




# BMJ Open Patient financial incentives to improve asthma management: a systematic review

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## ABSTRACT

**Objectives** The objectives of this systematic review are to identify studies that assess the effectiveness of patient-directed financial incentive interventions to improve asthma management behaviours, determine overall effectiveness of financial incentives, identify design characteristics of effective interventions and assess the impact on longer-term outcomes in the context of asthma.

**Design** Systematic review with narrative synthesis.

**Data sources** Electronic databases (MEDLINE, Embase, Global Health, PsycINFO, CINAHL, PubMed and Web of Science) and grey literature sources (NHS Digital, CORE, ProQuest, Clinical Trials Register and EU Clinical Trials Register) were searched in November 2021 and updated March 2023.

**Eligibility criteria** Eligible articles assessed financial incentives to improve asthma management behaviours (attendance at appointments, medication adherence, tobacco smoke/allergen exposure, inhaler technique and asthma education) for patients with asthma or parents/guardians of children with asthma. Eligible study design included randomised controlled, controlled or quasi-randomised trials and retrospective/prospective cohort, case-controlled or pilot/feasibility studies.

**Synthesis** A narrative synthesis was conducted; eligible studies were grouped by asthma management behaviours and financial incentive framework domains.

**Results** We identified 4268 articles; 8 met the inclusion criteria. The studies were from the USA (n=7) and the UK (n=1). Asthma management behaviours included attendance at appointments (n=4), reduction in smoke exposure (n=1) and medication adherence (n=3). Five studies demonstrated positive behaviour change, four of which were significant (attendance at appointments (n=3) showed significant differences between intervention and control: 73% and 49% in one study, 46.3% and 28.9% in another, and 35.7% and 18.9%, respectively; medication adherence (n=1) showed significant change from 80% during intervention to 33% post intervention). These four significant studies used 'positive gain', 'certain', 'fixed' financial incentives of smaller magnitude, given for 'all' instances of behaviour.

**Conclusion** There is some evidence that patient-directed financial incentives improve asthma management behaviours. However, in view of the wide heterogeneity in study design and measured outcomes, determining overall effectiveness was challenging.

**PROSPERO registration number** CRD42021266679.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This systematic review identified studies assessing effectiveness of financial incentives to improve asthma management behaviours and identified the key design characteristics for effective studies using the financial incentive framework.
- ⇒ The wide heterogeneity of included studies, such as study design and outcome measures, made overall interpretation and assessment of clinical and longer-term impact challenging. No subgroup analysis was performed to separate the effects of the intervention on adults and children.
- ⇒ Most studies were conducted in the USA, meaning financial incentives may be more acceptable, given the prevalence of private healthcare insurance schemes.
- ⇒ Most financial incentive interventions were multi-component, making it difficult to attribute findings to the financial incentives alone.

## INTRODUCTION

Asthma is one of the most common chronic conditions in the UK and the USA affecting approximately 5.4 million individuals (4.3 million adults and 1.1 million children)<sup>1</sup> and 25 million individuals (almost 21 million adults and 4.8 million children), respectively.<sup>2</sup> The UK has some of the worst asthma outcomes in Europe including asthma deaths and hospitalisations<sup>3,4</sup> with little improvement seen in over a decade.<sup>5-7</sup> Supported self-management is an important component of asthma care<sup>8</sup> which often includes adhering to medication, attending asthma-related appointments, reducing tobacco smoke/allergen exposure, asthma education and having an effective inhaler technique.<sup>8,9</sup> Children and young people (CYP) are often supported with their asthma management by parents/guardians until they become independent to self-manage. The National Review of Asthma Deaths highlighted that most deaths are avoidable and that poor asthma management was a significant contributor.<sup>9</sup>

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Achieving sustained behaviour change to improve suboptimal disease management is complex.<sup>10</sup> Financial incentives have yielded positive results in many health-care contexts including smoking cessation,<sup>11</sup> vaccination/screening attendance,<sup>12</sup> physical activity,<sup>12</sup> weight management<sup>13</sup> and medication adherence.<sup>14–16</sup> Typically, financial incentive programmes consist of monetary rewards (cash/vouchers) or a chance to win a monetary reward (lottery-style prize draws) contingent on behaviour. Most studies provide financial incentives to adults to facilitate behaviour change that aim to improve their health or the health of their young children. However, there is a growing body of evidence for financial incentives given directly to CYP to facilitate their own healthy behaviour change; a recent review highlighted their benefits for healthy eating in school-aged children and improving glycaemic control in adolescents, with some studies showing long-term improvements for both of these behaviours.<sup>17</sup>

Financial incentive interventions vary widely in their nature, making it difficult to ascertain which characteristics are most effective for facilitating behaviour change. A financial incentive framework was developed in 2013 to guide researchers when reporting financial incentive interventions.<sup>18</sup> By using this framework, researchers can build a sufficient evidence base to allow for comparisons between studies and to identify which characteristics lead to effective behaviour change. The framework proposes nine domains: direction (framing of financial incentive), form (type of financial incentive), magnitude (total value of financial incentive offered across intervention), certainty (likelihood of receiving financial incentive after behaviour), target (type of behaviour financial incentive aims to improve), frequency (proportion of behaviour financially incentivised), immediacy (how soon after behaviour financial incentive is given), schedule (value of financial incentive for each instance of behaviour) and recipient (to whom financial incentive is given to), all of which have various dimensions. In addition to the framework's reporting benefits, several systematic reviews have used it as a synthesis tool<sup>12 19 20</sup> when comparing their included studies.

It is unknown as to if and why financial incentives are effective in different conditions, and little is known about financial incentive use in asthma care. The aim of this systematic review is to explore the effectiveness of patient-directed financial incentives in improving asthma management and to explore intervention design using the existing financial incentive framework (the term patient-directed here also encompasses incentives to parents/guardians of CYP with asthma, given the important role they play in asthma management). The objectives of this systematic review are to identify studies that assess the effectiveness of patient-directed financial incentive interventions to improve asthma management behaviours, to determine overall effectiveness, to identify the design characteristics of effective interventions using the financial incentive framework and to assess the impact of financial incentives on longer-term outcomes.

## METHODS

The protocol for this review is registered with the International Prospective Register of Systematic Reviews: CRD42021266679.

### Patient and public involvement

It was not appropriate or possible to involve patients or the public in the design, conduct, reporting or dissemination plans of our research.

### Data sources

We searched MEDLINE (Ovid), Embase (Ovid), Global Health (Ovid), PsycINFO (Ovid), CINAHL, PubMed, Web of Science and grey literature sources including NHS Digital, CORE, ProQuest, Clinical Trials Register, and EU Clinical Trials Register (November 2021, updated March 23). The searches were limited to 'English language' between 1990 and 2022. The reference lists of eligible articles were also hand-searched.

### Search strategy

Keywords, Medical Subject Headings and free-text terms identified from a scoping review of relevant literature were used, such as 'asthma\*', 'financial incentiv\*', 'financial reinforce\*', 'financial reward', 'monetary incentiv\*' and 'financial reimburse\*'. Search strategy was specific for each source dependent upon search term options (see online supplemental material 1 for full search strategy).

### Eligibility criteria

Eligible studies aimed to explore the effectiveness of patient-directed financial incentives in improving asthma management behaviours. Inclusion and exclusion criteria were based on a participants, intervention, comparator, outcome measures and study design search strategy (table 1).

### Data screening and extraction

Search results were downloaded and screened for duplications by the lead reviewer using EndNote 20 reference management tool (JH). Title and abstract screening to remove irrelevant articles and full-text screening of potentially eligible articles was conducted independently by two reviewers using 'Covidence' screening management tool (JH and BL with updated search screening conducted by JHa and LF). If any full-text articles were unavailable, the lead reviewer attempted to contact authors. Data were extracted by the two reviewers independently. Conflicts throughout the screening process were discussed between the two reviewers until an agreement was reached, with input from a third reviewer (LF).

### Risk of bias

Included randomised controlled trials (RCTs) were assessed using the revised Cochrane Risk of Bias Tool for Randomised Trials (RoB2)<sup>21</sup> and non-randomised studies were assessed using the Cochrane Risk of Bias in Non-randomised Studies of Interventions (ROBINS-I)<sup>22</sup> by two researchers (JH and BL) independently.

**Table 1** PICOS search strategy

Participants	<ul style="list-style-type: none"> <li>▶ People with asthma (patients of any age).</li> <li>▶ Parents/guardians of children and young people (aged 18 and below) with asthma.</li> </ul>
Interventions	<ul style="list-style-type: none"> <li>▶ Patient-directed financial incentives (eg, vouchers, cash, or choosing reward of monetary value, or gamification including raffle, lottery, prize draw, earning points to choose reward of monetary value) to improve asthma management.</li> </ul>
Comparison	<ul style="list-style-type: none"> <li>▶ Usual care.</li> <li>▶ Control group.</li> <li>▶ Other intervention types.</li> <li>▶ Preintervention and postintervention (repeated measures).</li> </ul>
Outcome measures	Primary outcomes (any measurements of) <ul style="list-style-type: none"> <li>▶ Adherence to medication.</li> <li>▶ Attendance at asthma-related appointments.</li> <li>▶ Smoke or allergen exposure.</li> <li>▶ Inhaler technique.</li> <li>▶ Asthma education.</li> </ul> Secondary outcomes (any measurements of) <ul style="list-style-type: none"> <li>▶ Asthma control (eg, symptoms, attacks, unscheduled healthcare visits).</li> <li>▶ Quality of life.</li> <li>▶ Airway function or inflammation.</li> </ul>
Study type	<ul style="list-style-type: none"> <li>▶ Randomised controlled trials.</li> <li>▶ Controlled trials.</li> <li>▶ Quasi-randomised trials.</li> <li>▶ Prospective/retrospective cohort studies.</li> <li>▶ Case controlled trials.</li> <li>▶ Pilot/feasibility studies will be included if sufficient data.</li> </ul>

PICOS, participants, intervention, comparator, outcome measures and study design.

## Synthesis

A narrative synthesis was conducted following the ‘synthesis without meta-analysis’ guidelines, where appropriate,<sup>23</sup> due to heterogeneity of eligible studies. A narrative synthesis aims to combine and summarise findings from studies using text and is typically used when a meta-analysis is not appropriate.<sup>24</sup> Standardised metrics were used to present intervention effects per study such as p values, mean differences and ORs, dependent on study analysis methods. Studies were grouped according to asthma management behaviour and by the financial incentive framework domains.<sup>18</sup>

## RESULTS

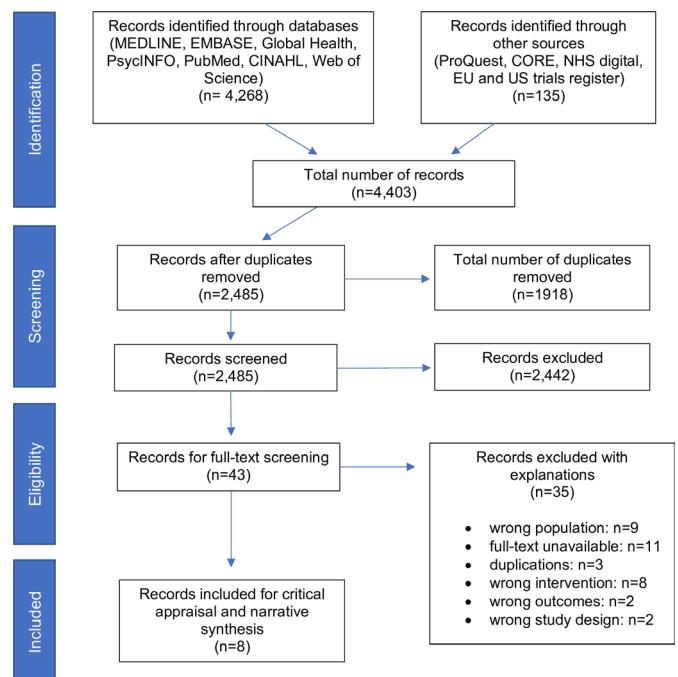
### Study selection

As detailed in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart<sup>25</sup> (see figure 1), searches identified 4268 articles; 8 met the eligibility criteria.<sup>26–33</sup>

### Study characteristics

These are detailed in online supplemental material 2. Studies were conducted in the USA (n=7)<sup>26–30 32 33</sup> and the UK (n=1).<sup>31</sup> There were five RCTs<sup>26–30</sup> and three non-randomised studies.<sup>31–33</sup> Three studies were theory-based.<sup>29 31 33</sup> Five studies provided financial incentives to patients with asthma,<sup>26 27 31–33</sup> and three studies provided financial incentives to parents of CYP.<sup>28–30</sup> There were

data available for attendance at asthma-related appointments (n=4),<sup>26–29</sup> tobacco smoke exposure (TSE) (n=1)<sup>30</sup> and medication adherence (n=3).<sup>31–33</sup> There was no evidence for inhaler technique or asthma education. Five


**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart.

RoB2 for randomised controlled trials						
Study	Risk of bias domains					Overall
	D1	D2	D3	D4	D5	
Baren et al 2006	+	-	+	+	+	-
Baren et al 2001	+	X	+	+	+	-
Jassal et al 2021	+	-	+	+	+	-
Smith et al 2004	+	-	+	+	+	-
Smith et al 2006	+	-	+	+	+	-

Domains:  
D1: Bias arising from the randomization process.  
D2: Bias due to deviations from intended intervention.  
D3: Bias due to missing outcome data.  
D4: Bias in measurement of the outcome.  
D5: Bias in selection of the reported result.

Judgement  
X High  
- Some concerns  
+ Low

ROBINS-I for non-randomised studies								
Study	Risk of bias domains							Overall
	D1	D2	D3	D4	D5	D6	D7	
DeSimoni et al., 2021	-	+	+	-	-	-	+	-
Kenyon et al., 202	-	+	+	+	+	-	+	-
Mosnaim et al., 2015	-	+	+	+	+	-	+	-

Domains:  
D1: Bias due to confounding.  
D2: Bias due to selection of participants.  
D3: Bias in classification of interventions.  
D4: Bias due to deviations from intended interventions.  
D5: Bias due to missing data.  
D6: Bias in measurement of outcomes.  
D7: Bias in selection of the reported result.

Judgement  
- Moderate  
+ Low

**Figure 2** RoB2 and ROBINS-I results for all eligible, included studies. RoB2, Cochrane Risk of Bias Tool for Randomised Trials; ROBINS-I, Cochrane Risk of Bias in Non-randomised Studies of Interventions.

studies showed improvements in asthma management behaviours,<sup>26–28 32 33</sup> four of which were statistically significant (attendance at appointments (n=3) showed significant differences between intervention and control groups, 73% and 49% in one study<sup>26</sup>; 46.3% and 28.9% in one study<sup>27</sup>; and 35.7% and 18.9% in another study<sup>28</sup>; medication adherence (n=1) showed significant change from 80% during intervention to 33% post intervention<sup>32</sup>).

Four studies assessed ‘one-off’ behaviours (eg, attendance at one asthma-related appointment<sup>26–29</sup>), so longer-term behaviour change was not reported. However, two studies assessing medication adherence reported follow-up data after cessation of the financial incentives; neither demonstrated sustained behaviour change.<sup>29 30</sup>

Four studies reported clinical outcomes throughout the intervention, including subsequent hospitalisations,<sup>26 32</sup> asthma symptoms<sup>28</sup> and asthma control<sup>33</sup>; only one study showed a significant difference in decrease of asthma symptoms post intervention between control and intervention; however, this difference was not sustained at the 6-month follow-up.<sup>28</sup>

### Risk of bias in studies

The RCTs (n=5),<sup>26–30</sup> assessed by RoB2, had ‘some concerns’ of bias arising from lack of blinding. Non-randomised studies (n=3)<sup>31–33</sup> had ‘moderate’ risk of

bias arising from confounding, assessed by ROBINS-I (figure 2).

### Asthma management behaviours

#### Attendance at asthma-related appointments

Four RCTs were conducted which aimed to improve attendance at one primary care provider (PCP) appointment following presentation to an emergency department (ED) with an asthma attack.<sup>26–29</sup> All studies assessed attendance by self-report, which was confirmed by medical records. Studies explored multicomponent interventions including financial incentives (transportation vouchers to patients/cash to parents) alongside free medication, reminders<sup>27</sup> and appointment time preferences<sup>26</sup> or asthma coaching.<sup>28 29</sup> There was mixed effectiveness; three studies showed significant benefit.<sup>26–28</sup> These were two studies providing transportation vouchers to patients<sup>26 27</sup> and one study providing cash to parents of children with asthma.<sup>29</sup> One significant study had two financial incentives arms.<sup>26</sup> The arm that provided financial incentives alongside a preference of appointment time yielded significant results compared with other financial incentives arm and control arm, suggesting the appointment time preference had a larger impact, compared with the incentive. In addition, two studies conducted by similar research groups<sup>28 29</sup> found only one intervention to be

significant.<sup>29</sup> Although the financial incentives were similar in each study, the difference in statistical significance may be related to differences in the location and timing of the asthma coaching offered alongside the financial incentives (coaching via a telephone call 2 and 5 days after an ED visit vs coaching in the ED), as well as differences in sample size and incentivisation of control group participants.

Two studies reported clinical outcomes<sup>26 28</sup>; one study showed no significant difference between groups in asthma control measures (including subsequent hospitalisations or inhaled corticosteroid (ICS) use) at 30-day and 1-year follow-up<sup>26</sup>; and one study showed decreases in asthma symptoms for both groups between baseline and 6-month follow-up.<sup>28</sup> However, between baseline and 2 weeks, asthma symptoms decreased significantly more in intervention compared with control.<sup>28</sup>

Financial incentive uptake was reported in two studies; one study reported only 27% of transportation vouchers were used to attend an asthma-related appointment,<sup>27</sup> while another study reported 100% of cheques were cashed post attendance at an asthma-related appointment.<sup>28</sup> Two studies provided reward contingent on parental self-report of attendance, and both studies showed over-reporting when compared with objective measure.<sup>28 29</sup> One study provided all parents with \$15 to compensate for their time when introducing the study in the ED.<sup>29</sup>

#### Tobacco smoke or allergen exposure

One RCT testing financial incentives alone in the form of cash (given to maternal caregiver of child with asthma and one chosen member of social network who both actively smoke and contribute to child's TSE) showed no effect on reducing passive TSE measured by mean change in monthly paediatric salivary cotinine levels.<sup>30</sup> There were no follow-up data reported, and paediatric asthma control was only assessed at baseline.

It was reported that only 1 of 90 adult participants (maternal caregivers/social network member) earned the maximum financial incentive, with an average earning of \$100/\$250 per month. All control triads (child, maternal caregiver and social network member) were given \$20 reimbursement each month for study participation (\$120 maximum).

#### Medication adherence

Three non-randomised prestudies–poststudies targeted medication adherence of financial incentives in the form of cash or vouchers given to patients (aged 5–18).<sup>31–33</sup> All studies were feasibility studies, two of which assessed feasibility/acceptability and medication adherence as the primary outcome<sup>31 33</sup> and one solely assessed feasibility/acceptability as the primary outcome, with medication adherence as a secondary outcome.<sup>32</sup> All studies measured adherence using electronic monitoring devices, and all interventions were multicomponent, including financial incentives alongside electronic reminders,<sup>31</sup>

electronic reminders and weekly feedback<sup>32</sup> and electronic reminders, asthma education, tailored feedback, reinforcement and other rewards.<sup>33</sup> Only one study showed significant improvement in adherence when providing cash.<sup>32</sup> Two studies assessed asthma control<sup>32 33</sup> (eg, asthma control test (ACT) or ED visits/hospitalisations), one of which showed 58% achieved the clinically important difference in ACT score.<sup>33</sup> Both studies which had follow-up data demonstrated a subsequent decline in adherence, once the incentive was removed.<sup>31 32</sup>

The UK study reported the average reward earned by participants across the 8-week intervention ranged between £50 and £104 (out of a possible £112 maximum).<sup>31</sup> One study all gave caregivers \$20 reimbursement for each study visit they completed throughout the intervention.<sup>32</sup>

#### Financial incentive framework domains

Financial incentive domain definitions and characteristics by study are detailed in online supplemental material 3 and are described further.

#### Direction

All studies used 'positive reward'<sup>26–33</sup>; there was no removal or reduction of reward for non-engagement with incentivised behaviour.

#### Form

Four studies used 'vouchers' (transportation vouchers, specifically for PCP appointment travel<sup>26 27</sup>/smartphone application vouchers<sup>33</sup>/online retail gift cards<sup>31</sup>) and four studies provided 'cash' (cheques<sup>28 29</sup>/debit card<sup>32</sup>/cash<sup>30</sup>).

#### Magnitude

In the US studies, total available financial incentives ranged between \$15 and \$500 per intervention (\$15 (n=2),<sup>26 27</sup> \$30 (n=3),<sup>28 29 32</sup> \$112 (n=1)<sup>33</sup> and \$500 (n=1)).<sup>30</sup> The UK study offered participants up to £112.<sup>31</sup>

#### Certainty

All eight studies used 'certain' financial incentives<sup>26–33</sup>; there was no use of 'uncertain' incentives such as lottery tickets.

#### Target

Four studies targeted 'process' behaviours (attending PCP appointment<sup>26–29</sup>); one study targeted an 'outcome' behaviour (TSE<sup>30</sup>); and three studies targeted 'intermediate' behaviours (medication adherence<sup>31–33</sup>).

#### Frequency

Seven studies incentivised 'all' behaviours (eg, for every instance of engagement in target behaviour such as attending a single follow-up asthma appointment<sup>26–29</sup> and full-dose inhaler use<sup>31–33</sup>). The TSE study incentivised 'some' behaviours by rewarding monthly cotinine test results rather than daily smoking data.<sup>30</sup>



## Immediacy

Two studies provided financial incentives prior to behaviour (eg, transport voucher to enable attendance at one PCP appointment<sup>26,27</sup>). The TSE study provided financial incentives immediately after the monthly cotinine test.<sup>30</sup> Five studies provided delayed financial incentives: two post behaviour (between 0 week and 2 weeks after attendance at one PCP appointment)<sup>28,29</sup> and three post intervention (two after an 8-week intervention<sup>31,33</sup> one after a 1-month intervention<sup>32</sup>), where rewards were accumulated depending on daily medication adherence.

## Schedule

All studies used 'fixed' incentives.<sup>26-33</sup> For example, medication adherence studies offered the same financial incentive value per full-dose/adherent day to each participant (ranging from \$0.25 to \$1.00/£1.00)<sup>31-33</sup> and attendance at asthma-related appointment studies offered \$15 either per appointment attended<sup>28,29</sup> or per travel to and from appointment.<sup>26,27</sup> The TSE study used both fixed and 'variable' incentives. All participants were offered \$50 per successful reduction in cotinine test compared with baseline but were also offered a \$100 bonus at two time points for continued cotinine reduction across the previous 3 months.<sup>30</sup>

## Recipients

All studies provided financial incentives to 'individuals'.<sup>26-33</sup> Five studies provided financial incentives to patients with asthma<sup>26,27,31-33</sup> (three included CYP (age ranging between 5 years old and 18 years old)<sup>31-33</sup>; one included both young people and adults (16–45 years old, no children)<sup>27</sup>; and one included both CYP and adults (2–54 years old)<sup>26</sup>). For the latter study, it was unclear whether financial incentives were given to parents of younger children. Three studies provided financial incentives to parents of CYP (2–12 years old) with asthma.<sup>20-30</sup>

All US studies targeted urban minority populations,<sup>26-30,32,33</sup> four of which were described as poor/low-income,<sup>26,28-30</sup> with one study reporting >70% of participants' annual income was below the poverty level.<sup>30</sup> Six studies reported health insurance status; three specifically recruited participants with either government (eg, Medicaid) or no insurance<sup>28,29,33</sup>; and three reported between 73% and 79% of participants had government or no insurance at baseline.<sup>26,27,32</sup>

The UK study recruited participants from the NHS (government-funded healthcare system).<sup>31</sup>

## Summary of effective financial incentive framework domains

The four studies that demonstrated significant behaviour change were designed using the following financial incentive characteristics. All studies used 'positive gain', certain, fixed financial incentives that were given for all instances of behaviour.<sup>26-28,32</sup> Financial incentives were cash (cheque/study debit card<sup>28,32</sup>) or transportation vouchers<sup>26,27</sup> of smaller magnitude (\$15–\$30).<sup>26-28,32</sup> Financial incentives targeted attending asthma-related

appointments<sup>26-28</sup> and medication adherence<sup>32</sup> and were provided to patients with asthma<sup>26,27,32</sup> or to parents of CYP with asthma.<sup>28</sup>

## DISCUSSION

### Summary of findings

We found limited evidence for the effectiveness of financial incentives to improve asthma management. Eight eligible studies were identified, and the four studies that demonstrated significant behaviour change, for attendance at asthma-related appointments and medication adherence, used positive gain, certain, fixed financial incentives, given for all instances of behaviour that were of smaller magnitude.<sup>26-28,32</sup>

### Comparison with other studies

In this review, three out of the four studies showing significant results were aimed at improving attendance at an asthma-related appointment.<sup>26-28</sup> This finding aligns with existing reviews that found financial incentives to be most effective when targeting simple, infrequent behaviours (such as one-off behaviours), compared with more complex behaviours (such as smoking cessation).<sup>34-36</sup> As these simple behaviours are more feasible to achieve, the benefit of obtaining a financial reward is likely to outweigh any negatives. However, there is also some evidence suggesting providing financial incentives for an infrequent behaviour can have a negative effect. For example, an RCT found that financial incentives did not improve uptake of diabetes screening,<sup>37</sup> with suggestions that the financial incentive could have implied negative associations (eg, it must be unpleasant, if they are offering a reward).

The four studies included in this review targeting attendance at asthma-related appointments were simple ED interventions<sup>26-29</sup> (eg, participants were encouraged to arrange and attend one follow-up appointment and were rewarded for their attendance<sup>28,29</sup> or given a prepaid voucher for travel<sup>26,27</sup>), and although most showed promising results, the findings may not translate to other appointments (such as yearly asthma reviews) as compliance may be falsely elevated post attack.

Asthma medication adherence studies which aimed to facilitate behaviour change in CYP<sup>31-33</sup> share similar features with successful financial incentive interventions conducted for children with diabetes, such as the magnitude, direction, frequency and schedule of financial incentive.<sup>38-40</sup> However, included studies were intervention-only (no control group) with small sample sizes<sup>31-33</sup> and the use of randomisation is recommended to strengthen findings.

The longer-term impact of financial incentives on behaviour needs further exploration. Existing evidence rarely explores this, and those that have often see a decline in behaviour once financial incentives are removed,<sup>34,41</sup> which could be due to an expectation of reward. Only two included studies explored follow-up data, and there

was no sustained behaviour change.<sup>31 33</sup> However, as four of the included studies were exploring one-off behaviours (eg, attendance of one follow-up appointment<sup>26-29</sup>), this was not feasible to assess this longer term.

It is also important for behaviour change interventions to assess clinical outcomes, but this is seldom done. More recent studies assessing financial incentives to improve paediatric diabetes self-management report findings of both self-management behaviours and whether this translates to changes in average blood glucose levels (haemoglobin A1c).<sup>38-40</sup> Only half of the included studies for this review assessed at least one clinical outcome.<sup>26 28 32 33</sup> An intervention can facilitate behaviour change, but if this does not translate to any clinical benefit, is it worthwhile?

The financial incentive framework was a useful tool for comparing financial incentive characteristics between studies. This review provided some evidence towards which financial incentive characteristics facilitated effective behaviour change in asthma management.

The magnitude of incentive could determine likelihood of behaviour. Health economics principle suggests the larger the incentive, the more likely the behaviour change,<sup>42</sup> yet the included asthma study which provided the largest incentive was negative.<sup>30</sup> On the other hand, behavioural economics suggests that even small incentives can be effective.<sup>43</sup> For example, behaviour change in children is often facilitated by smaller financial incentives,<sup>17 38-40</sup> which is supported by our findings to some extent in the medication adherence interventions.<sup>31-33</sup> Additionally, financial incentives are likely to be more effective when provided to those from lower socioeconomic backgrounds.<sup>34 44 45</sup> There is some evidence to support this in our findings. Included US studies recruited from poor/low-income populations<sup>26 28-30</sup> or enrolled participants with primarily government-funded healthcare insurance<sup>26-29 32 33</sup> with majority offering smaller financial incentives,<sup>26-29 32 33</sup> five of which demonstrated asthma management behaviour change.<sup>26-28 32 33</sup> However, as there is no comparison of low to high socioeconomic status within or between studies, this concept needs further exploration.

It is possible that there is some interaction between domains which could contribute to the effectiveness of financial incentives. For example, if frequent and smaller incentives are preferred compared with one large reward, this suggests an interaction between magnitude and frequency. However, these interactions may also be person-specific.

Seven studies<sup>26-29 31-33</sup> rewarded all (eg, reward for every time inhaler was used) rather than some (eg, reward for monthly cotinine level, not for every cigarette missed<sup>30</sup>) instances of behaviour. In some cases, rewarding some and not all instances of behaviour may reduce motivation for behaviour change. For example, if a medication adherence intervention rewarded daily adherence rather than morning and evening adherence separately, participants who do not take their morning dose may be

less motivated for their evening dose as they would not receive the daily reward.

Although not explicitly detailed within the financial incentive framework, it would also be useful for studies to report total financial incentive uptake throughout the intervention to give some indication of intervention fidelity. Four studies in this review reported this to some extent,<sup>27 28 30 31</sup> but the variation in what was reported made any comparisons challenging. However, reporting these findings could also provide some indication of financial incentive feasibility and acceptability, which may contribute to the understanding as to why an intervention is or is not effective or may provide insight on how the intervention could be improved. For example, one study in this review detailed only 27% of transportation vouchers<sup>27</sup> were claimed, which could suggest poor acceptability.

In addition, it would also be useful for the financial incentive framework to discuss the target behaviour in more depth. The framework currently offers the following 'target behaviour' dimensions: outcome, intermediate or process behaviour, which does not include whether the behaviour is complex (eg, smoking cessation) or simple (eg, attending appointments). This would be an important addition to the framework to establish whether financial incentives have different impacts on these behaviours.

### Strengths and limitations

This systematic review identified studies assessing effectiveness of financial incentives to improve asthma management behaviours through an extensive search of the literature and identified the key design characteristics for effective studies using the financial incentive framework.

The wide heterogeneity of included studies made interpretation of findings challenging. However, as financial incentive use in asthma is limited, it was important to identify all studies conducted to date. Some eligible studies in this review included both adult and paediatric populations; however, the results were not analysed separately. Therefore, from these studies, it is difficult to ascertain whether a population group had any impact on the financial incentive effectiveness. In addition, the studies that targeted attendance at asthma-related appointments can be grouped into two, where studies are replications of each other from same/similar authorships but on larger scales,<sup>26-29</sup> which could reduce generalisability of results.

As this review aimed to identify all studies conducted within asthma, it should be noted that all searches were limited by 'English language', which may fail to cover a true global search.<sup>46</sup>

Most studies were conducted in the USA, which may mean participants are more familiar with the transactional nature of healthcare since the USA operates mainly through private healthcare insurance schemes. This suggests financial incentive programmes may be more feasible and acceptable compared with other global areas, potentially reducing generalisability of results.



Seven studies,<sup>26–29 31–33</sup> including five that showed positive behaviour change,<sup>26–28 32 33</sup> were multicomponent interventions. This made it difficult to attribute findings to the financial incentives alone. However, this suggests that financial incentives may work best alongside other components for an intervention to be successful, especially as the only study testing solely a financial incentive intervention yielded non-significant results.<sup>30</sup> Finally, one study that showed significant results had multiple financial incentive arms, which suggested the preference of appointment time was more influential than the financial reward.<sup>26</sup>

A common recruitment or retention technique within research is to reimburse participants with a monetary reward<sup>47</sup>; however, if also assessing the effectiveness of a financial incentive intervention, reimbursement could undermine validity of results. Two studies included in this review adopted this technique by providing \$20 reimbursement to parents/social network members for completion of each study visit.<sup>29 30</sup> One of these studies reimbursed parents in both the control and intervention (in addition to the money in the intervention) arm,<sup>29</sup> whereas one study gave this reimbursement to control participants only.<sup>30</sup> One non-randomised study provided \$15 to parents for enrolling their child in the programme.<sup>32</sup> Providing a financial reward to those in the control group may have altered engagement with the study, perhaps not giving a true representation of patient behaviour. However, compensation for those randomised to a control group is important for research ethics. The three remaining randomised studies did not report any form of reimbursement for those in the control group.<sup>26–28</sup>

### Future research

Further research is needed to determine overall effectiveness and to compare financial incentive characteristics such as direction, frequency and magnitude to identify their contribution to intervention effectiveness. Most studies did not effectively assess clinical outcomes or longer-term impact on behaviour change, which are important when evaluating overall intervention success. Similarly, it would be helpful for studies to stratify data based on participant age and socioeconomic status to determine any financial incentive effectiveness differences. Cost-effectiveness should also be explored to assess the suitability of using financial incentives within standard clinical practice.

### CONCLUSION

There is some evidence that financial incentives can improve asthma management behaviours. Studies that showed significant improvements in asthma management behaviours used positive gain, certain, fixed financial incentives of smaller magnitude, given for all instances of behaviour. Interventions were predominantly multi-component and financial incentive design was diverse, making it difficult to draw conclusions on what financial incentive characteristics were most effective. Further

research is needed to establish intervention design and to assess impact on clinical asthma outcomes, and cost-effectiveness assessments would be a useful additional parameter to help determine policy and practice.

**Correction notice** This article has been corrected since it was first published. Affiliation 3 has been updated.

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### REFERENCES

- 1 Asthma + Lung UK. What is asthma. Available: <https://www.asthma.org.uk/advice/understanding-asthma/what-is-asthma/> [Accessed 15 Oct 2022].
- 2 Asthma and Allergy Foundation of America. Asthma facts and figures. 2023. Available: <https://aafa.org/asthma/asthma-facts/>
- 3 Asthma + Lung UK. UK asthma deaths rates among worst in Europe. Available: <https://www.asthma.org.uk/about/media/news/press-release-uk-asthma-death-rates-among-worst-in-europe/> [Accessed 15 Oct 2022].
- 4 Wolfe I, Thompson M, Gill P, *et al.* Health services for children in Western Europe. *Lancet* 2013;381:1224–34.
- 5 Nuffield Health Trust. Uk young people let down on long-term illness new international report finds. 2019. Available: <https://www.nuffieldtrust.org.uk/public/news-item/uk-young-people-let-down-on-long-term-illness-new-international-report-finds> [Accessed 15 Oct 2022].
- 6 Nuffield Health Trust. How has the rate of emergency admissions for asthma for children and young people changed over time. 2018. Available: <https://www.nuffieldtrust.org.uk/public/chart/how-has-the>

- rate-of-emergency-admissions-for-asthma-for-children-and-young-people-changed-over-time-1 [Accessed 15 2022].
- 7 Asthma + Lung UK. The great asthma divide. 2019. Available: <https://www.asthma.org.uk/58a0ecb9/globalassets/campaigns/publications/The-Great-Asthma-Divide.pdf> [Accessed 15 2022].
  - 8 Pinnock H, Parke HL, Panagioti M, *et al.* Systematic meta-review of supported self-management for asthma: a Healthcare perspective. *BMC Med* 2017;15:64.
  - 9 Royal College of Physicians. Why asthma still kills: the National review of asthma deaths (NRAD). 2014. Available: <https://www.rcplondon.ac.uk/projects/outputs/why-asthma-still-kills> [Accessed 15 2022].
  - 10 Michie S, Van Stralen MM, West R. The behaviour change wheel: A new method for Characterising and designing behaviour change interventions. *Implement Sci* 2011;6:42.
  - 11 Tappin D, Sinclair L, Kee F, *et al.* Effect of financial voucher incentives provided with UK stop smoking services on the cessation of smoking in pregnant women (CPIT III): pragmatic, Multicentre, single blinded, phase 3, randomised controlled trial. *BMJ* 2022;379:e071522.
  - 12 Giles EL, Robalino S, McColl E, *et al.* The effectiveness of financial incentives for health behaviour change: systematic review and meta-analysis. *PLoS One* 2014;9:e90347.
  - 13 Pasdar Y, Najafi F, Darbandi M, *et al.* Financial incentive strategy for weight loss and maintenance of weight loss. *J Prev Med Hyg* 2021;62:E206–12.
  - 14 Petry NM, Rash CJ, Byrne S, *et al.* Financial Reinforcers for improving medication adherence: findings from a meta-analysis. *Am J Med* 2012;125:888–96.
  - 15 Priebe S, Yeeles K, Bremner S, *et al.* Effectiveness of financial incentives to improve adherence to maintenance treatment with antipsychotics: cluster randomised controlled trial. *BMJ* 2013;347:f5847.
  - 16 Barankay I, Reese PP, Putt ME, *et al.* Effect of patient financial incentives on Statin adherence and lipid control: A randomized clinical trial. *JAMA Netw Open* 2020;3:e2019429.
  - 17 Kenyon CC, Flaherty C, Floyd GC, *et al.* Promoting healthy childhood behaviors with financial incentives: A narrative review of key considerations and design features for future research. *Acad Pediatr* 2022;22:203–9.
  - 18 Adams J, Giles EL, McColl E, *et al.* Carrots, sticks and health Behaviours: a framework for documenting the complexity of financial incentive interventions to change health Behaviours. *Health Psychol Rev* 2014;8:286–95.
  - 19 Jackson T, Shields MD, Heaney LG, *et al.* The impact of financial incentives on the implementation of asthma or diabetes self-management: A systematic review. *PLoS One* 2017;12:e0187478.
  - 20 Luong M-LN, Hall M, Bennell KL, *et al.* The impact of financial incentives on physical activity: a systematic review and meta-analysis. *Am J Health Promot* 2021;35:236–49.
  - 21 Sterne JAC, Savović J, Page MJ, *et al.* Rob 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019;366:l4898.
  - 22 Sterne JA, Hernán MA, Reeves BC, *et al.* ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016;355:i4919.
  - 23 Campbell M, McKenzie JE, Sowden A, *et al.* Synthesis without meta-analysis (swim) in systematic reviews: reporting guideline. *BMJ* 2020;368:l6890.
  - 24 Popay J, Roberts H, Sowden A. *Guidance on the conduct of narrative synthesis in systematic reviews: a product of the ESRC methods programme (Version1)*. Lancaster, UK: University of Lancaster, 2006.
  - 25 Page MJ, McKenzie JE, Bossuyt PM, *et al.* The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71.
  - 26 Baren JM, Boudreaux ED, Brenner BE, *et al.* Randomized controlled trial of emergency Department interventions to improve primary care follow-up for patients with acute asthma. *Chest* 2006;129:257–65.
  - 27 Baren JM, Shofer FS, Ivey B, *et al.* A randomized, controlled trial of a simple emergency Department intervention to improve the rate of primary care follow-up for patients with acute asthma exacerbations. *Ann Emerg Med* 2001;38:115–22.
  - 28 Smith SR, Jaffe DM, Fisher Jr EB, *et al.* Improving follow-up for children with asthma after an acute emergency Department visit. *J Pediatr* 2004;145:772–7.
  - 29 Smith SR, Jaffe DM, Highstein G, *et al.* Asthma coaching in the pediatric emergency Department. *Acad Emerg Med* 2006;13:835–9. Available <http://blackwell-synergy.com/doi/abs/10.1197/acem.2006.13.issue-8>
  - 30 Jassal MS, Lewis-Land C, Thompson RE, *et al.* Randomised pilot trial of cash incentives for reducing Paediatric asthmatic tobacco smoke exposures from maternal Caregivers and members of their social network. *Arch Dis Child* 2021;106:345–54.
  - 31 De Simoni A, Fleming L, Holliday L, *et al.* Electronic reminders and rewards to improve adherence to inhaled asthma treatment in adolescents: a non-randomised feasibility study in tertiary care. *BMJ Open* 2021;11:e053268.
  - 32 Kenyon CC, Sundar KG, Grushchow SM, *et al.* Tailored medication adherence incentives for high-risk children with asthma: a pilot study. *J Asthma* 2020;57:1372–8.
  - 33 Mosnaim G, Li H, Martin M, *et al.* A tailored mobile health intervention to improve adherence and asthma control in minority adolescents. *J Allergy Clin Immunol Pract* 2015;3:288–90.
  - 34 Mantzari E, Vogt F, Shemilt I, *et al.* Personal financial incentives for changing habitual health-related behaviors: a systematic review and meta-analysis. *Prev Med* 2015;75:75–85.
  - 35 Sutherland K, Christianson JB, Leatherman S. Impact of targeted financial incentives on personal health behavior: a review of the literature. *Med Care Res Rev* 2008;65(6 Suppl):36S–78S.
  - 36 Jochelson K. Kings fund: paying the patient: improving health using financial incentives. 2007. Available: [https://www.kingsfund.org.uk/sites/default/files/field/field\\_document/paying-the-patient-kicking-bad-habits-supporting-paper-karen-jochelson.pdf](https://www.kingsfund.org.uk/sites/default/files/field/field_document/paying-the-patient-kicking-bad-habits-supporting-paper-karen-jochelson.pdf) [Accessed 15 Oct 2022].
  - 37 Judah G, Darzi A, Vlaev I, *et al.* Financial disincentives? A three-armed randomised controlled trial of the effect of financial incentives in diabetic eye assessment by screening (IDEAS) trial. *Br J Ophthalmol* 2018;102:1014–20.
  - 38 Wong CA, Miller VA, Murphy K, *et al.* Effect of financial incentives on glucose monitoring adherence and Glycemic control among adolescents and young adults with type 1 diabetes: a randomized clinical trial. *JAMA Pediatr* 2017;171:1176–83.
  - 39 Petry NM, Cengiz E, Wagner JA, *et al.* Testing for rewards: a pilot study to improve type 1 diabetes management in adolescents. *Diabetes Care* 2015;38:1952–4.
  - 40 Wagner JA, Petry NM, Weyman K, *et al.* Glucose management for rewards: a randomized trial to improve glucose monitoring and associated self-management behaviors in adolescents with type 1 diabetes. *Pediatr Diabetes* 2019;20:997–1006.
  - 41 Camerer CF. Removing financial incentives Demotivates the brain. *Proc Natl Acad Sci U S A* 2010;107:20849–50.
  - 42 Kane RL, Johnson PE, Town RJ, *et al.* A structured review of the effect of economic incentives on consumers' preventive behavior. *Am J Prev Med* 2004;27:327–52.
  - 43 Vlaev I, King D, Darzi A, *et al.* Changing health behaviors using financial incentives: a review from behavioral economics. *BMC Public Health* 2019;19:1059.
  - 44 Promberger M, Brown RCH, Ashcroft RE, *et al.* Acceptability of financial incentives to improve health outcomes in UK and US samples. *J Med Ethics* 2011;37:682–7.
  - 45 White M, Adams J, Heywood P. How and why do interventions that increase health overall widen inequalities within populations? In: Babones S, ed. *Social inequality and public health*. Bristol: Policy Press, 2009: 65–82.
  - 46 Stern C, Kleijnen J. Language bias in systematic reviews: you only get out what you put in. *JBI Evid Synth* 2020;18:1818–9.
  - 47 Grady C. Payment of clinical research subjects. *J Clin Invest* 2005;115:1681–7.