Magna Scientia
Open access publication

Magna Scientia Advanced Research and Reviews

eISSN: 2582-9394

Cross Ref DOI: 10.30574/msarr

Journal homepage: https://magnascientiapub.com/journals/msarr/

(Review Article)

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Literature Review: The role of inhaler technique education on symptom control and treatment adherence in asthma patients

Muhammad Faruq Fajar [1], Danial Habri Arsyi [2] and Wiwin Is Effendi [3,*]

[1] *Medical Study Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[2] *Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, United States of America.*
[3] *Department of Pulmonary and Respiratory, Faculty of Medicine, Universitas Airlangga; Dr. Soetomo General Academic Hospital Surabaya, Indonesia.*

Magna Scientia Advanced Research and Reviews, 2026, 17(02), 110–119

Publication history: Received on 31 May 2026; revised on 05 July 2026; accepted on 09 July 2026

Article DOI: https://doi.org/10.30574/msarr.2026.17.2.0129

Abstract

Asthma is a chronic airway disease that requires long-term inhaled therapy. Inhaler devices are the primary route of drug delivery in asthma, yet a number of studies have reported that more than 60% of patients fail to use them correctly, a situation associated with reduced pulmonary drug deposition and poor symptom control. This narrative literature review examines findings from published studies on the role of inhaler technique education in symptom control and treatment adherence among asthma patients, drawing on 35 peer-reviewed articles from both international and national journals. Several educational intervention models were studied in the reviewed literature, including pharmacist-led education, the teach-to-goal method, video directly observed therapy (vDOT), one-on-one coaching, repeated instruction sessions, and smart inhaler technology. Improvements in Asthma Control Test (ACT) and Asthma Quality of Life Questionnaire (AQLQ) scores following inhaler technique education were reported in a number of studies. Treatment adherence was found to be shaped by multiple factors, including patient knowledge, drug costs, access to healthcare, and personal beliefs about therapy, rather than technical skill alone. Age, cognitive capacity, and device type were also noted to influence educational outcomes. Studies examining digital technology and smart inhalers suggest potential utility in adherence monitoring, although long-term evidence is still limited. Taken together, findings from the reviewed corpus indicate that inhaler technique education may play a role in asthma management, although the size and consistency of its effects varied across studies.

Keyword: Asthma; Inhaler Technique; Patient Education; Medication Adherence; Asthma Control; Inhaled Corticosteroids; Pharmacist-Led Intervention; Smart Inhaler; Asthma Control Test; Video Directly Observed Therapy

1. Introduction

Asthma is a chronic inflammatory airway disease defined by bronchial hyperresponsiveness and reversible airflow obstruction. At the pathophysiological level, T-helper (Th2) lymphocyte activation drives a cytokine cascade, including IL-4, IL-5, and IL-13, that underlies eosinophilic airway inflammation, mucus hypersecretion, and bronchial remodeling (1). Airway hyperresponsiveness in asthma has been linked to the interplay of exaggerated smooth muscle contractility, active inflammation, and epithelial structural changes (2). Because the disease is chronic, long-term management is a fundamental requirement for most patients.

Globally, asthma is estimated to affect between 1% and 18% of the population, varying by country and region. In Indonesia, patients managed at primary care facilities have been reported to have suboptimal disease control in a

* Corresponding author: Wiwin Is Effendi

meaningful proportion of cases (3). Worldwide, over 260 million individuals are estimated to live with poorly controlled asthma, with a disproportionate burden of disability and premature death falling on low- and middle-income settings (4).

Inhaler devices represent the primary means of drug delivery in asthma. They encompass both inhaled corticosteroids (ICS) used as controller therapy and bronchodilators prescribed as reliever agents (3,4). A range of device types is available in clinical practice: pressurized metered-dose inhalers (pMDI), dry powder inhalers (DPI) including the Turbuhaler, Diskus, Ellipta, and Cyclohaler, as well as soft-mist inhalers, each with its own distinct technical requirements (5). Multiple studies have reported that over 60% of asthma patients do not use their inhaler correctly (5,7). A study from Indonesia found no statistically significant correlation between inhaler technique accuracy and spirometric FEV1 before patient education was provided; that correlation became statistically significant only after education was delivered (6). Inhaler technique errors have been reported in association with poor symptom control, increased exacerbation frequency, and higher oral corticosteroid use (7,8,9).

Inhaler technique education has received growing attention as a component of asthma management. Some studies have reported that patients' inhaler skills tend to decline over time, suggesting that periodic reassessment and reinforcement may be needed (7,12). This review aims to examine, from a narrative perspective, what published studies have reported regarding the role of inhaler technique education in symptom control and treatment adherence in asthma patients, based on a predefined corpus of articles.

2. Literature review methods

This is a narrative literature review that draws on 35 peer-reviewed articles from both international and national journals. The study designs represented in the reviewed literature include randomized controlled trials (RCTs), prospective studies, cohort studies, cross-sectional studies, quasi-experimental trials, scoping reviews, systematic reviews, meta-analyses, and perspective articles. Populations covered include asthma patients across pediatric, adult, and elderly age groups, from countries such as Indonesia, Nigeria, India, Poland, Spain, Jordan, Iraq, Finland, Sweden, and the United Kingdom, among others. Studies that involved COPD or mixed asthma-COPD populations were used only as indirect supporting evidence and are explicitly identified as such throughout the discussion. Articles addressing asthma pathophysiology served as scientific background material. The primary focus of the review was inhaler technique educational interventions, their reported associations with asthma symptom control, and their relationships with treatment adherence.

3. Results and discussion

3.1. Definition and Clinical Relevance of Inhaler Technique Education

Correct inhaler technique has been defined as the patient's ability to carry out each step of inhaler use in the proper sequence — preparation of the device, body positioning, the inhalation manoeuvre itself, breath-holding, and post-inhalation procedures — so that drug reaches the airways in an effective amount (11). The term mastery of inhaler technique is used in the literature to describe a state in which the patient carries out every step consistently and without critical errors (11). Critical errors are distinguished from device-specific errors: whereas the latter are unique to a particular device, critical errors can occur across device types and directly result in failure to deliver drug to the lungs (5,9).

Several sources have noted that verbal instruction alone is insufficient to produce meaningful improvement in technique. Studies and review articles describe effective education as requiring direct demonstration by a healthcare professional, observation of the patient performing the technique independently, error correction, teach-back practice, and periodic reassessment (11,12). A study in Nigeria found that one-on-one pharmacist-delivered intervention was associated with greater improvement in inhaler technique scores compared with interventions delivered through caregivers without direct patient education (12).

3.2. Burden of Inhaler Technique Errors in Asthma

Inhaler technique errors have been reported across a wide range of clinical settings. A Polish study evaluating five inhaler types found that before any education programme was delivered, the proportion of patients making technique errors remained substantial — even though critical errors were less frequent than general errors (5). In Sweden, a study of hospitalised asthma and COPD patients found that 26.1% had at least one critical error in their inhaler use (9). In

Jordan and Iraq, poor asthma control was found in more than half of the patients surveyed, and inadequate knowledge of inhaler technique was identified as one contributing factor (8).

The types of errors reported varied by device. For pMDIs, the most common errors involved poor coordination between device actuation and inhalation, and an inhalation speed that was too fast. For the Turbuhaler DPI, a study in children with asthma found that 35.5% of patients failed to exhale to residual volume before inhalation, 13.5% inhaled with insufficient force, and 13.5% did not rinse their mouth after using an ICS-containing device (10). On the parameter side, 90.8% had an effective inspiratory time below 2 seconds, 41.8% had a peak inspiratory flow rate (PIFR) below 60 L/min, and 27.0% did not achieve adequate breath-hold time (10). In a vDOT study involving children aged 6–11 years, the errors identified included inadequate breath-holding (34%), incorrect breathing technique (29%), failure to shake or improper shaking of the device (22%), and not rinsing the mouth following ICS use (15%) (15).

A study in Indonesia found no significant correlation between inhaler technique accuracy and spirometric FEV1 before education ($p = 0.941$); after education, the correlation was statistically significant ($p = 0.049$) (6). A prospective study in India on 400 adult asthma patients reported a mean pre-test Inhaler Technique Score (ITS) of only 6.91 out of 10, despite all participants having used their inhaler for at least three months prior to enrolment (7). Technique errors have also been reported in association with more frequent exacerbations, greater oral corticosteroid use, and unscheduled healthcare visits (7,8,9). In the United Kingdom, an increasing pattern of intermittent oral corticosteroid use was found to be associated with suboptimal asthma management (29). In the paediatric asthma population, excessive oral corticosteroid use was reported to be associated with obesity (28).)

3.3. Relationship Between Inhaler Technique, Treatment Adherence, and Asthma Control

Inhaler technique and medication adherence are related but conceptually distinct. Technique adherence refers to the patient's ability to use the device correctly on each occasion, while medication adherence refers to the consistency with which medication is taken as prescribed — in terms of both dose and schedule (8,12). Several studies have assessed these two dimensions concurrently and reported varying findings.

A cross-sectional study of 300 asthma patients in Jordan and Iraq found poor asthma control at both sites — 52.0% in Amman and 70.0% in Baghdad were classified as uncontrolled — and the majority of patients at both sites did not adhere to their prescribed management plan (8). A national cohort study in Sweden involving 30,880 adult asthma patients reported that 73% of patients on treatment steps 2–5 had poor ICS adherence; within the subgroup with uncontrolled asthma, those who had received asthma management education were found to have better adherence (OR 0.85, 95% CI 0.78–0.93) compared with those who had not (22). On the other hand, a Finnish study of 411 adult asthma patients on regular ICS found a median adherence level of 76%, yet no correlation was observed between adherence and ACT score ($r = 0.011$, $p = 0.822$) or exacerbation frequency (23). A study of children in Leicestershire, UK, reported a mean ICS adherence of only 36.2%, with an inconsistent relationship between adherence and spirometric values or FeNO levels (24).

A prospective study in India reported that ACT scores rose from a mean of 17.06 at baseline to 20.52 at week 8 ($p < 0.001$), alongside increases in ITS over the same period; a positive correlation was found between changes in ITS and changes in ACT scores ($r^2 = 0.659$, $p < 0.05$ from baseline to week 4) (7). An observational study in Iraq reported that the proportion of patients with controlled asthma rose from 12% before education to 45% after three months of education delivered by a pulmonologist, with a mean ACT increase of 4.21 points that was statistically significant (14). Taken together, these findings indicate that the relationship between technique, adherence, and asthma control is complex and does not appear to follow a uniform pattern across different populations and study settings.

3.4. Models of Inhaler Technique Educational Intervention

A number of distinct educational intervention models have been studied in the reviewed literature, across varied clinical contexts and patient populations. What follows is a summary of the findings associated with each model.

Pharmacist-led interventions. A quasi-experimental study in Nigeria involving 130 asthma and COPD patients reported that the intervention group receiving pharmacist-delivered education showed an increase in correct pMDI use from 22.8% to 80.7% ($p < 0.001$) and correct Diskus use from 35.0% to 70.0% ($p = 0.025$); the proportion with well-controlled asthma rose from 35.3% to 60.4% ($p < 0.001$), while the control group showed no statistically significant change (13). A separate Nigerian study comparing three groups found that individual pharmacist intervention was associated with more consistent improvements in inhaler technique scores than caregiver-assisted intervention alone (12). Community pharmacists in Malaysia were identified as potential key providers of inhaler education for short-acting beta-2 agonist (SABA) inhalers, though their knowledge and practice were reported to vary considerably (26). In

Palestine, pharmacists with better knowledge and more positive attitudes were reported to engage more actively in patient inhaler education (27).

Teach-to-goal. An RCT protocol for elderly patients with asthma or COPD described a teach-to-goal approach combining direct demonstration, technique assessment, feedback, and repeated practice until a predefined technique standard was achieved — applied at baseline, month 3, and month 6 — with a 12-month follow-up period (20). As this was a published protocol rather than a completed trial, outcome data from this study were not available in the current corpus.

Video directly observed therapy (vDOT). A pilot RCT involving 22 children aged 6–11 years with persistent asthma reported a median inhaler technique accuracy of 88% in the vDOT group compared with 75% in the control group; however, the difference did not reach statistical significance ($p = 0.11$). The median number of days until no observable technique errors were recorded in the vDOT group was 10 days (range 0–25) (15). As a pilot study with a small sample, the interpretive value of these findings is limited.

One-on-one coaching. A prospective study on 101 COPD patients reported that one-on-one coaching using a 12-step guidance protocol reduced the rate of pMDI misuse from 43.5% to 12.9% ($p < 0.001$), with the mean number of errors falling from 3.1 to 1.7 ($p < 0.001$) (17). This study was conducted in a COPD population; caution is therefore needed when applying these findings to asthma patients. The same study noted that patients with cognitive impairment tended to make more errors and responded less to coaching (17).

Repeated education. A prospective cohort study in India found that mean ITS increased gradually from 6.91 at baseline to 9.55 at week 4 and 9.87 at week 8, with education reinforced at each monthly visit (7). A study of elderly patients with respiratory disease in South Korea found no statistically significant difference in inhaler use accuracy across device types after individual training, and repeat training was associated with increased proportions of acceptable use for all device types evaluated (16).

Paediatric education and caregiver involvement. A scoping review covering 33 studies on inhaler teaching methods in children with asthma found that education was delivered by a wide range of healthcare professionals across different clinical settings; brief instruction and teach-back were the two most frequently reported methods, and physical demonstration was present in nearly all approaches reviewed (11). A Chinese study comparing 50 children receiving multifaceted education with 50 children receiving standard care reported statistically significant improvements in symptom control, treatment adherence, and quality of life in the education group (21).

Primary care professional education. A cluster randomised trial in Spain evaluating an education programme targeting primary care healthcare professionals reported statistically significant improvements in knowledge and inhaler technique skills in those who received the intervention, compared with controls (19). An observational study in Iraq reported meaningful improvement in asthma control following face-to-face education delivered by a pulmonologist — covering symptoms, triggers, inhaler technique, adherence, written asthma action plans, and self-monitoring (14).

3.5. Impact of Education on Inhaler Technique Accuracy

Several studies reported improvements in inhaler technique accuracy following structured educational interventions. A multicentre Polish study evaluating five devices found statistically significant reductions in technique errors for all inhaler types: Cyclohaler and pMDI ($p < 0.0001$), Turbuhaler ($p = 0.0014$), Diskus ($p = 0.0025$), and Ellipta ($p = 0.0091$) (5). Before education, the Ellipta had the highest error count of all devices evaluated; after education, the differences in accuracy across devices were no longer statistically significant (5).

A study of elderly patients with respiratory disease in South Korea found that before training only 24.7% of patients used their inhaler correctly; after individual training, the proportions with acceptable technique increased across all device types (Evohaler 63.9%; Respimat 86.1%; Turbuhaler 74.3%; Ellipta 64.6%; Breezhaler/Handihaler 65.3%), with no statistically significant differences between devices ($p = 0.129$) (16). Among children using the Turbuhaler, a Chinese study found that only 35.5% of 141 children achieved a perfect checklist score; regression analysis identified low medication adherence ($p = 0.045$), PIFR ($p = 0.041$), breath-hold time ($p = 0.003$), and duration of Turbuhaler use ($p = 0.009$) as significantly associated with technique (10).

A prospective observational study in COPD patients in Thailand (indirect evidence) found that although all patients demonstrated correct DPI use immediately after training — and 88.1% demonstrated correct pMDI use — the proportion maintaining correct technique declined at the one-month follow-up across all device types (18). In a multivariate analysis, a MoCA score of ≤16 was independently associated with critical errors one month after training (adjusted OR 12.7; 95% CI 1.8–88.2; $p = 0.010$) (18).

3.6. Impact of Education on Asthma Symptom Control

A number of studies reported changes in asthma symptom control measures following inhaler technique educational interventions. The prospective Indian study of 400 adult asthma patients found ACT scores rising from a mean of 17.06 at baseline to 19.37 at week 4 and 20.52 at week 8 ($p < 0.001$ for each comparison); AQLQ scores increased from 4.45 at baseline to 5.45 at week 8 ($p < 0.001$) (7). A positive correlation was reported between changes in ITS and changes in both ACT and AQLQ scores over the study period (7).

An observational study in Iraq on 100 asthma patients reported that the proportion with controlled asthma rose from 12% before education to 45% after three months, with a mean ACT increase of 4.21 points (statistically significant) (14). In the paediatric context, the Chinese multifaceted education study comparing 50 children per group reported statistically significant improvements in symptom control and quality of life in the education group versus controls (21). The Indonesian study reported a statistically significant correlation between inhaler technique accuracy and FEV1 after education ($p = 0.049$), while no such correlation was found before education ($p = 0.941$) (6).

That said, it bears noting that the studies summarised above differ in design, population, and sample size. Several lacked a matched control group, meaning that the reported changes cannot be attributed exclusively to inhaler technique education. The Finnish study, for instance, found no correlation between ICS adherence and ACT scores (23) — a finding that points to the complexity of the relationship between education, technique, adherence, and clinical control, which appears to differ across patient populations and healthcare settings.

3.7. Impact of Education on Treatment Adherence

Some studies reported changes in medication adherence measures following educational interventions. The Nigerian quasi-experimental study found that the proportion of patients with optimal adherence rose from 33.3% to 63.3% ($p < 0.001$) in the pharmacist intervention group, compared with a change from 18.6% to 27.1% ($p = 0.132$, non-significant) in the control group (13). The barriers to adherence most commonly identified in that study were knowledge-related (40.4%), practical (38.7%), and attitudinal (20.9%) (13).

A review of adherence determinants in asthma reported that individual factors — particularly age and patient attitudes towards adherence — are among the most important, and that the mental health of both patient and caregiver has been found relevant to adherence outcomes (25). Additional factors noted to influence adherence include medication cost, access to healthcare, adverse effects, beliefs about the need for medication, and treatment regimen complexity (25).

The Swedish national cohort study found that among patients with uncontrolled asthma, poor adherence was significantly associated with SABA overuse (OR 1.71; 95% CI 1.50–1.95), exacerbations (OR 1.29; 95% CI 1.15–1.46), current smoking (OR 1.38; 95% CI 1.21–1.57), and inversely associated with having received asthma management education (OR 0.85; 95% CI 0.78–0.93) (22). The Finnish study, by contrast, found no correlation between ICS adherence and ACT scores or exacerbation frequency — leading the authors to conclude that adherence alone does not consistently predict asthma control (23). Community pharmacists in Malaysia and Palestine were identified as potential contributors to inhaler adherence monitoring, though their knowledge and practice levels were reported to vary (26,27).

3.8. Patient Specific and Device Specific Factors

Multiple studies have reported that demographic, cognitive, and device-related factors are associated with variation in inhaler technique education outcomes. Regarding age, a scoping review on inhaler teaching methods in children with asthma found that various educational methods have been delivered by multiple healthcare professional types, and children across age groups were reported to be trainable in correct inhaler use (11). In elderly patients, decreased cognitive function, reduced physical strength, and impaired manual dexterity have been reported to be associated with incorrect inhaler use (16).

Cognitive capacity has been reported as a factor associated with a patient's ability to retain correct inhaler technique after training. A COPD study in Thailand (indirect evidence) found that a MoCA score of ≤16 was independently associated with critical technique errors one month after training (adjusted OR 12.7; 95% CI 1.8–88.2; $p = 0.010$); the prevalence of cognitive impairment in that patient population was reported to range from 10% to 77% (18). A one-on-one coaching study in COPD patients also reported that cognitively impaired patients tended to have more errors and responded less favourably to training sessions (17).

Each inhaler type presents different technical requirements. For pMDIs, hand-breath coordination has been reported as the primary challenge. For DPIs, adequate inspiratory capacity is a key requirement; among children using the Turbuhaler, 41.8% were found not to achieve the minimum PIFR and 90.8% had an effective inspiratory time below the threshold (10). Duration of Turbuhaler use ($p = 0.009$) and adherence level ($p = 0.045$) were significantly associated with technique in that paediatric study (10). Prior inhaler experience does not appear to guarantee correct technique — the Indian study found a mean ITS of only 6.91 out of 10 among patients who had already been using their inhaler for a minimum of three months (7). Health literacy and language barriers have also been noted; a study in Australia identified the need for a validated Arabic-language MDI technique questionnaire for Arabic-speaking patients (34). A community-based pulmonary rehabilitation programme reported improvements in quality of life and functional capacity, although its primary focus was physical training and general disease education rather than inhaler technique specifically (35).

3.9. Digital Technology and Smart Inhalers in Education and Adherence Monitoring

Smart inhalers are devices equipped with electronic sensors that record the time and frequency of inhaler use, provide reminders, and in some cases offer adherence feedback or assess inhalation technique parameters (33). A number of studies and clinical trial protocols have examined the potential application of this technology in asthma management.

The multicentre INCA Sun RCT — conducted across 10 severe asthma clinics — reported that in the group whose treatment decisions were guided by digital data on adherence, inhaler technique, and peak expiratory flow, fewer patients required treatment escalation compared with the control group; the study authors interpreted this as suggesting that digital data may support clinical decision-making (30). The ACCEPTANCE trial protocol from the Netherlands described a 12-month cluster RCT designed to evaluate the effectiveness of a smart inhaler programme in improving adherence and asthma control in patients with uncontrolled disease; outcome data from this trial were not available in the current corpus (31).

A meta-analysis examining digital technology and smart inhaler studies in asthma reported a pooled odds ratio for adherence of 2.64 (95% CI 1.49–4.68), indicating an association between digital interventions and higher adherence compared with controls (32). A narrative review of medication non-adherence burden in asthma and COPD concluded that smart inhalers may offer a more objective approach to identifying and managing non-adherence, but noted that stronger cost-effectiveness evidence is needed before routine clinical integration can be recommended (33). Limitations cited across these studies include relatively high device costs, constrained technology access in lower-resource settings, variable uptake across age groups, and data privacy concerns (32,33).

3.10. Comparison of Technique Errors by Inhaler Device Type

Based on findings reported across studies in the corpus, each inhaler type is associated with a distinct profile of technique errors. Table 1 summarises the most commonly reported errors, required patient skills, educational focus areas, and clinical implications with key references for each device type.

Table 1 Technique Errors, Educational Focus, and Clinical Implications by Inhaler Device Type

Device Type	Common Errors	Required Patient Skill	Education Focus	Clinical Implication & Key References
pMDI (Pressurized Metered-Dose Inhaler)	- Poor actuation–inhalation coordination - Inhalation too fast - Failure to hold breath - Not exhaling before inhalation - Not shaking device before use	- Hand-breath coordination - Slow, deep inhalation - Breath-hold of 5–10 seconds	- Live demonstration and teach-back - Repeated coordination practice - Spacer if coordination is difficult - Technique check at every visit	A Nigerian study reported an increase in correct pMDI use from 22.8% to 80.7% following pharmacist intervention ($p<0.001$). A COPD coaching study reported a reduction in pMDI misuse from 43.5% to 12.9% after one-on-one training ($p<0.001$). Refs: (5,9,12,13,17)

	- Not rinsing mouth after ICS			
DPI – Turbuhaler®	- Failure to exhale to residual volume (35.5%) - Insufficient inhalation force (13.5%) - Not rinsing mouth after ICS (13.5%) - EIT < 2 seconds (90.8%) - PIFR < 60 L/min (41.8%) - BHT < 5 seconds (27.0%)	- Minimum PIFR of 60 L/min - Fast, deep inhalation - Adequate breath-holding	- Verify PIFR before prescribing - Instruct: exhale first, then inhale fast - Periodic reassessment in children	A study of 141 children with asthma reported only 35.5% achieved a perfect checklist score. Duration of Turbuhaler use (p=0.009) and low adherence (p=0.045) were significantly associated with technique. Refs: (5,10,12)
DPI – Diskus (Accuhaler)	- Incorrect lever rotation - Insufficient inhalation force - Not holding breath - Exhaling into the mouthpiece - Not rinsing mouth after ICS	- Correct device manipulation - Strong inhalation without exhaling into device - Open-and-inhale coordination	- Demonstrate horizontal opening - Emphasise: do not exhale into device - Teach-back and error correction	A Nigerian study reported that correct Diskus use increased from 35% to 70% (p=0.025) following pharmacist intervention. Individual education was reported to be more effective than caregiver-mediated instruction for the Accuhaler. Refs: (12,13)
DPI – Ellipta	- Incorrect opening of the cover - Inhalation not strong or deep enough - Opening cover too slowly - Not closing cover after use - Reported highest error count before education	- Fast open-and-inhale coordination - Adequate PIFR - Understanding the one-step preparation	- Demonstrate one-step mechanism - Practise opening and inhaling in one motion - Reinforce cover closure after use	A Polish study reported Ellipta had the most errors before education. After education, accuracy was reported to be statistically comparable to other devices (p=0.0091). Refs: (5,16)
Soft-Mist Inhaler (Respimat)	- Incorrect first-time device preparation - Not agitating device before use - Incorrect button-press and slow-inhalation coordination	- Hand-breath coordination (slow inhalation) - Understanding the aerosolisation mechanism - Pressing while inhaling slowly	- Demonstrate first-use preparation - Teach slow (not fast) inhalation - Teach-back with training device - Additional attention in elderly patients	A study in elderly patients reported that 50% used the Respimat correctly at baseline; this rose to 86.1% following individual training (statistically significant). Refs: (16)

	- Not holding breath after inhalation			

Note: pMDI = pressurized metered-dose inhaler; DPI = dry powder inhaler; ICS = inhaled corticosteroid; PIFR = peak inspiratory flow rate; EIT = effective inspiratory time; BHT = breath-hold time.

As illustrated in Table 1, each device type is associated with a distinct error profile reflecting differences in drug delivery mechanisms. pMDIs consistently required hand-breath coordination, which was reported as a challenge across multiple patient groups (5,9); spacer use has been reported to help address this difficulty and is noted in several sources as particularly applicable to children and the elderly (11). DPIs such as the Turbuhaler and Diskus require adequate inspiratory capacity, and a number of studies reported that many children do not meet the minimum required inhalation parameters (10). The Polish study reported that error rates across device types became statistically comparable after an education programme was delivered (5); a similar finding was reported for elderly patients in the South Korean study (16). These findings, however, come from studies with specific design limitations, and broad generalisations should be made with caution.

4. Conclusion

This narrative literature review examined 35 articles on inhaler technique education, asthma symptom control, and treatment adherence. Across the corpus reviewed, multiple studies reported that inhaler technique errors remain common, including among patients with prior inhaler experience. Such errors were reported in association with suboptimal symptom control and greater use of rescue and supplementary therapies in several studies, although the consistency of this association varied.

A range of educational intervention models was studied in the reviewed literature, including pharmacist-led interventions, teach-to-goal, vDOT, one-on-one coaching, and repeated education sessions. Several studies reported improvements in ACT scores, AQLQ scores, and spirometric parameters following these interventions, with some studies also reporting positive correlations between technique improvement and symptom control measures. Medication adherence was found to be shaped by multiple factors beyond inhaler technique, including age, patient attitudes, cost, and healthcare access, and the relationship between education and adherence should therefore be interpreted within this broader context. Studies on digital technology and smart inhalers reported potential utility in adherence monitoring, although many of the relevant studies were pilot studies or published protocols, making firm conclusions premature. Overall, the reviewed findings are heterogeneous in terms of study design, population, and clinical setting, and any general conclusions drawn from them need to be framed with appropriate caution.

Compliance with ethical standards

Acknowledgments

The authors would like to thank the Faculty of Medicine, Universitas Airlangga, for academic support and resources that contributed to the completion of this literature review.

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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