Pharmacist-Led Inhaler Technique Education and Asthma Outcomes in Rural Jordan: A Pre–Post Interventional Study

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ABSTRACT

Background: Correct use of inhaler devices is essential for effective asthma management. Patients in rural areas often face barriers to accessing structured asthma education, which may contribute to poor disease control and high reliever use. Pharmacists are well placed to provide inhaler technique education in these settings.

Objectives: To evaluate the effect of pharmacist-delivered inhaler technique education on asthma patients living in rural Jordan, specifically on:

1. inhaler technique performance,
2. Asthma Control Test (ACT) score,
3. forced expiratory volume in 1 second ($FEV_1\%$), and
4. reliever inhaler use (puffs/day).

Methods: A pre–post interventional study was conducted over 6 months (February–July 2017) in rural regions of Jordan. Asthma patients attending respiratory clinics and using a metered dose inhaler (MDI) or turbuhaler (TH) as controller therapy were randomly recruited. Baseline data included demographics, inhaler technique (assessed using validated checklists), ACT score, $FEV_1\%$ (spirometry), and reliever use (puffs/day). Patients then received structured, pharmacist-led inhaler technique education using a "show and tell" plus return demonstration approach. The same measures were reassessed 3 months later. Statistical analyses included paired comparisons, correlation analyses, and multiple linear regression with change in ACT score as the main outcome.

Results: A total of 103 patients (TH: n=44; MDI: n=59) were included (mean age 46.5±13.5 years; 74% female). Most patients had poorly controlled asthma at baseline; only 1.9% were well controlled. Mean ACT score was 10.5±4.3, and baseline $FEV_1\%$ was 54.36±18.47.

Reliever use was high (mean 5.1±4.2 puffs/day). Inhaler technique was suboptimal: mean score 5.4±2.2/9, and only one patient demonstrated fully correct technique. Three months after education, both TH and MDI users showed significant improvement in inhaler technique. MDI users had a mean ACT score increase of 3.03±4.30 (p<0.001), meeting the minimum clinically important difference; TH users improved by 2.07±4.72 (p=0.031). FEV_1% improved significantly among MDI users (p=0.005) but not TH users (p=0.097). Reliever use decreased significantly in both groups. In regression analysis, baseline ACT and change in FEV_1% were significant predictors of ACT improvement (R^2=0.631, p<0.001); changes in inhaler technique score were not.

Conclusion: Asthma patients living in rural Jordan had poor asthma control, low FEV_1%, and high reliever overuse, largely in the context of incorrect inhaler technique. A simple pharmacist-led inhaler education intervention substantially improved inhaler technique, ACT scores, FEV_1% (for MDI users), and reduced reliever use. Empowering rural pharmacists to routinely deliver such interventions may represent a practical strategy to improve asthma care where access to other services is limited.

Keywords: inhaler technique, asthma control, pharmacist intervention, reliever use, rural health, Jordan

INTRODUCTION

Asthma is a chronic respiratory disease affecting an estimated 300 million people worldwide, with prevalence varying widely between countries. In many low- and middle-income settings, the burden of asthma is increasing, including in Jordan, where recent data suggest a worrying rise in prevalence over the past decade.

The primary aim of asthma management is to achieve and maintain good symptom control and reduce the risk of exacerbations. Despite the availability of effective inhaled medications, many patients remain poorly controlled. Incorrect inhaler technique is one of the most frequently cited reasons for this gap between treatment potential and real-world outcomes. This problem is seen with both pressurized metered dose inhalers (MDIs) and dry powder inhalers (DPIs), including devices such as the turbuhaler (TH). Each device requires specific handling steps and inhalation patterns, and errors at critical steps can result in minimal drug deposition in the lungs.

MDIs are widely used due to their comparatively low cost and independence from high inspiratory flow. In contrast, DPIs such as the TH can simplify coordination between actuation and inhalation, but rely heavily on patients' ability to generate sufficient inspiratory flow. In practice, both device types require careful instruction and periodic reassessment. Inadequate asthma education, particularly in relation to inhaler technique, is associated with poor control, more frequent exacerbations, reduced health-related quality of life, and higher health-care utilization. These challenges can be more pronounced in rural regions, where access to primary care and specialist services is restricted by distance, cost, and resource limitations.

In rural Jordan, primary care facilities and respiratory clinics are not uniformly accessible, and structured asthma education is rarely available. Pharmacists, who often serve as easily accessible health-care providers in such communities, could play an important role in bridging this gap. Their involvement in inhaler technique training, reinforcement, and follow-up has been shown in other settings to improve patient outcomes.

This study therefore aimed:

1. To describe inhaler technique performance, asthma control (ACT), $FEV_1\%$, and reliever use in asthma patients living in rural Jordan.

2. To evaluate the effect of pharmacist-led inhaler technique education on inhaler technique scores, ACT, $FEV_1\%$, and reliever use over a 3-month period.

MATERIALS AND METHODS

Study Design and Setting

This was a **pre–post interventional study** conducted over 6 months (February–July 2017) in rural areas of Jordan. Ethical approval was obtained from the Jordanian Ministry of Health and from each participating hospital. The study followed the principles of the Declaration of Helsinki.

Patients were recruited from respiratory clinics in three public hospitals that serve rural populations:

- Al-Salt Hospital (Al-Salt, west Jordan),
- Princess Basma Hospital (Irbid, north Jordan),
- Al Basheer Hospital (Amman, serving surrounding rural areas).

Participants

Eligible patients were:

- ≥14 years old,

- diagnosed with asthma by a physician,

- using an inhaled corticosteroid (with or without a long-acting β₂-agonist) as controller therapy via either an MDI or TH,

- and had used the same inhaler for at least 1 month before enrollment.

Patients were excluded if:

- they did not self-administer their inhaler,

- or could not speak or understand Arabic.

Patients from rural areas attending respiratory clinics were randomly approached. Those who agreed to participate provided written informed consent; for participants under 18 years, consent was obtained from a parent or guardian.

Baseline Data Collection

At baseline, participants completed a structured questionnaire covering:

- demographic data (age, sex, marital status, education, employment, smoking status),

- age at asthma onset and duration of inhaler use,

- details of controller and reliever medications (type, frequency, number of canisters per month),

- prior education on inhaler use (provider, timing, mode of delivery),

- attitudes and concerns about their inhaler and treatment.

A pilot test of the questionnaire was performed with 30 asthma patients to ensure clarity and feasibility. These data were not included in the final analysis.

Asthma Control Assessment

Asthma control was measured using the **Arabic version of the Asthma Control Test (ACT)**. Scores range from 5 to 25:

- 20–25: well controlled,

- 16–19: not well controlled,

- 5–15: very poorly controlled.

A change of **3 points** in ACT score is considered the minimum clinically important difference.

Lung Function (FEV$_1$%)

Spirometry was performed using a Spirolab device with disposable turbines and mouthpieces. FEV$_1$% predicted was recorded. Patients were instructed to perform at least three acceptable maneuvers, and the best reading was used for analysis.

Inhaler Technique Assessment

Inhaler technique for each participant's controller device (MDI or TH) was assessed using placebo inhalers supplied by the manufacturers. Validated, published inhaler technique checklists specific for MDI and TH were used. Each checklist comprised several steps, some of which were identified as "essential" (i.e., errors that would likely prevent adequate lung deposition).

For each patient, the following were recorded:

- total inhaler technique score (number of correctly performed steps),
- whether *all* steps were correct (correct technique),
- whether *all essential* steps were correct (correct essential technique).

Educational Intervention

Immediately after the baseline assessment, patients received individualized **pharmacist-led inhaler technique education**. This "show and tell" intervention included:

- verbal explanation of each checklist step in Arabic,
- physical demonstration of correct technique using a placebo device,
- return demonstration by the patient,
- focused feedback on incorrectly performed steps,
- repetition of the cycle up to three times, or until all steps were correctly demonstrated.

The inhaler technique checklist was used as both an assessment and teaching tool, emphasizing the clinical importance of each step.

Follow-Up Assessment

Approximately **3 months** after the baseline visit, patients were invited back to the clinic. The same researcher reassessed:

- inhaler technique,
- ACT score,
- FEV$_1$%,
- and reliever use (puffs/day).

Statistical Analysis

Data were analyzed using SPSS version 21.

Key analyses included:

- Descriptive statistics for baseline characteristics.

- Paired comparisons (baseline vs follow-up) for continuous variables (inhaler technique score, ACT, $FEV_1\%$, reliever puffs/day) using paired tests (e.g., Wilcoxon signed-rank where appropriate).

- Comparisons of proportions (correct technique vs not, etc.) using Pearson's χ^2 test.

- Correlation analysis (Pearson's r) between changes in:

o ACT score,

o $FEV_1\%$,

o inhaler technique scores,

o and reliever use.

- Multiple linear regression with **change in ACT score** (follow-up minus baseline) as the dependent variable. Independent variables included:

o inhaler type (TH vs MDI),

o age,

o gender,

o baseline ACT,

o change in $FEV_1\%$,

o change in inhaler technique score.

A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of **103 asthma patients** from rural areas were enrolled:

- TH users: 44

- MDI users: 59

    Mean age was **46.5±13.5 years** (range 14–79), and **74% were female**. Most participants:

- were married (77.7%),

- had elementary or high school education (85.5%),

- were unemployed (70.9%),

- were non-smokers (66%).

Over 80% developed asthma after the age of 18 (mean onset 32.5±5.1 years), and many had been using inhalers for more than 12 years. There were no significant demographic differences between MDI and TH groups.

Mean reliever use at baseline was **5.1±4.2 puffs/day**, indicating substantial overuse of short-acting β_2-agonists.

Baseline Asthma Control and Lung Function

ACT results at baseline showed:

- **1.9%** of patients had well-controlled asthma (ACT >19),
- **19.4%** had not well-controlled asthma (ACT 16–19),
- **78.6%** had very poorly controlled asthma (ACT <16).

The mean ACT score was **10.53±4.29**, reflecting overall poor control.

Asthma control differed by education level: patients with only elementary education had lower ACT scores compared with high school or university-educated patients. Older age was associated with lower ACT scores.

Baseline FEV_1% was **54.36±18.47** (≤80% predicted in most patients), with values ranging from 16% to 80%, indicating generally reduced lung function.

Baseline Inhaler Technique

Mean baseline inhaler technique score (out of 9 steps) was **5.4±2.2** for both device types combined. Only **one patient** (TH user) demonstrated fully correct technique. Correct essential technique was also rare, with only a small proportion of patients performing all essential steps correctly (around 7% for both devices).

Despite this, most patients believed they used their inhaler correctly, illustrating a mismatch between self-perception and actual performance.

Previous Inhaler Education

Nearly all patients (95.15%) reported that their inhaler had been prescribed by a specialist. Most had received some form of inhaler counseling in the past, primarily from hospital clinic staff, usually at the time of first prescription. However:

- fewer than 13% reported receiving any inhaler counseling in the previous 12 months,
- only 6.8% had their technique checked after initial instruction.

Many patients said they liked their preventer inhaler and reported few concerns. Only a small minority were worried about corticosteroid side effects or disliked the inhaler's taste.

Use of other self-management tools was very limited:

- only 26.21% rinsed their mouth after using preventer inhalers,

- 6.8% reported oral thrush,

- fewer than 4% had ever used a peak flow meter,

- none reported having a written asthma action plan.

Follow-Up Outcomes

All participants attended the 3-month follow-up. The mean time to follow-up was similar for TH and MDI users (about 3.6–3.7 months).

Asthma Control (ACT)

Both TH and MDI users showed significant improvements in ACT scores.

- **MDI users:**

  o Mean ACT change: **+3.03±4.30** (p<0.001)

  o This meets the threshold for clinically meaningful improvement.

- **TH users:**

  o Mean ACT change: **+2.07±4.72** (p=0.031)

  o Statistically significant, but slightly below the 3-point clinical threshold.

At follow-up, more patients moved from the "very poorly controlled" category into "not well controlled" or "well controlled" asthma in both device groups.

Lung Function (FEV$_1$%)

- FEV$_1$% improved significantly among **MDI users** (p=0.005).

- Improvement for **TH users** was not statistically significant (p=0.097).

Reliever Use

Reliever (Ventolin®) puffs/day decreased significantly in both groups:

- TH: mean change −2.16±4.00 puffs/day

- MDI: mean change −2.69±3.35 puffs/day

There was no significant difference in magnitude of reduction between device groups.

Inhaler Technique at Follow-Up

At 3 months, inhaler technique scores, correct technique rates, and correct essential technique rates improved significantly in both groups compared with baseline. Differences between MDI and TH users at follow-up were not significant.

Certain steps remained more challenging than others:

- For MDI users, common baseline errors included head positioning, slow-deep inhalation continuation, and breath-holding. Several of these improved significantly, though not all.

- For TH users, frequent errors involved holding the device upright, exhaling to residual volume, and exhaling away from the mouthpiece. Most of these showed strong improvement following education.

Correlation and Regression Analyses

Correlation analysis showed:

- A strong positive correlation between improvement in ACT and improvement in $FEV_1\%$ (r=0.612, p<0.001).

- A modest negative correlation between improvement in $FEV_1\%$ and change in reliever use (r=−0.261, p=0.037), indicating that better lung function was associated with reduced reliever use.

- No significant correlations between improvements in inhaler technique scores and improvements in ACT, $FEV_1\%$, or reliever use.

Multiple linear regression with change in ACT score as the dependent variable showed that:

- baseline ACT,

- and change in $FEV_1\%$

were the only significant predictors of ACT improvement (R^2=0.631, p<0.001). Changes in inhaler technique score and inhaler type did not independently predict ACT change when these factors were accounted for.

DISCUSSION

This study highlights the reality of asthma management in rural Jordan: patients are mostly poorly controlled, using large amounts of reliever medication, with compromised lung function and very poor inhaler technique. Important components of guideline-recommended care—such as written action plans, regular technique review, and peak flow monitoring—were largely absent.

A key finding is that a relatively straightforward, pharmacist-led educational intervention focusing on inhaler technique produced significant improvements in:

- inhaler technique itself,

- ACT scores,

- $FEV_1\%$ (for MDI users),

- and reduction in reliever use for both device groups.

These results support the idea that pharmacists, particularly in rural settings where access to specialists is limited, can play a pivotal role in asthma management by:

- identifying technique errors,

- providing tailored education,

- and reinforcing correct use over time.

Interestingly, although inhaler technique clearly improved, statistical analyses did not show a direct linear relationship between change in technique score and change in ACT or $FEV_1\%$. Several factors may explain this:

- baseline asthma control was very poor in most patients, so multiple factors beyond inhaler technique (such as adherence, triggers, comorbidities) likely contributed to clinical status.

- all participants received technique training at baseline, and many achieved correct technique immediately after education, so there may have been limited variability left to explain differences in outcome changes.

- ACT improvement was strongly tied to changes in $FEV_1\%$, suggesting that broader physiological improvement rather than the checklist score alone drove perceived control.

Nevertheless, in practical terms, inhaler technique remains a fundamental prerequisite for adequate drug delivery and should continue to be a routine focus of asthma care.

The study also reinforces a common but important observation: **most patients do not realize they are using their inhaler incorrectly**. The majority believed they were doing it right, while objective checks showed only 1% had fully correct technique at baseline. This means that relying on patients to self-identify technique problems is not sufficient. Instead, health-care professionals—especially pharmacists—should proactively assess technique at every opportunity.

From a rural health perspective, the findings are particularly relevant. Pharmacists in such settings often have frequent contact with patients and can provide ongoing, low-cost interventions. With minimal training and the use of simple checklists, they can systematically improve inhaler technique and support better asthma control.

STRENGTHS AND LIMITATIONS

Strengths:

- Use of validated checklists for inhaler technique, enabling reproducible assessment.

- Inclusion of both clinical (ACT, $FEV_1\%$) and behavioral (reliever use, technique) outcomes.

- Real-world rural setting, enhancing practical relevance.

- Use of checklists not only for assessment but also as structured teaching tools, with emphasis on essential steps.

Limitations:

- Pre–post design without a control group; improvements cannot be exclusively attributed to the intervention, though the timing makes this likely.

- Possible Hawthorne effect, as participants knew their technique was being observed.

- Follow-up was limited to 3 months; longer-term maintenance of technique and control was not assessed.

- The sample was skewed toward patients with very poorly controlled asthma, which may limit generalizability but reflects a high-risk group in real life.

CONCLUSION

Asthma patients from rural areas in Jordan demonstrated poor inhaler technique, suboptimal asthma control, low $FEV_1\%$, and high dependence on reliever medications. Despite this, pharmacists had previously played a limited role in ongoing asthma education.

A simple pharmacist-led inhaler technique intervention significantly improved technique, asthma control, lung function (in MDI users), and reduced reliever use over a 3-month period. These findings support integrating structured inhaler technique assessment and education into routine pharmacy practice in rural settings. With targeted training and standardized tools, pharmacists can substantially contribute to improving asthma outcomes where access to other health services is constrained.

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