Authority |
| **HRB** | Health Research Board |
| **HSE** | Health Service Executive |
| **ICER** | incremental cost-effectiveness ratio |
| **IRR** | incident risk ratio |
| **KASE-AQ** | Knowledge Attitude Self-Efficacy Asthma Questionnaire |
| **mOCS** | maintenance oral corticosteroids |
| **NCEC** | National Clinical Effectiveness Committee |
| **NRCT** | non-randomised controlled trial |
| **NRSI** | non-randomised studies of interventions |
| **PICO** | population, intervention, comparison, outcome |
| **PPI** | patient and public involvement |
| **PRISMA** | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| **PROSPERO** | International Prospective Register of Systematic Reviews |
| **QOL** | quality of life |
| **QALY** | quality-adjusted life year |
| **RCT** | randomised controlled trial |

| | |
|---|---|
| **RoB** | Risk of Bias |
| **ROBINS-I** | Risk of Bias In Non-randomised Studies of Interventions |
| **RR** | risk ratio |
| **SD** | standard deviation |
| **SE** | standard error |
| **TARCiS** | Terminology, Application, and Reporting of Citation Searching |
| **TFA** | Theoretical Framework of Acceptability |

# 1 Background

## 1.1 Description of the condition

Asthma is defined as a chronic inflammatory disorder, in which the bronchial airways in the lungs become narrow and swollen, impacting breathing.[1, 2] Asthma can range in severity from mild to severe, with typical symptoms including wheezing, coughing, shortness of breath, and chest tightness.[3] Asthma is a "complex genetic disorder with strong environmental influence", whose risk factors include air pollution, smoking, atopy (a genetic tendency to develop an exaggerated immune response), stress, and obesity.[4, 5] Asthma is associated with an increased risk of accompanying health conditions, including rhinitis, sinusitis, gastroesophageal reflux, and obstructive sleep apnoea.[6, 7] In Ireland, approximately 5-10% of the adult population has been diagnosed with asthma.[8, 9] Occasionally, individuals with asthma may experience a sudden worsening of their symptoms, also known as an asthma exacerbation or an asthma attack. Asthma attacks are characterised by rapid breathing, difficulty speaking, accelerated heart rate, and low oxygen saturation and may vary in severity from mild to life-threatening.[10] They can be triggered by viral respiratory infections, like the common cold, or by exposure to allergens.[11, 12]

Asthma attacks are typically treated with a combination of inhaled short-acting bronchodilators and systemic corticosteroids.[13] Severe asthma attacks may become life-threatening and require emergency medical intervention. Emergency treatment for an acute asthma attack may include nebulised bronchodilators (such as short-acting beta-2 agonists and ipratropium bromide), corticosteroids, and supplementary oxygen, and in very severe cases, mechanical ventilation.[14] Experiencing repeated severe asthma attacks can lead to an accumulation of risk for patients, including an increased likelihood of further attacks.[15] In 2024, there were 4,054 discharges from inpatient hospital care with a principal diagnosis of asthma in Ireland; 98% (n=3,982) of these were "emergency admissions", meaning that they were unplanned admissions requiring immediate care and treatment and were likely admitted through the emergency department (ED).[16, 17]

## 1.2 Specialist care for asthma

For severe and difficult-to-control asthma, specialist assessment and management (defined as care provided by healthcare providers with specialised training and expertise in asthma, including respiratory consultants, clinical nurse specialists, and specialist physiotherapists) has been found to be associated with improved asthma control, reduced exacerbations, and a planned lowering of maintenance oral corticosteroid (mOCS) dose.[18-20] Similarly, there is evidence that follow-up by specialist services after an asthma-related ED presentation is associated with fewer subsequent ED visits and hospitalisations, as well as improved asthma control.[21] Several international clinical guidelines refer to specialist assessment and management. Global Initiative for Asthma (GINA) guidelines from 2024 suggest that the optimal frequency and location of reviews (primary care versus specialist) for patients with severe asthma will depend on the patient's asthma control, risk factors, and comorbidities and that referral for expert advice should be considered for patients who have been hospitalised for asthma.[1] According to the British Thoracic Society and Scottish Intercollegiate Guidelines Network (BTS/SIGN) guideline from 2019, all patients hospitalised with an acute exacerbation of asthma should be reviewed by a respiratory nurse specialist or respiratory consultant within a month of discharge.[22]

In Ireland, the National Framework for the Integrated Prevention and Management of Chronic Disease in Ireland in 2020-2025[23] and End to End Model of Care for Asthma[24] outline how specialist respiratory care should be provided in the context of the Chronic Disease Community Specialist team, which includes an Integrated Care Respiratory Nursing Service, Respiratory Physiotherapy Service, and Respiratory Consultant. Eligibility criteria for referral include having clinically-confirmed asthma with more than two unplanned asthma-related attendances in 12 months at a GP practice or attending an out-of-hours service or ED with an acute asthma exacerbation.[25] Since 2020, the Health Service Executive (HSE) has been rolling out Chronic Disease Community Speciality Teams for respiratory, cardiology, and diabetes in all areas of the country, with each team covering a population of approximately 150,000. All 30 teams are, at the time of writing, initiated at various levels of operation, with the HSE envisioning that all teams will be fully operational by 2027.[26]

## 1.3 Self-management education and support for people with asthma

A self-management intervention is broadly defined as "an intervention primarily designed to develop the abilities of patients to undertake management of health conditions through education, training and support to develop patient knowledge, skills or psychological and social resources."[27] Self-management has been well-established as a core component of models of care for people with chronic disease,[28, 29] including in the context of asthma.[30] Optimal self-management for asthma has previously been described as including a written action plan for self-management of drugs for exacerbations, together with self-monitoring and regular medical review.[31] International guidelines (for example from GINA and BTS/SIGN) have recommended the use of self-management interventions for people with asthma since 1990s,[1, 22] and there is evidence that supported self-management can reduce hospitalisations, ED presentations, and unscheduled consultations, and improve markers of control and quality of life (QOL) for people with asthma across a range of cultural, demographic and healthcare settings.[32] Despite this, asthma self-management remains underutilised in clinical practice, with international evidence estimating that only approximately one-third of people with asthma have personal asthma action plans.[33, 34] A 2014 UK National Review of Asthma Deaths found that, of all asthma mortalities, only 23% had documented evidence of having been provided with self-management education.[35] Self-management support and or education specifically aimed at patients who have been hospitalised for an acute exacerbation, focusing on increased knowledge of their condition and how to monitor and control it to prevent future exacerbations and reduce the risk of re-hospitalisation, may be an important aspect of asthma care.

## 1.4 Purpose of the reviews

The purpose of these systematic reviews was to identify and evaluate the clinical and economic evidence relating to specialist assessment and self-management and educational interventions in adults who have presented to ED and or have been admitted to hospital with an acute asthma exacerbation. This will help to inform the recommendations of the upcoming update of NCEC National Clinical Guideline on Management of an Acute Asthma Attack in Adults (aged 16 years and older).

# 2 Methods

These systematic reviews were reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria.[36] The completed PRISMA statement checklist is available in Appendix 1. National HIQA guidelines were adhered to for identifying and evaluating clinical and economic evidence.[37, 38] The reviews were pre-registered on the International Prospective Register of Systematic Reviews (PROSPERO) database of systematic reviews and meta-analyses (record numbers: CRD420251122370 and CRD420251122376).[39-41] The protocol for these reviews, including the draft data extraction forms, is available on HIQA website.[42]

## 2.1 Research questions

The following research questions were considered:

1. *What is the clinical and cost-effectiveness of specialist assessment in adults who have presented to ED and or have been admitted to hospital with an acute asthma exacerbation?*
2. *What is the clinical and cost-effectiveness of self-management and educational interventions in adults who have presented to ED and or have been admitted to hospital with an acute asthma exacerbation?*

These questions were formulated in line with the population, intervention, comparison, and outcome (PICO) framework, as presented in Table 1. Critical and important outcomes were identified in collaboration with the PPI representatives in the GDG.

**Table 1 PICO framework for review questions**

| | |
|---|---|
| **Population** | Patients 16 years of age or older who have attended the ED or been admitted to hospital for an exacerbation of asthma |
| **Intervention** | **Include:**<br>▪ Review 1: Assessment by an outpatient specialist service (for example respiratory consultant, respiratory specialist hub, respiratory clinical nurse specialist/advance nurse practitioner, respiratory physiotherapy).<br>▪ Review 2: Asthma-related self-management or education intervention delivered in the outpatient specialist setting (including those initiated in an inpatient or ED setting).<br>**Exclude:**<br>▪ interventions aimed at current inpatients only, without continuation in the outpatient setting<br>▪ studies focusing on all asthma patients, regardless of previous presentation or admission to hospital for an exacerbation<br>▪ interventions delivered in primary care or general practice settings |
| **Comparator** | Usual care, no intervention, or other intervention. |
| **Outcome** | **Critical outcomes:**<br>▪ Subsequent severe asthma exacerbation requiring hospitalisation (ED visit or inpatient admission) within a timeframe of up to 12 months from the index presentation (number of events and or proportion of patients experiencing events).<br>▪ Patient satisfaction/acceptability of intervention, measured using a validated tool (for example Theoretical Framework of Acceptability (TFA)).<br>▪ Improvement in patient's asthma-related knowledge or confidence within a timeframe of up to 12 months, measured pre and post-intervention using a validated tool (for example Knowledge Attitude Self-Efficacy Asthma Questionnaire (KASE-AQ)).<br>▪ Asthma-related quality of life (for example Asthma Quality of Life Questionnaire (AQLQ), EuroQoL 5-Dimension 5-Level (EQ-5D-5L)) post intervention, within a timeframe of up to 12 months.<br>**Important outcomes:**<br>▪ Subsequent asthma exacerbation (any severity, defined as an exacerbation requiring a change in treatment) within a timeframe of up to 12 months (number of events and or proportion of patients experiencing events).<br>▪ Treatment adherence within a timeframe of up to 12 months, measured using for example self-report, collateral report, medical records, and or |

| | |
|---|---|
| | objective measurements such as canister weighing, electronic tracking, or biomarkers.<br>▪ Asthma control (for example Asthma Control Test (ACT), Asthma Control Questionnaire (ACQ) post intervention, within a timeframe of up to 12 months).<br>Any relevant measures of costs and benefits which may be applicable to the Irish setting, see section 2.3 |
| **Study design** | **Include:**<br>▪ randomised controlled trials (RCTs)<br>▪ non-randomised studies of interventions (NRSIs), including non-randomised controlled trials (NCRTs) and uncontrolled pre/post studies<br>**Exclude:**<br>▪ cross-sectional studies with no follow-up, case-control studies, case series |
| **Search period** | All time for evaluating clinical effectiveness, 10 years for cost-effectiveness |

## 2.2 Health economic studies

This systematic review aimed to identify health economic studies including economic evaluations (cost-effectiveness analyses, cost-utility analyses, cost-minimisation analyses and cost-benefit analyses) related to the review questions. Economic outcome measures considered applicable to this review include:

**Economic evaluations**

- Cost-utility and or cost-effectiveness analysis:
  - incremental cost-effectiveness ratio (ICER)
  - cost per unit of effect (such as cost per life year gained) or effects per unit cost (for example, life years gained per Euro spent)
  - quality-adjusted life years (QALYs), disability-adjusted life years, or health/life years equivalent
  - incremental net monetary benefit.
- Cost-benefit and or cost-minimisation analysis:
  - net monetary benefit
  - incremental costs
- Cost consequence analyses

- costs of implementing the intervention
- consequences of implementing the intervention (such as health outcomes, quality of life, wellbeing, or cost savings) in their natural units.

**Other economic outcome measures**

- Costs and resource use:
  - direct (for example, cost of staffing and equipment) and indirect (for example, lost productivity) costs, offsets and savings
  - implementation costs (for example, training and education)
  - service utilisation cost.

## 2.3 Search strategy

The search strategy was developed and run by an in-house medical librarian. Electronic searches were conducted in MEDLINE Complete via EBSCO, Embase via Elsevier, Cochrane Library, CINAHL Complete via EBSCO, APA PsycINFO via EBSCO, and ClinicalTrials.gov on 13 June 2025. The Medline search strategy is included in Appendix 2 and complete search strategy documentation is available from the open repository Zenodo: https://doi.org/10.5281/zenodo.18220236. In addition to the database search, backward- and forward-citation screening was conducted for eligible studies using "citationchaser" software.[43]

As a confirmatory check of the search, during the title and abstract screening in Covidence, any relevant systematic reviews were tagged by reviewers. Thirty-four potentially relevant reviews were identified during title and abstract screening: none matched our review question and PICO framework. One reviewer checked the list of included studies in these systematic reviews for any additional relevant studies that were not captured by the database search strategy and subsequent backward- and forward-citation screening.

## 2.4 Selection of eligible publications

All citations identified from the collective search strategy were exported to EndNote (Version 20) for reference management, where duplicates were identified and removed. Using Covidence (www.covidence.org), two reviewers independently reviewed the titles and abstracts of the remaining citations to identify those eligible for full-text review. The full texts

were obtained and independently evaluated by two reviewers applying the defined inclusion and exclusion criteria (see Table 1). Where disagreements around eligibility occurred, discussions were held to reach consensus and a third reviewer was consulted where necessary. Citations excluded during the full-text review stage were documented alongside the reason for their exclusion and included in a PRISMA flow diagram (see Figure 1).

## 2.5 Data extraction and management

Data was extracted from studies by one reviewer using a pre-specified data extraction table in Microsoft Excel. Data extracted was checked for accuracy and omissions by a second reviewer. Extracted data included study characteristics (year of publication, country, study design, number of participants, description of the intervention, description of the comparison groups, and outcomes used) and numerical results for the outcomes identified as critical and important for the purpose of this review.

## 2.6 Risk of bias assessment

Two reviewers independently assessed the risk of bias for critical and important outcomes in included studies using Cochrane Risk of Bias (RoB) 2 for RCTs[44] and Risk Of Bias In Non-randomised Studies of Interventions, version 2 (ROBINS-I V2)[45, 46] for NRSIs. Any disagreements were discussed and where necessary a third reviewer was consulted. Risk of bias due to missing data was assessed using domain 3 (risk of bias due to missing outcome data) in ROB 2 and domain 5 (risk of bias due to missing data) in ROBINS-I V2. The plots for the risk of bias tools were generated using *rob vis.*[47]

## 2.7 Data synthesis

Outcomes were synthesised according to their pre-specified importance for decision-making, classified as critical or important. Among the critical outcomes, subsequent severe asthma exacerbation requiring hospitalisation was the only one consistently reported in a format suitable for meta-analysis. To ensure comparability between studies and use of the best available evidence, only RCTs were included in the meta-analysis. Following Cochrane guidance (section 10.3),[48] the generic inverse variance method with a random effects model was used to calculate pooled effect estimates, assess heterogeneity and produce forest plots.

A random effects model, which allows for between-study variation when study populations vary considerably, was chosen due to observed heterogeneity between studies.

For the subsequent severe asthma exacerbation outcome, we calculated incidence rate ratios (IRRs) for ED visits and hospital admissions separately. As log-transformed values are approximately normally distributed and have variances that can be estimated directly from study data, the log IRR for each study was computed as the difference in log incidence rates between the intervention and control groups, based on the number of events and person-months of follow-up. Standard errors (SEs) were estimated using the inverse of the number of events in each group. Effect estimates were pooled using a DerSimonian and Laird random-effects model and 95% confidence intervals were calculated using the Wald approximation. Results were exponentiated to produce IRRs. A continuity correction of 0.5 was applied to intervention and control groups for studies with zero events in either group to allow calculation of IRR. Additional random-effects meta-analyses were also conducted to estimate the risk ratios (RR) of having at least one ED visit or at least one hospital admission during the follow-up period. RRs were calculated from the number of events and the total number of participants in the intervention and control groups. For all meta-analyses, statistical heterogeneity was assessed using the $I^2$ statistic, representing the proportion of total variation across studies due to heterogeneity rather than chance. Forest plots were used to present individual and pooled effect sizes for all meta-analyses. Due to the low number of identified studies, we did not assess studies with an educational intervention and studies with an assessment and educational component separately, and we were not able to conduct subgroup analysis by risk of bias or to create a funnel plot to assess publication bias. Analysis was conducted in Stata 14 using the metan command.[49] The code was examined by a second researcher and analyses were replicated for quality assurance. The code and data underlying the meta-analyses, including events in intervention and control groups and calculated rates and IRRs and RRs, are available in the open repository Zenodo: https://doi.org/10.5281/zenodo.18223242.

None of the other outcomes were suitable for quantitative synthesis due to inconsistent measurement or reporting and were therefore analysed using narrative synthesis. The

narrative synthesis examined the direction and consistency of effects across studies, taking into account variations in study design, population, and intervention characteristics.

## 2.8 Assessing the certainty of the body of evidence using the GRADE approach

The certainty of the clinical effectiveness evidence for critical and important outcomes was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach as outlined in the GRADE handbook.[50, 51] Two reviewers independently assessed GRADE for each outcome. For the outcome of subsequent severe exacerbations, GRADE assessments were conducted for each method of measurement (IRR and RR for ED and hospital admission respectively) of the outcome, along with an overall GRADE assessment for the outcome. Any disagreements were discussed and where necessary a third reviewer was consulted. The software GRADEpro GDT was used to record the assessment and to prepare the summary of findings tables.[52]

In the GRADE system, RCTs start as "high-quality" evidence, while observational studies start as "low-quality" evidence. For this review, only RCT evidence was used to inform GRADE for each outcome and certainty was rated in relation to the null effect threshold. Evidence was downgraded by one level for serious (or by two levels for very serious) limitations, depending on the assessments of the risk of bias, indirectness of evidence, inconsistency, imprecision of effect estimates, or potential publication bias. Upgrading of evidence was considered based on the magnitude of an effect, dose-response gradient and effect of plausible residual confounding. Evidence was graded as high, moderate, low, or very low, indicating the confidence in the effect estimate.

## 2.9 Protocol deviations

The original protocol specified a follow-up period of up to 90 days. After full-text review, it was discovered that none of the studies included follow-up within 90 days, therefore the maximum allowable timeline for follow-up was extended to 12 months.

Quality of life was initially identified as an important outcome rather than a critical outcome. However, because no evidence was located for the critical outcome of patient satisfaction or acceptability, following consultation with the guideline development group, quality of life was redefined as a critical outcome.

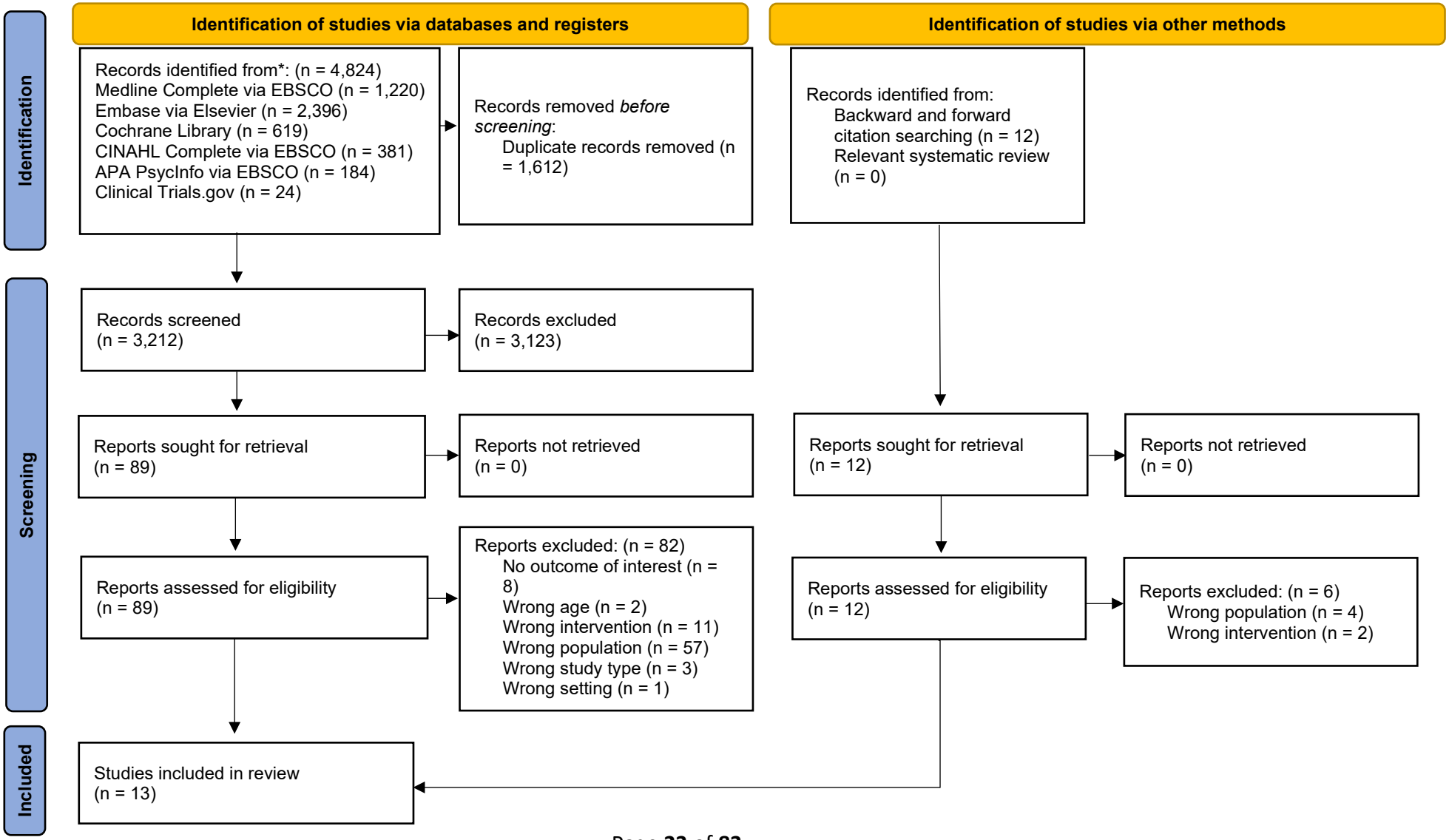
# 3 Results

## 3.1 Search results

The search of electronic databases identified 4,824 citations. After removal of duplicates, the titles and available summaries of 3,212 citations were independently screened by two reviewers, after which 3,123 records were excluded. Eighty-nine full-texts were independently assessed by two reviewers applying the predefined inclusion and exclusion criteria, and seven were included in the review.

Backward- and forward citation searching for the included records identified 279 backward- and 1,083 forward-citation results via citation chaser. Following screening of these citations for relevance independently by two reviewers, 12 additional records were identified and retrieved for full-text review. On full-text review, six of the additional studies were included in the review, leading to a total of 13 included studies. No additional studies were identified during the confirmatory check of relevant systematic reviews from the database search. A PRISMA flow chart summarising the search process and subsequent results is provided in Figure 1. A table with reasons for full-texts excluded following the database search and citation searching is available in Appendix 3.

**Figure 1 PRISMA flowchart**



## 3.2 Study characteristics

Thirteen studies were identified for this review. Seven of the studies[53-59] investigated interventions that had both a specialist assessment and an educational component and six[60-65] investigated educational or self-management interventions only. None of the studies focused on specialist assessments without an educational component. Nine[53, 55, 58, 60-65]of the included studies were RCTs and four[54, 56, 57, 59] were NRSIs. Out of the four NRSIs, two[56, 59] used control groups matched on chart review and two[54, 57] did not use control groups. Sample sizes were typically small, ranging from 25[57] to 396[59] , with seven out of 13 having samples of less than 100 people. Five of the studies were at least partly funded by pharmaceutical companies [55, 56, 60, 61, 65]All the studies were conducted in high-income countries (as defined by the World Bank[66]), with all but one (Coté et al.[65] used a French-Canadian population) conducted in English-speaking populations. Two of the studies were aimed at specific subpopulations; Cowie et al.[53] included adolescents and young adults only (aged 15-20) and Kelso et al.[56] included African-Americans only. Garrett et al.[60] included children and adults (aged 2-65), however data for over 15s were reported separately for the most part. The remaining studies[54, 55, 57-59, 61-65] investigated interventions aimed at the general population who met the criteria for inclusion. Seven of the studies[54-57, 60, 63, 64] were conducted in the 1990s, five studies[53, 58, 59, 61, 65] in the 2000s, and one[62] in the 2010s. An overview of study characteristics is outlined in Table 2.

A detailed description of the study interventions is presented in Table 3. Most of the study interventions were conducted on an individual basis but five featured group education.[57, 60, 63-65] The number of sessions ranged from one[60, 63, 65] to nine,[62] and their duration ranged from ten minutes[62] to two hours.[58] Most interventions took place in-person but three also incorporated some telephone-based content.[55, 57, 62] The interventions were delivered by a range of personnel, most often nurses and asthma specialists.[54, 55, 58-61, 64] Most interventions were delivered in the outpatient setting but five included a hospital-based component[55, 59, 62, 64, 65] and two incorporated home visits.[58, 59] The most common topics covered were asthma pathology and triggers, medications, inhaler technique, self-treatment and escalation, and action or care plans.

## Table 2 Study characteristics

| Study | Year | Country | Study design | Sample Size | Inclusion criteria | Type of intervention | Critical outcomes | Important outcomes | Follow up time-points of interest | Funding Source |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bolton et al**[64] | 1991 | US | RCT | 241<br>-119 intervention<br>-122 control | Adults (18-70 years) attending ED | Education | -Subsequent severe exacerbation | None | 12 months (subsequent severe exacerbation) | Not reported |
| **Coté et al**[65] | 2001 | Canada | RCT | 98<br>-33 intervention<br>-30 limited inpatient education<br>-35 control | Adults (18+ years) with an exacerbation presenting to ED | Education | -Subsequent severe exacerbation<br>-Asthma knowledge<br>-QOL | -Treatment adherence | 12 months (subsequent severe exacerbation; asthma knowledge; treatment adherence; QOL) | Glaxo Wellcome Canada |
| **Cowie et al**[53] | 2002 | Canada | RCT | 93<br>-group allocation not reported at baseline | Adolescents and adults (15-20 years) who had received urgent treatment for asthma in ED | Assessment+ education | -Subsequent severe exacerbation<br>-QOL | None | 6 months (subsequent severe exacerbation; QOL) | Alberta Lung Association |
| **Garrett et al**[60] | 1994 | New Zealand | RCT | 270<br>-138 intervention<br>-132 control | Children and adults (2-65 years) attending the ED for treatment of acute asthma. Some results are reported separated for adults and children. | Education | -Subsequent severe exacerbation<br>-Asthma knowledge | Treatment adherence | 9 months (subsequent severe exacerbation; asthma knowledge; treatment adherence) | New Zealand Lotteries Board; Allen and Hanbury's Ltd. |
| **George et al**[55] | 1999 | US | RCT | 77<br>-43 intervention<br>-34 control | Adults (18-45 years) with asthma and admitted as in-patients from ED | Assessment+ education | -Subsequent severe exacerbation | None | 6 months (subsequent severe exacerbation) | National Institute of Health; Health Management Alternatives; Abbott |

| Study | Year | Country | Study design | Sample Size | Inclusion criteria | Type of intervention | Critical outcomes | Important outcomes | Follow up time-points of interest | Funding Source |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Laboratories; Mary Rockefeller Foundation; Merck & Co |
| **Levy et al[61]** | 2000 | UK | RCT | 211<br>-103 intervention<br>-108 control | Adults (18+ years) attending ED for an exacerbation of asthma | Education | -Subsequent severe exacerbation<br>-QOL | None | 6 months | National Asthma Campaign; Allen and Hanbury's; Clement Clarke International; Astra Pharmaceuticals; Rhone-Poulenc Rorer |
| **Manusco et al[62]** | 2011 | US | RCT | 296<br>-148 intervention<br>-148 control | Adults (18+ years) with asthma presenting to ED with respiratory symptoms | Education | -Subsequent severe exacerbation<br>-QOL | None | 4 months | National Heart, Lung, and Blood Institute |
| **Shelledy et al[58]** | 2009 | US | RCT | 159<br>-100 interventions<br>- 59 control | Adults (18-64 years) treated in ED or hospitalised with asthma | Assessment+ education | -Subsequent severe exacerbation<br>-QOL | None | 6 months | American Association for Respiratory Care |
| **Yoon et al[63]** | 1993 | Australia | RCT | 76<br>-37 intervention<br>-39 control | Adolescents and adults (16-65 years) admitted with an exacerbation of asthma | Education | -Subsequent severe exacerbation | None | 10 months | Asthma Foundation of New South Wales; Commonwealth Government of Australia |
| **D'Souza et al[54]** | 1996 | New Zealand | NRSI | 30<br>-no control | Adult (18+ years) patients who were treated for severe asthma in the ED and discharged | Assessment+ education | -Subsequent severe exacerbation | None | 6 months (subsequent severe exacerbation) | Health Research Council of New Zealand |
| **Kelso et al[56]** | 1996 | US | NRSI | 39<br>-21 intervention<br>-18 control | Adults (African American, 18+ years) moderate to severe asthma, and | Assessment+ education | -Subsequent severe exacerbation | None | 12 months (subsequent severe | Glaxo Wellcome Inc.; General Clinic |

| Study | Year | Country | Study design | Sample Size | Inclusion criteria | Type of intervention | Critical outcomes | Important outcomes | Follow up time-points of interest | Funding Source |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | frequent ED visits (~5 in the previous 2 yrs or 3 in the previous 12 months) or hospitalisations (~ 2 during the previous 2 years), or at least 1 ICU unit admission in the previous 2 years. | | -QOL | | exacerbation; QOL) | Research Center |
| **Pauley et al[57]** | 1995 | US | NRSI | 25<br>-no control | Adults (18+ years) more than 3 ED visits for acute exacerbation of asthma in the previous 12 months. | Assessment+ education | -Subsequent severe exacerbation | None | 6 months | Not reported |
| **Tatis et al[59]** | 2005 | US | NRSI | 396<br>- 198 intervention<br>- 198 control (matched chart review) | Adults (18+ years) attending ED for asthma care | Assessment+ education | -Subsequent severe exacerbation<br>-QOL | None | 12 months (subsequent severe exacerbation), 5.5+/-3.7 months (QOL) | National Heart, Lung, and Blood Institute |

Key: ED: emergency department; NRSI: non randomized studies of intervention; QOL: quality of life; RCT: randomized control study

## Table 3 Overview of study interventions

| Study | Intervention Description | | | | Control Description |
|---|---|---|---|---|---|
| | Overview | Personnel | Setting | Goal and content | |
| **Bolton et al[64]** | **Education intervention**<br>Educational group (6-10 people) sessions. Three 1-hour education sessions. | Specialist registered general nurse | Two hospitals | Education on asthma as a condition, its pathology and triggers, medication management, inhaler technique, relaxation techniques | Usual care |
| **Coté et al[65]** | **Education intervention**<br>Once-off individual or group educational session within two weeks of discharge | Not reported | University hospitals | Health-related behaviours: predisposing factors (belief, attitude, knowledge), enabling factors (community resource, family support), and reinforcement, focus on self-management | Limited in-patient education or usual care |
| **Garrett et al[60]** | **Education intervention**<br>A once-off educational intervention (one to one or group) post discharge | Nurse specialist and community health workers | Community health centre | To educate in basic pathophysiology of asthma, definition and avoidance of triggers, asthma medications, inhaler technique, self-management skills, and how to access medical care | Usual care |
| **Levy et al[61]** | **Education intervention**<br>An initial 1-hour consultation with nurse, followed by two more follow-up consultations (lasting half an hour, at 6-weekly intervals) | Specialist asthma nurse | Outpatient setting | Patient's asthma control and management were assessed followed by education on recognition and self-treatment of episodes of asthma | Usual care |
| **Manusco et al[62]** | **Education intervention**<br>An initial 10 minute review in ED followed by telephone reinforcement phone calls weekly for 8 weeks | Study personnel | Emergency Department, telephone | Review of the workbook, help to make a behavioural contract, and inhaler education during the training in ED, encouragement to persevere with workbook during phone calls | Usual care and brief 2 min intervention |

| Study | Intervention Description | | | | Control Description |
|---|---|---|---|---|---|
| | Overview | Personnel | Setting | Goal and content | |
| **Yoon et al[63]** | **Education intervention**<br>A single small group asthma education session | Not reported | Clinic | To improve inhaler skills and to teach how to adjust drug doses according to PEF assessment and a treatment plan | Usual care (control group received the intervention after the study) |
| **Cowie et al[53]** | **Education + specialist assessment**<br>A 90-120 min session specialist assessment, education and delivery of action plan with physician, spirometry, and general asthma education and a follow-up visit | Asthma educators, respiratory therapists and respiratory physicians | Setting not specified- located centrally in the city | To achieve improved asthma control | Spirometry and limited education on spirometry technique |
| **D'Souza et al[54]** | **Education + specialist assessment**<br>Three educational/therapeutic sessions<br>Instructions on how to use a peak flow meter at 0 months, a self-management plan given at 1 month, and final visit at 3 months | Specialist or medical registrar | Hospital outpatient clinic | Inflammatory basis of asthma, the use of regular inhaled steroids and bronchodilators, adequate drug delivery, the recognition of unstable asthma through the educated interpretation of symptoms and PEFR measurements, and appropriate self-management using the self-management plan | No control group |
| **George et al[55]** | **Education + specialist assessment**<br>Nurse-led education as an in-patient, followed by a specialist clinician examination and additional education with nurse specialist within 7 days of discharge | Specialist clinician and specialist nurse | Emergency department then telephone and outpatient setting | To improve inhaler technique and to stress the chronic nature of asthma and need for long-term follow-up, as well as the design of an action plan for each patient | Usual care |
| **Kelso et al[56]** | **Education + specialist assessment**<br>1 hour asthma education session, followed by visits to a specialist | Pharmacist investigators | Clinic | Environmental control, objective monitoring at home with peak flow meters, asthma education and | Usual care |

| Study | Intervention Description | | | | Control Description |
|---|---|---|---|---|---|
| | Overview | Personnel | Setting | Goal and content | |
| | clinic depending on individual need (every month then every 2-3 months depending on individuals need) | | | partnership between the patient and the health-care professionals in our clinic, and medications. | |
| **Pauley et al**[57] | **Education + specialist assessment** Assessment by physician specialist and small-group pharmacist education session (3 people) in clinic, followed by continued care in special asthma clinic as needed (open- door clinic) and telephone contact with pharmacist as needed at the earliest signs of exacerbation. | Physician specialist, pharmacist | Outpatient setting in a university-affiliated urban teaching hospital | Specialist assessment reconfirmed the diagnosis of asthma, and developed treatment plan. The education session: definition of asthma, individualized signs and symptoms of an acute exacerbation, exacerbation triggers, role of each medication in the medical regimen, plans relating to maintenance versus acute therapy, and instruction on the correct use of metered-dose inhalers | No control group |
| **Shelledy et al**[58] | **Education + specialist assessment** Five at-home visits for assessment and education (each session lasted 1-2 hours) | Respiratory therapist or nurse | Home visits | Optimisation of the home environment to reduce asthma triggers; optimisation of the patient's self-care to include medications and monitoring; and development of a care plan | Usual care (instructed to return to their physician for routine follow-up) |
| **Tatis et al**[59] | **Education + specialist assessment** Assessment and education session provided by pulmonologist, education by asthma educator, followed by home-visit by nurse. Approximate 3-month follow-up visit for a period of up to 18 months | Pulmonologist, asthma educators (non-medical background who was trained by physicians and nurses), nurses | Academic medical centre and a local community-based organisation | Explanation of the chronic inflammation that is associated with asthma, need for daily controller therapy, review of inhaler technique and environmental trigger control | NA except for healthcare utilisation only, 198 control matched from chart review on age and sex |

Key: PEFR: peak expiratory flow rate

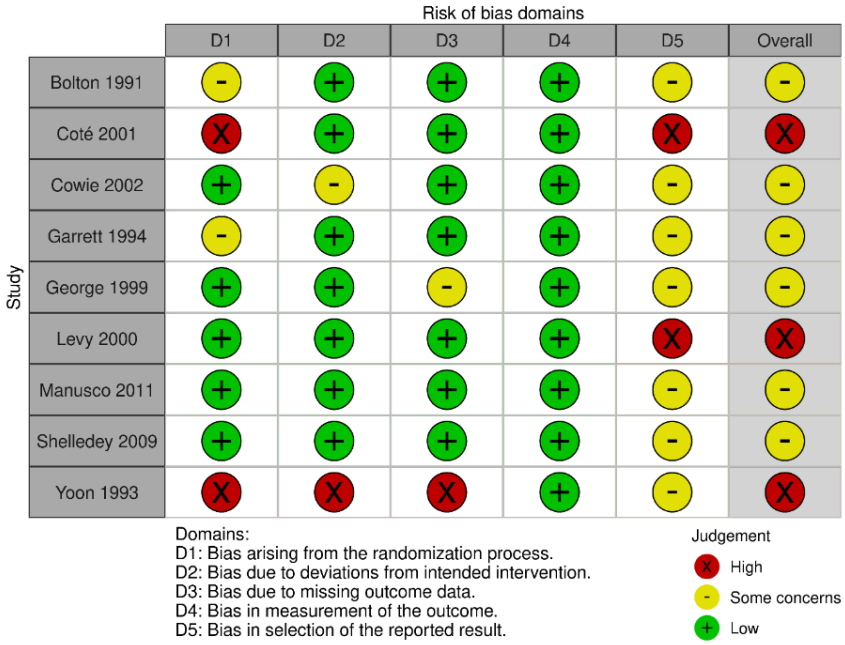
## 3.3 Risk of bias

### 3.3.1 ROB2 assessment for subsequent severe asthma exacerbation requiring hospitalisation

Nine RCTs[53, 55, 58, 60-65] were assessed using ROB2 for the critical outcome subsequent severe asthma exacerbation requiring hospitalisation. There were three studies[61, 63, 65] with high overall risk of bias and six studies[53, 55, 58, 60, 62, 64] with overall judgement of some concerns for risk of bias. There were no studies with an overall low risk of bias judgement.

For bias arising from the randomisation process, there was high risk of bias for two studies, [63, 65] due to lack of information on allocation sequence and differences between groups at baseline. There were some concerns for two studies,[60, 64] due to lack of information around allocation sequence and its concealment. There was one study with high risk of bias,[63] and one had some concerns,[53] due to deviations from the intended intervention. There was one study with a high risk of bias,[63] and one had some concerns,[55] due to missing outcome data. All included studies had low risk of bias for measurement of the outcomes. For the domain focusing on bias in selection of reported results, two studies were at high risk,[61, 65] and seven studies had judgement of some concerns.[53, 55, 58, 60, 62-64] Of note for this last domain, there was no study protocol with a pre-specified analysis plan available for any of the included studies, which adversely impacted their assessed risk of bias in this domain. See Figure 2 for risk of bias for each domain across the studies.

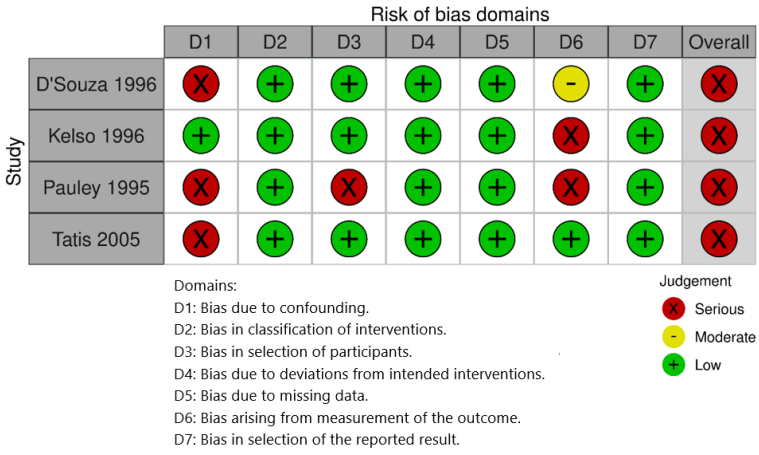
**Figure 2 ROB 2 assessment for subsequent severe asthma exacerbation requiring hospitalisation**




### 3.3.2 ROBINS-I V2 assessment for subsequent severe asthma exacerbation requiring hospitalisation

Four NRSIs[54, 56, 57, 59] were assessed using ROBINS-I V2 for the critical outcome subsequent severe asthma exacerbation requiring hospitalisation. The overall risk of bias assessments for these four studies were serious. The lack of control groups or unsuitable control groups impacted the risk of bias assessments. See Figure 3 for risk of bias for each domain across the studies.

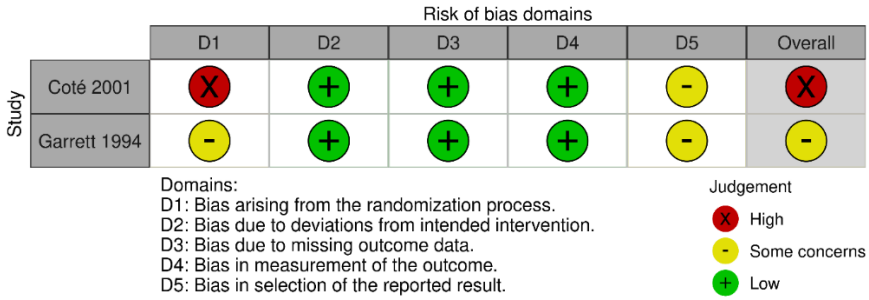
**Figure 3 ROBINS-I V2 assessment for subsequent severe asthma exacerbation requiring hospitalisation**



### 3.3.3 ROB2 assessment for asthma-related knowledge

Two RCTs[60, 65] were assessed using ROB2 for the critical outcome asthma-related knowledge. One study[65] had an overall high risk of bias and one study[60] was deemed to have some concerns overall. Coté et al.[65] had a high risk of bias arising from the randomisation process due to lack of clear methods for allocation to groups. In addition, this study had some concerns in selection of the reported results. Garrett et al.[60] had some concerns of a risk of bias arising from the randomisation process and in the selection of the reported results. See Figure 4 for risk of bias for each domain across the studies.

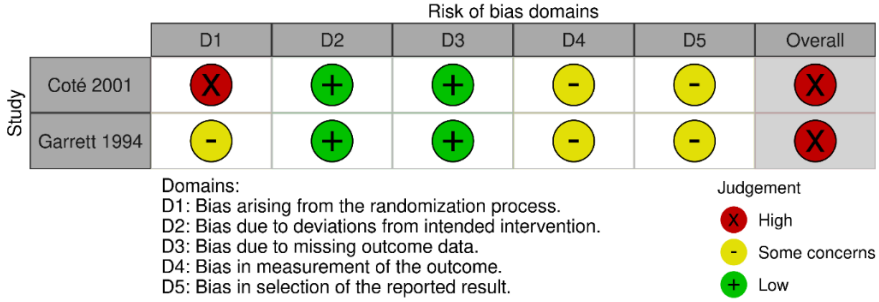
**Figure 4 ROB-2 assessment for asthma-related knowledge**




### 3.3.4 ROB2 assessment for treatment adherence

Two RCTs [60, 65] were assessed using ROB2 for the important outcome of treatment adherence. Both studies had an overall high risk of bias. Coté et al.[65] had a high risk of bias arising from the randomisation process due to a lack of clear methods for allocation to groups. In addition, this study had some concerns in the measurement of the outcome and selection of the reported results. Garrett et al.[60] had some concerns of a risk of bias arising from the randomisation process, in measurement of the outcome and in selection of the reported results. See Figure 5 for risk of bias for each domain across the studies.

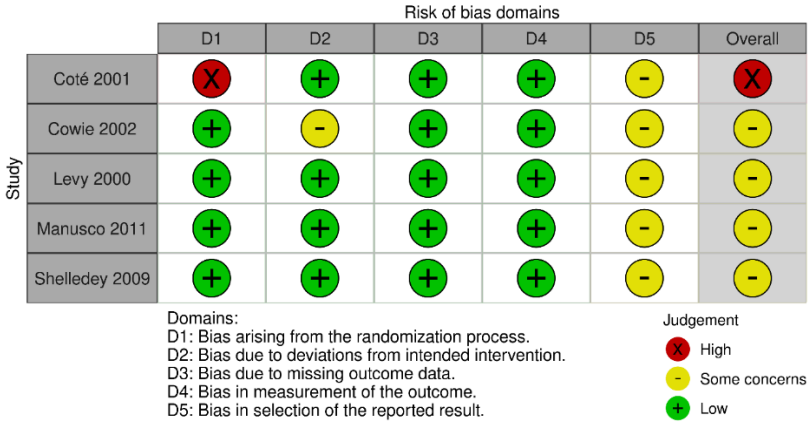
**Figure 5 ROB 2 assessment for treatment adherence**



### 3.3.5 ROB2 assessment for quality of life

Five RCTs[53, 58, 61, 62, 65] were assessed using ROB2 for the critical outcome quality of life. There was one study[65] with a high overall risk of bias and four studies[53, 58, 61, 62] with an overall judgement of some concerns for risk of bias. See Figure 6 for risk of bias for each domain across the studies.

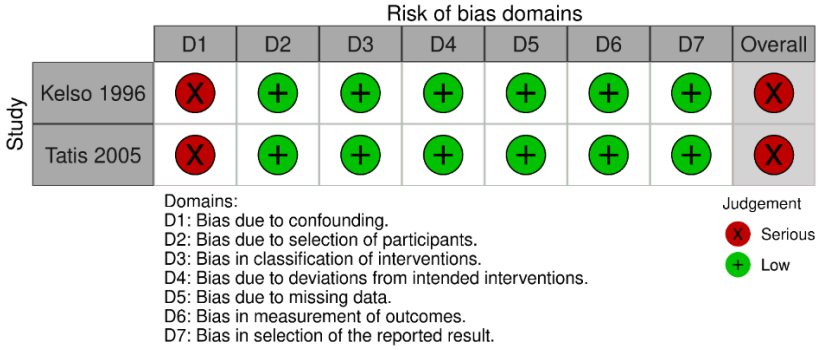
**Figure 6 ROB 2 assessment for quality of life**




### 3.3.6 ROBINS-I V2 assessment for quality of life

Two NRSIs[56, 59] were assessed using ROBINS-I V2 for the critical outcome quality of life. The overall risk of bias assessment for these two studies was serious. The lack of control groups or unsuitable control groups impacted the risk of bias assessment. See Figure 7 for risk of bias for each domain across the studies.

**Figure 7 ROBINS-I V2 assessment for quality of life**



## 3.4 Clinical effectiveness

Seven of the 13 studies[53-59] had both an educational and specialist assessment component and six[60-65] investigated educational self-management interventions in isolation. None of the studies investigated specialist assessment as a stand-alone intervention. Results are reported jointly for both intervention types. Quantifying the relative impact of self-management education versus self-management education with specialist assessment was not deemed feasible due to the low number of studies identified and potential synergistic effects of combining an educational and specialist assessment component.

### 3.4.1 Clinical effectiveness for critical outcomes

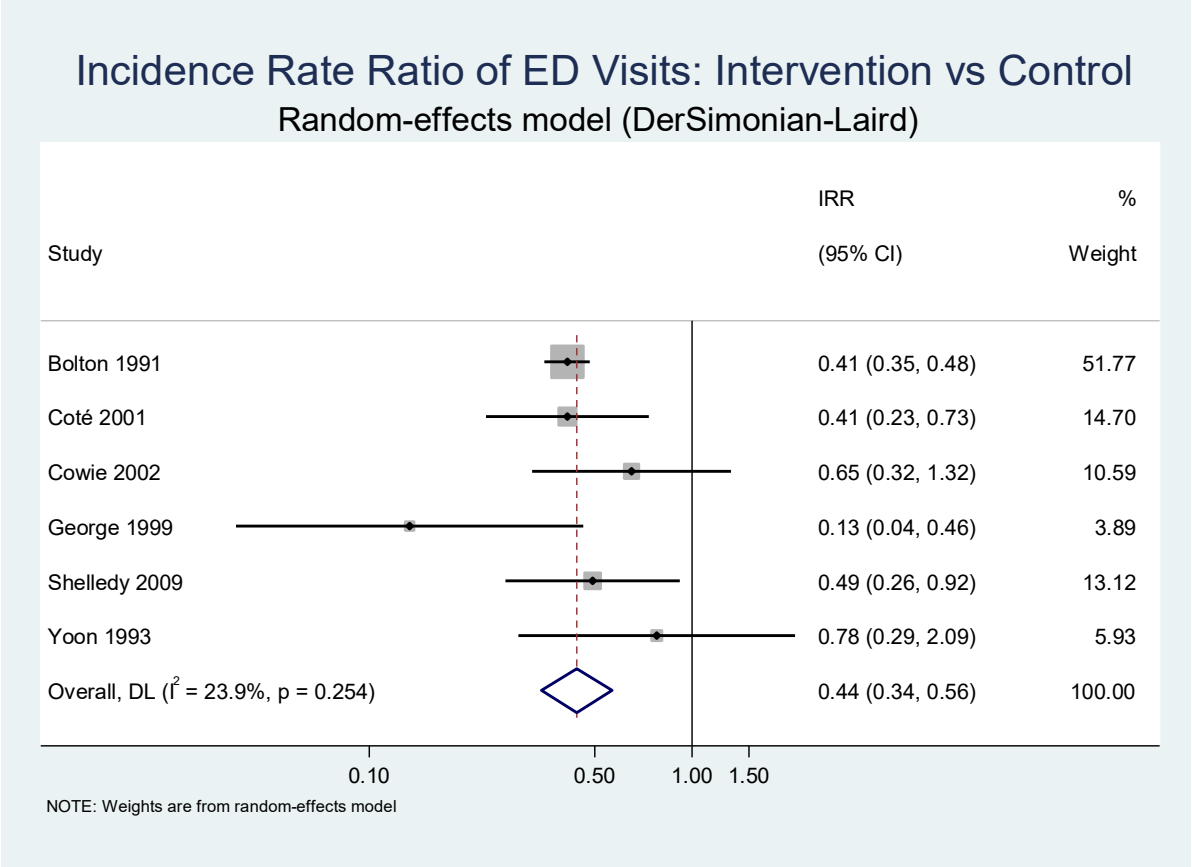
*Subsequent severe asthma exacerbations requiring ED visit/inpatient admission*

Subsequent asthma exacerbations requiring an ED visit and or admission to hospital was the most frequently reported outcome and was investigated in all 13 studies.[53-65] The outcome was ascertained through interviews with participants for five of the studies,[53, 62-65] through reviews of hospital records for four,[55, 58, 60, 61] and through a combination of interviews and hospital record review for one.[57] For three of the studies, it was unclear how the outcome was ascertained.[54, 56, 59] Subsequent ED visits for asthma exacerbation were investigated in all 13 studies while subsequent hospital admission for asthma exacerbation was investigated in nine studies. Of the nine studies that reported on both subsequent ED attendance and hospital admissions for asthma exacerbation, there is no indication that counts of ED attendance in any of the studies were limited to people discharged from ED without being admitted as inpatients, therefore the admissions are likely a subset of the ED attendance, although it is possible that some individuals were admitted directly to hospital through other routes, for example outpatient departments or medical assessment units. To ensure comparability between studies, only the nine RCTs[53, 55, 58, 60-65] were considered for inclusion in the meta-analyses, with seven ultimately included. Two of the seven included RCTs were included in all four meta-analyses [53, 63] and five were included in two meta-analyses.[55, 58, 62, 64, 65]

For subsequent ED visits for asthma exacerbations, six out of the nine RCTs,[53, 55, 58, 63-65] reported rates of ED attendance, total number of attendances, or mean number of

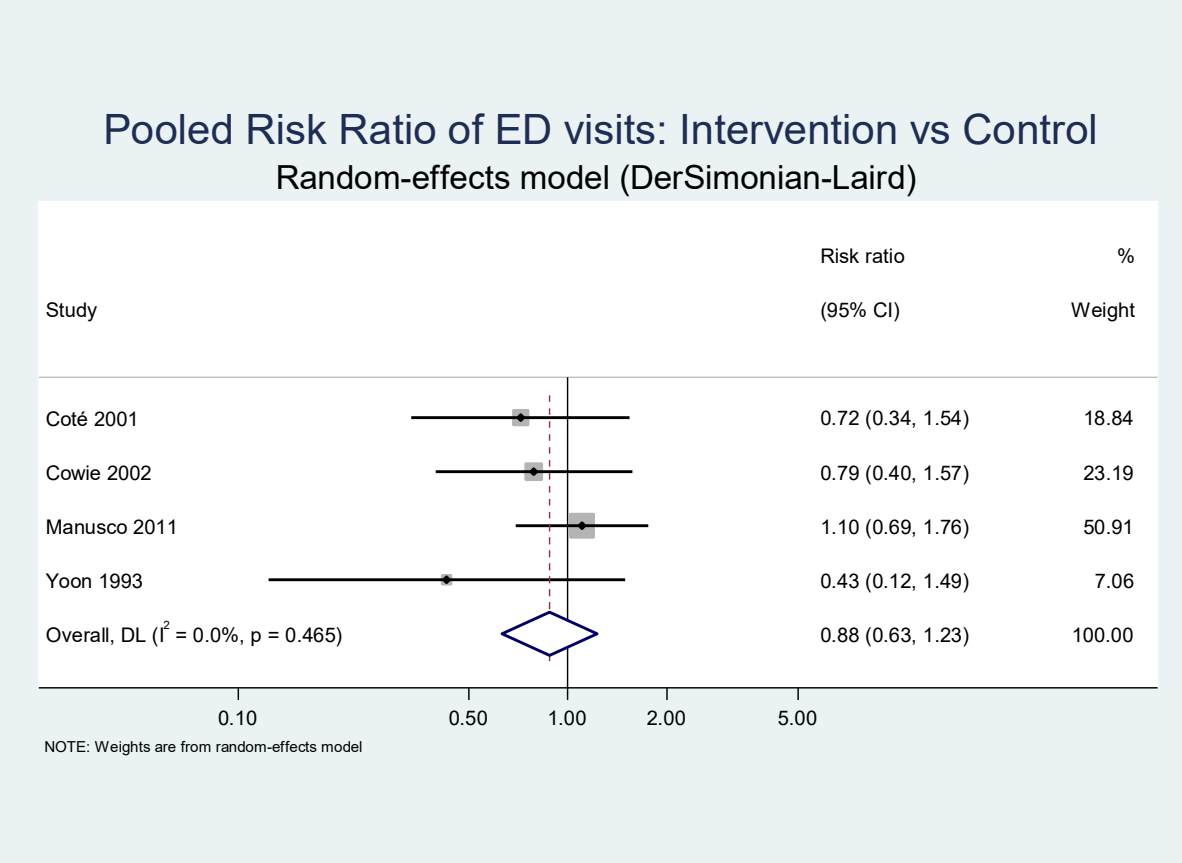
attendances per person, and were included in the meta-analysis for IRRs of ED visits. Follow-up ranged from six to 12 months. As reported above, four of the studies[53, 55, 58, 64] were assessed as having some concern of bias and two[63, 65] as at a high risk of bias. The pooled IRR was 0.44 (95% confidence interval (CI) 0.34-0.56). Heterogeneity per the $I^2$ statistic was non-significant at 23.9% (see Figure 8).

**Figure 8 Meta-analysis for IRR of subsequent ED visits for asthma exacerbation**



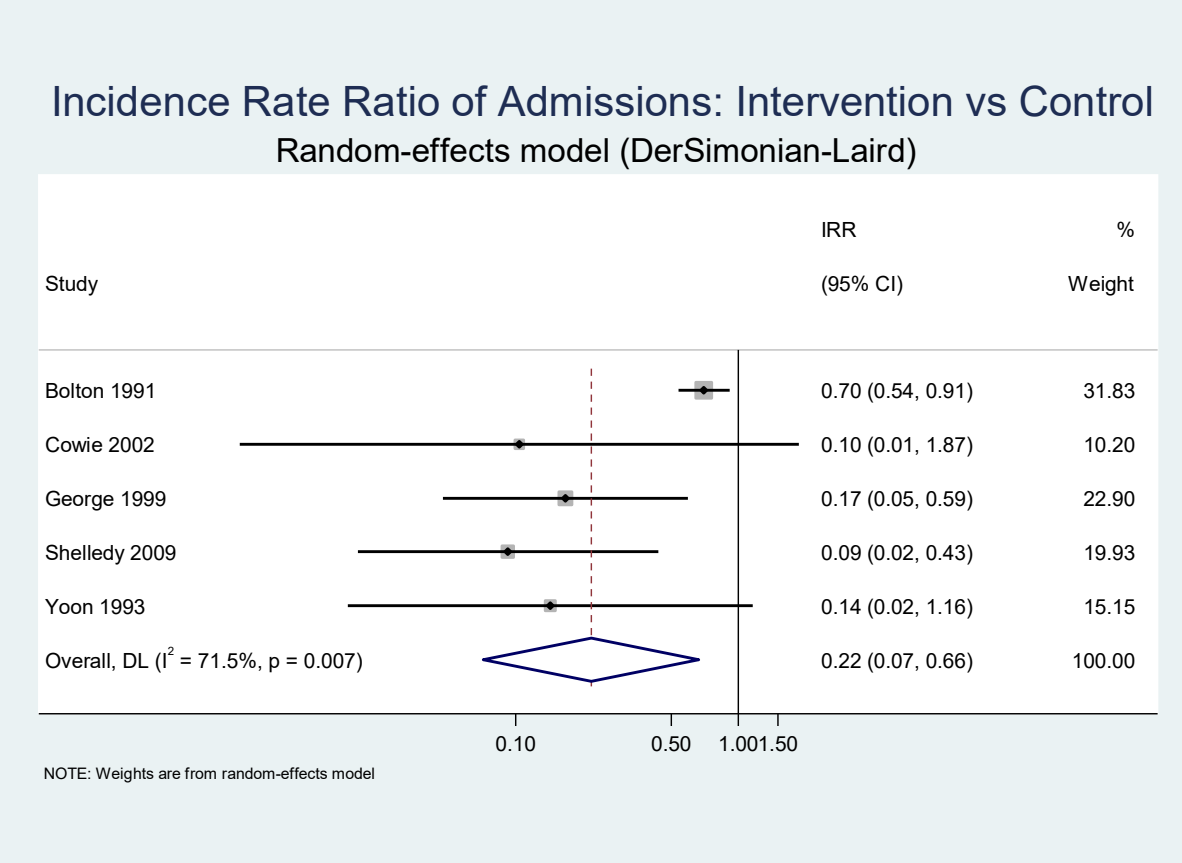

Four[53, 62, 63, 65] out of the nine RCTs reported on the total number or proportion of individuals with any ED visit for asthma exacerbation during the follow-up period and were included in the meta-analysis for RRs of any ED attendance. Follow-up varied between two and 10 months. As reported above, two of the studies[53, 62] were assessed as having some concern of bias and two[63, 65] as at a high risk of bias. The pooled RR for the four studies was 0.88 (95% CI 0.63-1.23). Heterogeneity as per the $I^2$ statistic was non-significant at <0.01% (see Figure 9).

**Figure 9 Meta-analysis for RR of any subsequent ED visit for asthma exacerbation**



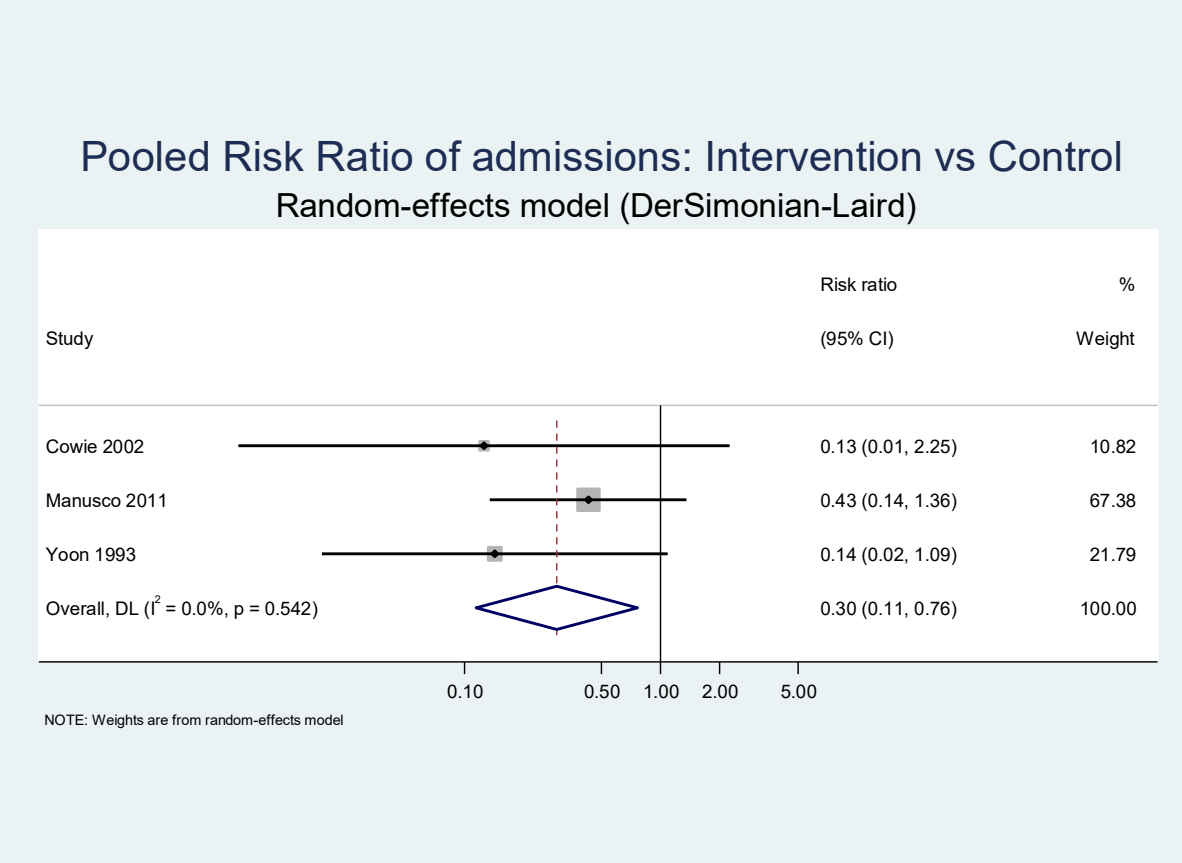

For subsequent hospital admission for asthma exacerbation, five[53, 55, 58, 63, 64] of the nine RCTs reported rates of hospital admissions, total number of admissions, or mean number of admissions per person, and were included in the meta-analysis for IRRs of hospital admission. Follow-up varied between six and 12 months. As reported above, four[53, 55, 58, 64] of the studies were assessed as having some concern of bias and one[63] as high risk of bias. The pooled IRR was 0.22 (95% CI 0.07-0.66). Heterogeneity as per the $I^2$ statistic was significant at 71.5% (see Figure 10).

**Figure 10 Meta-analysis for IRR of subsequent hospital admissions for asthma exacerbation**




Three[53, 62, 63] out of the nine RCTs reported on the total number or proportion of individuals with any subsequent hospital admission for asthma exacerbation during the follow-up period and included in the meta-analysis for RRs of any admission. Follow-up varied between two and 10 months. As reported above, two of the studies[53, 62] were assessed as having some concern of bias and one[63] as at a high risk of bias. The pooled RR for the three studies was 0.30 (95% CI 0.11-0.76). Heterogeneity as per the $I^2$ statistic was non-significant at <0.01% (see Figure 11).

**Figure 11 Meta-analysis for RR of any subsequent hospital admission for asthma exacerbation**




Two[60, 61] of the nine RCTs, assessed as having some concerns of bias[60] and at a high risk of bias[61] respectively, were not included in either of the meta-analyses. Levy et al.[61] only reported the median number of subsequent ED visits for asthma exacerbation per patient and as such did not allow calculation of study-level IRR or RR. The median number of visits for asthma exacerbation per person six months after the intervention was compared with that in the control group, with the difference between the two groups being non-significant. Garrett et al.[60] reported the proportion of patients with ED visits and with admissions for asthma exacerbation at nine months' follow-up, however results were not reported separately for adults and children. In the intervention group, 13% had one ED visit for asthma exacerbation and 15% had two or more visits in the nine months before the intervention, compared to 19% and 16% in the nine months after. In the control group the corresponding figures were 15% and 12% before the intervention, and 16% and 17% after the intervention. No significant group effect was identified.

The four identified NRSIs[54, 56, 57, 59] were not included in the meta-analyses due to the heterogeneity in study design and non-comparable intervention and control groups. All four studies were assessed as of a serious risk of bias. Three of the four studies investigated the total number of subsequent ED visits and hospital admissions for asthma exacerbation. Kelso et al.[56] reported mean number of subsequent ED visits for asthma exacerbation in a figure without exact numbers. The intervention group had a statistically significantly lower mean number of ED visits for asthma exacerbation, 0.5 ED visits at 12 months' follow-up compared to 2.5 in the control group. Similarly, for hospital admissions for asthma exacerbation, there was a statistically lower mean number of admissions, with a mean of 0.1 (SE 0.1) in the intervention group compared to 0.8 (SE 0.2) in the control group at 12 months. Pauley et al.[57] compared the mean number of ED visits for asthma exacerbation six months after the intervention to six months prior to the intervention, as well as to the same six months of the study period during the previous calendar year, and identified a statistically significantly lower mean after the intervention (0.24 (standard deviation (SD) 0.66)) compared to the two control periods (1.88 (SD 2.74) and 3.68 (SD 1.73)). Tatis et al.[59] compared mean ED visits and hospital admissions for asthma exacerbation 12 months before and after the intervention in the intervention group and in a matched control group, with no between-group comparisons conducted. In the intervention group, the mean number of ED admissions for asthma exacerbation significantly decreased from 3.9 (SE 3.5) to 2.8 (SE 2.7); no change was seen in the control group (2.16 (SE 1.67) vs 2.16 (SE 2.88)). Similarly, there was a significant decrease in hospital admissions for asthma exacerbation, with the mean number per patient decreasing in the intervention group from 1.65 (SE 1.83) to 0.97 (SE 1.2), with no significant change seen in the control group (1.5 (SE 1.26) vs 1.39 (SE 0.83)). One[54] of the four studies reported the proportion of patients with an ED visit for asthma exacerbation in the six months before the intervention compared to six months after the intervention, and found that it significantly decreased from 58% to 15%.

*Patient satisfaction / acceptability of the intervention*

This outcome was not reported in any of the studies.

*Asthma-related knowledge*

Two studies[60, 65] investigated the impact of the intervention on asthma knowledge using validated tools. Both were RCTs and assessed as of a high risk of bias[65] and of having some concerns of bias[60] respectively.

Coté et al.[65] used an asthma knowledge questionnaire which had previously been validated in the author's institution. Results were reported as a percentage of the maximum score. The questionnaire was administered at 12 months post intervention, with significantly different scores between the study's three groups: intervention group (80%), limited education group (60%), and control group (56%).

Garrett et al.[60] used a validated scenario-based tool, where two asthma exacerbation scenarios were presented, one with a slow onset of symptoms and one with a rapid onset, and questions on appropriate courses of action were posed. The tool was administered before the intervention and nine months after, and results were reported as proportion of patients scoring within specified ranges. Actual scores were not reported separately for children and adults. However, it was reported that there was a significant improvement in scores for both scenarios after the intervention for adults. No improvement was seen in the control group. Results beyond the statistical significance were not reported and the intervention and control groups were not statistically compared to each other.

A further three studies used non-validated tools to assess asthma knowledge.[58, 59, 63] As they were non-validated, data from these studies were not quality-appraised for this systematic review and did not contribute to the GRADE assessment for this outcome.

*Asthma-related quality of life*

Seven studies[53, 56, 58, 59, 61, 62] used validated tools to investigate the impact of the intervention on self-reported QoL. Due to the variation in study design, tools used, and which subscales of the tools were reported, a meta-analysis was not feasible. As reported above, four studies[53, 58, 61, 62] were assessed as having some concerns of bias and one[65] as of a high risk of bias using ROB2 and two studies[56, 59] were assessed as of a serious risk of bias using ROBINS-I V2. Four[53, 59, 62, 65] of the studies used the Asthma Quality of Life Questionnaire (AQLQ),[67] one[61] used the St George's Respiratory Questionnaire (SGRQ),[68] one[56] used Short Form (36) Health Survey (SF-36),[69] and one[58] used both the SF-36 and SGRQ.

AQLQ is a disease-specific instrument for use in clinical trials that measures QoL in adults with asthma. It contains 32 items, grouped into four domains (symptoms, activity limitation, emotional function, and environmental stimuli). Responses are on a 7-point Likert scale where 1=maximum impairment and 7=no impairment, with a higher score indicating better QoL. Overall score is the mean of all 32 items, with a change of 0.5 units considered the smallest meaningful difference in overall score or domain scores.[70] A MiniAQLQ,[71] containing 15 items across the same four domains, is also available and used in one of the studies.

Coté et al.[65] found a significant improvement in the symptoms and physical activity domains for the intervention group 12 months after the intervention, compared to before the intervention. No significant change was observed for the emotional and environmental domains. Actual scores were not reported. The mean overall score also significantly improved in the intervention group, increasing from approximately 3 to 5.5 (results interpreted from figure). No significant change was seen in the control group. Cowie et al.[53] found a significant difference in the symptoms (5.6 (SD 1.28) vs 4.9 (SD 1.41)) and emotional (5.9 (SD 1.47) vs 5.1 (SD 1.71)) domains for the intervention group compared to the control group six months after the intervention. No difference in overall score was found between the intervention and control group at six months. Both intervention and control groups showed a significant improvement in overall score from the time of entry to the study to six months after entry, but actual scores were not reported. Manusco et al.[62] reported overall scores only, and did not find a significant difference between intervention and control groups at baseline, one, two, or four-months' follow-up. Tatis et al.[59] administered the miniAQLQ to the intervention group only. It was administered before the intervention and again after a mean period of 5.6 ± 3.7 months. Comparing scores before and after the intervention, a mean clinically significant improvement was seen for the symptoms (3.05 (SE 0.82) vs 3.97 (SE 0.62)), emotional (2.92 (SE 1.34) vs 3.53 (SE 1.17)), and environmental (1.97 (SE 1.23) vs 2.97 (SE 1.05)) domains, as well as for the overall score (2.84 (SE 0.99) vs 3.50 (SE 1.02)); p-values were not reported.

SGRQ is a disease-specific instrument designed to measure health-related QoL in patients with chronic airway obstruction, including COPD and asthma. It contains 50 items across three domains (symptoms, activity, and impacts) as well as an overall score. Scores are on a 0-100

scale, where higher scores indicate worse health and a difference of 4 points is considered clinically meaningful.[72]

Levy et al.[61] appear, from a table of results, to have identified statistically worse scores for the symptom domain six months after the intervention in the intervention group compared to the control group. However, elsewhere in the paper it states that there was no statistically significant difference in the scores between the groups. The paper further states that the QoL scores improved significantly in both the intervention and control groups. However, the results of that analysis are not reported. Shelledy et al.[58] reported mean change in scores (pre-intervention and six months after the intervention) for the three domains and the overall score in the two intervention groups (one conducted by a respiratory therapist and one by a nurse) and the control group. For the group where the intervention was conducted by a respiratory therapist, there was a significantly greater reduction in total score (mean change -11.0 (SD 15)) compared with the control group (-2.5 (SD 15)). Among the subscales, the symptom score in this intervention group (-8.4 (SD 21)) was also significantly different compared with the control group (+2.7 (SD 17)). No difference was seen for the activity and impact subscales. No significant difference was observed between the nurse-led intervention group and the control group at follow-up for either the total score or any of the subscale scores. For the group where the intervention was nurse-led, no significant difference compared to the control group was seen at follow-up for either the total score or any of the subscales.

SF-36 is a generic (not disease-specific) health status and QoL tool, developed for use in clinical practice, clinical trials, and general population surveys.[69] The SF-36 has 36 items covering eight health domains (physical functioning, physical limitations, bodily pain, vitality, health perception, social functioning, and emotional limitations). Items have various response formats (Likert scales, yes/no) and are in some cases negatively worded and reverse-scored. Responses are transformed to a 0-100 scale for each domain, where a higher score indicates better health. Summary scores are also created by grouping the physical domains and mental domains respectively. A difference of at least 10 points in domain scores may be considered clinically meaningful for asthma.[73]

Kelso et al.[56] administered the SF-36 to the intervention group only. They reported a statistically significant improvement in scores across the physical limitations, health perception, social functioning, and mental health domains at six and 12 months' follow-up, compared to before the intervention. An improvement was seen for the emotional limitations domain at six months only. Shelledy et al.[58] reported mean change in scores (pre-intervention and six months after the intervention) for the physical and mental summary domains only. At six months, both intervention groups had significant improvements in the physical component summary domain compared with the control group. The registered nurse-led intervention showed a mean change of +9.4 (SD 18.1) and the respiratory therapist-led program showed a mean change of +16.9 (SD 21.4), whereas the usual care group declined by -3.1 (SD 12.9). No significant differences between groups were seen for the mental health component summary score.

### 3.4.2 Clinical effectiveness for important outcomes

*Subsequent asthma exacerbation (any severity)*

This outcome was not reported in any of the studies.

*Treatment adherence*

Treatment adherence was investigated in two[60, 65] of the included studies. As reported above, both were assessed as of a serious risk of bias. Coté et al.[65] assessed the proportion of people with a current prescription for an inhaled corticosteroid at 12 months after the intervention, and found no significant difference among the three groups (intervention group 100%, limited education group 97%, and control group 91%). Garrett et al.[60] assessed compliance with prophylactic medication as an outcome but gave no information on how this outcome was operationalised. They reported there was no difference in compliance between intervention and control groups at nine months.

*Asthma control*

This outcome was not reported in any of the studies.

## 3.5 Cost effectiveness

No relevant economic evaluations were found during the search.

## 3.6 GRADE assessment

The certainty of evidence for each critical and important outcome was assessed using the GRADE approach as described above. For all outcomes, only RCT evidence was used to assess the certainty of evidence. A detailed summary of findings is available in Table 4.

### 3.6.1 GRADE assessment for critical outcomes

The outcome subsequent severe exacerbations of asthma was operationalised across four meta-analyses (person-month rate of ED visits, person-month rate of hospital admissions, person-based risk of any ED visit, and person-based risk of any hospital admission) using evidence from seven RCTs.[53, 55, 58, 62-65] The certainty of evidence was moderate for person-month rate of ED visits for asthma exacerbation, low for person-month rate of hospital admissions and person-based risk of any hospital admission for asthma exacerbation, and very low for person-based risk of any ED visit for asthma exacerbation, with the overall evidence for subsequent severe exacerbations consequently considered low. For asthma knowledge, the certainty of evidence was assessed as very low, using evidence from two RCTs.[60, 65] For quality of life, the certainty of evidence was assessed as very low, using evidence from five RCTs.[53, 58, 61, 62, 65] Certainty of evidence could not be assessed for patient acceptability and satisfaction as no evidence was identified.

### 3.6.2 GRADE assessment for important outcomes

For treatment adherence, the certainty of evidence was assessed as very low, using evidence from two RCTs.[60, 65] Certainty of evidence could not be assessed for subsequent exacerbations of any severity or asthma control as no evidence was identified.

## Table 4 GRADE summary of findings

**Self-management interventions and or specialist assessments compared to usual care in people who have attended hospital with an acute exacerbation of asthma**

**Patient or population:** people who have attended hospital with an acute exacerbation of asthma
**Setting:** out-patient
**Intervention:** self-management interventions with or without specialist assessment
**Comparison:** usual care

| Outcomes | Anticipated absolute effects* (95% CI) | | Relative effect (95% CI) | № of participants (studies) | Certainty of the evidence (GRADE) | Comments |
|---|---|---|---|---|---|---|
| | Risk with usual care | Risk with intervention | | | | |
| **Critical outcomes** | | | | | | |
| Incidence rate of subsequent ED visits | 220 per 1,000 person-months | **97 per 1,000 person-months** (75 to 123) | **IRR 0.44** (0.34 to 0.56) | 645 (6 RCTs) | ⨁⨁⨁◯ Moderate[a] | Self-management education with or without specialist assessment after an exacerbation of asthma probably reduces the number of ED visits |
| Incidence rate of subsequent hospital admissions | 75 per 1,000 person-months | **17 per 1,000 person-months** (5 to 50) | **IRR 0.22** (0.07 to 0.66) | 551 (5 RCTs) | ⨁⨁◯◯ Low[a,b] | Self-management education with or without specialist assessment after an exacerbation of asthma may reduce the number of hospital admissions |
| Any subsequent ED visit | 248 per 1,000 population | **226 per 1,000 population** (159 to 315) | **RR 0.91** (0.64 to 1.27) | 493 (4 RCTs) | ⨁◯◯◯ Very low[a,c] | It is uncertain whether self-management education with or without specialist assessment after an exacerbation of asthma reduces the risk of attending ER |
| Any subsequent hospital admission | 105 per 1,000 population | **33 per 1,000 population** (13 to 87) | **RR 0.32** (0.12 to 0.83) | 393 (3 RCTs) | ⨁⨁◯◯ Low[a,d] | Self-management education with or without specialist assessment after an exacerbation of asthma may reduce the risk of being admitted to hospital |
| Asthma knowledge | | | | 363 (2 RCTs) | ⨁◯◯◯ Very low[a,e,f] | It is uncertain whether self-management education with or without specialist assessment after an exacerbation of asthma improves asthma knowledge |

**Self-management interventions and or specialist assessments compared to usual care in people who have attended hospital with an acute exacerbation of asthma**

**Patient or population:** people who have attended hospital with an acute exacerbation of asthma
**Setting:** out-patient
**Intervention:** self-management interventions with or without specialist assessment
**Comparison:** usual care

| Outcomes | Anticipated absolute effects* (95% CI) | | Relative effect (95% CI) | № of participants (studies) | Certainty of the evidence (GRADE) | Comments |
|---|---|---|---|---|---|---|
| | Risk with usual care | Risk with intervention | | | | |
| Quality of life | | | | 826 (5 RCTs) | ⨁◯◯◯ Very low[a,i,j] | It is uncertain whether self-management education with or without specialist assessment after an exacerbation of asthma improves quality of life |
| **Important outcomes** | | | | | | |
| Treatment adherence | | | | 367 (2 RCTs) | ⨁◯◯◯ Very low[a,g,h] | It is uncertain whether self-management education with or without specialist assessment after an exacerbation of asthma improves treatment adherence |

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
**CI:** confidence interval; **RR:** risk ratio

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

***Explanations:***a. included studies were either of some concern or high risk for bias, b. heterogeneity as assessed by the $I^2$ statistic >70%, c. 95% CI crossing 1 and total number of events low, d. total number of events low, e. different tools used, even though both are stated to be validated they are not widely adopted tools, f. small sample size, g. lack of validity of the outcome marker, h. small sample size, limited statistical information available, i. mixed results across studies, j. limited statistical information available

# 4 Discussion

The educational self-management interventions examined in this review varied widely in terms of format, location, and duration. However, their content was fairly consistent, most often covering asthma pathology and triggers, medications, inhaler technique, self-treatment and escalation, and action or care plans. Overall, educational self-management interventions, with or without a specialist assessment component, for adults who have presented to hospital with an acute exacerbation of asthma appear to have a positive effect on clinical outcomes. Three outcomes were identified as critical a priori for this review: subsequent severe asthma exacerbations, asthma-related knowledge, and patient satisfaction or acceptability of the intervention. As there was no evidence identified for patient satisfaction or acceptability, the important outcome QoL was reclassified as an additional critical outcome. The impact on subsequent severe asthma exacerbations was evaluated through four meta-analyses of RCTs and a narrative synthesis of NRSI. Three of the four meta-analyses demonstrated statistically significant reductions in severe exacerbations requiring emergency department attendance or hospital admission among participants receiving the intervention compared with control groups. Findings from NRSIs showed a consistent positive direction of effect. Improvements in asthma-related knowledge were reported in two studies, although the overall evidence was limited, and heterogeneity in measurement tools and reporting precluded firm conclusions. QoL was measured using a variety of instruments and outcomes, and showed inconsistent results, with several studies demonstrating improvements in specific domains, but not consistently across all domains or instruments.

For the outcomes identified as important, evidence was sparse. Treatment adherence was investigated in two of the included studies, with no significant impact of the interventions identified in either study. For two other important outcomes, subsequent exacerbations of asthma of any severity and asthma control, no evidence was identified. Moreover, no studies of the cost-effectiveness of educational self-management interventions nor specialist assessment were identified.

The overall positive findings are broadly consistent with previous research demonstrating that structured self-management education can reduce hospital utilisation and improve disease control among individuals with asthma and other chronic conditions.[32, 74-77] Previous

evidence similarly suggests that educational self-management interventions incorporating regular professional review are effective in reducing unscheduled care and improving quality of life, regardless of asthma severity and hospital attendance.[31] While most available evidence relates to the general asthma population, and not specifically to individuals required to attend hospital for an exacerbation, there is evidence that educational interventions administered as part of an ED attendance for asthma are associated with a reduced risk of subsequent hospital admission, but not with subsequent ED attendance.[78] We believe this is the first systematic review to examine the clinical effectiveness of educational self-management interventions in the aftermath of an acute asthma exacerbation.

Of note, no studies investigating the impact of specialist assessment in isolation were identified in this review. Due to the variation in what a specialist assessment may entail, for example, in terms of diagnostic tests, patient-level variation in disease severity and comorbidities, treatment planning, and follow-up, measuring the effect of just the specialist assessment (as distinct from other parts of care management, including education and self-management support) is difficult. A previous UK registry study showed significant reductions in healthcare use, including ED visits and hospital admissions, 9-10 months after an initial specialist assessment for individuals with severe asthma. However, details of what care was provided after the initial assessment is not reported.[79]

Several international guidelines currently include recommendations around self-management for asthma, as well as referral to specialist services for individuals having attended hospital for an exacerbation.[1, 22] In Ireland, specialised respiratory care is delivered in the context of Chronic Disease Community Specialist teams. They include access to specialist respiratory nursing and physiotherapy services, as well as respiratory consultants. Any individual having attended an ED for an exacerbation of asthma is eligible for referral to these services, and if fully operational (currently estimated for 2027)[26] this service may be able to deliver specialised, person-centred care to this patient group.

The included studies had a number of limitations. While the review included nine RCTS, most of the studies included in the current review were relatively small and lacked pre-published protocols, limiting transparency and replicability. Considerable heterogeneity was observed across studies, including differences in intervention content (self-management education

alone versus self-management education plus specialist assessment, as well as variation in timing of education sessions and personnel involved in the interventions), study design, and outcome measurement tools. None of the identified studies met the initial inclusion criteria of a three-month follow-up, and the inclusion criterion for the review was consequently expanded to 12 months. No study evaluated specialist assessment as a stand-alone intervention, making it impossible to disentangle the relative contributions of education and specialist review. Another important limitation is that most of the included studies were conducted more than two decades ago, raising concerns about applicability to contemporary asthma management. Current asthma management guidelines tend to emphasise integrated multidisciplinary care and personalised self-management strategies.[1] However, this review includes predominantly older evidence, and the interventions may differ in content and format from what is currently practised, omitting for example digital interventions. Additionally, 12 of the 13 studies were conducted outside of Europe, within healthcare systems substantially different from the Irish system.

Risk of bias was a concern across all included studies. Among the nine RCTs, all were rated as having either "some concerns" or "high" risk of bias using ROB2, while all four NRSIs were judged to be at "serious" risk of bias using ROBINS-I. Due to these methodological limitations, meta-analysis was restricted to RCTs as the best available evidence, to ensure comparability and minimise bias. The small number of eligible studies precluded meaningful subgroup analyses in our meta-analyses, including by intervention type, study design, or risk of bias. As subsequent severe exacerbations were measured in multiple ways, four separate meta-analyses were performed for rate and risk-based measures, limiting the power of the individual analyses. Two of the meta-analyses compared the RRs of any subsequent severe exacerbation during follow-up, however, the follow-up periods varied between six and 12 months for any ED visit and four and 10 months for any hospital admission, potentially impacting the pooled estimates.

The certainty of evidence was assessed for three of the four critical outcomes and one of the three important outcomes identified for the purpose of this review using the GRADE approach, while no evidence was identified for three of the outcomes. Due to heterogeneity in reporting, the certainty of evidence for subsequent severe exacerbations was assessed

across four separate operationalisations, with evidence assessed as moderate for one (rate of ED visits for asthma exacerbation), low for two (rate and risk of hospital admission for asthma exacerbation), and very low for one (risk of ED visit for asthma exacerbation). Overall, the certainty of evidence was considered low for this outcome. The certainty of evidence for the outcomes of asthma knowledge, treatment adherence, and quality of life were all assessed as very low. The varying level of certainty across outcomes suggests that, although the findings are broadly supportive of self-management interventions with or without a specialist assessment following an acute asthma exacerbation, our certainty around the true magnitude and consistency of their effect is very low overall.

*Strengths and limitations*

This review has several strengths. It was reported according to PRISMA guidelines and pre-registered on PROSPERO. A comprehensive search strategy was developed in collaboration with an in-house librarian, incorporating backward and forward citation searching. Quantitative synthesis was undertaken where feasible, providing pooled effect estimates for key outcomes. Critical and important outcomes were identified in collaboration with the PPI representatives of the GDG.

However, several limitations should be noted. Firstly, six out of the 13 included studies were identified through forward and backward citation searching, rather than through the search strategy, which may indicate that the search strategy had limitations in terms of ability to identify all relevant studies. We believe that this is due to the wide topic area and varying terminology. In line with the Terminology, Application, and Reporting of Citation Searching (TARCiS) statement recommendations,[80] we conducted backward- and forward citation searching, as well as reviews of systematic reviews describing similar interventions identified as part of our search strategy. This additional step increases our confidence that we sufficiently captured the relevant evidence. The small number of eligible studies and heterogeneity in study design, interventions, and outcome measures limited the strength of conclusions and precluded subgroup or sensitivity analyses. Importantly, we were unable to quantify the relative impact of self-management educational interventions alone compared to interventions also incorporating a specialist component. Simulations have shown that statistical power in meta-analyses is strongly related to the number of included studies and

their sample sizes, and that with less than five studies, heterogeneity estimates are unstable and overall power to detect a nonzero mean effect is low, with power improving substantially once 10 or more studies are included.[81] Additionally, meta-analyses including fewer than 10 studies are at indeterminate risk of publication bias,[82] which should be considered when interpreting these results.

*Conclusion*

Educational self-management interventions, with or without specialist assessment, may reduce severe asthma exacerbations requiring ED attendance or hospitalisation in individuals previously attending hospital for an exacerbation. It is uncertain if the interventions improve asthma knowledge, treatment adherence, and quality of life. However, the overall certainty of the evidence remains low due to study limitations, heterogeneity, and risk of bias. There is also uncertainty regarding the effectiveness of contemporary care models and the relative impact of self-management education and specialist assessment components. Moreover, further research is required to assess the cost-effectiveness of these interventions.

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# Appendices

## Appendix 1: PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a systematic review. | Title page, section 1.4 |
| **ABSTRACT** | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | N/A |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | Section 1.1-1.3 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | Section 1.4 and section 2.1 |
| **METHODS** | | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | Section 2.1 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | Section 2.3 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | Section 2.3 and appendix 2 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | Section 2.4 |
| Data | 9 | Specify the methods used to collect data from reports, including how many reviewers collec | Section 2.5 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| collection process | | data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used the process. | |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | Section 2.1 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | Section 2.5 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | Section 2.6 and section 2.9 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | Section 2.7 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | Section 2.7 |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | Section 2.7 |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | Section 2.7 |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | Section 2.7 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study | Section 2.7 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | | results (e.g. subgroup analysis, meta-regression). | |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | Section 2.7 |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | Section 2.6 |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | Section 2.8 |
| **RESULTS** | | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | Section 3.1 |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | Section 3.1 and appendix 3 |
| Study characteristics | 17 | Cite each included study and present its characteristics. | Section 3.2 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | Section 3.3 |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | Section 3.4 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | Section 3.4 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and | Section 3.4 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | | measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | N/A |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | N/A |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | Section 3.3 |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | Section 3.6 |
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | Section 4 |
| | 23b | Discuss any limitations of the evidence included in the review. | Section 4 |
| | 23c | Discuss any limitations of the review processes used. | Section 4 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | Section 4 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | Section 2 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | Section 2 |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | Section 2.9 |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | Title pages |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| Competing interests | 26 | Declare any competing interests of review authors. | Title pages |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | Section 2 (protocol contains data collection form; Zenodo) |

## Appendix 2: Search Strategy

SOURCES SEARCHED

| **Databases** | Number of results | Date searched |
|---|---|---|
| Medline Complete via EBSCO | 1220 | 13/06/2025 |
| Embase via Elsevier | 2396 | 13/06/2025 |
| The Cochrane Library | 619 | 13/06/2025 |
| CINAHL Complete via EBSCO | 381 | 13/06/2025 |
| PsychInfo via EBSCO | 184 | 13/06/2025 |
| Clinical trials.gov | 24 | 13/06/2025 |
| **Total** | 4824 | |
| **Total after duplicates removed** | **3222** | |

Database Name Medline via EBSCO
Date search was run 12 June 2025

| # | Query | Limiters/Expanders | Last Run Via | Results |
|---|---|---|---|---|
| S38 | S26 OR S37 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,220 |
| S37 | S19 AND S36 | Limiters - Publication Date: 20150101-<br>Expanders - Apply equivalent | Interface - EBSCOhost Research Databases | 145 |

| | | | | |
|---|---|---|---|---|
| | | subjects<br>Search modes - Proximity | Search Screen - Advanced Search<br>Database - MEDLINE Complete | |
| S36 | S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,082,234 |
| S35 | AB ( (adjusted or quality-adjusted) N1 year* ) OR TI ( (adjusted or quality-adjusted) N1 year* ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 33,851 |
| S34 | AB ( expenditure* N2 (health or direct or indirect) ) OR TI ( expenditure* N2 (health or direct or indirect) ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 12,099 |
| S33 | AB ( out-of-pocket N1 (payment* or expenditure* or cost* or spending or expense*) ) OR TI ( out-of-pocket N1(payment* or expenditure* or cost* or spending or expense*) ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 8,288 |
| S32 | (MH "Health Expenditures") OR (MH "Hospital Costs") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 80,344 |

| | | | | |
|---|---|---|---|---|
| S31 | (MH "Cost of Illness") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 34,576 |
| S30 | (MH "Quality-Adjusted Life Years") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 17,910 |
| S29 | AB ( "quality-adjusted life years" or "quality adjusted life years" or QALY* ) OR TI ( "quality-adjusted life years" or "quality adjusted life years" or QALY* ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 19,635 |
| S28 | AB ( burden* N1 (illness or disease* or condition* or economic*) ) OR TI ( burden* N1 (illness or disease* or condition* or economic*) ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 70,864 |
| S27 | AB cost* OR TI cost* OR (MH "Costs and Cost Analysis+") OR AB "cost benefit analys*" OR TI "cost benefit analys*" OR (MH "Cost-Benefit Analysis") OR (MH "Health Care Costs+") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,019,881 |

| | | | | |
|---|---|---|---|---|
| S26 | S19 AND S25 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,158 |
| S25 | S22 OR S23 OR S24 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 7,753,390 |
| S24 | MH "Systematic Review" OR MH "Meta Analysis" OR PT "Meta-Analysis" OR TI systematic* N1 (review* OR overview*) OR AB systematic* N1 (review* OR overview*) OR TI "meta analys*" OR TI "meta analyz*" OR AB "meta analys*" OR AB "meta analyz* OR TI literature N2 (review* OR overview*) OR AB literature N2 (review* OR overview*) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 940,053 |
| S23 | MH "Cohort Studies" OR MH "Longitudinal Studies" OR MH "Prospective Studies" OR MH "Follow Up Studies" OR MH "Retrospective Studies" OR TI (cohort OR longitudinal OR prospective OR "follow up" OR | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 2,832,668 |

| | | | | |
|---|---|---|---|---|
| | retrospective) N1 (study OR analys* OR design OR method*) OR AB (cohort OR longitudinal OR prospective OR "follow up" OR retrospective) N1 (study OR analys* OR design OR method*) | | | |
| S22 | S20 NOT S21 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 5,384,776 |
| S21 | (MH "Animals+") NOT(MH "Humans") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 5,345,466 |
| S20 | (MH "Randomized Controlled Trial") OR PT controlled clinical trial OR ( AB (randomized or placebo or randomly or trial or groups) ) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 6,175,508 |
| S19 | S9 AND S18 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 2,220 |

| | | | | |
|---|---|---|---|---|
| S18 | S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 585,815 |
| S17 | XB (specialist* N3 (service* or assess* or management or consultant or physio* or clinic* or hub* or nurs* or respiratory) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 29,671 |
| S16 | XB outpatient* | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 234,563 |
| S15 | (MH "Outpatient Clinics, Hospital+") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 17,532 |
| S14 | XB ("personal care" or "self efficacy" or self-efficacy) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 56,208 |
| S13 | XB (patient* N3 (knowledge or education* or learning)) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 86,491 |

| | | | | |
|---|---|---|---|---|
| S12 | XB (self-manag* or "self manag*" or self-care or "self care") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 58,330 |
| S11 | (MH "Patient Education as Topic+") OR (MH "Patient Participation") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 118,791 |
| S10 | (MH "Self-Management") OR (MH "Self Care+") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 72,105 |
| S9 | S1 OR S2 OR S3 OR S4 OR S5 OR S8 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 33,834 |
| S8 | S6 AND S7 | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 5,759 |
| S7 | (MH "Airway Obstruction+") OR TX("fatal attack*" or "near fatal" or "respiratory failure") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 146,380 |

| | | | | |
|---|---|---|---|---|
| S6 | (MH "Asthma+") OR asthma | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 234,923 |
| S5 | XB (asthma* N3 (crisis or shock or state or attack* or exacerbat*)) | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 17,694 |
| S4 | XB status asthmaticus | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,391 |
| S3 | XB "acute asthma" | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 3,967 |
| S2 | XB "severe asthma" | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 11,407 |
| S1 | (MH "Status Asthmaticus") | Expanders - Apply equivalent subjects<br>Search modes - Proximity | Interface - EBSCOhost Research Databases<br>Search Screen - Advanced Search<br>Database - MEDLINE Complete | 1,334 |

## Appendix 3: Reasons for full text exclusion from database search and citation searching

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Abbott 2022** | Impact of outpatient follow-up on likelihood of emergency department revisit within 30 days following index visit for acute asthma exacerbation | 10.1164/ajrccm-conference.2022.205.1_MeetingAbstracts.A5095 | No outcome of interest |
| **Abraham 2018** | Evaluating a multidisciplinary approach for the management of severe asthma in the New York City borough of the Bronx: The Montefiore Asthma Center experience | 10.1016/j.jaci.2017.12.309 | Wrong age (<16 years) |
| **Adams 2001** | A randomized trial of peak-flow and symptom-based action plans in adults with moderate-to-severe asthma | 10.1046/j.1440-1843.2001.00350.x | Wrong population (no ED or IP admission for exacerbation) |
| **Adelsberg 2003** | A management strategy that controls lower airway eosinophilic inflammation and symptoms reduced exacerbations in asthma | 10.7326/acpjc-2003-139-1-013 | Wrong population (no ED or IP admission for exacerbation) |
| **Adisa 2024** | Impact of pharmacist-led intervention in medication adherence and inhaler usage on asthma and chronic obstructive pulmonary disease control: a quasi-experimental study | 10.1186/s12913-024-11683-9 | Wrong population (no ED or IP admission for exacerbation) |
| **Andreasson 2022** | Breathing exercises for patients with asthma in specialist care a multicenter randomized clinical trial | 10.1513/AnnalsATS.202111-1228OC | Wrong population (no ED or IP admission for exacerbation) |
| **Arguel 2013** | An internet intervention to improve asthma management: rationale and | 10.2196/resprot.2695 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| | protocol of a randomized controlled trial | | |
| **Avram 2015** | The role of specialist nurse led review on reducing emergency asthma admissions in a district general hospital (DGH) | 10.1183/13993003.congress-2015.PA2535 | Wrong study type (cross-sectional with no follow up, case-control, case series, costing study) |
| **Baptist 2018** | A self-regulation intervention can decrease asthma exacerbations among older adults | https://doi.org/10.1016/j.jaci.2017.12.661 | Wrong population (no ED or IP admission for exacerbation) |
| **Baptist 2020** | A behavioral intervention can decrease asthma exacerbations in older adults | 10.1016/j.anai.2019.12.015 | Wrong population (no ED or IP admission for exacerbation) |
| **Beerthuizen 2020** | Internet-based self-management support after high-altitude climate treatment for severe asthma: randomized controlled trial | 10.2196/13145 | Wrong population (no ED or IP admission for exacerbation) |
| **Berg 1997** | An evaluation of a self-management program for adults with asthma | 10.1177/105477389700600304 | Wrong population (no ED or IP admission for exacerbation) |
| **Beydon 2017** | [Digital action plan for asthma exacerbations (PANAME)] | 10.1016/j.rmr.2016.10.881 | Wrong population (no ED or IP admission for exacerbation) |
| **Beydon 2023** | Digital action plan (web app) for managing asthma exacerbations: randomized controlled trial | 10.2196/41490 | Wrong population (no ED or IP admission for exacerbation) |
| **Brown 2006** | Randomized trial of a comprehensive asthma education program after an emergency department visit | 10.1016/S1081-1206(10)61368-3 | Wrong intervention (not OPD specialist/self-management/education) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Brunton 2020** | Comparison of exacerbations and health-care resource utilization before and after allergist/immunologist or pulmonologist management in patients with severe asthma in the United States | 10.1016/j.chest.2020.08.1552 | Wrong population (no ED or IP admission for exacerbation) |
| **Buist 2006** | A randomized clinical trial of peak flow versus symptom monitoring in older adults with asthma | 10.1164/rccm.200510-1606OC | Wrong population (no ED or IP admission for exacerbation) |
| **Byrne 1993** | Evaluation of the efficacy of an instructional programme in the self-management of patients with asthma | 10.1046/j.1365-2648.1993.18040637.x | Wrong population (no ED or IP admission for exacerbation) |
| **Cabrera 2002** | [Group health education of patients with airflow limitation in primary care] | 10.1016/S1130-8621(02)73770-4 | Wrong population (no ED or IP admission for exacerbation) |
| **Castro 2003** | Asthma intervention program prevents readmissions in high healthcare users | 10.1164/rccm.200208-877OC | Wrong intervention (not OPD specialist/self-management/education) |
| **Chamnan 2010** | Implementation of a 12-week disease management program improved clinical outcomes and quality of life in adults with asthma in a rural district hospital: pre- and post-intervention study | PMID: 20527511 | Wrong population (no ED or IP admission for exacerbation) |
| **Chapman 2015** | Changing adherence-related beliefs about ICS maintenance treatment for asthma: feasibility study of an intervention delivered by asthma nurse specialists | 10.1136/bmjopen-2014-007354 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Chen 2010** | The effects of the self-efficacy method on adult asthmatic patient self-care behavior | 10.1097/NRJ.0b013e3181fbe33f | Wrong population (no ED or IP admission for exacerbation) |
| **Cheng 2011** | Computerized decision support for outpatient asthma management | 10.1378/chest.1119874 | Wrong population (no ED or IP admission for exacerbation) |
| **Choi 2017** | Effects of education about action plans according to self-monitoring on self-management adherence, knowledge, symptom control, and quality of life among adult asthma patients: a randomized controlled trial | 10.4040/jkan.2017.47.5.613 | Wrong population (no ED or IP admission for exacerbation) |
| **Cicutto 2000** | A comprehensive educational programme was effective for inner city patients with asthma | 10.1136/ebn.3.2.44 | Wrong study type (cross-sectional with no follow up, case-control, case series, costing study) |
| **Coté 1997** | Influence on asthma morbidity of asthma education programs based on self-management plans following treatment optimization | 10.1164/ajrccm.155.5.9154850 | Wrong population (no ED or IP admission for exacerbation) |
| **Côté 2000** | Influence of asthma education on asthma severity, quality of life and environmental control | 10.1155/2000/787980 | Wrong population (no ED or IP admission for exacerbation) |
| **Cowie 1997** | The effect of a peak flow-based action plan in the prevention of exacerbations of asthma | 10.1378/chest.112.6.1534 | Wrong intervention (not OPD specialist/self-management/education) |
| **Daly 2015** | A multidisciplinary patient education programme significantly improves asthma control and quality of life in patients with severe asthma | 10.1136/thoraxjnl-2015-207770.270 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **DeOliveira 1999** | Evaluation of an educational programme for socially deprived asthma patients | 10.1034/j.1399-3003.1999.14d30.x | Wrong population (no ED or IP admission for exacerbation) |
| **Dobler 2010** | Acute respiratory assessment clinic: An alternative model of care | 10.1111/j.1440-1843.2010.01735.x | No outcome of interest |
| **Drexel 2023** | Enhancing adoption of new targeted agents and empowering patients with severe asthma: the role of tethered education for health care providers and patients | 10.1164/ajrccm-conference.2023.C102 | Wrong population (no ED or IP admission for exacerbation) |
| **D'Souza 2000** | Asthma morbidity 6 yrs after an effective asthma self-management programme in a Maori community | 10.1034/j.1399-3003.2000.15.07.x | Wrong population (no ED or IP admission for exacerbation) |
| **Dzyngel 1994** | Assessment of an ambulatory care asthma program | 10.3109/02770909409089476 | Wrong population (no ED or IP admission for exacerbation) |
| **ElAbed 2023** | Setting up and assessing a therapeutic education program for asthmatic patients | 10.4103/jehp.jehp_1868_22 | Wrong population (no ED or IP admission for exacerbation) |
| **Epozturk 2010** | The results of face to face asthma education by an allergy nurse | 10.1111/j.1398-9995.2010.02393.x | Wrong intervention (not OPD specialist/self-management/education) |
| **Faruqi 2019** | Care for patients attending emergency departments in England with an acute asthma exacerbation: Can targeted interventions improve compliance with suggested British Thoracic Society standards? | 10.1136/thorax-2019-BTSabstracts2019.302 | No outcome of interest |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Felix 2018** | Clinical, functional and inflammatory evaluation in asthmatic patients after a simple short-term educational program | https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2018.197.1_MeetingAbstracts.A3637 | Wrong population (no ED or IP admission for exacerbation) |
| **Fernandes 2011** | Improving asthma control with therapeutic education intervention | 10.1183/13993003/erj.38.Suppl_55.p4997 | Wrong population (no ED or IP admission for exacerbation) |
| **Fevranoglou 2013** | Achieving better control of asthma by a self education program in Asian immigrants with low socioeconomic status and complete ignorance of the Greek language | 10.1111/all.12251 | Wrong population (no ED or IP admission for exacerbation) |
| **Fornell 2014** | Can we improve the follow up of asthmatic patients with asthma educational program (PAMA)? | 10.1183/13993003/erj.44.Suppl_58.P3021 | Wrong population (no ED or IP admission for exacerbation) |
| **Freeman 2005** | Effects of imagery, critical thinking, and asthma education on symptoms and mood state in adult asthma patients: A pilot study | 10.1089/acm.2005.11.57 | Wrong population (no ED or IP admission for exacerbation) |
| **Freitas 2021** | A behavior change intervention aimed at increasing physical activity improves clinical control in adults with asthma: a randomized controlled trial | 10.1016/j.chest.2020.08.2113 | Wrong population (no ED or IP admission for exacerbation) |
| **Gardner 2022** | Home monitoring & telehealth education for asthma disease management | 10.1016/j.anai.2022.08.636 | Wrong population (no ED or IP admission for exacerbation) |
| **Goeman 2013** | Educational intervention for older people with asthma: A randomised controlled trial | 10.1016/j.pec.2013.08.014 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Gomez 2017** | A cost-benefit analysis of a state-funded healthy homes program for residents with asthma: Findings from the New York State Healthy Neighborhoods Program | 10.1097/PHH.0000000000000528 | Wrong population (no ED or IP admission for exacerbation) |
| **Griffiths 2004** | Specialist nurse intervention to reduce unscheduled asthma care in a deprived multiethnic area: the east London randomised controlled trial for high risk asthma (ELECTRA) | 10.1136/bmj.37950.784444.EE | Wrong age (<16 years) |
| **Hale 2023** | Use of digital measurement of medication adherence and lung function to guide the management of uncontrolled asthma (INCA Sun): a multicentre, single-blinded, randomised clinical trial | 10.1016/S2213-2600(22)00534-3 | Wrong intervention (not OPD specialist/self-management/education) |
| **Hohner 2016** | Implementation of an emergency department-based clinical pharmacist transitions-of-care program | 10.2146/ajhp150511 | No outcome of interest |
| **Huang 2009** | Individualized programme to promote self-care among older adults with asthma: Randomized controlled trial | 10.1111/j.1365-2648.2008.04874.x | Wrong population (no ED or IP admission for exacerbation) |
| **Ja Yun Choi 2017** | Effects of education about action plans according to self-monitoring on self-management adherence, knowledge, symptom control, and quality of life among adult asthma patients: a randomized controlled trial | 10.4040/jkan.2017.47.5.613 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Ibrahim 2022** | Clinical outcomes of pharmacist interventions on Iraqi asthmatic patients (sample population): a comparative study | https://connectjournals.com/pages/articledetails/toc035394 | Wrong population (no ED or IP admission for exacerbation) |
| **Ignacio-Garcia 1995** | Asthma self-management education program by home monitoring of peak expiratory flow | 10.1164/ajrccm.151.2.7842191 | Wrong population (no ED or IP admission for exacerbation) |
| **Ireland 2021** | Improving the follow-up of patients with exacerbations of asthma after discharge from the emergency department | 10.1136/thorax-2020-BTSabstracts.290 | No outcome of interest |
| **Jain 2014** | Impact of an integrated disease management program in reducing exacerbations in patients with severe asthma and COPD | 10.1016/j.rmed.2014.09.010 | No outcome of interest |
| **Janson 2009** | Individualized asthma self-management improves medication adherence and markers of asthma control | 10.1016/j.jaci.2009.01.053 | Wrong population (no ED or IP admission for exacerbation) |
| **Kelso 1995** | Educational and long-term therapeutic intervention in the ED: effect on outcomes in adult indigent minority asthmatics | 10.1016/0735-6757(95)90046-2 | Wrong intervention (not OPD specialist/self-management/education) |
| **Keskin 2017** | Assessing the impact of smoking status and number of comorbidities on improvement in asthma knowledge in patients receiving the algorithmic software tool to help manage asthma (asthma)-educator and nurse-delivered asthma education | 10.1016/j.jaci.2016.12.331 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Khdour 2019** | Pharmaceutical care for adult asthma patients: A controlled intervention one-year follow-up study | 10.1111/bcpt.13344 | Wrong population (no ED or IP admission for exacerbation) |
| **Khusial 2019** | Myaircoach: mHealth assisted self-management in patients with uncontrolled asthma, a randomized control trial | 10.1183/13993003.congress-2019.PA745 | Wrong population (no ED or IP admission for exacerbation) |
| **Khusial 2020** | Effectiveness of myAirCoach: a mHealth self-management system in asthma | 10.1016/j.jaip.2020.02.018 | Wrong population (no ED or IP admission for exacerbation) |
| **Kotses 1996** | Evaluation of individualized asthma self-management programs | 10.3109/02770909609054539 | Wrong population (no ED or IP admission for exacerbation) |
| **Langan 2022** | Implementation of an asthma QI project in Galway University Hospital | 10.1007/s11845-022-03209-1 | No outcome of interest |
| **Lim 2021** | Implementation of a nursing led intervention bundle in the emergency department : Outcomes | 10.1183/13993003.congress-2021.PA3530 | Wrong intervention (not OPD specialist/self-management/education) |
| **Maiman 1979** | Education for self-treatment by adult asthmatics | PMID: 430774 | Wrong intervention (not OPD specialist/self-management/education) |
| **Mayo 1990** | Results of a program to reduce admissions for adult asthma | 10.7326/0003-4819-112-11-864 | No outcome of interest |
| **McDonald 2017** | Multidimensional assessment and targeted therapy of severe persistent asthma: A randomised controlled trial | 10.1111/resp.13009 | Wrong population (no ED or IP admission for exacerbation) |
| **Muntner 2001** | Predictors of participation and attendance in a new asthma patient self-management education program | 10.1378/chest.120.3.778 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Nanishi 2021** | Hospital-initiated care bundle, posthospitalization care, and outcomes in adults with asthma exacerbation | 10.1016/j.jaip.2021.06.044 | Wrong intervention (not OPD specialist/self-management/education) |
| **Nathan 2006** | A randomized controlled trial of follow-up of patients discharged from the hospital following acute asthma: best performed by specialist nurse or doctor? | 10.1016/S0012-3692(15)50952-5 | Wrong intervention (not OPD specialist/self-management/education) |
| **Neo 2013** | Outcome monitoring of asthma education intervention at emergency department | 10.1111/all.12294 | Wrong setting (IP only or PC/GP) |
| **Ngamvitroj 2005** | Effects of psychosocial factors and recording methods on adherence to self-monitoring among adults with asthma | https://digitalcommons.library.uab.edu/etd-collection/5422 | Wrong population (no ED or IP admission for exacerbation) |
| **Patel 2009** | Improving asthma care for the elderly: a randomized controlled trial using a simple telephone intervention | 10.1080/02770900802460563 | Wrong intervention (not OPD specialist/self-management/education) |
| **Perneger 2002** | Effect of patient education on self-management skills and health status in patients with asthma: a randomized trial | 10.1016/s0002-9343(02)01136-1 | Wrong population (no ED or IP admission for exacerbation) |
| **Pourdowlat 2013** | Relaxation training in asthmatic patients | 10.1111/resp.12042 | Wrong population (no ED or IP admission for exacerbation) |
| **Redmond 2022** | Benefits of specialist severe asthma management: demographic and geographic disparities | 10.1183/13993003.00660-2022 | Wrong population (no ED or IP admission for exacerbation) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Sahasranaman 2013** | Impact of interventions in asthma readmissions and asthma care in inpatient setting in an inner-city hospital | https://www.atsjournals.org/doi/10.1164/ajrccm-conference.2013.187.1_MeetingAbstracts.A4216 | Wrong study type (cross-sectional with no f/up, case-control, case series, costing study) |
| **Smith 2005** | The Coping with Asthma Study: a randomised controlled trial of a home based, nurse led psychoeducational intervention for adults at risk of adverse asthma outcomes | 10.1136/thx.2005.043877 | Wrong population (no ED or IP admission for exacerbation) |
| **Staten 2025** | Effectiveness of a respiratory therapist-led, community-based asthma program in an under resourced rural border town In California | 10.1016/j.rmed.2025.108071 | Wrong population (no ED or IP admission for exacerbation) |
| **Sulaiman 2018** | A randomised clinical trial of feedback on inhaler adherence and technique in patients with severe uncontrolled asthma | 10.1183/13993003.01126-2017 | Wrong population (no ED or IP admission for exacerbation) |
| **Taille 2014** | Evaluation of an outpatient pulmonary rehabilitation program in severe asthmatics with fixed airway obstruction | https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2014.189.1_MeetingAbstracts.A1292 | Wrong population (no ED or IP admission for exacerbation) |
| **Tonweber 2024** | Trusted messengers virtual asthma coaching using an asthma app improves asthma control and engagement | 10.1016/j.anai.2024.08.159 | Wrong population (no ED or IP admission for exacerbation) |
| **Villa-Roel 2017** | Emergency department directed multifaceted interventions to improve outcomes after asthma exacerbations: A 3-armed randomized controlled trial | 10.1080/24745332.2017.1332400 | Wrong intervention (not OPD specialist/self-management/education) |

| Study | Title | DOI/PMID/URLSEa | Reasons for exclusion |
|---|---|---|---|
| **Wang 2004** | Effect of asthma self management programme on asthma morbidity and health care utilization in adult patients admitted to hospital with acute asthma in Hong Kong: a randomised controlled trial | https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/j.1440-1843.2004.00673.x | Wrong intervention (not OPD specialist/self-management/education) |
| **Zeiger 1991** | Facilitated referral to asthma specialist reduces relapses in asthma emergency room visits | 10.1016/0091-6749(91)92162-t | Wrong population (no ED or IP admission for exacerbation) |
| **Zhang 2021** | Positive change in asthma control using therapeutic patient education in severe uncontrolled asthma: a one-year prospective study | 10.1186/s40733-021-00076-y | Wrong population (no ED or IP admission for exacerbation) |
| **Zhou 2025** | Efficacy of medical education combined with extended care on adherence to inhaled glucocorticoids and clinical effects in patients with bronchial asthma | 10.1080/02770903.2024.2410423 | Wrong population (no ED or IP admission for exacerbation) |
| **Abbreviations:** ED: emergency department; IP: inpatient; OPD: outpatient | | | |

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