Self-management interventions to reduce healthcare use and improve quality of life among patients with asthma: systematic review and network meta-analysis

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Additional material is published online only. To view please visit the journal online.

Cite this as: *BMJ*2020;370:m2521

http://dx.doi.org/10.1136/bmj.m2521

Accepted: 9 June 2020

ABSTRACT

OBJECTIVE

To compare the different self-management models (multidisciplinary case management, regularly supported self-management, and minimally supported self-management) and self-monitoring models against usual care and education to determine which are most effective at reducing healthcare use and improving quality of life in asthma.

DESIGN

Systematic review and network meta-analysis.

DATA SOURCES

Medline, the Cochrane Library, CINAHL, EconLit, Embase, Health Economics Evaluations Database, NHS Economic Evaluation Database, PsycINFO, and ClinicalTrials.gov from January 2000 to April 2019.

REVIEW METHODS

Randomised controlled trials involving the different self-management models for asthma were included. The primary outcomes were healthcare use (hospital admission or emergency visit) and quality of life. Summary standardised mean differences (SMDs) and 95% credible intervals were estimated using bayesian network meta-analysis with random effects. Heterogeneity and publication bias were assessed.

RESULTS

From 1178 citations, 105 trials comprising 27 767 participants were included. In terms of healthcare use, both multidisciplinary case management (SMD −0.18, 95% credible interval −0.32 to −0.05) and regularly supported self-management (−0.30, −0.46 to −0.15) were significantly better than usual care. For quality of life, only regularly supported self-management (SMD 0.54, 0.11 to 0.96) showed a statistically significant benefit compared with usual care. For trials including adolescents/children (age 5-18 years), only regularly supported self-management showed statistically significant benefits (healthcare use: SMD −0.21, −0.40 to −0.03; quality of life: 0.23, 0.03 to 0.48). Multidisciplinary case management (SMD −0.32, −0.50 to −0.16) and regularly supported self-management (−0.32, −0.53 to −0.11) were most effective at reducing healthcare use in patients with symptoms of severe asthma at baseline.

CONCLUSIONS

This network meta-analysis indicates that regularly supported self-management reduces the use of healthcare resources and improves quality of life across all levels of asthma severity. Future healthcare investments should provide support that offer reviews totalling at least two hours to establish self-management skills, reserving multidisciplinary case management for patients with complex disease.

SYSTEMATIC REVIEW REGISTRATION

PROSPERO number CRD42019121350.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Over the past three decades, international guidelines have recommended the use of supported self-management interventions for people with asthma

However, different self-management interventions for asthma involve varying levels of support and review from healthcare professionals and have varying delivery modes

Considerable uncertainty remains about which of these different self-management interventions for asthma are most effective

WHAT THIS STUDY ADDS

Support involving regular reviews totalling at least two hours was effective at establishing self-management skills and significantly better than usual care at reducing healthcare use

Multidisciplinary case management should be reserved for patients with complex disease

Unsupported, or minimally supported, self-management programmes were not effective

Introduction

Asthma is a major source of global economic burden that affects more than 330 million people worldwide (6 million people in the UK and 25 million in the US),[1] causing 250 000 deaths each year.[2] Although the number of deaths has decreased with the regular use of inhaled glucocorticoids, the global impact remains high.[3] The number of people worldwide who will have asthma by 2025 is now estimated at more than 400 million.[4]

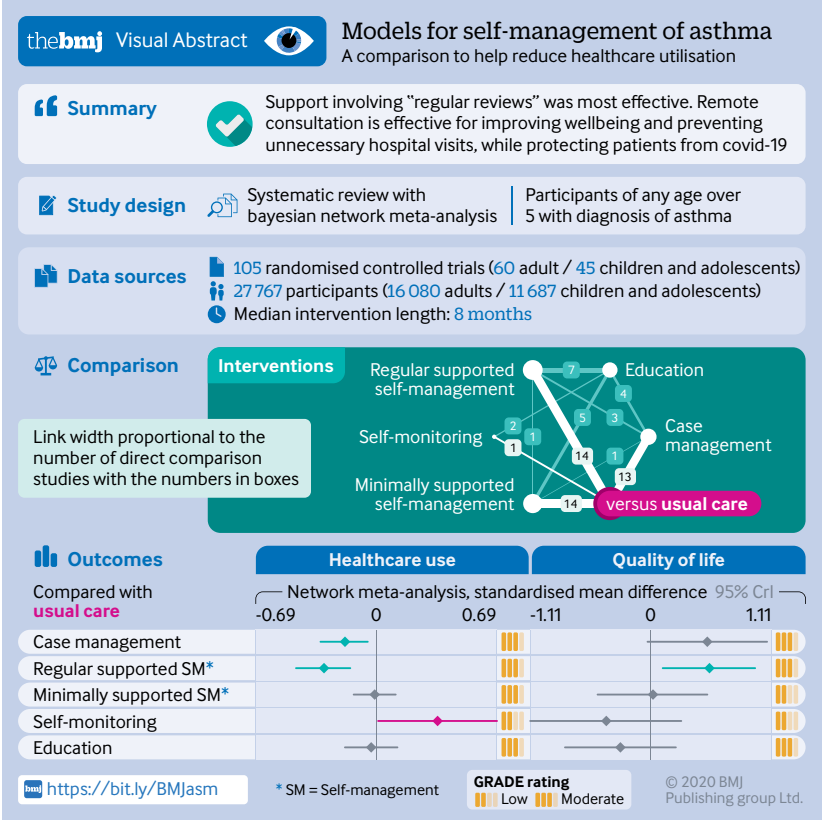
The existing evidence indicates that simply providing information to patients is ineffective in improving asthma care.[5] Over the past 25 years,[6] international guidelines such as those from the Global Initiative for Asthma and the British Thoracic Society/Scottish Intercollegiate Guidelines Network have recommended the use of self-management interventions for people with asthma.[7-9] A self-management intervention has been 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."[10] Informed by Gibson 2002, which defined "optimal self-management" as including a written action plan for self-management of drugs for exacerbations, together with self-monitoring and regular medical review,[5]

guidelines use terminology such as "supported" and "guided."[7 8] However, different interventions involve varying levels of review by healthcare professionals, and no evidence exists to guide what level of support is needed for an intervention to be effective. Three broad models of self-management intervention can be described (what we have described as minimally supported self-management, regularly supported self-management, and multidisciplinary case management), each reflecting an increasing degree of support by regular review from health professionals. Alternatives to self-management interventions include self-monitoring models, which involve delivery by telehealth and smartphone applications and do not involve professional review or advice on self-management actions (table 1).

Understanding the relative advantages of these different models of self-management intervention is important, especially as different models may be more or less amenable to wider implementation. A key factor that could determine implementation of self-management interventions for asthma at scale is the degree of involvement by health professionals needed. The balance between the amount of (expensive) health professional support and the potential savings in terms of unscheduled care will be a major driver of cost and of the scope for delivery (as most healthcare systems face major workforce shortages). The benefits of different self-management interventions may also interact with patient related factors such as age (given the prevalence of asthma in children) and severity of asthma. For example, more complex self-management interventions (that is, multidisciplinary case management) might be best suited to patients with more severe symptoms.[11]

Several systematic reviews have examined the effectiveness and efficiency of self-management interventions for asthma. The largest of these is the PRISMS (Practical systematic Review of Self-Management Support for asthma) study,[12 13] a meta-review involving 27 systematic reviews. PRISMS showed that self-management interventions were associated with fewer hospital admissions and greater health related quality of life in people with asthma.[13] However, despite the 244 randomised controlled trials reviewed as part of PRISMS, no guidance exists as to the most efficient models of self-management interventions for asthma.[14] The study authors highlighted the need to overcome this major limitation in a more robust meta-analysis.[15]

Comparing the effects of different self-management intervention models in a precise way would give better insight into which models or combinations of models are optimal in terms of effects on health outcomes and healthcare use.[16] Network meta-analysis has a distinct advantage over conventional meta-analysis, as it allows different intervention models to be evaluated both directly and indirectly, providing a more comprehensive analysis of evidence. This study aims to compare the effects of different models of self-management intervention for managing asthma in adults and children and to inform policymakers in their decisions about which models are best suited to widespread implementation.



Methods

Search methods

We searched bibliographic databases from January 2000 to April 2019 (with no language restriction) in the Cochrane Central Register of Controlled Trials (CENTRAL), Cumulative Index to Nursing and Allied Health (CINAHL), EconLit (the American Economic Association's electronic bibliography), Embase, Health Economics Evaluations Database, Medline (the US National Library of Medicine's database), Medline In-Process and Other Non-Indexed Citations, NHS Economic Evaluation Database (NHS EED), and PsycINFO (the behavioural science and mental health database). We aimed to include all relevant studies of self-management interventions but focused our search on studies after 2000, as this was just before the highly influential Cochrane review that defined optimal self-management as including an action plan and being supported by regular professional review.[5] In addition, it coincided with growing policy interest in self-management as a strategy for managing the increasing burden of long term conditions.[17] We used combinations of MeSH terms and text words around "self-management interventions" and "asthma". The full search strategy is available in supplementary appendix 1. Additional studies came from screening the reference lists of included trials and previous systematic reviews. We also contacted experts in

doi: 10.1136/bmj.m2521 | BMJ 2020;370:m2521 | thebmj

Table 1 | Interventions models (three self-management, one self-monitoring) and comparator groups, with descriptions

Intervention or comparator group	Description
Intervention model	
Multidisciplinary case management	Involving an individualised written action plan that is characterised to the patient's underlying asthma severity and treatment. Support is often provided face to face by a multidisciplinary team
Regularly supported self-management	Characterised by regular consultations (totalling ≥2 hours) with a healthcare professional during the intervention period for the purpose of reviewing the patient's asthma status and medications. This may occur as a formal part of the intervention, or the patients may be advised to see their own doctor on a regular basis
Minimally supported self-management	Characterised by limited routine support (<2 hours' consultation) and review, by mixed healthcare professionals (doctors, nurses, or community based worker) during the intervention period—eg, advised to see their healthcare professional only once during the length of the programme
Self-monitoring	Self-monitoring by patients with regular measurement of either peak expiratory flow or symptoms, but which do not involve any action or management decisions on the part of the patient. Diaries may be recorded on paper or digitally using smartphone applications or telehealth
Comparator group	
Education	Involves education to promote patients' understanding of their respiratory condition and teach specific prevention and treatment strategies without a focus on self-management. Can include the provision of pamphlets, brochures, and SMS text messages that differ from information provided in a standard usual care group. It may be interactive or non-interactive, and structured or unstructured
Usual care	Standard usual care or no intervention

the field to enquire about unpublished studies and searched trial registers (ClinicalTrials.gov, ISCTRN, the WHO ICTRP portal, and OpenTrials.net) to identify any unpublished or ongoing trials.

Eligibility criteria

Studies of patients with asthma including adults (19-59 years), adolescents (13-18 years), or children (5-12 years) were eligible. We excluded studies involving children under 5 years of age, as self-management interventions are generally not effective in these populations,[8] and we excluded people diagnosed as having chronic obstructive pulmonary disease or other respiratory conditions.

We categorised the self-management interventions into three types reflecting varying degrees of support and regular review by health professionals: multidisciplinary case management involving action planning; regularly supported self-management, which involves a total of more than two hours of support at regular intervals; and minimally supported self-management, which involves less than two hours of consultation over the course of the self-management intervention (table 1). We included all formats and delivery methods (for example, group or individual, face-to-face or remote, professional or peer led).

More than a third of the trials included in PRISMS enhanced usual care by providing some "education" to the control group. This implies that potentially valuable direct comparisons of different models of self-management support are excluded from the evidence base. We therefore characterised comparator groups as either usual care or education (table 1).

Primary outcomes were healthcare use (such as hospital admission, accident and emergency visits) and quality of life (disease specific—that is, Asthma Quality of Life Questionnaire, St Georges Respiratory Questionnaire (SGRQ), Paediatric Asthma Quality of Life Questionnaire, Pediatric Quality of Life Inventory Asthma Symptoms Scale[10]; or generic—that is, SF-36 or ED-2Q)). The secondary outcome was total cost (covering consultation and primary care). We excluded studies if they had not included either of the two primary outcomes.

We included individual or cluster randomised controlled trials evaluating the use of self-management interventions. We excluded observational, cross sectional, or qualitative studies.

Data collection and extraction

Four independent reviewers (AH, MP, SSZ, and CG) worked in pairs to screen publications and extract data. They used a modified version of the Cochrane Public Health Group's data extraction template,[18] after pilot testing it on five studies to ensure reliability. Data extractions allow for arm level, contrast level (mean difference, odds ratio), and dichotomous data, with the latter transformed into effects on a continuous scale by using the Comprehensive Meta-Analysis software package.[19 20]

Assessment of risk of bias

The same four reviewers assessed risk of bias for each study by using the Cochrane Risk of Bias tool.[21] For cluster randomised controlled trials, they consulted the Cochrane Handbook section 16.3.2 and the revised Risk of Bias tool (version 2.0).[22 23] Additionally, we assessed the certainty of evidence contributing to network estimates of the main outcomes with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework.[24]

Data synthesis

We firstly did pairwise meta-analyses with the DerSimonian-Laird random effects method.[25] We calculated standardised mean differences or effect sizes by using Hedges' g and interpreted them according to Cohen's criteria.[26 27] We presented pooled effect results with 95% confidence intervals and used forest plots with I^2 (with test based 95% confidence intervals)[28] to display statistical heterogeneity.

We then synthesised the study effect sizes by using a network meta-analysis, which allowed for the simultaneous evaluation of our four intervention models

while preserving the within study randomisation.[29] To ensure transitivity within the network, we categorised all models of self-management intervention, self-monitoring, and usual care comparators into nodes and compared the distribution of clinical and methodological variables.[30] We used a bayesian, random effects, network meta-analysis model with a normal likelihood for both outcomes. We accounted for the correlations induced by multigroup studies by using multivariate distributions. We considered the variance in the random effects distribution (heterogeneity variance (τ)) to measure the extent of the influence of variability across and within studies on treatment effects. To assess the amount of heterogeneity, we compared the posterior distribution of the estimated heterogeneity variance with its predictive distribution. To rank the treatments for each outcome, we used the surface under the cumulative ranking curve (SUCRA) and the P score, a frequentist analogue to SUCRA.[31] We statistically evaluated consistency (that is, the agreement between direct and indirect evidence), first with the "loop specific" approach and then by separating out direct evidence from indirect evidence by using node splitting.[32 33] We used Cochran's Q statistic to calculate consistency throughout the entire network.[34]

We did meta-regressions on both outcomes involving all studies to assess the effects of important covariates. The covariates included in the regression models were length of intervention (≥12 months *v* <12 months), method of delivery (face-to-face, telecommunication/website based, pure self-regulation, or mixed), provider (physicians or allied health professionals (that is, nurses, health trainers, or community workers)), healthcare setting (primary care or home/school based), age group (adults, adolescents, or children), sex, and severity of asthma at baseline (severe persistent or non-severe (moderate/mild persistent or mild intermittent)) in accordance with the widely accepted classifications of the National Heart, Lung and Blood Institute's National Asthma Education and Prevention Program.[35] We assessed goodness of fit for each model by comparing total residual deviance and deviance information criterion. On the basis of the models with best fit, we then did a covariate adjusted network meta-analysis.[36]

We fitted all models in OpenBUGS (version 3.2.3),[37] using uninformative prior distributions for the treatment effects and a minimally informative prior distribution for common heterogeneity standard deviation. We assumed uninformative priors (that is, N(0,1000)) for all meta-regression coefficients. We ensured model convergence by visual inspection of three Markov Chain Monte Carlo chains after considering the Brooks-Gelman-Rubin diagnostic and autocorrelation plots. Statistical evaluation of inconsistency and production of network graphs and result figures used the "netmeta" package in R (version 3.4.3)[38] and the "network" and "network graph"[39] packages in Stata (version 15.0). We duplicated network meta-analysis of both outcomes in a frequentist environment by using the netmeta package in R. We investigated publication bias with comparison adjusted funnel plots. The statistical code for the network models is available at the end of the supplementary appendix.

The study was conducted in accordance with the Cochrane Handbook[22] and was registered with PROSPERO (registration number CRD42019121350). Reporting was consistent with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA)[40] extension statement for network meta-analyses.[41]

Patient and public involvement

We consulted a group of 20 patient partners who were members of an established patient and public involvement group about the appropriateness of our research questions, classification of the four self-management interventions, and selection of the outcome measures of this study. Patient partners advised on the interpretation of our findings and their dissemination.

Results

The search retrieved 1178 references. After full text screening of 224 studies, 105 randomised controlled trials (comprising 27 767 participants) done between 2000 and 2019 met our inclusion criteria: 60 studies involving 16 080 adults and 45 involving 11 687 adolescents or children (fig 1). Supplementary appendix 2 lists the included studies, and supplementary appendix 3 summarises their characteristics.

Characteristics of included studies

In total, 15 693 participants were randomly assigned to one of the three self-management interventions; 1365 were compared with self-monitoring, 6640 with usual care, and 4069 with education. The median sample size was 173 (range 80-271) participants. In the studies involving adults, the median age was 46 (range 17-73) years, and in studies involving adolescents/children it was 14 (5-18) years. The sex balance reflected the known age-sex characteristics of asthma; 35 (78%) studies in adolescents/children involved mostly male patients, in contrast to the studies in adults, which mostly (n=42; 70%) involved female patients. The four intervention models were delivered in primary care in 74 studies (70%), whereas 26 (25%) studies were school or home based programmes and five (5%) were hospital based. Forty nine (47%) studies recruited patients in North America and 31 (30%) in Europe. Severity of asthma at baseline was evenly distributed across studies, with 40 (38%) studies reporting mostly severe disease and 58 (55%) reporting mostly mild to moderate disease; the seven (7%) remaining studies did not report any data on severity.

Regularly supported self-management was the most common self-management intervention model (n=54 trials), followed by multidisciplinary case management (n=36). Interventions were delivered either by phy-

sicians (n=41) or by allied health professionals such as nurses, health trainers, or community workers (n=64). In more than half of the studies, the delivery of the intervention was face to face (n=57). Others were done by telehealth (n=29) or were unsupervised after initial training (n=19). The uptake of the intervention was high (median 85%, range 76-93%), and this was consistent over a median study length of eight months (range 15 days to five years).

Assessment of risk of bias

The quality of the studies varied as shown in supplementary appendix 4. Fifty six (53%) studies had a low risk of bias for the random sequence generation, and 30 (29%) showed low risk for allocation concealment. Similarly, for blinding of outcome assessment, 46 (44%) studies showed a low risk of bias, with 16 (15%) studies having high risk for this domain. Criteria for incomplete outcome data showed 55 (52%) studies at low risk, with 22 (21%) studies having high risk. In 79 (75%) of the studies, risk of selective reporting bias was considered to be low, with only six (6%) studies having a high risk of bias.

Network meta-analysis

Figure 2 shows the network of eligible comparisons for the primary outcomes involving all trials. The network of evidence included 11 three-arm studies; the rest were two-arm studies. Regularly supported self-management was directly compared with multidisciplinary case management once in the network.

Inconstancy analysis

We found evidence of statistical inconsistency in one of the loops within the networks for quality of life (supplementary appendix 5). Closer inspection through node splitting analysis showed significant inconsistency owing to one comparison of regularly supported self-management against usual care (z=−2.56; P=0.01) for healthcare use; this was because one study was at high risk of bias due to missing data.[42] For quality of life, both multidisciplinary case management (z=2.32; P=0.02) and regularly supported self-management (z=−1.97; P=0.05) showed inconsistency when compared against the education group. This was due to one study that had used a quality of life scale that was not based solely on the assessment of asthma and another that reported a significant mean asthma severity baseline imbalance score in the self-management intervention arm, which was considerably lower than the usual care group.[43 44] Because consistency (transitivity) is a central assumption of network meta-analysis, we removed all three trials leaving 102 randomised controlled trials for both outcomes.

Primary and secondary outcomes

Figure 3 shows the network meta-analysis results for the primary outcomes of all eligible trials after the inconstancy analysis. In terms of healthcare use, multidisciplinary case management (standardised mean difference −0.18, 95% credible interval −0.32 to −0.05; n=13, direct only) and regularly supported self-management (−0.30, −0.46 to −0.15; n=14) showed statistically significant benefits compared with usual care. Similarly, regularly supported self-management showed a significant increase in quality of life compared with usual care (standardised mean difference 0.54, 0.11 to 0.96; n=18). The pairwise meta-analysis results for the primary outcomes were consistent with the network meta-analysis results (supplementary appendix 6). For the secondary outcome (costs; supplementary appendix 6), we found no differences in the pairwise results between the four intervention models (standardised mean difference 0.27, −0.47 to 1.20; n=10).

The surface under the cumulative ranking curve (SUCRA) also supported the network meta-analysis results by showing the best ranking treatment as regularly supported self-management for healthcare use (97.9%) and for quality of life (89.5%), followed by multidisciplinary case management (supplementary appendix 7). Consistent with the main results, regularly supported self-management was the best performing intervention model for both outcomes compared with usual care in the subgroup of studies involving only adolescents/children (fig 4).

The league table showing the results of the network meta-analysis comparing the effects of all models (fig 4) showed that regularly supported self-management and multidisciplinary case management were the most effective intervention models for both outcomes. To ensure the certainty of evidence for each head-to-head comparison, we incorporated the GRADE judgments into the figure. The evidence according to GRADE was moderate overall (supplementary appendix 8). All direct comparisons with regularly supported self-management and multidisciplinary case management were highly reliable, with moderately graded quality of evidence. Adjusted funnel plots are provided in supplementary appendix 9.

Meta-regressions and adjusted analysis

The median heterogeneity variances were low for healthcare use (τ=0.15, 95% credible interval 0.07 to 0.24) and high for quality of life (τ=1.02, 0.84 to 1.23) (supplementary appendix 10). Severity at baseline was the strongest explanation of heterogeneity and inconsistency in meta-regression analyses (supplementary appendix 11). Exclusion of studies mainly involving patients with non-severe asthma at baseline resulted in a 32% reduction in heterogeneity for healthcare use and a 26% reduction for quality of life. Patients' age showed an effect of reducing heterogeneity by 11% for healthcare use and 10% for quality of life when only studies involving adult patients were included. Furthermore, including only patients followed up for more than 12 months reduced heterogeneity by 8% for healthcare use and 4% for quality of life. The healthcare setting had no effect on the heterogeneity in either network.

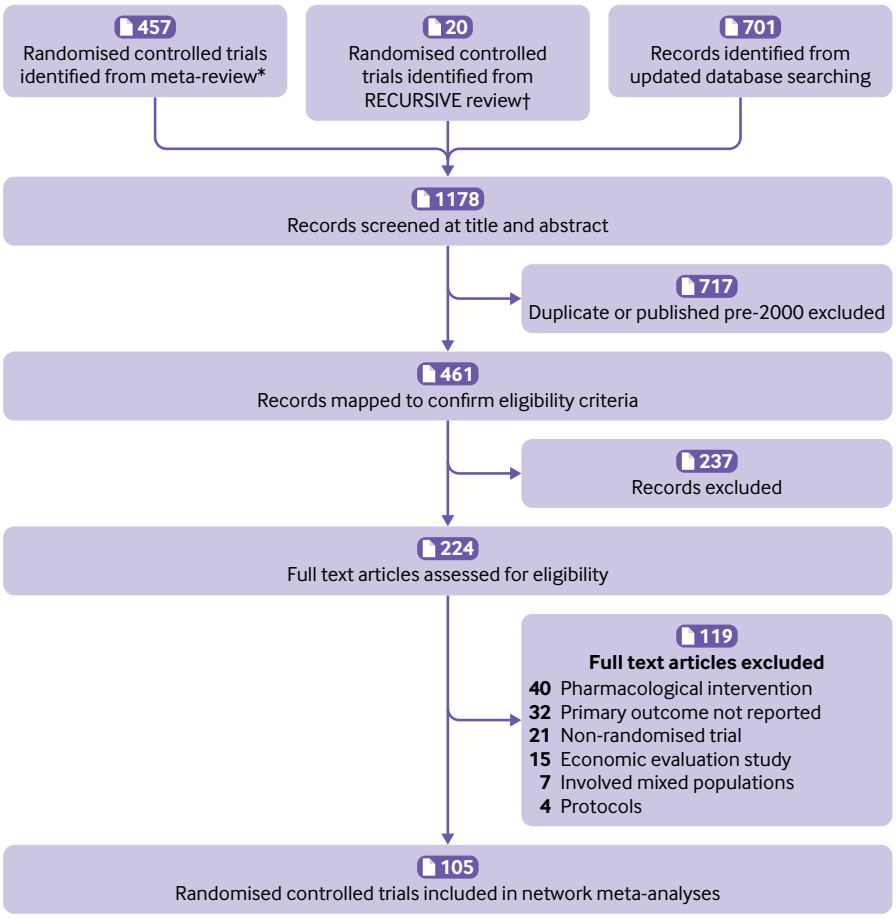


Fig 1 | Study selection process. *Pinnock et al, 2015[12] and 2017[13]. †Panagioti et al, 2014[47]

Figure 5 shows the covariate adjusted network analysis for asthma severity. The network meta-analysis results showed that both regular supported self-management (standardised mean difference −0.32, −0.53 to 0.11) and multidisciplinary case management (−0.32, −0.50 to −0.16) were significant for healthcare use in studies involving patients with more severe symptoms of asthma (supplementary appendix 12). Regularly supported self-management also showed significant benefits in patients with less severe symptoms of asthma (standardised mean difference −0.28, −0.48 to −0.09), but multidisciplinary case management did not.

Discussion

This is the largest and most comprehensive meta-analysis assessing the effects of different levels of professional support for self-management of asthma in children and adults. Regularly supported self-management (which involves more than two hours of support) was more effective than all other models when compared against usual care. This model showed the greatest reduction in healthcare use while achieving the greatest gains in quality of life among all patients with asthma. This was particularly true in patients with mild to moderate symptoms of asthma. Multidisciplinary case management interventions also showed a significant reduction in healthcare use compared with usual care, but only in patients with severe asthma. However, this improved performance was modest compared with regularly supported self-management.

Consistent with these main results including all studies, regularly supported self-management was again the best performing intervention model for both outcomes when compared with usual care in studies involving only adolescents or children. The severity of asthma was the only factor that moderated these effects. After we controlled for baseline asthma severity in the analyses, regularly supported self-management significantly reduced healthcare use across all patients irrespective of the severity of their asthma symptoms, whereas multidisciplinary case management was significantly effective only at reducing healthcare use in studies involving children and adolescents with more severe asthma. Other factors such as length of intervention, healthcare setting, and sex did not influence the effects of the intervention models.

Comparison with similar research

The results of this study are in line with PRISMS and the Cochrane review,[5 13] which both assessed whether supported asthma self-management reduces the use of healthcare resources and improves asthma

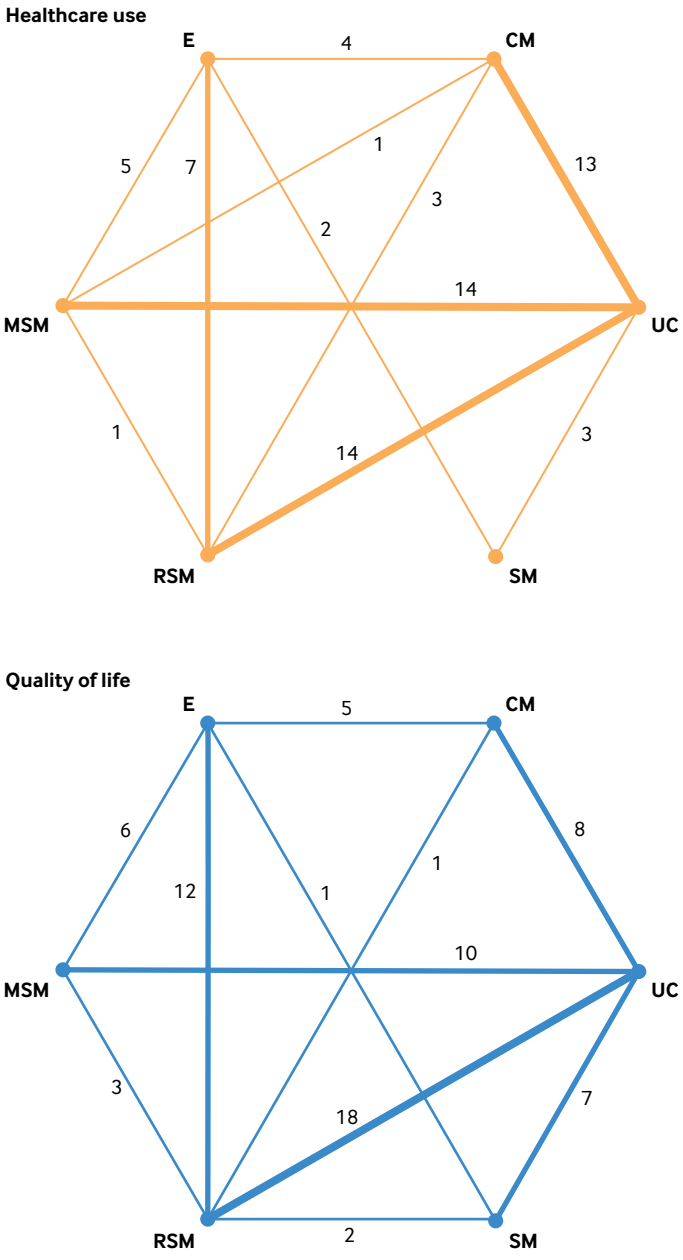


Fig 2 | Network meta-analysis of eligible comparisons for healthcare use (top) and quality of life (bottom), showing total number of direct comparisons for each intervention pair. CM=multidisciplinary case management; E=education; MSM=minimally supported self-management; RSM=regularly supported self-management; SM=self-monitoring; UC=usual care

control. However, the PRISMS researchers did not synthesise the main outcomes in a meta-analyses and did not explore different levels of support within the interventions.[13] The Cochrane review,[5] published almost two decades ago in 2003, assessed asthma self-management programmes coupled with review by health practitioners but did not qualify review by hours of support as we have done. Our more up to date analysis has identified that two hours of support maximises the benefit to patients and healthcare systems.

Reductions in healthcare use were generally larger in adults than in children or adolescents, although this difference was not significant. Evidence suggests that technology based programmes might appeal to adolescents,[45] and innovative school based programmes (which this review did not include) could have value in supporting children as they learn to take over self-management responsibilities from their parents or carers.[46]

Strengths and weaknesses of study

Our review provides the largest evidence base of individual randomised controlled trials obtained through exhaustive searches for published and unpublished information. The results are much more precise than those of other meta-analyses, not just because of the larger quantity of data from a greater volume of asthma trials, but because we also applied the GRADE assessment criteria to increase the methodological rigour of the evidence and because we have looked more extensively at several methodological factors relating to key interventional features (length of the intervention, delivery, personnel, uptake, and healthcare setting) and participants' demographics (age, sex, and severity of asthma) that have not been assessed previously.

Our review has some limitations. We searched for studies published after 2000, because shortly after this the concept of supported self-management was clearly articulated in the Gibson Cochrane review.[5] This also coincides with the growing interest in self-management as a strategy for managing long term conditions.[17] More than 50% of the trials did not report adequate information about randomisation, allocation concealment, and blinding, which could restrict the interpretation of these results. We contacted authors to confirm any unclear risk of bias fields or missing data, but only 11% responded. We also included only studies with amenable data for at least one of the two primary outcomes, meaning that six studies had to be excluded from this review because data for the primary outcomes were not available.

One strength of our analysis was that we adjusted for the severity of asthma at baseline in the model. However, the exact severity classifications were not always clearly defined, so we had to rely on pre-specified inclusion criteria as defined in the primary study reports. We were also unable to include two covariates (method of delivery and provider of intervention) in the meta-regression analysis. This was because we could not categorise them reliably into groups. We therefore provided a descriptive summary for each instead. Furthermore, long term follow-up of patients up to 12 months or longer, based on the primary outcomes, was rarely reported among the included studies, with only 11% providing data. Without these data, the efficacy of the different models over time remains relatively unknown.

The costs of self-management interventions were assessed in a previous review,[47] but only nine trials (involving patients with any respiratory condition) were identified and the results showed no difference in costs between multidisciplinary case management

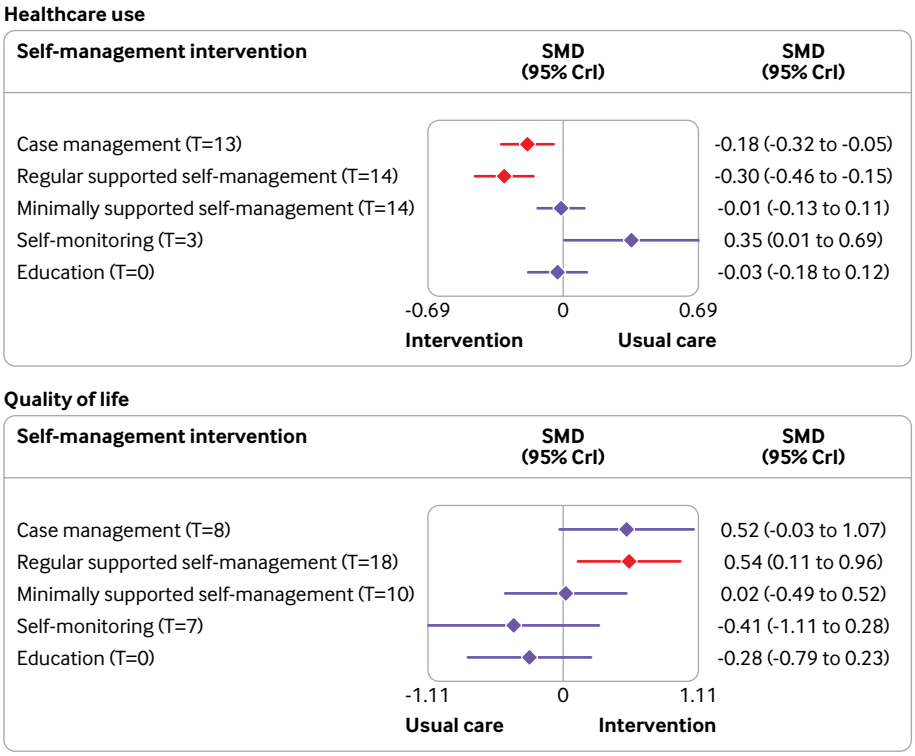


Fig 3 | Forest plots of network meta-analysis of all trials for healthcare use and quality of life. Intervention models were compared with usual care as reference control. CrI=credible interval; SMD=standardised mean difference; T=number of direct comparisons

and self-management. We were unable to assess this reliably across the four different intervention models, as only 10 studies provided cost data amenable to analysis. We have explored different models of self-management intervention that involve varying professional input (and thus different direct treatment costs), and we have explored their effects on healthcare use. These are not comprehensive analyses of costs, however, and we recommend that these data are reported in future research to allow proper economic analyses to be carried out. Furthermore, we did not investigate intervention related and participant demographic related modifiers of treatment response at the individual patient level. However, recent research suggests that evaluating self-management interventions in patients with chronic obstructive pulmonary disease through individual patient data meta-analysis is problematic owing to poor reporting of the characteristics of interventions and patients.[48]

Implications in practice

Guidelines for asthma management in the UK, such as those of the National Institute for Health and Care Excellence (November 2017)[49] and the British Thoracic Society/Scottish Intercollegiate Guideline Network 2019,[8] and the recent report by the Global Initiative for Asthma 2019,[7] recommend the use of "supported self-management" programmes comprising an action plan and regular review. Our findings endorse the key role of healthcare professionals in supporting people with asthma to self-manage their condition and, for the first time, clarify optimal levels of support. We found that trials that provide scheduled follow-up totalling at least two hours' contact with a healthcare professional during the trial period were more effective at reducing healthcare use and improving quality of life than were interventions offering fewer, ad hoc reviews.

We offer practical guidance for clinical practice. An initial self-management discussion should be reinforced in regular reviews, enabling the action plan to be clarified, revised, or both. This is not the remit of any single healthcare professional; physicians, nurses, asthma educators, and community workers were all involved in delivering interventions in the included studies. Although one professional may take a lead and provide the initial education, all those involved in reviewing people with asthma can contribute incrementally to the two hours of support that our findings suggest is optimal. This will require a team approach so that (for example) the physician managing an acute attack can endorse the action plan provided by an asthma educator by asking the patient about their actions before seeking medical advice. Organisational strategies will be needed to ensure routine follow-up.

The resource implications will depend on whether this level of support needs to be sustained after the initial programme is complete. Time limited randomised controlled trials cannot answer this question, but qualitative studies show that patients learn experientially to cope with their variable symptoms and highlight the importance of providing

All studies

CM	-0.02 (-0.64 to 0.61)*	0.50 (-0.17 to 1.17)*	**0.93 (0.08 to 1.78)†**	**0.80 (0.19 to 1.40)†**	0.52 (-0.03 to 1.07)*
0.12 (-0.07 to 0.31)*	RSM	0.52 (-0.04 to 1.09)*	**0.95 (0.20 to 1.70)†**	**0.81 (0.35 to 1.29)***	**0.54 (0.11 to 0.96)***
-0.17 (-0.35 to -0.01)*	**-0.29 (-0.46 to -0.13)***	MSM	0.43 (-0.39 to 1.25)†	0.29 (-0.24 to 0.85)*	0.02 (-0.49 to 0.52)*
-0.52 (-0.89 to -0.17)†	**-0.64 (-1.00 to -0.30)†**	**-0.35 (-0.70 to -0.01)†**	SM	-0.13 (-0.91 to 0.64)‡	-0.41 (-1.11 to 0.28)*
-0.15 (-0.34 to 0.03)*	**-0.27 (-0.43 to -0.12)***	0.02 (-0.12 to 0.16)†	**0.37 (0.05 to 0.70)‡**	E	-0.28 (-0.79 to 0.23)*
-0.18 (-0.32 to -0.05)*	**-0.30 (-0.46 to -0.15)***	-0.01 (-0.13 to 0.11)*	**0.35 (0.007 to 0.69)***	-0.03 (-0.18 to 0.12)*	UC

Studies of adolescents/children

CM	-0.24 (-0.54 to 0.04)*	-0.07 (-0.34 to 0.21)*	0.15 (-0.56 to 0.87)†	0.05 (-0.21 to 0.32)†	-0.01 (-0.26 to 0.26)*
0.11 (-0.11 to 0.32)*	RSM	0.17 (-0.06 to 0.43)*	0.39 (-0.29 to 1.09)†	**0.29 (0.12 to 0.49)***	**0.23 (0.03 to 0.48)***
-0.19 (-0.38 to -0.01)*	**-0.26 (-0.49 to -0.11)***	MSM	0.22 (-0.48 to 0.92)†	0.12 (-0.11 to 0.35)*	0.06 (-0.11 to 0.24)*
-0.53 (-1.11 to 0.03)†	**-0.64 (-1.23 to -0.06)***	-0.35 (-0.92 to 0.22)†	SM	-0.10 (-0.76 to 0.57)‡	-0.16 (-0.86 to 0.55)*
-0.19 (-0.39 to -0.001)*	**-0.30 (-0.48 to -0.12)***	-0.00 (-0.14 to 0.14)*	0.35 (-0.23 to 0.92)‡	E	-0.06 (-0.28 to 0.18)*
-0.11 (-0.25 to 0.03)*	**-0.21 (-0.40 to -0.03)***	0.08 (-0.06 to 0.24)*	0.43 (-0.12 to 0.99)*	0.08 (-0.09 to 0.26)*	UC

Fig 4 | Head-to-head comparisons for healthcare use (orange) and quality of life (blue) of all four intervention models. Network meta-analysis results including all studies (top) and only studies of adolescents or children (bottom). Interventions are reported in alphabetical order. Data are standardised mean differences (95% credible intervals) in column-defining treatment compared with row-defining treatment. CM=multidisciplinary case management; E=education; MSM=minimally supported self-management; RSM=regularly supported self-management; SM=self-monitoring; UC=usual care. *Moderate quality of evidence (according to GRADE). †Low quality of evidence (GRADE). ‡Very low quality of evidence (GRADE)

self-management education at the point of diagnosis to establish appropriate practice from the outset.[50] Once established, the support can probably be less intense, with the caveat that an acute attack should be seen as a reminder to review self-management skills formally.

The investment of time in supporting people to develop self-management skills is offset by time saved in providing acute care, and our findings suggest that for most people with mild to moderate asthma, regularly supported self-management is appropriate. The additional resources needed for multidisciplinary case management may be warranted in patients with more severe asthma and complex health problems.

Understanding the action to take if asthma deteriorates is a core component of supported self-management of a variable condition such as asthma.[51] Our finding that self-monitoring as an isolated intervention was ineffective raises concerns about the plethora of available smartphone applications enabling logging of symptoms or peak flows but with no advice on how to respond to deterioration.[52] Only a few of the available applications adhere to the legislative requirements so that they can link monitoring to personalised actions recommended by the patient's healthcare adviser.

For three decades, guidelines have recommended written action plans as a device for summarising the self-management discussion between the patient and their professional adviser. Not all the randomised controlled trials included in our analysis used written action plans to reinforce advice in their self-management interventions. The format in which information is given to patients is not necessarily the crucial component, as long as the actions to be taken if asthma deteriorates are discussed, understood, agreed, and reinforced regularly. Crucially, information on managing an unexpected acute event needs to be available for reference when the attack arises (whether written, digital, online, or whatever medium is most convenient). A copy stored on the patient's electronic health record would help to ensure consistency in advice from different professionals.

Implementation remains challenging. Pressures of time, organisational barriers,[53] and the need to develop professional skills,[54] as well as negative views about the usefulness of action plans,[55-57] are barriers to adoption of supported self-management into routine clinical practice. Our findings suggest that initiatives that facilitate regular review (including mobile phone and internet interventions),[58] ensure that reviews are appropriate (for example, to cultural needs),[59] or involve non-medical or peer support[60] may offer promise for future implementation and research endeavours.[61]

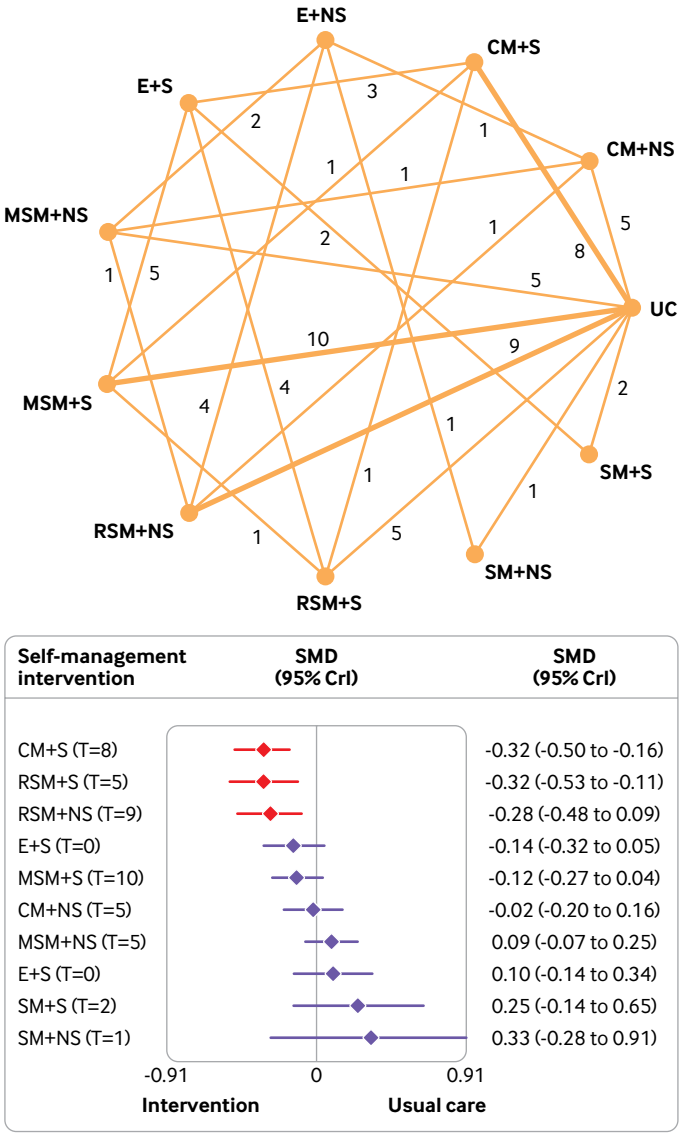


Fig 5 | Network graph and forest plot of network meta-analysis of healthcare use after adjustment for severity of asthma at baseline. CrI=credible interval; CM=multidisciplinary case management; E=education; MSM=minimally supported self-management; NS=trials in patients with mild to moderate asthma; RSM=regularly supported self-management; S=trials in patients with severe asthma; SM=self-monitoring; SMD=standardised mean difference; T=number of studies providing direct evidence

Conclusions

Our findings not only confirm the clinical benefit of supported self-management for adults, adolescents, and children with asthma but provide practical guidance for models of service that are likely to be effective. Future research and policy investments should focus on implementing regularly supported self-management offering regular reviews totalling at least two hours to establish self-management skills. This investment in time is offset by a reduction in unscheduled healthcare use. Multidisciplinary case management should be reserved for patients with complex disease. Our analysis thus brings clarity to the support needed for effective asthma self-management, which will inform guidelines, influence policy based decisions, and enable healthcare professionals and managers to optimise self-management programmes to realise the potential benefits for people living with asthma.

We thank the Evidence Synthesis-Working Group at the National Institute for Health Research (NIHR) School for Primary Care Research who are funding this project and future ongoing work. We also thank the PRISMS team (principal investigators: Stephanie Taylor, HP, and Luke Daines), who provided the list of eligible studies from their meta-review. This publication presents independent research funded by the NIHR School for Primary Care Research Project 390. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Contributors: MP, EK, and PB had the initial research idea and obtained funding for this study. AH, MP, EK, and PB formulated the research questions and designed the study. AH searched for published work, selected articles, extracted and analysed data, and drafted the protocol and manuscript. MP, SSZ, and CG helped with searching for articles and data selection and extraction. MP substantially contributed to designing the searches and the statistical analysis plan, writing the manuscript, and interpreting the findings. EK, PB, and HP substantially contributed to the manuscript by providing review comments and edits. All authors have read and approved the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. AH is the guarantor.

Funding: This study is funded by the Evidence Synthesis Working Group (project 390), which is supported by the NIHR School for Primary Care Research. The NIHR Greater Manchester Patient Safety Translational Research Centre has partly funded the time of MP. The research team members were independent from the funding agencies. The views expressed in this manuscript are those of the authors and not necessarily those of the NIHR or the Department of Health. The research team members were independent from the funding agencies. The funders had no role in the design and conduct of the study; the collection, management, analysis, and interpretation of the data; and the preparation, review, or approval of the manuscript.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: funding support from the Evidence Synthesis Working Group (project 390), NIHR School for Primary Care Research, and NIHR Greater Manchester Patient Safety Translational Research Centre for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: Not required.

Data sharing: All summary level data are available from https://data.mendeley.com/datasets/hkkptmkyw4/1, and the statistical code is provided at the end of the supplementary appendix.

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: Dissemination of this research will be done at the Health Services Research UK conference in July 2020 (https://hsruk.org/conference-2020), and though a press release from the University of Manchester and the Usher Institute at the University of Edinburgh, social media and twitter, and charities including Asthma UK and the Asthma UK Centre for Applied Research.

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Web appendix: Supplementary appendices