Pharmacists and medication adherence in asthma: a systematic review and meta-analysis

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Take-Home Message
Pharmacist-led interventions can improve medication adherence in people with asthma

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Author's contributions

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Abstract

The Lancet Asthma Commission highlighted that non-adherence remains a persistent barrier within asthma care. Medical consultations remain pivotal in addressing non-adherence, but interest in additional adherence support from pharmacists is increasing. This systematic review and meta-analysis aims to evaluate how effective pharmacist-led interventions are in improving medication adherence in adults with asthma.

Studies were included if they had adult participants with asthma, pharmacist-led or collaborative care interventions, randomised controlled trial (RCT) designs comparing interventions with usual pharmacist care, and a medication adherence outcome. We analysed adherence data using the standardised mean difference (*d*) and the remaining data was synthesized narratively.

From 1159 records, 11 were included in the narrative synthesis and nine in the meta-analysis. The meta-analysis for adherence produced a medium effect size of $d = 0.49$ (SE = 0.08, 95% CI 0.35-0.64, $p < 0.0001$) with low statistical heterogeneity.

In line with the Perceptions and Practicalities Approach (PAPA), interventions targeted to address both the perceptions and practicalities that influence individual motivation and ability to adhere were more effective. Contextual factors (country and healthcare setting) were also influential. Our findings suggest that with adequate remuneration and integration into asthma care, pharmacists can help improve adherence in asthma.

Plain Language Summary

Many people with asthma get a preventer inhaler to take every day. This inhaler has a small dose of steroids that protects the lungs from asthma attacks. These inhalers only protect against attacks if they are used every day (as prescribed). Taking medication exactly as prescribed by a healthcare professional is known as medication adherence. Forgetting or skipping the inhaler, changing the daily dose, or not picking up prescriptions are all examples of medication non-adherence. Medication non-adherence is common in people with asthma. Pharmacists may have the right training and knowledge to help people with asthma take their inhaler more consistently. We reviewed past research on this topic by summarising and comparing published studies. We found that pharmacists are able to help people take their preventer inhaler regularly as prescribed.

Introduction

There are over 300 million people with asthma worldwide and this figure is set to increase by 100 million by 2025 [1, 2]. Research has consistently demonstrated a link between asthma, poor health outcomes, and substantial healthcare costs [3-6]. Better implementation of current diagnosis and management strategies may help reduce the impact of asthma globally. However, global asthma mortality rates have not changed in over a decade and novel approaches to support people with asthma should also be considered [3, 7].

Adherence to inhaled preventive asthma medication is sub-optimal in over 50% of people with asthma, with the recent Lancet Asthma Commission calling for more effective methods of identifying and addressing non-adherence [7, 8]. Although the medical consultation is pivotal, there is increasing interest in additional support delivered outside the consultation. Due to the growing pressure on primary care practitioners, interest in pharmacist-led adherence support has grown, as demonstrated by recent healthcare initiatives and government policy [9-12]. Although several studies have examined pharmacist-led adherence support, this literature has not been reviewed.

The aims of our systematic review and meta-analysis were to determine 1.) the overall effectiveness of pharmacist-led adherence support for adults with asthma 2.) whether the *content* of interventions influenced their effectiveness. In particular, whether or not they applied adherence theory and behaviour change strategies, and 3.) whether the *context* of interventions (country and healthcare setting) influenced their effectiveness [13].

Methods

We conducted a systematic review and meta-analysis. Our protocol was registered on the International Prospective Register of Systematic Reviews (record CRD42016035657, http://www.crd.york.ac.uk/PROSPERO) by the Centre for Reviews and Dissemination (CRD). The review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14].

Search strategy

We searched four pharmacy-relevant databases (EMBASE, MEDLINE, Web of Science, and CENTRAL). The search began on May 5th 2016, with weekly alerts for new publications until the last search on June 15th 2017. Our search strategy used database-specific vocabulary (e.g. Medical Subject Headings) and free text expanding from "pharmacist" and "asthma". As we wanted to capture studies even if adherence was not a primary intervention target, "adherence" was not included as a search term. Cochrane Collaboration search filters for identifying randomised controlled trials (RCTs) were used on MEDLINE (sensitivity-maximising) and EMBASE (sensitivity-and-precision maximising) [15, 16]. We included literature published in English, Spanish, German, and Dutch (languages spoken by the research team). There were no restrictions on publication date.

Study selection

EndNote reference manager was used to store records and remove duplicates [17]. Authors of studies were contacted if further information was needed for an inclusion decision. One investigator (MM) screened all titles and abstracts. Inclusion decisions were cross-checked with other research team members (CK, RH, and ST). Two investigators (CK and MM)

independently screened full-text articles. All inconsistent inclusion decisions were resolved through consensus.

Inclusion criteria followed the Participant-Intervention-Comparison-Outcome-Study Design (PICOS) framework [15]. Participants were adults with asthma and no other respiratory conditions, with a prescription for asthma medication. There were no restrictions on how asthma was diagnosed. We excluded participants with other respiratory conditions because their medication and adherence behaviour may be different to participants with only an asthma diagnosis. During our initial searches, we found many studies that included underage (17 years and below) and adult participants (18 years and over). Separate group data were often unavailable. We therefore included studies if the majority of participants were adults.

Intervention content could be partially or completely delivered by a pharmacist (i.e. pharmacist-led). Collaborative care interventions delivered with other healthcare professionals (e.g. nurses) were included only if pharmacists were involved in delivering intervention content. We excluded studies where pharmacists only assisted in research activities (e.g. recruitment). Studies had to compare pharmacist-led interventions with usual pharmacist care in a RCT design. Usual pharmacist care was defined as dispensing and providing basic information about asthma and its treatment.

We included studies with adherence as a primary or secondary outcome. We focused on summary estimates, rather than participant-level data. Where studies used multiple measures of adherence, the most objective measure was included in the following order: electronic adherence monitoring devices (e.g. Doser™, Smartinhaler™), pharmacy-based data (e.g. prescription refill rates), patient self-report measures, and reports from healthcare professionals or carers. RCTs were randomised at the participant or cluster level. We focused only on RCTs to compare data of a similar methodological standard.

Data collection

Authors of included studies were contacted for further information about study design and intervention content. Published protocols were consulted where possible. We used the Cochrane Collaboration's tool to assess risk of bias [18]. We extracted data about research design, location, healthcare setting, participants, outcome measures, intervention delivery, and intervention content (See Supplement 1). One investigator (MM) extracted this data across all studies. Another investigator (CK) independently extracted intervention content data and coded risk of bias across 25% of included studies for crosschecking.

We categorised intervention content based on 1.) whether it was informed by a Perceptions and Practicalities Approach (PAPA), as recommended by the National Institute for Health and Care Excellence (NICE) guidelines for medicines adherence [19, 20] (Figure 1) and 2.) the implemented Behaviour Change Techniques (BCTs) as defined by Michie, Richardson [21]. According to the PAPA, tailored interventions targeted to address the perceptions (e.g. beliefs about illness and treatment) and practicalities (e.g. capability and resources) affecting motivation and ability to adhere to treatment are more effective [19].

Interventions were categorised as non-PAPA (targeting only perceptions or practicalities), partial PAPA (targeting perceptions and practicalities), or full PAPA interventions (tailored approach targeting perceptions and practicalities). The BCT Taxonomy is a classification that outlines standardised techniques that can change behaviour when applied in the right context

(e.g. “demonstration of a behaviour” to teach inhaler technique) [21]. It is a useful tool to identify exactly which parts of an intervention are effective.

Data synthesis

For our narrative synthesis, we compared studies that found an intervention effect (positive studies) with those that did not (negative studies). We first identified differences based on risk of bias, research design, location, healthcare setting, participants, outcome measures, and intervention delivery to see if they affected adherence outcomes. We then compared studies based on intervention content to see if specific components of interventions improved adherence.

Where feasible and appropriate, we conducted a meta-analysis using the standardised mean difference (*d*). We chose a random effects model due to the expected heterogeneity of participants and interventions. We chose *d* because we assumed that adherence is a continuous construct regardless of how it is measured. Furthermore, data had to be standardised for comparison because studies used different adherence measures [15]. Where necessary, we adjusted cluster-randomised studies by inflating standard errors (SEs) using an intra-cluster correlation coefficient (ICC) of 0.05, based on previous estimates [22, 23]. We assessed heterogeneity (Chi-squared test, I^2 statistic, forest plots) and publication bias (funnel plots, fail-safe N). We conducted sensitivity analyses for ICC used (0.01, 0.05, 0.07, or 0.10), risk of bias (high risk studies removed), mixed age samples (studies with participants under 18 years removed), and meta-analysis model (fixed and random effects).

Results

Study characteristics

A total of 843 studies were retrieved from the databases. We excluded 797 studies based on titles and abstracts and 35 studies were excluded based on full-text articles (Figure 2). Primary reasons for exclusion were: same participant sample, not asthma patients, not RCT, author non-response to request for information, no adherence measure, not pharmacist-led, no usual care control group, and unpublished studies (Figure 2). We included 11 studies in the narrative synthesis [24-34] and nine studies in the meta-analysis [24-27, 29, 31-34]. Authors of eight included studies provided further information upon request [24-26, 29, 30, 32-34]. Two authors did not respond [27, 31]. One author was unable to provide further details due to intellectual property restrictions [28].

Five (45%) studies were cluster-randomised by pharmacy [24, 26-28, 32]. The remaining studies were randomised at the participant level (Table 1). All studies met the criteria for a usual pharmacist care control group. However, three (27%) of these studies were delivered through clinical settings (hospitals and federal health clinics) with a possibly better quality of usual care [31, 33, 34]. One (9%) study gave control participants an educational asthma booklet and another study (9%) provided inhaler technique training [25, 33]. Studies had a follow-up period of four [33], six [24, 25, 27, 29, 31, 32, 34], 5.3 [30], nine [28] and 12 months [26]. Studies were conducted in Australia [24], Canada [25], Malta [26], Spain [27], Italy [28], Belgium [29], Taiwan [31], Malaysia [32], Brazil [33], and the United States of America (USA) [30, 34]. Most interventions (64%) were delivered in community pharmacies. Two (18%) interventions were delivered in outpatient clinics [31, 33]. One (9%) intervention was delivered completely over the telephone [34].

Five (45%) studies reported on adherence as a primary outcome [26, 31-34]. The most common outcome reported was asthma control (73% of studies) [24-29, 32, 34]. Adherence was most commonly measured using validated self-report measures (55%) [24, 27, 31-34], followed by non-validated self-report measures (36%) [26, 28-30], and prescription refill data (27%) [25, 29, 33] (Table 1).

TABLE 1. RESEARCH DESIGN, LOCATION, AND OUTCOME CHARACTERISTICS OF INCLUDED STUDIES

STUDY	RANDOMISED	*n*		FOLLOW-UP (MONTHS)	COUNTRY	HEALTHCARE SETTING[#]	ADHERENCE MEASURE[¶]	SIGNIFICANT INTERVENTION EFFECT? [+]
		IG	CG					
Armour et al. (2007) [24]	Cluster	165	186	6	Australia	Community	Brief Medication Questionnaire (BMQ)	Yes
Charrois et al. (2006) [25]	Patient	36	34	6	Canada	Community	Prescription refill rates	No
Cordina et al. (2001) [26]	Cluster	64	55	12	Malta	Community	Self-reported rates of forgetting per day	No
García-Cárdenas et al.(2013) [27]	Cluster	186	150	6	Spain	Community	MMAS-4	Yes
Manfrin et al. (2017) [28]	Cluster	400	416	9	Italy	Community	2 items from MMAS-8	Yes
Mehuys et al. (2008) [29]	Patient	80	70	6	Belgium	Community	Prescription refill and Self-report: "How often do you not take your controller as prescribed?"	Yes
Munzenberger & Hill (2007) [30]	Patient	31	29	5.3	USA	Community	Self-report, appropriate use of inhaled steroid: "How often do you take your controller medication?"	No
Wang et al. (2010) [31]	Patient	29	32	6	Taiwan	Outpatient	MMAS-4	No
Wong et al. (2017) [32]	Cluster	80	77	6	Malaysia	Outpatient and Telepharmacy	MALMAS	Yes
Xaubet Olivera et al. (2016) [33]	Patient	52	53	4	Brazil	Outpatient	MMAS-4 and prescription refill rates	Yes
Young et al. (2012) [34]	Patient	41	42	6	USA	Telepharmacy	MMAS-8	No

[#]Community pharmacy (community), ambulatory care/outpatient clinics (outpatient), telephone-based (telepharmacy)
[¶]Morisky Medication Adherence Scale (MMAS, 4 and 8 items), Malaysian Medication Adherence Scale (MALMAS)
[+]Yes (significant intervention effect, $p < 0.05$) and No (no significant intervention effect, $p \geq 0.05$)

TABLE 2. PARTICIPANT CHARACTERISTICS OF INCLUDED STUDIES

STUDY	AGE (YEARS)	SEX (MALE)	UPTAKE	ATTRITION	ASTHMA CONTROL[#]
Armour et al. (2007) [24]	50.2 ± 16.4	35.0%	-	11.4%	Mixed
Charrois et al. (2006) [25]	37.2 ± 10.5	47.2%	77.4%	1.4%	Uncontrolled only
Cordina et al. (2001) [26]	43.2 ± 18.3	50.6%	-	21.7%	Mixed
García-Cárdenas et al.(2013) [27]	55.8 ± 19.1	46.1%	97.1%	9.9%	Mixed
Manfrin et al. (2017) [28]	54.1 ± 17.2	41.2%	-	35.4%	Mixed
Mehuys et al. (2008) [29]	35.7 ± 5.5	46.9%	72.8%	25.4%	Mixed
Munzenberger & Hill (2007) [30]	36.1 ± 14.5	23.3%	100%	26.8%	Uncontrolled only
Wang et al. (2010) [31]	28.2 ± 10.9	72.1%	-	11.6%	Mixed
Wong et al. (2017) [32]	55.2 ± 13.3	46.5%	79.5%	8.2%	Mixed
Xaubet Olivera et al. (2016) [33]	52.0 ± 10.2	27.6%	-	11.8%	Mixed
Young et al. (2012) [34]	44.6 ± 15.8	23.5%	77.8%	15.3%	Mixed
Overall	50.2±16.0	41.8 ± 14.2%	84.1 ± 11.5%	16.3 ± 9.9%	-

[#]Mixed levels of controlled, partly controlled, and uncontrolled asthma (Mixed)

Participant characteristics

The mean ± standard deviation (SD) age across the review was 50.2±16.0 years (Table 2). Four (36%) studies included a small number of participants under the age of 18; the maximum percentage of participants in any one study under 18 years was 23% [25, 26, 29, 30]. The mean±SD percentage of male participants was 41.8±14.2%. The median sample size across studies was 119, with an interquartile range (IQR) of 170. The median sample size was 64 (IQR= 84) for the intervention groups and 55 (IQR = 75.5) for the control groups. The mean±SD rate of study uptake (percentage of study invitations accepted per invitations extended) was high (84.1±11.5%) for the six studies that reported this data [25, 27, 29, 30, 32, 34]. The mean±SD percentage of participants lost to follow-up was 16.3 ± 9.9%.

Four (36%) studies had equal proportions of uncontrolled, controlled, and partly controlled asthma in their samples [26, 31, 32, 34]. Three (27%) studies had samples with a higher proportion of uncontrolled asthma [24, 27, 33]. Two (18%) studies had a higher proportion of controlled and partly controlled asthma in their samples [28, 29]. Two (18%) studies focused only on uncontrolled asthma [25, 30].

Risk of bias

Studies were categorised as having a low [32, 33], moderate [24, 27, 29, 34], or high risk of bias [25, 26, 28, 30, 31] (see Supplement 2). The overall risk of bias across the review was moderate to high. There was a high risk of performance bias in all studies partly because it is difficult to blind participants in behavioural intervention trials as the intervention and control conditions are noticeably different. Consequently, eight (73%) studies were judged as having a high risk of detection bias because they relied on self-report measures of adherence with non-blinded participants [24, 26-28, 30-32, 34]. Other sources of bias included possible contamination between groups and use of non-validated measures of adherence [25, 26, 28-30, 34].

Effects on medication adherence

Six (55%) studies found a significant intervention effect on medication adherence (positive studies) [24, 27-29, 32, 33]. We adjusted estimates from three studies for clustering [24, 26, 27]. The random effects meta-analysis produced a medium effect size of $d = 0.49$ (SE = 0.08, 95% CI 0.35-0.64, $p < 0.0001$) [35]. There was low statistical heterogeneity in the analysis according to the Chi-squared statistic ($\chi^2 = 9.84$, df = 8, $p = 0.28$), I^2 statistic (16.42%), and forest plot (Figure 3). Due to the small number of studies in the meta-analysis, we were unable to conduct moderator and publication bias analyses. Results remained consistent across all sensitivity analyses.

Intervention delivery

With regards to intervention delivery, pharmacists were trained using self-study manuals and/or interactive workshops. Teaching methods included roleplay and feedback, patient actors, group discussions, and question-and-answer sessions [24-26, 28, 30, 34]. Training was led by communication reviewers [25, 34], researchers [24, 26, 30], and previously trained pharmacists [28]. Nine (81%) interventions were delivered exclusively by pharmacists. Two (18%) interventions were delivered by pharmacists in collaboration with nurses [31], or respiratory therapists and physicians [25]. One (9%) intervention was delivered over the telephone in individual sessions [34]. Another intervention was delivered face-to-face in group

sessions with other asthma patients [33] . The remaining interventions (81%) were delivered face-to-face in individual sessions.

Intervention content

Five (45%) studies were categorised as non-PAPA interventions because they focused solely on increasing people's knowledge about asthma through education, rather than addressing people's perceptions of asthma and/or asthma treatment [25, 26, 29-31]. Although limited knowledge of a chronic condition can lead to poor health outcomes, an educational approach only addresses the practicalities affecting adherence (i.e. knowledge) [36]. Research shows that increased knowledge does not necessarily guarantee behaviour change [37, 38]. One (9%) study was categorised as a partial PAPA intervention because it targeted perceptions (e.g. beliefs about asthma and its treatment) as well as practicalities (e.g. inhaler technique). However, it was delivered in a group setting and this limited the pharmacist's ability to tailor adherence support [33]. The remaining five (45%) studies were categorised as full PAPA interventions because they targeted perceptions and practicalities in a tailored manner [24, 27, 28, 32, 34]. In terms of how interventions tried to change adherence, we coded BCTs across eight categories; goals and planning, feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, natural consequences, self-belief, and associations (see Supplement 3).

Discussion

Main findings

This is the first systematic review and meta-analysis of pharmacist-led adherence support in adults with asthma. Our findings show that pharmacist-led interventions can significantly improve medication adherence (medium effect size in meta-analysis, $d = 0.49$) [35]. In line with the NICE guidelines, pharmacist-led interventions applying a full PAPA were more effective [19, 20]. The type and number of BCTs used in the intervention did not determine effectiveness, though this finding may be due to insufficient data to accurately code BCTs.

Intervention context (country and healthcare setting) may have influenced effectiveness. Interventions delivered in Australia, Belgium, Spain, and Italy may have benefited from pharmacist involvement in public health policy [39], adequate pharmacist training and remuneration [28, 39-41], and/or more pharmacists per 100,000 people [42]. In contrast, the healthcare systems in Canada, Malta, and the USA posed barriers such as fewer pharmacists per 100,000 people [43], asthma only being treated in secondary care [26], and limited private health insurance coverage beyond medication dispensing [44].

Our findings are in line with a recent Cochrane review of interventions targeting adherence to inhaled corticosteroids (ICS). The review found a significant intervention effect on adherence when compared to usual care [45]. In terms of intervention location, previous research looking at pharmaceutical care activities and resources across Europe also found significant differences between countries [46].

Limitations of included studies

None of the studies were able to blind their participants to allocation and this may have significantly affected study outcomes [47]. Studies that used self-report measures of adherence with non-blinded participants were subject to detection bias. Self-report measures of adherence are limited when participants are untruthful [48]. Furthermore, participant behaviour in

behavioural intervention trials can be affected by the act of filling in a questionnaire [49]. Research suggests that prescription refill data is a more reliable proxy measure of adherence [50]. However, it is based on the assumption that medication is taken correctly. This is problematic when it comes to asthma medication, where patients may be losing a proportion of each dose due to poor inhaler technique [51].

Contamination between the intervention and control groups may have been an issue in the studies randomised at the participant level. Few included studies examined intervention fidelity, with only two studies reporting measures to ensure the intervention was being delivered as intended [24, 27]. Most studies had a follow-up period of six months, making it difficult to assess the sustainability of intervention effects.

Strengths and limitations of the current review

This review considered intervention content, delivery, and context when reviewing intervention effectiveness, as per current research guidance [52]. We analysed intervention content using both the PAPA and the BCT Taxonomy [19, 21] This two-tiered analysis approach encompasses both outcome and process, as recommended in the Medical Research Council (MRC) guidance for developing and evaluating complex interventions [52]. With regards to delivery, we looked at pharmacist training, delivery channels (pharmacist-led or collaborative care), and delivery modes (e.g. face-to-face individual sessions). In terms of context, we went beyond looking at study location (country) and explored national healthcare policies, pharmacy guidelines, and pharmacy literature to explain the differences seen in intervention effectiveness.

The review is limited by the small number of included studies, suggesting a need for further research in this area. The generalizability of our findings is limited because we were unable to conduct moderator and publication bias analyses. The reliability of our findings is limited by the moderate to high risk of bias across the review. However, behavioural intervention trials often cannot meet the criteria in the Cochrane Collaboration's risk of bias tool because it was developed based on clinical RCTs [18].

We did not analyse data for asthma control, the most common primary outcome. However, it was felt that a review of data on adherence to asthma medication and subsequent asthma control was covered in a recent Cochrane review, so we did not duplicate this [45]. The guidelines for a small, medium, and large effect size (*d*) do not translate directly into the healthcare realm. A small effect size for one condition may have a larger clinical impact than a large effect size for another condition [53].

Implications for clinical practice and future research

In clinical practice, pharmacists can act as "medication experts" providing updated information and ongoing support for people with long-term conditions. Community pharmacy interventions such as the New Medicine Service (NMS) can significantly increase adherence [54]. These interventions offer convenient access points to the healthcare system and ensure consistent contact with people through the provision of ongoing pharmaceutical care.

Our findings suggest that pharmacist-led interventions may be more effective if they are integrated into government policy and existing healthcare services. Notably, NHS England recently extended the Clinical Pharmacists in General Practice pilot [10]. These embedded

pharmacists are working to improve patient safety and quality of care, whilst reducing the pressure on General Practitioners (GPs).

Further RCTs investigating the effect of pharmacist-led interventions on adherence in asthma are needed. However, this review has provided an important summary of evidence to date highlighting the potential of pharmacist-led interventions. Future studies should aim to reduce the risk of detection bias and contamination between groups. Electronic monitoring devices should be used to measure adherence, although objective data (e.g. prescription refill rates) combined with blinded outcome assessors may be more pragmatic for pharmacy-based research. Adequately powered cluster-randomised trials will help reduce the risk of contamination between groups.

To build a reliable evidence base for effective interventions, future publications should report intervention content in sufficient detail. This may involve publishing an intervention protocol separately. Intervention fidelity measures are needed to ensure that interventions are being delivered as reported. Most included studies were conducted in Western cultures [24-30, 34] and the cross-cultural applicability of our findings should be explored. Investigating the clinical relevance of effect estimates (e.g. *d*) will help frame the real-life impact of research findings for people with asthma.

As outlined by the Lancet Asthma Commission, monitoring adherence in asthma will be an iterative and adaptive process requiring multi-disciplinary input [7]. This review, combined with existing evidence, suggests that pharmacist-led interventions can effectively contribute to that process.

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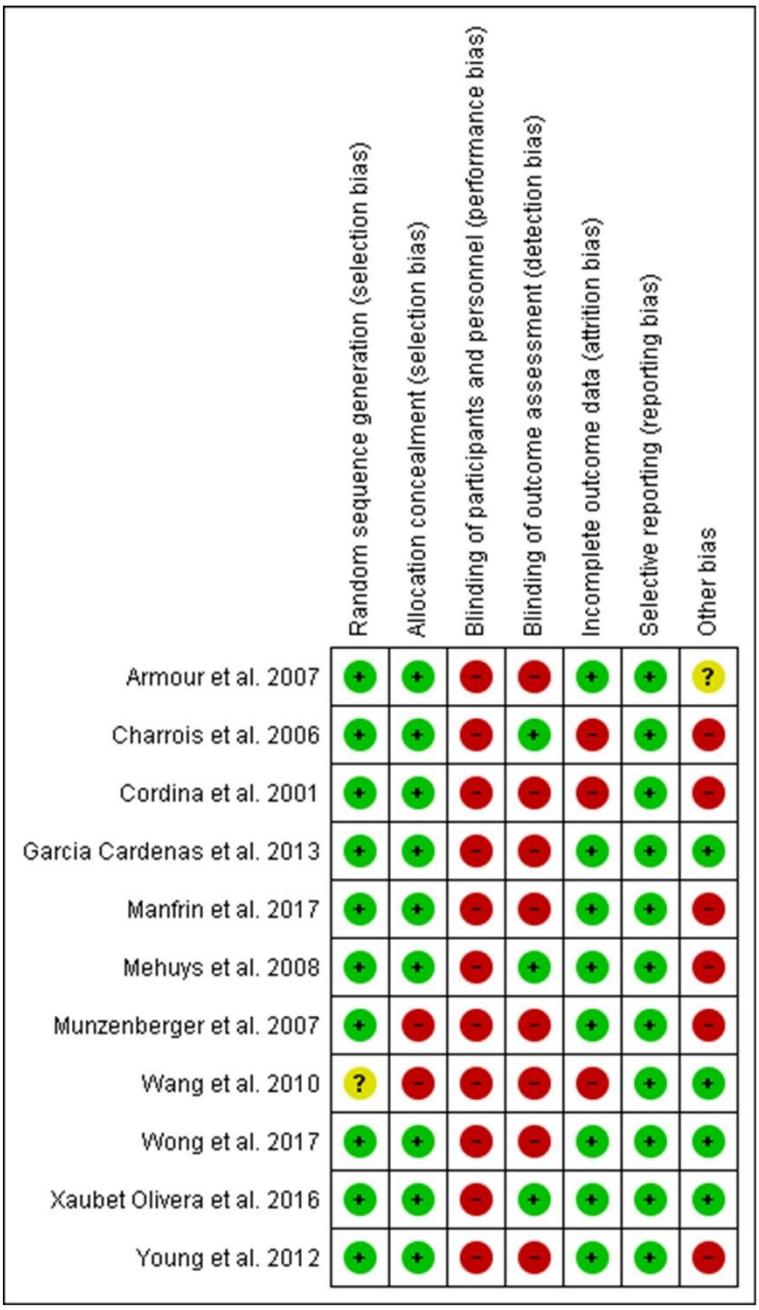
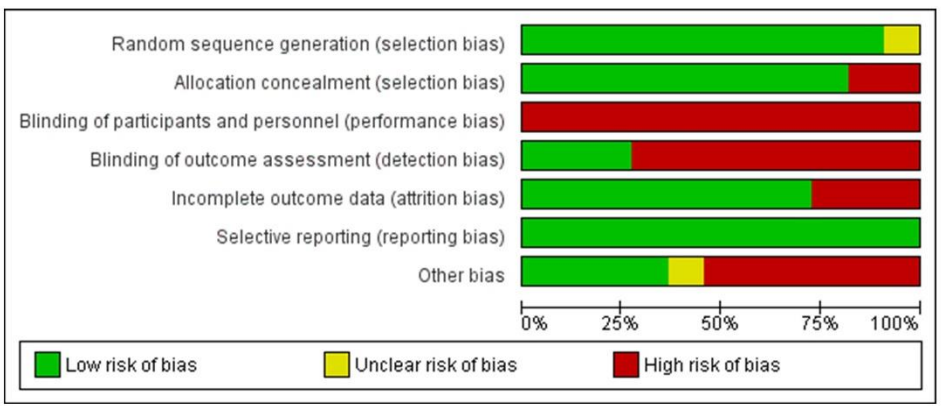
Supplement 1: Data Extracted from Included Studies

DATA EXTRACTED FROM INCLUDED STUDIES

CHARACTERISTICS	INFORMATION EXTRACTED
Risk of Bias (Cochrane tool) [18]	
Research Design	Study design
	Unit of randomisation (participant or cluster)
	Number of intervention and control groups/clusters
	Nature of control group
	Length of follow-up (months)
Context	Study location (country)
	Healthcare setting (e.g. community pharmacy)
Participants	Age (years)
	Sex (% male participants)
	Sample size (n - total, intervention group, control group)
	Study uptake (% invitations accepted)
	Attrition rate (% baseline sample lost)
	Baseline differences between intervention and control group
	Asthma control (controlled, partly controlled, uncontrolled)
Outcome measures	Adherence as primary outcome measure (yes/no)
	Adherence measures used
	Other study outcomes
Intervention delivery	Pharmacist training and support
	Delivery channel (pharmacist versus collaborative care)
	Delivery mode (e.g. face-to-face individual sessions)
Intervention content	Perceptions and Practicalities Approach (PAPA) [19]
	Behaviour Change Techniques (BCTs) Taxonomy [21]

Supplement 2: Risk of Bias Figures





Supplement 3: Examples of Behaviour Change Techniques (BCTs) Coded Across Studies

EXAMPLES OF BEHAVIOUR CHANGE TECHNIQUES (BCTs) CODED ACROSS STUDIES

BEHAVIOUR CHANGE TECHNIQUE	CODED IN	DEFINITION [21] AND EXAMPLE QUOTE
1.1 Goal setting (behaviour)	Armour et al (2007) [24]	**Set or agree a goal defined in terms of the behaviour to be achieved** "Eighty-seven (53%) of the intervention patients set goals related to medications (e.g. "remembering to take medications even when well")… (p.500)" [24]
1.3 Goal setting (outcome)	Armour et al (2007) [24] García-Cárdenas et al. (2013) [27]	**Set or agree on a goal defined in terms of a positive outcome of wanted behaviour** "Exercise tolerance (e.g. "increase exercise" and "be more active") was another common theme of goals…as was asthma control (e.g. "not to wake up at night with asthma")… (p. 500)" [24]
1.4 Action planning	Armour et al (2007) [24] Charrois et al. (2006) [25] Munzenberger & Hill (2007) [30] Wong et al. (2007) [32] Young et al. (2012) [34]	**Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional, or cognitive) – includes implementation intentions.** "If necessary, patients received an updated written action plan summarising their medical treatment. (p.149)" [30]
1.5 Review behaviour goals 1.7 Review outcome goals	Armour et al (2007) [24]	**Review behaviour goal(s)/outcome goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement.** From published protocol : "Whether or not the patient needed to attend visit 3 was based on the patients' asthma management and achievement of goals. This decision was left to the pharmacists' discretion. (p.34)" [55]
2.2 Feedback on behaviour	Cordina et al. (2001) [26] Manfrin et al. (2017) [28]	**Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity).** "The pharmacists were trained to identify pharmaceutical care issues (PCIs) which could impact on optimal medicines use or asthma control and provide advice to patients and recommendations to their GP, as necessary. (p.3)" [28]
2.4 Self-monitoring of outcome of behaviour	Cordina et al. (2001) [26] Wang et al. (2010) [31]	**Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy.** "Patients were monitored by supplying them with a peak flow meter and asking them to record their PEF rate in the morning and evening, together with asthma symptoms, on a diary card. Patients were instructed to present their diary card to their community pharmacist for review monthly when patients collected their drugs. (p.1198)" [26]
2.7 Feedback on outcome(s) of behaviour	Cordina et al. (2001) [26] Mehuys et al. (2008) [29]	**Monitor and provide feedback on the outcome of performance of the behaviour** "Pharmacists [gave] advice based on the [Asthma Control Test] score of the patient…(p. 791)" [29]
4.1 Instructions on how to perform a behaviour	Armour et al (2007) [24] Charrois et al. (2006) [25] Cordina et al. (2001) [26] García-Cárdenas et al. (2013) [27] Mehuys et al. (2008) [29] Wong et al. (2007) [32] Xaubet Olivera et al. (2016) [33] Young et al. (2012) [34]	**Advise or agree on how to perform the behaviour (includes "Skills Training")** "Patients were educated using verbal instructions, physical demonstration, and written information about turbuhaler use (p.1348)" [27]

4.2 Information about antecedents	García-Cárdenas et al. (2013) [27] Xaubet Olivera et al. (2016) [33]	**Provide information about antecedents (e.g. social and environmental situations and events, emotions, cognitions) that reliably predict performance of the behaviour** "When appropriate, the type of non-adherence (intentional or unintentional) and causes of intentional nonadherence were explored with the Beliefs about Medicines Questionnaire and Health Beliefs Model. (p.1348)" [27]
5.1 Information about health consequences	Armour et al (2007) [24] Cordina et al. (2001) [26] Wang et al. (2010) [31] Wong et al. (2007) [32]	**Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour** "PharMS consisted of (i) education on asthma (including signs and symptoms, trigger factors, **consequences of uncontrolled asthma**) with the aid of a booklet which was especially designed for asthma patients (p.4)" [32]
6.1 Demonstration of the behaviour	Armour et al (2007) [24] Charrois et al. (2006) [25] Cordina et al. (2001) [26] García-Cárdenas et al. (2013) [27] Wong et al. (2007) [32]	**Provide an observable example of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate** "Verbal education and demonstration of inhaler technique were supported by written information and provision of a short videotape for home viewing. (p.1198)" [26]
7.5 Remove aversive stimulus	Armour et al (2007) [24] Charrois et al. (2006) [25] Cordina et al. (2001) [26] Manfrin et al. (2017) [28]	**Advise or arrange for the removal of an aversive stimulus to facilitate behaviour change** From published protocol: "The pharmacists also provided adherence support, discussed potential or actual drug related problems, and prompted for medical checks.(pg. 34)" [55]
8.1 Behavioural practice/rehearsal	Mehuys et al. (2008) [29]	**Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill** From protocol (Translated from Flemish): "Next, ask the patient to use their inhaler again and check whether he/she has mastered the correct technique. (p.4)" [56]
15.1 Verbal persuasion about capability	Young et al. (2012) [34]	**Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed** From published protocol: "Pharmacists used motivational interviewing (MI) to address problems related to low self-efficacy or motivation. MI is a theory-based skilful clinical method and style of counselling and psychotherapy designed for assessing patients' source of motivation and assisting patients to commit to change. MI has been found to overcome motivational barriers and adhere to prescribed regimens. (p.5)" [57]